

THE CARBON EMISSION DILEMMA: SOLUTIONS MAY COME FROM MARKET OR BEHAVIORAL CHANGE?

O Dilema de emissões de carbono: soluções podem vir de mercado ou de mudanças comportamentais?

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Abstract: This article aims to promote a discussion on environmental issues from the perspective of Evolutionary Theory (Nelson & Winter, 2005; Hodgson, 2007). Some evidence regarding carbon Market has been used, which is a common proposal for the reduction of Greenhouse Gases. An interdisciplinary and systemic perspective was developed based on areas of production, administration and economy as a background for the discussion of production and consumption conventional processes that seems to show that market solutions are not effective. Moreover, it is emphasized that the issues that motivate evolutionary theorists may help in the search for solutions closer to reality presented in this early twenty-first century. Thus, the forms and organizational routines are focused to understand the reasons to keep on a behavior harmful to the environment.

Key words: Evolutionary Theory; Environment; Carbon Trade; Sustainability

Resumo: Este artigo pretende promover uma discussão sobre questões ambientais a partir da perspectiva da Teoria Evolucionista (Nelson & Winter, 2005; Hodgson, 2007). Foram utilizadas algumas evidências sobre o Mercado de Carbono, que é uma proposta comum para a redução de Gases de Efeito Estufa (GEE). Uma perspectiva interdisciplinar e sistêmica foi desenvolvida com base nas áreas de produção, administração e economia como pano de fundo para a discussão dos processos convencionais de produção e consumo que parece mostrar que as soluções de mercado não são realmente efetivas. Além disso, é enfatizado que as questões que motivam os especialistas na Teoria Evolucionista poderiam ajudar na busca de soluções mais próximas da realidade apresentada neste século XXI. Assim, as formas e rotinas organizacionais são focadas para entender as razões para continuar com um comportamento prejudicial ao meio ambiente.

Palavras chave: Teoria Evolucionista; Meio Ambiente; Créditos de Carbono; Sustentabilidade.

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INTRODUCTION

From the Industrial Revolution until the mid-twentieth century the economy functioned on the basis of an extractive paradigm. Countries believed that economic growth depends exclusively on the free exploitation of resources (Coelho et al., 2008; Lombradi, 2008). An example of this way of thinking may be seen in operating cycles going on in Brazil during what is called the Brazil Empire Period (exploration: Pau Brazil, Rubber, Gemstones etc.).

The mechanized production, mainly introduced with the steam engine, no doubt brought benefits to productivity, but also an increasing consumption of natural resources. After this period began a permanent search of energy for industries to keep and improve production processes, helping companies and countries to increase their competitiveness. The main resources extracted from the environment to provide power for these new production processes have been fossil fuels. First burning coal, and then with technological advances there has been switching to oil, and going to natural gas.

Seiffert (2009) points out that this process of industrialization was largely responsible for imbalances in biogeochemical cycles of carbon, nitrogen and sulfur in different ecosystems, since the burning of these fuels over time released large amounts of gases in the atmosphere. Thus this process is recognized as the main cause of climate change and hence the greenhouse as was mentioned at the recent COP 21 in Paris. Frondizi (2009) confirms that the intensification of the greenhouse effect is directly linked to human activities resulting from the burning of fossil fuels what is now being identify as the Anthropocene. It is noteworthy that this burning occurs in domestic as well as commercial area, in transportation activities in power generation, industry and agriculture.

Therefore, the problem of climate change is directly linked to energy options adopted at each country in addition to the consumption pattern of people (Seiffert, 2009). This discussion has led to several agreements on how to deal with the problem of emissions of greenhouse gases (GHGs), which are considered the main sources responsible for global warming.

The society at the beginning the twenty-first century is still polluting the environment by its industrial processes, agricultural activities, inadequate waste treatment and increased deforestation. However, with the establishment of the Kyoto Protocol it was possible to reinforce the desire to protect the climate system and preserve the quality of life for future generations. Teixeira et al. (2010) said that Kyoto Protocol was aimed to control the rise of the planet's temperature by decreasing the emission of carbon dioxide (CO₂) and other five other greenhouse gas effect. For this purpose developed the idea of a carbon credit market that could charge for the emissions of GHGs.

CO₂ as commodity is currently the physical-spatial product that stands out in these transactions. Each ton of the five greenhouse gases are converted to tCO₂ (ton equivalent CO₂) which is the standar measure of the negotiations. Thus, the market sets a price for tCO₂ according to supply and demand of emissions in the international market (Nápravník Filho, 2006).

Nonetheless, this type of business is uncertain since does not establish new general rules for carbon trading mainly because the rules established by the Kyoto Protocol were worth only until 2012. Nevertheless, the COP 21 that took place in France in 2015 had as one of their objectives to discuss the problems of production and consumption, as well as carbon credit trading (COP-21, 2015).

In this context searching for a sustainable planet and market solutions makes sense since we are globally in an Open System so CO₂ (carbon dioxide) acts globally and its impact on the environment is also global. Thus, the solutions based on the carbon market offer a general control that is independent of who is the company or the country that is polluting. An important aspect of this system is that there is compensation in the generation of greenhouse gases on the planet, in a debit and credit relationship.

This article aims to propose a distancing from these assumptions. Logic does not solve environmental problems because the search for a balance in the market becomes a paradoxical activity, since maximization of the firm's results may be adversely affected by the externality factors of production. Moreover it could be mentioned the criticism of evolutionary researchers on the static nature of the problems and Neoclassical models (Nelson & Winter, 2005).

Therefore, it is necessary to rescue the open, dynamic and evolutionary nature of the economy (Nelson & Dosi, 1994; Conceição, 2007). It is worth highlighting that the evolutionary theorists oppose assumptions as equilibrium optimization and substantive rationality, and this is an important to be considered on this paper. Another important aspect to point out in addition to the dynamic nature of society is the focus on forms and routines given by evolutionary theorists. Thus, the behavior of social actors becomes the object of activity and not commercial transactions.

CARBON TRADE FROM THE PERSPECTIVE OF EVOLUTIONARY THEORY

1. Climate change and the Kyoto protocol

At the end of 1960s, some researchers began to notice an intensification of global warming. Teixeira et al. (2010) explained that the greenhouse effect is produced by a layer of gas existing in the atmosphere that prevent heat from dissipating to levels that make the planet cool down. Lombardi (2008) reports that according to observatory data from Mauna Loa NASA in 2007, there was an increase in more than 100 ppm of CO₂ concentrations in the last 175 years, and an increase of approximately 0.7 C° in the planet's surface average temperature.

This global warming promotes the melting at the poles, which causes the flooding of coastal areas; biodiversity elimination of the planet; increased desertification areas; savannization of tropical forests; increase the frequency of droughts and floods; reduction in crop yields; damage to the health of populations as a result of heat waves; increased occurrence of hurricanes and cyclones; among other so extreme events and calamities that the people of this planet are likely to face.

In 1988 in Toronto, during the Conference on the Changing Atmosphere, it was created the International Panel on Climate Change (IPCC). In 1990 he was presented the first IPCC report, and the reports started showing historical events of the last decades, providing scientific information with higher quality and reliability. So it was created the UNFCCC (United Nation Framework Convention on Climate Change), which was approved during the ECO 92 and came into force in 1994 (UNFCCC, 2012).

The Conference of the Parties (COP) met for the first time in early 1995, in Berlin. The COP meetings had as main objective to find solutions to the environmental problem of global warming. The conference had the greatest highlight was the COP-3, held in December 1997 in the city of Kyoto in Japan. At COP-3 was established the Kyoto Protocol, which set quantified commitments for industrialized countries to reduce or limit the combined anthropogenic emissions of GHGs (Protolo de Quioto, 2012).

The Kyoto Protocol has also created a system for controlling emissions of GHGs, and was fixed a target of 5.2% reduction of greenhouse gases by the year 2000. Developed countries, which already were in accordance with its obligations reductions, argued the need for financial mechanisms that may allowed the fulfillment of these goals. Three forms of cooperation were negotiated: a) the emissions trading; b) joint implementation, whose different parts of entities could implement activities together, sharing the reduction of emissions; and c) the Clean Development Mechanism - CDM (Lombardi, 2008).

The Clean Development Mechanism (CDM) aimed to achieve sustainable development in developing countries through the implementation of cleaner technologies (Delgado & Altheman, 2007; Teixeira et al., 2010). Paragraph 5 of Article 12 of the Kyoto Protocol lists the essential requirements for CDM projects result in obtaining documents as Certified Emission Reductions (Coelho et al., 2008; Protolo de Quioto, 2012).

The CDM is a mechanism based on the development of projects that have to be responsible to private enterprise. CDM project activities must be related to the reduction in GHG emissions or at least influence the incidence of CO₂ (Fronidizi, 2009). Therefore, CDM projects may involve replacement of fossil energy by other renewable sources, energy use rationalization, afforestation and reforestation activities, more efficient urban services, among other possibilities.

The processing of a CDM project follows a similar logic to the Management System Certification, according to ISO model to ensure the credibility of the certification process of Carbon Credits. In addition, governments interested in implementing the CDM project, should designate by the UNFCCC (United Nations Framework Convention on Climate Change) an institution responsible for the evaluation and approval of CDM projects (Lombardi, 2008; Fronidizi, 2009; Seiffert, 2009).

The CEMDL is the last and final instance for approval of a CDM project. At this stage it will be up to the Council officially accept or not the CDM project activity (Seiffert, 2009). The certificate issuance of CERs (Certified Emission Reductions) is the later stage to check that analyzes over a period of time, the project activity achieved the reduction of GHG emissions or removals of CO₂. After these steps the Carbon Credits are issued. Seiffert (2009) reports that the CERs are carbon credits certificates from a CDM project registered with the UN (United Nations organizations). These issued certificates may be negotiated on the global market (Delgado & Altheman, 2007; Fronidizi, 2009).

In April 2000 it was launched the Prototype Carbon Fund, which was a partnership between seventeen companies and six governments managed by the World Bank. The purpose of this fund was to bring together, on one hand the money of the participants and on the other CDM projects (Lombardi, 2008; Institute Carbon Brazil, 2012). Thus began an effective carbon market through a marketable commodity for GHG emission reductions.

The negotiations on the carbon market became more sophisticated over time and some financial systems began to operate in that segment like traders and as a CDM project financiers (Lombardi, 2008; Institute Carbon Brazil, 2012). Thus, it may be seen that while it came to reduce global GHG emissions, has increased profitability and investment in new forms of sustainable production (Nápravník Filho, 2006). This process is correlative to the Polluter Pays Principle (Pigou, 1932), because with the purchase of emission rights (allowances), the country that need help to meet their emissions targets will pay for it, so it can finance the implementation of mechanisms to generate new URE (Ministério da Ciência e Tecnologia, 2012; Alvim & Goularte, 2011).

The logic of this market is that the CO₂ (carbon dioxide) operates globally and its impact on the environment is similar to all over the planet, so just seeks emissions to drop below the predetermined limit. Thus, for control purposes, no matter who is the company or the country that is polluting more or less. The important aspect of this system is that there is compensation in the generation of GHGs in the world.

After the evolution of this Carbon Market new interested actors have emerged, so there was a supply and demand increase. Of course this made prices arise. In February 2005, when the Kyoto Protocol begin running, the ton of carbon price was USD\$ 5.00. Many projects holders indexed the prices of carbon credits according to the European market, where the permissions had a system known as Cap-and-Trade (Lombardi, 2008).

The Cap-and-Trade system had government regulators that indicate companies with GHG emission allowances, so they may reach a certain level of emissions. Permissions (allowances) can be acquired plants that may even reduce their emissions beyond the authorized level. Being a market mechanism, any interested party may acquire and / or transact permissions. Each facility could use up to 8% of total emissions (Lombardi, 2008).

Carbon market activities started on January 1st 2005 and already in 2008, 404 million tons of carbon were traded, for a total of US \$ 6.5 billion (Word Bank, 2015). The evolution of the projects and negotiations have caused prices rose with greater speed and consistency (Robles Jr. & Bonelli, 2006). The existing carbon prices vary significantly—from less than US\$1 per tCO_{2e} to US\$130 per tCO_{2e}. It is worth highlighting that 85% of emissions are priced at less than \$ 10 per tCO₂, which is considerably lower than the price that economic models have estimated is needed to meet the 2 ° C climate stabilization goal recommended by scientists (World Bank, 2015). In 2015 in Tokyo the price per ton of CO₂ was already USD \$ 38.

Since the entry into force of the Kyoto Protocol, CDM projects had their lowest level in 2010, during which retreated to about \$ 1.5 billion. In addition, the carbon market has brought uncertainty about its course after 2012, and this scenario is influenced by a series of crises and social, political and economic conflicts across the globe.

At COP-21, in France, the so-called Paris Agreement established as a celling a Global warming of 2 ° C. In addition, it was also indicated that US \$ 100 billion per year should be used to help the poorest countries meet their reduction targets of GHGs. Nevertheless, it is necessary to deepen the discussion on the effectiveness of market or taxation by governments to adjust the emission GEES.

2. The evolutionary theory and the limits of market

The formal orthodox economic theory tries to explain the determination of equilibrium prices, inputs and products with regard to various conditions underlying the demand for goods and the supply of factors of production (Nelson & Dosi, 1994; Nelson & Winter, 2005). Moreover, it can be said that the law of scarcity and substantive rationality are part of the postulates of the orthodox argument, where the agents involved in the production and consumption process have their behaviors oriented to maximize individual well-being in an exclusive utilitarian perspective (Stark, Jakubek & Kobus, 2015; Kitchel, 2016).

However, we emphasize here that is quite questionable this market ability to allocate effectively the scare resources, because as points out Hodgson (2007), and is also exposed in the theory of Transaction Costs by Williamson (1971, 2000), the agents do not develop a rational choice able to control the resources in a context of scarcity. These authors, as well as Coase (1998), reinforce the idea that this positive relationship between increased social welfare and efficiency and effectiveness of the production process are only obtained on a real transaction zero cost.

Also in the same line of reasoning on transaction costs, these costs depend on the institutions involved; and it may be said that the institutions are not rational optimization mechanisms of allocative efficiency, which can only arise from the dynamic and continuous interactive process between the actors, and this process is relatively uncertain and inseparable from technological and social changes (Nelson, 1995; Conceição, 2007; Braunerhjelm & Svensson, 2014). Furthermore, there are micro and macro environmental factors that constantly change routines firms (Becker, 2004).

North (1993) stresses that the institutions are not necessarily designed to be socially efficient; moreover they often are created to serve the interests of those with bargaining power to create rules (Williamson, 1979; Williamson, 2000). Veblen (1989) pointed out that the evolution of institutions is directly associated with a circular causation process. Thus, it is worth mentioning that the evolutionary theorists oppose equilibrium assumptions, optimization and substantive rationality hence being necessary to strengthen the fact that the three supporting pillars of orthodox models of the firm are: i) maximizing objectives (profit or present value); ii) the set of things that the firm can do (routines); iii) the optimizer choice rationally based on the market.

Hence, the search for a balance in the market is more a paradoxical activity because the maximization of the firm's results may be adversely affected by the factors of production. Thus, when giving emphasis to rational market mechanisms, a simple relationship of transaction is based on the Pareto optimal vision (Prescott & Townsend, 1984; Fleischer, 2003), forgetting the reality in obtaining and allocation of resources by agents. That is, do not take into account the pragmatism of the real world, where resources are not available or the same amount or in same value for all.

Moreover, the evolutionary theory takes as the unit of analysis not the market, especially in the rational bias understood by the orthodox, but the forms and routines of organizations to understand better the functioning of organizations and society (Nelson & Winter, 2005; Hodgson, 2007). By the same way, processes are analyzed and diagnosed in order to understand the routines and organizational forms that have been institutionalized and recognized as benchmark.

3. Evolutionary theory to discuss market rationality

Market-based views actually encourage expansionists, extractive and exploitative activities that contribute to achieving the firm's goals and exceed their profit expectations (Chi, 2010; Teixeira, Koufteros & Peng, 2012). Meantime, the economic model based on "extract, transform, discard" depends on economies of scale, low-cost materials and easy access to goods and services by consumers. However this orthodox model of production and consumption is reaching its physical limits, leading for the need to search for new paradigms of production and consumption (Macarthur, 2012).

Ying and Li-Jun (2012) argue that the economy should be based on reducing, reusing and recycling inside the production and consumer cycle of activities, circulation and consumption of goods and services. Moreover this new paradigm in production and consumption should adopt regenerative and restorative aspects of resources. Therefore, the goal is to keep products, components and materials at its highest level of utility and value for a longer time (Zhu, Geng & Lai, 2010) as is the case of the Led Lamps. This model runs off the rational logic of the exploration market, and aims to mitigate market inefficiencies.

Pigou (1932) explored how the tax could help solve inefficiencies in the functioning of markets and the behavior of economic agents. Pigou said that the costs of the damage that an agent in carrying out an economic activity imposes on third parties should be internalized in the cause of the activity cost. In its turn Coase (1960) argued that the solution to the problems of the damage caused by economic activities comes from the market itself, or property rights. Regan (1972) points out that the Coase argument may be valid and applicable in an ideal context in which rationality is the dominant logic and negotiation between the agents is an achievable goal, a win-win kind of economy which is not easily found.

These two ideas moreover gives an important question about the problem of social costs such as pollution and the environment protection, because it can't be solved simply by paying a fee or negotiating a simple economic equation of the type: "I pay, so I have the right to pollute ". In this scenario of how to deal with the damage caused by the decisions of production and consumption in the formulation and analysis of the polluter pays principle it should be established the need to internalize the social and not only the environmental costs of pollution. A document should be signed by the polluter regarding the social costs of pollution caused by it, which must prevent, compensate and mitigate the damage, not only to goods and people, but also to nature.

In this line of reallocating resources to mitigate the damage to the environment, some countries receive aid funds and subsidies that could theoretically solve problems arising from polluting processes as may be shown in Figure 1.

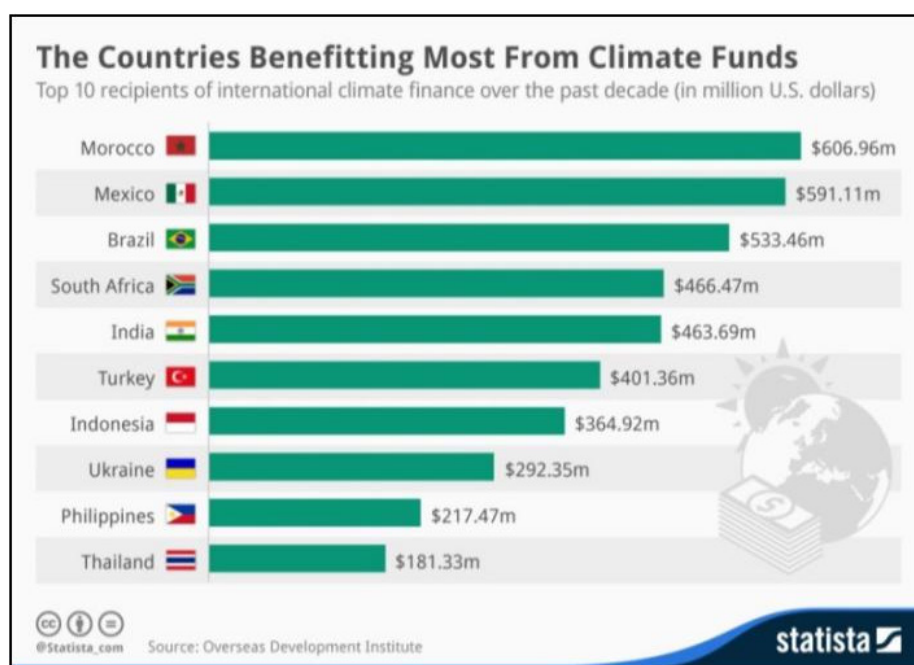


Figure 1 Countries Benefitting from Climate Funds
Source: International-Climate-Finance, 2016.

Therefore to protect natural resources, environmental economics proposes the evaluation of resources, the correction in prices and the accountability of environmental impacts. Therefore, its vision for sustainable development may be understood as the internalization of external costs helping countries to change their activities and processes that may harm the environment.

Moreover although the monetization of the problems is not the best solution, we may have to deal with the use of resources in a systematic and interdisciplinary way and not only by taxation (Pigou) or free trade certificates that allow polluting or using natural resources (Coase).

As it's shown in Table 1 a reduction in GHG emissions over time didn't happen in countries receiving such financial support, on the contrary, we may even see increases in emissions and inefficient public policies that could have help in the sustainability of the planet.

Table 1 Total of CO₂ per Capita Emissions Coming from Fossil Fuels

Country	2011	2010	2009	2008	2005	2000
África do Sul	2,51	2,41	2,56	2,54	2,24	2,25
China	1,80	1,66	1,55	1,43	1,21	,73
Ucrânia	1,70	1,80	1,53	1,83	1,94	1,79
Tailândia	1,24	1,22	1,15	1,09	1,05	,81
Turquia	1,20	1,13	1,06	1,11	,95	,93
México	1,07	1,03	1,06	1,13	1,12	1,04
Indonésia	,63	,50	,52	,48	,41	,34
Brasil	,61	,59	,52	,55	,51	,51
Marrocos	,48	,48	,46	,47	,41	,32
Índia	,46	,44	,45	,42	,34	,31
Filipinas	,24	,24	,22	,23	,24	,26

Source: Fossil-Fuel CO₂ Emissions by Nation, 2015.

Moreover we could also mention that in global terms, the total value of the carbon market grew 11% in 2011, reaching the figure of \$ 176 billion, according to the report "State and Trends of the Carbon Market", published by the World Bank.

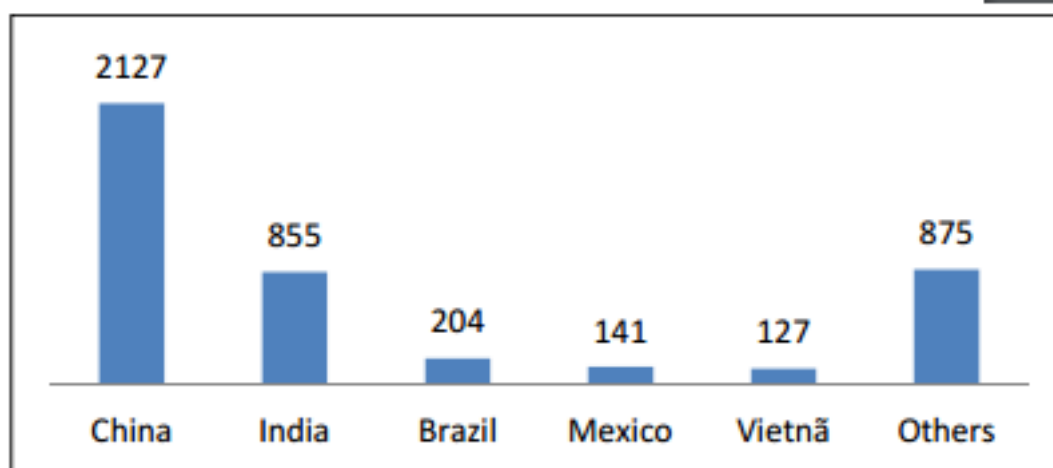


Figure 2 Number of MDL Projects Registered by 2012

Source: UNFCCC, 2012.

On this Figure 2 we one could see the countries with the largest number of CDM projects registered by 2012. Therefore, it's necessary to question the capacity to regulate market GHG emissions. Moreover, if we compare the maps of Figure 2 one may see that there were no reductions in GHG emissions from 2005 to 2011, and even in countries like India that were benefited from the CDM projects the situation was even worsened.

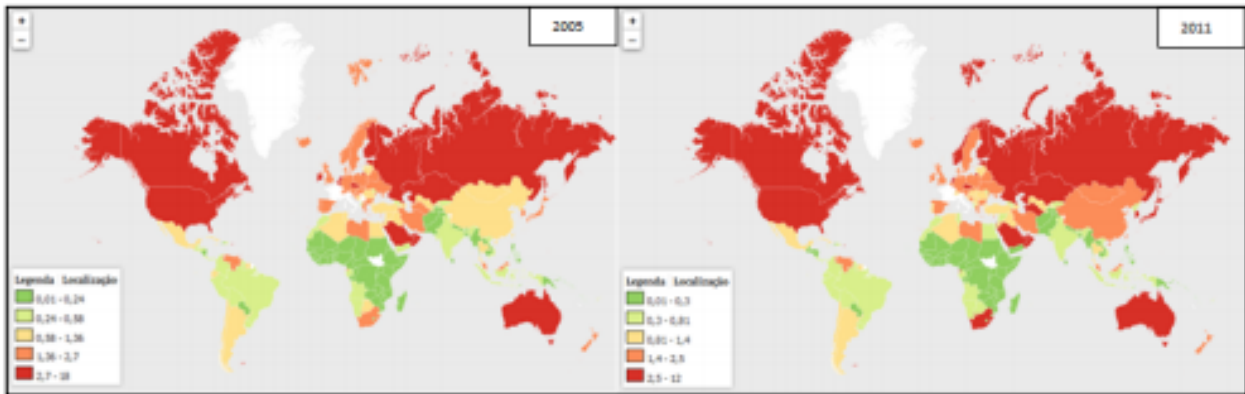


Figure 3 Changes in Total of CO₂ per Capita Emissions Coming from Fossil Fuels
Source: Fossil-Fuel CO₂ Emissions by Nation, 2015

Therefore a shift in perspective in discussions on the production and consumption processes is really needed; a change that moves away from orthodox economic models adopting concepts of the evolutionary theory to deal with the global problems of sustainability focusing in particular forms and organizational routines in search of a more sustainable planet and the welfare of the population.

CONCLUSIONS

To deal today with the question of global sustainability there is an increasing need to consider a new perspective in the treatment of production and consumption processes since the orthodox way so far being used is not given satisfactory results in solving the problem of emissions of GHGs; and there is now a need to consider the assumptions of evolutionary theory denying the rationality of the market to solve social and environmental problems.

To be realistic a solution based on Pigou or Coase's view it may work only when the situation presents itself as the Pareto optimal, which it's hardly a case since it will need that all agents have all the needed information and resources to make decisions with respect to production and consumption; and this is may be hardly find in this complex and dynamic early twenty-first century. Therefore to assume as a fact a substantive rationality of agents in their relationships may lead to paradoxical realities for the sustainability of the planet in the middle and long run. For this reason there is a need to consider an approach of evolutionary theory to lead with the environmental and social problems involved in particular in relation to the sale of carbon emissions, which are actually sealing our health and the health of our planet.

As a matter of fact, as we could see, many of the countries that benefited from subsidies or CDM negotiations did not solve the GHG emission problem, and even some had their situation worsened; so a pure market logic won't solve social and environmental problems. Hence one may see a need to study forward two main issues of Evolutionary Theory, namely: a) Could a pure market approach solve the resource allocation issues? b) Are actually the organizational structures that determine the allocation of resources?

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