



**Thiago Lima  
Klatau de Araújo**

**Desenvolvimento Sustentável e Alterações  
Climáticas: novas perspetivas legais, ambientais e  
socioeconómicas no Brasil**

**Sustainable Development in a Changing Climate: new legal,  
environmental, economic and social perspectives in Brazil**



**Thiago Lima  
Klautau de Araújo**

**Desenvolvimento Sustentável e Alterações  
Climáticas: novas perspectivas legais, ambientais e  
socioeconómicas no Brasil**

**Sustainable Development in a Changing Climate: new legal,  
environmental, economic and social perspectives in Brazil**

Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Biologia e Ecologia das Alterações Globais, realizada sob a orientação científica do Doutor Ulisses Manuel de Miranda Azeiteiro, Professor Associado com Agregação do Departamento de Biologia da Universidade de Aveiro, e coorientada pelo Doutor Amadeu Mortágua Velho da Maia Soares, Professor Catedrático do Departamento de Biologia da Universidade de Aveiro. A defesa da tese ocorreu no dia 14 de fevereiro de 2020.

The present thesis is presented to the University of Aveiro as a requirement to obtain the degree of Doctor of Biology and Ecology of Global Change, conducted under the scientific guidance of the supervisor Dr. Ulisses Manuel de Miranda Azeiteiro, Associate Professor with Habilitation of the Department of Biology of the University of Aveiro, and the joint supervisor Dr. Amadeu Mortágua Velho da Maia Soares, Full Professor of the Department of Biology of the University of Aveiro. The defense of the thesis occurred on February, 14<sup>th</sup>, 2020.

Aos meus pais, Dula e Mariano, pelo exemplo de honestidade e determinação em lutar pelo que acreditam. Suas obras (intelectuais e físicas) me inspiraram e plantaram em mim a semente desta investigação, que se desenvolveu e floresceu nesta tese.

## **o júri/the jury**

Presidente/President

Prof. Doutor Luís António Ferreira Martins Dias Carlos, Professor Catedrático da Universidade de Aveiro

Vogais/Members

Prof. Doutor Walter Leal Filho, Professor Catedrático da Hamburg University of Applied Sciences

Prof. Doutor Divaldo José da Costa Rezende, Vice-Presidente do Instituto Ecológica

Prof. Doutor João Alexandre Ferreira Abel dos Santos Cabral, Professor Associado com Agregação da Universidade de Trás-os-Montes e Alto Douro

Prof. Doutor Mário Jorge Verde Pereira, Professor Auxiliar da Universidade de Aveiro

Orientador/Supervisor

Prof. Doutor Ulisses Manuel de Miranda Azeiteiro, Professor Associado com Agregação da Universidade de Aveiro

## **agradecimentos acknowledgements**

Aos Professores Ulisses e Amadeu, pela atenção, disponibilidade e cooperação.

Ao Professor Pedro Sousa, pela valiosa colaboração nesta tese de doutoramento e por estar presente em meu caminho acadêmico desde o início do mestrado, tendo sido, formalmente, meu coorientador na dissertação, mas o real orientador daquele trabalho.

À minha mãe, Dula, por todo amor, afeto, carinho, apoio e motivação. Sem ela, iniciar e concluir este doutoramento não teria sido possível. Sou eternamente grato por tudo, mas especialmente pelo privilégio de a minha melhor amiga e companheira ser ela.

À Ester, que não mediu esforços para me ajudar e cuidar de mim quando sofri o acidente e durante a minha recuperação. Ela, de fato, tornou-se uma segunda mãe para mim e terá sempre minha gratidão. Ao José, seu marido e meu amigo, por ter aberto as portas da sua casa e me acolhido também – com secretos, batata frita e muitas histórias.

Aos meus padrinhos, Ana e Prudente, por sempre estarem ao nosso lado, nos bons e nos maus momentos. Mais do que família por consanguinidade, somos família por afinidade.

Por falar em afinidade, agradeço à Creuza por todos esses anos em que estive conosco e que, pelo afeto que se desenvolveu, já faz parte da família também.

To Natasza, for all the support and motivation in the moments I needed, for believing in me (even when I didn't). For actually being there, no matter what. For sharing good moments, Asian food every Tuesday, Portuguese ham and sausage, for obliging me to cook pierogi, trying hard to teach me Polish, insisting on going to Makro, reading my papers (and discussing the subject obsessively) and making me seeing always the good side in everything.

To Kathrin, the best Erasmus buddy I could have ever had, not only for all the laughs, the good stories and jokes, the festivals, São João, São Pedro(s), but also for visiting me in Porto, taking care of me and helping me to come back to my normal routine, little by little.

À Andreia (bué), pelo que representa nesta história (e na minha também) nos últimos dois anos. Sou muito grato por tudo e, ao olhar para trás, não tenho dúvidas da importância do nosso apoio mútuo, o que me orgulha sinceramente.

À Nezilour e ao Eduardo, pela amizade e companheirismo de todas as horas.

Ao Tio Álvaro Magno, que foi o melhor amigo do meu pai e da minha mãe, meu padrinho do coração, sempre ao nosso lado, com seu sorriso bom.

Ao Celestino Machado, amigo de verdade que veio junto com o apartamento, pelo acolhimento de braços abertos na sua casa e com a sua família, pelas boas risadas e pelo inestimável suporte em todos esses anos.

Ao Pedro Bellesi, que acompanhou e auxiliou boa parte desta caminhada.

À Fátima, muito importante no início deste doutoramento, ainda em Coimbra, minha eterna gratidão e admiração.

Ao Juliano, amigo com o qual eu tenho as melhores (e mais inacreditáveis) histórias para contar, e que esteve presente tanto no mestrado, quanto em parte do doutoramento.

## **agradecimentos acknowledgements**

Ao Luís, rising star da tecnologia e da dança no Porto e arredores, parceiro de bons momentos e companheiro nas horas más. É uma honra ter um amigo assim.

Ao Rafael, cuja amizade me fez sentir mais em casa no Porto, pelo city tour de 26 minutos no centro da Cracóvia (“pois... tá visto”), pelos bons (e também pelos péssimos) conselhos, e por estar presente (do jeito Rafa) nesta fase.

Ao Gonçalo Baptista, futura lenda da ESN Porto, pelos churrascos com teor de sal muito acima do recomendável, pelas histórias um pouco confusas que temos para contar e pelo apoio neste momento complicado de recuperação.

To Selman, for all the amazing moments, trips, stories, memories and fun shared. Definitely, we need to plan (but, really, this time, plan!) the next adventure!

To Anna Kartsch, the ESner that adopted me as her Erasmus buddy in Kraków, for the friendship, the tours and the bets nobody won.

À Margarida, por ter me dado excelentes buddies. Ou, pelo menos, por ter tentado.

À Tássia, sempre pronta a se estressar comigo por qualquer coisa, pela amizade verdadeira nesses quase dez anos em que nos conhecemos.

À Marta, parceirinha de queimas, dona de uma energia inesgotável (por mais que diga que está esgotada há muito), pelos bons momentos durante estes anos.

Aos de sempre e para sempre: Railson, Renan e Yasmin, por tudo.

To Professors Patrick Vaughan, Paweł Laidler and Marek Porzycki for their lessons, which opened new perspectives for this thesis.

À Professora Etelvina Figueira, pelo impecável trabalho realizado na coordenação de mobilidade do Departamento de Biologia, grande responsável por eu ter mantido minha ideia inicial de ir em Erasmus. Muito obrigado.

À Professora Aline Penedo, por ter sido tão importante no início da minha caminhada acadêmica, como minha professora de Direito Administrativo e como minha orientadora de TCC do curso de Direito.

Aos Professores Édson Franco e Ana Célia Bahia pelo apoio ao início do doutoramento.

Ao João Batista Klautau Leão, homem de inteligência ímpar, ao qual tenho a honra de ser amigo e primo, pela motivação no início do doutoramento, bem como pelas sempre animadas e produtivas conversas.

Ao Dr. João Pedro Melo, dos Serviços Académicos da Universidade de Aveiro, que acompanhou (sempre com muita educação, eficiência e disponibilidade) a saga das creditações desde o início. Meus sinceros votos de que a excelência do seu trabalho inspire seus colegas.

À Dra. Susana Duarte, do Gabinete de Relações Internacionais da Universidade de Aveiro, pelo acompanhamento do meu processo de Erasmus, sempre com muita disponibilidade e cordialidade.

**agradecimentos  
acknowledgements**

To Dr. Paulina Kowalska, from the International Students Office of the Uniwersytet Jagiellonski, for all the support before and during my exchange program in Kraków.

À Professora Paula Castro, pelo justo e correto processo editorial realizado em duas das publicações desta tese.

À equipe da ala de ortopedia do Hospital São João, especialmente aos enfermeiros António, Vânia, Francisca e Luís, pelo tratamento eficiente e humanizado que recebi quando lá estive.

Às equipes do Hospital privado de Almada (especialmente à Ana e à Paula), do Centro de Saúde de Almada, e do Centro de Saúde Barão de Nova Sintra (especialmente ao José Levi) pelo acompanhamento do meu tratamento.

Ao Dr. Luís Viana Jorge, médico de saúde mais concorrido de todo o Porto, pelo atendimento sempre competente, gentil, e bem-humorado que recebi e que tem me ajudado na recuperação. Quem dera houvesse mais médicos como ele. Assim, quem sabe, eu não precisasse disputar vagas com as velhinhas de manhã cedo para ser atendido pelo Dr. Luís.

À equipe da EsferaSaúde Porto, em especial ao Luís Miguel Pinto (fisioterapeuta responsável pela minha reabilitação e que acompanhou todo o processo de finalização, entrega e defesa da tese) por toda a atenção, preocupação e cuidado que me foram prestados. Sem a competência, profissionalismo e dedicação do Luís, minha recuperação não teria sido tão boa e a fase final desta tese teria sido muito mais complicada em razão disso. Minha eterna gratidão e amizade.

Às equipes da padaria Pão Fofó e do MeuSuper Soares dos Reis, pela gentileza e auxílio à minha readaptação à rotina normal, quando voltei à casa.

À ESN Porto, por ter tornado essa jornada de doutoramento mais divertida e bem menos solitária!

**palavras-chave**

Alterações Climáticas, Desenvolvimento Sustentável, Ativos Ambientais, Direito e Economia, Direito Ambiental, Brasil, Amazônia.

**resumo**

A discussão sobre a degradação ambiental, a destruição dos ecossistemas e as alterações climáticas é muito mais ampla do que critérios técnicos da biologia, química ou física. Como fenômenos causados pela atividade humana, é necessário compreender suas causas, possíveis caminhos para sua reversão, mitigação ou adaptação das populações para as presentes e futuras consequências. As questões ambientais se tornam ainda mais complexas quando verificadas que não estão isoladas dos outros problemas enfrentados pelas sociedades, especialmente no Brasil. Saneamento básico precário, elevados índices de pobreza e de violência, ineficiência dos serviços públicos, nomeadamente na educação e saúde, desemprego, baixos índices de desenvolvimento social e económico são algumas das muitas situações cujas soluções são vistas como prioritárias para o cidadão comum. A preservação ambiental pode ser – e frequentemente é – vista como um entrave ao crescimento e ao desenvolvimento do país. Algumas correntes políticas apontam os investimentos na área como um peso a ser sustentado pelo contribuinte. No entanto, mudanças na dinâmica económica e jurídica do Brasil podem transformar a atual conjuntura de degradação social e ambiental em um contexto mais sustentável e próspero. Ao utilizar as potencialidades – principalmente os ativos ambientais – de forma mais racional e ecológica, também é possível gerar riqueza para o país. O que é visto como problema, pode ser a mais eficiente solução. A presente tese está dividida em cinco publicações. Nelas, são abordadas questões atuais da dinâmica social, institucional, jurídica e económica que dificultam a implementação de um modelo económico mais sustentável. Assim, esta tese construiu um quadro mais preciso e atualizado de seu objeto, possibilitando proposições positivas, bem como desdobramentos e bases para novas soluções.



**keywords**

Climate Change, Sustainable Development, Environmental Assets, Law and Economics, Environmental Law, Brazil, Amazônia.

**abstract**

The discussion about environmental degradation, destruction of ecosystems and climate change is way broader than just biological, chemical or physical technical criteria. As phenomena caused by human activity, it is necessary to understand their causes, possible paths to their reversion, mitigation or adaptation of the populations for the present and future consequences. Environmental issues became even more complex when it is realized that they are not isolated from other problems faced by societies, especially in Brazil. Precarious basic sanitation system, high levels of poverty and violence, low indexes of social and economic development are some of the various situations which their solutions are seen as a priority by the common citizen. Environmental preservation can be – and frequently is – seen as a big hindrance to economic growth and development of the country. Some political currents point out the investments in the area as a burden that will be carried out by the tax payers. However, changes in the legal and economic dynamics in Brazil can transform current situation of social and environmental degradation into a more sustainable and prosper context. By using the potentialities – especially the environmental assets – in a more rational and ecological manner, it is also possible to create wealth to the country. What is seen as a problem may be the most efficient solution. The present thesis is divided in five publications, in which are addressed current issues of social, institutional, legal and economic dynamics that hinder the implementation of a more sustainable economic model. By that, this thesis has built a more precise framework of the theme, making possible to suggest alternatives, as well creating new ramifications and bases for new solutions.

## Index/Índice

<b>Section A – Introduction</b>	<b>1</b>
<b>Section B – Methodological choices</b>	<b>10</b>
<b>Section C – Publications</b>	<b>16</b>
<b>Publication 1</b> - Environmental Law, Public Policies, and Climate Change: A Social-Legal Analysis in the Brazilian Context	<b>17</b>
<b>Publication 2</b> - Public Policies and Education for Biodiversity: Brazilian Challenges in a New Global Context	<b>30</b>
<b>Publication 3</b> - Environmental Assets and Carbon Markets: Could It Be Amazônia's New Belle Époque?	<b>51</b>
<b>Publication 4</b> - Brazilian Amazônia, deforestation and environmental degradation: analyzing the process using game, deterrence and rational choice theories	<b>84</b>
<b>Publication 5</b> - Brazilian Amazônia, deforestation and environmental degradation: finding ways for a sustainable future	<b>103</b>
<b>Section D – Final Comments</b>	<b>122</b>
<b>References</b>	<b>127</b>

## **Section A - Introduction**

### **Climate change in an international scenario**

Huge transformations have been occurring in the last decades. From an abstract idea or a statement considered radical, climate change turned into a real and major threat to humanity. More than just “global warming”, the consequences can be disastrous: severe droughts, floods, raising of sea levels, loss of biodiversity, shortage of food and fresh water, among many others (IPCC 2007). For example, 2019 had the warmest July since the global records began, in 1880 (NOAA 2019).

It is almost unanimous inside scientific community that climate change is caused or magnified by human actions (eg. Oreskes 2004, Cook et al 2013, Finn 2013, IPCC 2013, Melillo et al 2014). Some surveys show that the population agrees with the statement that the climate is changing; however, influenced by political reasons, only part of it agrees that it is caused by human activity (Hartter et al 2018). We are putting our lives and future generations in danger.

It is needed to rethink the dynamics and the activities that contribute to high emissions of greenhouse gases, including deforestation and environmental degradation. Unfortunately, these processes still seem to be far from an end.

Political and economic interests have been influencing decisions that complicate the change in the current environmental paradigms. Especially in the international community, it is hard to reach consensus and/or to put agreements and treaties in practice. The failure of one country can put the result of a great international treaty at risk. For those reasons, environmental issues are extremely entangled, as they are not related only to environment.

### **Sustainable development: finding new ways to deal with old environmental problems**

The complexity of all the variables involved in the policies related to environment demands different solutions than the ones used so far. The urgency of taking actions to mitigate and to adapt to climate change and to stop environmental degradation is undeniable. However, the need of reducing poverty and alleviating social problems, for example, is also crucial.

Many times, public policies, especially for environment, have been separated and segregated from social or economic aspects (De Graaf et al 1996). Although common, this is not desirable and it is counterproductive, as the efforts are dispersed and can be incoherent.

With uncoordinated policies, the rejection against environmental issues can rise. It happens because political branches argue that environmental protection is a cost that sacrifices economic growth. In undeveloped countries, this is a huge problem.

However, it does not need to be like this. New ways that combine economic, social and environmental aspects not only can be done, but also need to be done.

Improving social conditions, conserving nature and economic growth are the basis for sustainable development. Any society that invests in policies that prioritize only one or two of these three aspects, will have an imbalance in the future. The “sustainability” of the sustainable development refers that if the three conditions are combined, it can continue without artificial incentives and without having huge distortions in the near future. In case one of these points is missing, it cannot be considered sustainable development (Gudmundsson & Höjer 1996). If a policy or an economic model needs these unnatural stimulus, they are doomed to fail when these incentives do not exist anymore.

In other words: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987), or “Sustainable development is a development of a socio-environmental system with a high potential for continuity because it is kept within economic, social, cultural, ecologic and physical constraints” (De Graaf et al 1996).

The environmental question and combat to climate change became way more than only preserving nature, avoiding deforestation and degradation of the environment. Now, it is also needed to implement strategies that can do it in a viable manner in long term.

The 17 Sustainable Goals of United Nations (UN 2019), for example, address issues related to economic, social and environmental cornerstones (Morton et al 2019). However, their implementation can be extremely complicated, as it would need the cooperation of various sectors of the society and national and local governments, which is not always easy.

Universities (Leal-Filho et al 2019), schools, associations and government agencies are valuable partners of it. But creating ways of enhancing participation in more sustainable

activities through economy attractiveness is really promising as well, and the present thesis worked with this hypothesis.

### **Aspects of the Brazilian context**

In this scenario, countries need to find internal legal, social and economic ways to deal with environmental questions and to pursue sustainable development. In the case of Brazilian, it is not different.

As the fifth biggest country in the world, with a territory that has around 25% of the species on the planet (Kageyama 2009) and with a still unknown biodiversity, Brazil plays an important role, not only for neighbor countries, but also for the whole Earth.

Despite its immense natural resources, Brazil is still an undeveloped country, with high social and regional inequalities. Some of its biomes are extremely endangered, such as Mata Atlântica, with only 12.4% of its original forest cover (SOSMA and INPE 2019) and Cerrado, which lost more than 50% of it (INPE 2019).

These results are related to years of inefficient public policies that disregarded social and environmental aspects. The uncoordinated actions of the governments did not reach the results and worsened some situations in other areas.

### **Why Brazil?**

Besides its environmental relevance, the diversity of its territory, the history of public policies for environment and the complexity of the legal system make Brazil an interesting case to be studied and analyzed.

Many lessons can be learned out from the way governments and society are interacting concerning the environment and the inability to contain deforestation in Brazil. Especially if we consider that although the deforestation destroyed more than half of Cerrado (INPE 2019), 87.6% of Mata Atlântica (SOSMA and INPE 2019) and around 20% of Brazilian Amazônia (Nobre et al 2016) and it continues without proper control, Brazil cannot be said as a developed country. Half of Brazilian emissions by 2016 were caused by land use

changes and deforestation fires (Azevedo and Angelo 2018). The argument of sacrificing the forests in order to make the country wealthier has proved to be wrong.

In a changing climate, tropical forests have an increasing importance and need to receive a special attention from the society and the governments. Amazônia is the biggest of its kind, with biodiversity that cannot find anything similar in the world and containing 20% of all fresh water in the planet (IBGE 2004). 60% of its extension is in Brazil, what represents almost half of the country's territory (IBGE 2004).

Its strategic position, its huge mineral and forestry resources, fresh water reserves and the provision of ecosystem services (like the rain cycle regulation) make Brazilian Amazônia an underestimated and undervalued region. Its resources and assets have been explored in a degrading and unsustainable way, not meeting the needs of its population and not assuring the use or the existence of it to next generations.

### **Why to focus more on Amazônia and not on other Brazilian biomes?**

As Amazônia tipping point is dangerously approaching (Nobre et al 2016) and the deforestation rates are increasing, it is needed to find solutions that understand the real vocation of the region, related to the environmental assets, that can bring economic growth, better social conditions and more ecofriendly dynamics.

By looking at Brazilian Amazônia's history, it is possible to identify several mistakes on planning and practice of the public policies for environment, for economy and for society. The last 60 years have been of a deep change in the economic, social, environmental and demographic aspects of the region in a way without any precedents. Big mineral, farming, land colonization, road building and timber projects transformed completely the landscape, but also the dynamics of cities, villages and local populations. From an almost untouched and isolated territory to a region that is struggling to contain and reduce environmental damage, it is challenging the population, governments, organized society and scientists to better understand the causes of the problems and what can be done about it.

Although these changes were centered in the exploitation of the forest and the clearance to farming and cattle (Paulino 2014, Wolford 2016, Garrett et al 2017), it is relatively recent in Amazônia.

The Brazilian part of Amazônia started to be colonized and explored to obtain the control on the Backland Drugs, substitutes of the Indian Spices, when Portugal lost the control of the route to India (Cardoso 2015). Centuries later, the rubber cycle brought wealth to the region, financing its *Belle Époque*.

These two phases had in common the exploration of really valuable non-timber products: the nature was the center of a very dynamic economic activity. However, this activity was made without the need of deforesting, as the most valuable products were obtained from the forest.

These natural areas were so valuable and of such importance that Brazil had to buy a territory from Bolivia where now is the state of Acre (the expansion of the rubber extraction in the countryside of Amazônia spread until the territory of Bolivia, and the number of Brazilian citizens harvesting rubber was so high that it caused a serious diplomatic crisis that was solved when Brazil bought the area).

When those activities were abandoned, there was a huge economic crisis, but the isolation of the cities in Amazônia from the rest of Brazil “forced” the region to produce its own products to maintain itself. The industry in the region absorbed part of the impact of the discontinuation of the previous main economic activities.

The project of national development initiated by Juscelino Kubistchek in the 1950’s started to change this reality. Huge works Juscelino wanted to build to leave his mark in the country affected Amazônia. The construction of the new capital city, Brasília, was one of them. To connect it to the rest of Brazil and to develop the new automobile industry, the Federal Government built several roads and begun a process of replacement of the railways (Paula 2000).

Belém, for example, had no road connections to other regions, it was only possible to reach it by plane or by boat. The roads built created an economic imbalance on the region, that lost almost all local industries (Mourão 1989, Klautau de Araújo 1995) and the margins of those roads became deforestation spots.

The problems in other regions of Brazil, such as land concentration and conflicts, for example, demanded some response of the Federal Government. As Amazônia was the last frontier to be explored, instead of making structural reforms in the land system, the government decided to start a colonization of Amazônia to “integrate the region” to the rest

of the country (Wolford 2016), to ease the pressure in other regions, as Southeast and Northeast, and to avoid political costs with the reforms. This process was not properly planned as disregarded the characteristics of the region, causing huge environmental damages and socioeconomic imbalances (Loureiro and Pinto 2005).

As the soil of Amazônia is poor and needs correction to be productive – although there is a myth about its endless fertility (Weinstein 1993), and without support from the government, the new farmers ended up selling their lands to big producers, what caused land concentration in the region as well.

These misguided public policies not only did not solve the problems in the other regions – until now, Brazil did not proceed with land reform – but also brought problems that did not exist before in Amazônia (Loureiro and Pinto 2005, Klautau de Araújo 1995). The new population without conditions to survive in their lands and without any infrastructure raised the pressure on natural resources.

Combined with it, huge reserves of iron, gold, bauxite and several other types of ore and minerals, such as precious stones were discovered during the 1960's, while the exploration of it started in the following decades.

More population was attracted to the region that had not enough structure to receive the immigrants. Lots of problems started and continued growing over the years: severe environmental degradation, land conflicts, violence, illegal deforestation, land grabbing, economic stagnation, predatory practices and fires, among several others (see with more details in Klautau de Araújo 1995, Loureiro and Pinto 2005, Paulino 2014, Lavelle et al 2016, Nobre et al 2016, Wolford 2016, Garrett et al 2017, Brito et al 2019)

The consequence of all of these choices made is not only an environmental issue, but also a huge social and economic chaos. The region is facing challenging obstacles that cannot be overcome with the present solutions that have proved to be wrong. Brazilian Amazônia could not develop with the models that were imposed over the last 60 years.



## **Outline of the thesis**

The focus of the research was especially on Brazilian Amazônia and the effects of Federal law and public policies in the region. As the laws are national, not from the states, the findings can be replicated in other regions as well, with adaptations to local reality.

This thesis, divided in five publications (3 peer reviewed chapters in international books and two submitted articles to ISI/SCI with peer review international journals), analyzed these aforementioned problems and tried to find points that can be improved, especially in law and public policies, to achieve better environmental results through sustainable development initiatives.

The first publication, named “Environmental Law, Public Policies, and Climate Change: A Social-Legal Analysis in the Brazilian Context”, published in 2014 in “Handbook of Climate Change Adaptation”, analyzed some aspects as the general framework of Environmental Law in Brazil and public policies.

Initiating the discussion about the importance of the local power to achieve better results and the bureaucracy in Brazil that impedes or hinders popular participation, passing by the public policies that started the environmental degradation in Brazilian Amazônia and presenting the example of the city of Paragominas, Pará, this short text begins the discussion deepened and enlarged in the next publications. The following articles address the points that were registered in this part of the thesis: bureaucracy, deficiencies in the law, lack of cooperation between agents, environmental assets, sustainable development and environmental education.

The second publication, named “Public Policies and Education for Biodiversity: Brazilian Challenges in a New Global Context”, published in 2016 in the book “Biodiversity and Education for Sustainable Development” deepens the topics started in the previous one, using an extensive analysis of Brazilian norms for the environment, scientific literature, cases to illustrate good and bad practices, and also Game and Marginal Utility theories to explain inefficiency of public policies for environment in Brazil.

The deficiencies and incoherencies in laws were exposed and analyzed in order to find out in which way they can harm the correct functioning of the institutions, their practical applications and the participation of the citizens. Public policies for this matter are also

examined to see if the provisions existing in Brazilian norms were being followed by Governments.

For the first time, Game Theory was used in the context of this thesis. Brazilian Constitution (Brasil 1988) shared the competences for environmental conservation and surveillance between Federal Government, states and cities. Inside the Federal sphere, there are several agencies that are related to the environment. However, the results did not match the expectations. Using an adaptation of the umbrella game (that can be considered similar to the prisoner's dilemma), it was possible to explain it. The theory of Marginal Utility was also used as a complementary explanation.

Concerning environmental education, the example of the Escola Bosque was chosen to illustrate a successful experience of a sustainable project of education that involved local population and obtained excellent results, but was discontinued for political reasons.

The third publication, named “Environmental Assets and Carbon Markets: Could It Be Amazônia's New *Belle Époque*?” (Klautau de Araújo, Soares and Azeiteiro), published in 2019 in the book “Climate Change-Resilient Agriculture and Agroforestry”, explored the historical context of the region, its close relation to the environmental assets, the reasons for the current environmental crisis and the new opportunities and challenges for the implementation of a market related to the sustainable exploration of those assets.

As the colonization of Brazilian Amazônia and its wealthiest period is directly related to the use of non-timber products that developed the economy without deforestation, the past is the prove that it is possible to achieve environmental conservation and economic growth at the same time. Based on that, the limitations of the law concerning the creation and regulation of the Carbon and Environmental Assets Markets in Brazil were analyzed. Possible challenges and models were considered and suggestions concerning it were proposed.

The fourth publication, named “Brazilian Amazônia, deforestation and environmental degradation: analyzing the process using game, deterrence and rational choice theories” (Klautau de Araújo, Sousa, Soares and Azeiteiro), submitted to the journal *Environmental Science and Policy* (currently in the peer-review process), focused on the interactions between governments, society and different agents that cause environmental degradation and deforestation.

Taking into consideration legal aspects, public policies, surveillance, economic profits with legal and illegal activities, fines and punishments, through Game Theory, it was built a mathematic model that shows that if the repetition of current interactions persists, the Tragedy of the Commons can be certain in Amazônia.

The fifth publication, named “Brazilian Amazônia, deforestation and environmental degradation: finding ways for a sustainable future” (Klautau de Araújo, Sousa, Soares and Azeiteiro), submitted also to Environmental Science and Policy, deepened the discussion about the possible solutions, focusing mainly on three points: popular participation, economic alternatives and changes in legal system (specially the procedures). Based on the findings of the previous publication, it was possible to suggest more accurate solutions.

## **Section B - Methodological choices**

### **The beginning of the research and its initial purposes**

Before describing the methodology of this research and accomplishing one more of the formal requests for the thesis, it is necessary to register how it began and how it was developed in real life. Different that in the five publications, introduction and final comments of this thesis, some of the next topics will be written in the first person, as the data collected, the legislation analyzed and the literacy chosen were crossed with my personal experience as an Amazonian citizen.

Although the first part of this thesis was published in 2014, this research began way before, but not in the pure academic way. Over the years before I have moved to Portugal, I had the opportunity to travel many times to different parts of Amazônia, especially in Pará, Amapá and Maranhão states.

Long hours by boat, bus, car or airplanes to reach far and sometimes untouched regions gave me the great opportunity to meet local communities, their problems and their culture. First, accompanying my parents, that were consultants for sustainable development of Amapá government, and later by myself. This was important not only to understand the real issues of the region, but also to understand in how the government works in practice – and to get extremely disappointed and intrigued with the lack of efficiency and the waste of public money.

During those trips, I had the opportunity to visit Bailique Archipelago, in the delta of the Amazon river, where Escola Bosque, mentioned in the second publication, was built with an innovative approach for environmental and sustainable education. The sailing used to take 18 hours from Macapá, the capital of Amapá. If the boat runs aground – what happened to us, it can take couple of days to reach the destination.

I also visited mineral projects, in Parauapebas, Paragominas and Barcarena in Pará, and the “legacy” of it in Serra do Navio, Amapá. In the western part of Pará, I have visited Alter do Chão, a small village of fishers that got famous for its natural beauty and now attracts tourists from all over the world, and the American influence in Belterra, one of the cities that received

the project of a huge plantation of rubber trees that would give Ford the independence of other suppliers of the material.

Also Marajó island, in Pará, a subregion that has cities with the lowest HDI in Brazil and has been prominent for its achievements in raising production of food, but without having significant rates of deforestation, as in the south of the state. An interesting case to be further studied.

In person, I could see how the reality of the region is like and how its possibilities are underexplored. The poverty, the evolution of the environmental degradation, the lack of structure on the roads, ports, airports. The lack of education and health services, electricity, communication systems. Numbers can express just a part of it, but only the real contact with this situation can give you the real dimension of the beauty of the region, and also the immense challenges that it is facing. Great part of what is happening in the region is not officially registered. Who knows the region also knows that the violence, the poverty, the structure and the services are worse than the official data. However, for academic purposes and for public policies, perceptions do not count.

Again, the research started way before this thesis. And the perceptions that important elements are missing, as well.

During my bachelor in Law and my Master in Law and Economics, I could notice that law is frequently overrated. In Law literature, public policies are commonly considered as a mere extent of legal norms itself. It is not rare to read that a government created policies for environment, when the only news are law bills that were delivered to the legislative.

Law is also overrated when it disregards local characteristics and peculiarities, popular participation and specialized knowledge. As it is pointed out in this thesis, Brazil has cases of absence of regulation and also of bad regulations. However, this practice of not considering the importance of other areas of knowledge is not exclusive of Law.

The cooperation is fundamental for the development of any area. But real interdisciplinarity is one of the keys to reach sound solutions for complicated issues, like building sustainable development in Amazônia. Isolated, economy, law and biology will not solve the problem.

“There is a better way” could be the synthesis of my frequent thoughts. The repetition of alleged solutions for the region that disregard one or more of these aspects truly annoys me.

The lack of knowledge of Brazilian population about Amazônia reflects a centralized and old fashioned model of education and politics, but it still shocks me. The politicization of environmental bothers me.

The alleged solutions for the region frequently insist that the popular participation in micro scale can solve the problems. But these authors completely ignore that Legal Brazilian Amazônia has more than 5 million square kilometers, and to replicate it sometimes is impossible.

The lack of knowledge about the region got even more evident when protesters drew giraffes to represent the forest fires in Brazilian Amazônia, or the common mistake of saying that Pará (or any other Northern state) is located in the Northeast region. Great projects, like Transamazônica, Br-163, the hydroelectric power plants of Balbina or the first version of Tucuruí, also disregard these characteristics and created huge problems.

The politicization of environmental issues put Brazilian forest into danger, and it minimizes the problems to a senseless discussion between Left and Right parties, while the situation degrades even more.

For those reasons, it was needed that the research to go deeper into analysis to cross the legal text, the legislative intention, the public policies executed and the results achieved, and only then to suggest the combination of factors that could work as a solution.

### **Methodology of the publications**

The present thesis is a qualitative research. Discourse, comparative and historic analysis, as well as Game, Deterrence and Rational Choice theories were used to evaluate laws, public policies and their respective results, in order to identify deficiencies, gaps, incoherencies and other aspects that may compromise their efficiency.

A really extensive research about state-of-the-art literacy, legal norms, official data about public policies, economy, social aspects, land use and environment was executed. From this point, it was possible to draw some lines and find patterns that helped to build the general overview about the current situation in Brazil, the evolution over the years, what was expected on the law and government policies and what were their real results.

In parallel, Game Theory was used to verify and validate some hypotheses, or probable causes of some interactions. Case studies were used as examples of good practices.

In the first publication, it was executed an analysis of the historical context of environmental problems boosted by government interventions, such as the road constructions without planning or environmental impact assessment. Deficiencies in the legal system about popular participation in surveillance and environmental conservation were pointed out through legal hermeneutics. The brief case study of Paragominas was used to illustrate how the corrections of the weaknesses observed can improve the results.

The second publication also evaluated law by legal hermeneutics and discourse analysis. Game Theory was used to identify the causes of the lack of efficiency of the environmental agencies that shared similar competences, by a game that simulates their interactions and shows the possible results. The Marginal Utility theory was also utilized as a complementary explanation, as its approach is not about the interaction itself, but about the overload of good/service. Again, a case study was presented to exemplify how the deficiencies found in public policies can be corrected, and how, in practical terms, the general guidance of law can be applied successfully in the concrete case.

The third publication was more centered in a historical and social analysis about the economy of Brazilian Amazônia, since its first settlement until the present date. Combining it with legal analysis of Federal laws, it was possible to assess the viability of Environmental Assets and Carbon Markets in Brazil, and to make projections about which models fit the current legal conditions, or what needs to be adapted in Brazilian norms for these markets to function.

Through the assessment of the points in the previous research, a mathematic model based on Game Theory was built and presented in the fourth publication. The deficiencies found that are related to the cooperation were considered as factors to the equations, be they legal, economic, or practical (lack of surveillance or punishment, for example). The result of the mathematic model validated the hypothesis of the Tragedy of the Commons is ongoing in Brazilian Amazônia. Deterrence and Rational Choice theories were also used as complementary analysis specifically addressing legal and surveillance aspects.

Based on the findings of the mathematic model of the previous article, the fifth publication analyzed each of the points that can be improved and suggested possible solutions. To build

it, legal hermeneutics, comparative and discourse analysis were used again to assess a large number of official data, norms and policies. Similar cases in other parts of the world were brought as a comparison standard, legal deficiencies and their practical effects were addressed and it was possible to reach a broader view and deeper conclusions about the subject.

### **Obstacles found during the thesis**

Writing about a subject as complex as sustainable development in Brazil can be extremely complicated. Since 2013/2014, Brazil has undergone deep and inconstant changes in economics and politics. Since then, there were three different presidents, turbulent elections in 2014, the biggest economic recession in history, high percentage of unemployment, a process of presidential impeachment, polarization in politics and new elections in 2018. All these events switched legal trends, economic models and future perspectives – for better and for worse.

The publication “Environmental Assets and Carbon Markets: Could It Be Amazônia’s New *Belle Époque?*” was especially difficult to write, as the research and the first writings about it started in the end of 2016. The topic about legal trends needed to be re-written and updated four times, because there was a huge controversy about changes in conservation areas, particularly concerning to Jamanxim National Park and Jamanxim National forest. The solution found was to wait until the situation was more stable – what happened partially, as the environmental debate in Brazil is still boiling. The chapter was accepted to publish in January of 2018, and published only one year later, in the beginning of 2019.

The research continued, and in 2018, I travelled to Brazil two times and visited some of the areas mentioned in the topic 1 of this methodology chapter. Because of the uncertainty related to the presidential elections and bureaucratic procedures of the University, it was decided to wait a bit for the conclusion and the submission of the two final publications.

### **Positive indirect results of the thesis**

Besides the five publications written for the present research, two entries for the “Encyclopedia of the UN Sustainable Development Goals: Climate Action” were produced:



1. *“Brazilian Amazônia and Climate Change: Barriers and Pathways for Forthcoming Sustainability”* and 2. *“Environmental Assets and Carbon Markets: Opportunities and Challenges for a Greener and Sustainable Economy in Brazil”*. Both entries approach aspects that were addressed during the thesis, but were not the main focus of it.

The preliminary results of the research of the thesis were presented at: 1. the World Symposium on Climate Change Communication, that occurred 22nd-24th February of 2017 in Manchester, England; 2. at the Faculty of Letters of the University of Lisbon, in 5<sup>th</sup> of May 2017; 3. The 2nd World Symposium on Climate Change Adaptation, at the University of Coimbra, on 7<sup>th</sup> of September of 2017. 4. In a lecture at University of Aveiro on 20<sup>th</sup> of November of 2017.

An interesting input to the research was the exchange under the Erasmus+ Program, between September 2018 and February 2019, at the Jagiellonian University in Kraków, Poland. The subjects (European and American Legal Systems: A Comparative Perspective, Monetary Law and Monetary Policy, Practical Aspects of Environmental Conservation, World Politics in the 21<sup>st</sup> Century: Towards a Post-American World?) were extremely productive and brought new perspectives, especially from political sciences and economy, particularly to the last two publications.

The paths chosen and the “accidents” on the way to produce the present thesis enriched the results and made an interesting (and necessary) balance between the reality of the region and the theories and methodologies used.

## Section C – Publications

1 – Klautau de Araújo TL (2014) Environmental law, public policies, and climate change: a social-legal analysis in the Brazilian context. In: Leal Filho W (ed) Handbook of climate change adaptation. Springer, Berlin, pp 973–982. doi: [https://doi.org/10.1007/978-3-642-40455-9\\_115-1](https://doi.org/10.1007/978-3-642-40455-9_115-1).

2 – Klautau de Araújo TL (2016) Public policies and education for biodiversity: Brazilian challenges in a new global context. In: Castro P, Azeiteiro UM, Bacelar Nicolau P, Leal Filho W, Azul AM (eds) Biodiversity and education for sustainable development. Springer, Berlin, pp 219–235.

3 – Klautau de Araújo TL, Soares AMVM, Azeiteiro UM (2019a) Environmental assets and carbon markets: could it be Amazônia’s new belle Époque? In: Castro P, Azul A, Leal FW, Azeiteiro U (eds) Climate change-resilient agriculture and agroforestry. Climate Change Management. Springer, Cham. doi: [https://doi.org/10.1007/978-3-319-75004-0\\_28](https://doi.org/10.1007/978-3-319-75004-0_28)

4 – Klautau de Araújo TL, Sousa P, Soares AMVM, Azeiteiro UM (2019b) Brazilian Amazônia, deforestation and environmental degradation: analyzing the process using game, deterrence and rational choice theories. Submitted to Environmental Science and Policy, under peer-review.

5 – Klautau de Araújo TL, Soares AMVM, Azeiteiro UM (2019c) Brazilian Amazônia, deforestation and environmental degradation: finding ways for a sustainable future. Submitted to Environmental Science and Policy.

## **Publication 1**

**“Environmental Law, Public Policies, and Climate Change: A Social-Legal Analysis in the Brazilian Context”**, published in the “Handbook of Climate Change Adaptation”, 2014.

Thiago Lima Klautau de Araújo

# **Environmental Law, Public Policies, and Climate Change: A Social-Legal Analysis in the Brazilian Context**

Thiago Lima Klautau de Araújo

## **Abstract**

This chapter aims to analyze the laws and public policies in relation to climate change in Brazil, its implementation, and concrete results. Through a review of legislation and state of the art, this chapter gives evidence to the positive and negative interventions of the public policies since the 1950s until the present moment, using some examples, such as the bad initiative of construction of roads that promoted the deforestation and the good work made in Paragominas, Pará, to reduce environmental degradation and deforestation. As results, this chapter proposes a new perspective of the environmental law and reveals its importance in order to cope with the challenges of climate change and environmental issues, in an integrative way. In order to do so, it seeks to integrate society and governments' efforts to make possible the changes in the present climate situation, as it has been made in some isolated cases, such as Paragominas.

**Keywords:** Climate change; Environmental law; Greenhouse gases emission; Public policies; Sustainable development.

## **Introduction**

Currently the approach to climate change focuses on technical issues and possible solutions for reducing the emission of greenhouse gases. Rising chances of international agreements and treaties are one of the, or perhaps the only, alternatives to the reformulation of the paradigm of the relationship between man and nature.

Little is said about the importance of environmental legislation and regional public policies as an alternative solution. It happens that, while it awaits a global decision, if nothing is done at national or local areas, the climate change issue is getting worse. International law is essential to resolve the issue, but alone will not take effect.

This is because law is an area full of meanings that makes sense to those related to a particular reality and so is considered a local knowledge (Geertz 1983). This chapter tries to rescue the importance of law and public policies for the solution of climate change problems, understanding that both are essential for achieving a positive or negative response.

Having as context the legal and legislative axe and the one of public policies, as a way to define, understand, and deal with climate change, this chapter was organized into three complementary parts. The first part is an overview of environmental issues discussed globally since the 1970s. The second part deals with the Brazilian environmental legislation and brings some challenges and inconsistencies between theory and practice. The third part discusses the need for the implementation of sustainable development as a tool for equalization of climate change problems; points out the good example of Paragominas, Pará; and discusses the importance of an integrated action across the whole society.

At all points, it is evidenced the need of a multidisciplinary and interdisciplinary analysis, where

natural and social sciences are considered sources of environmental law, but it can also be a valuable tool for the practical implementation of the acquired knowledge in those areas.

### **Climate Change and Legislation: old and new environmental problems that societies have to deal with**

Nowadays, climate change is recognized as the major environmental problem and has long been a matter of global concern of societies. Climate change public policies express the formal position of governments, somehow synthesizing scientific contributions, the political positions, and economic, social, and cultural constraints, “mainly emphasizing the mitigation and adaptive processes to CC and the possibilities of intervention at the level of ecosystems and human actions” (Alves et al. 2014).

In the public discourse, the debate on the need for change in public policy and on what role business and society have to perform in order to prevent the progression of global warming or to develop the mitigation of impacts caused by climate change is usual, among other phenomena associated with it. In international agreements and conventions, this is a very

recurrent theme, in which countries commit themselves to freely accept targets for reducing the emission of greenhouse gases.

This innovation in discussions about environmental issues has resulted, around the 1970s and the 1980s, from the realization of the fact that the planet could, actually, join an unprecedented environmental crisis, caused by human activity, and whose main target would be mankind itself.

In the words of Édis Milaré (Milaré 2009, p. 171):

The sustainability of the planet is, without any doubts, in the hands of man, the only being capable of, with his actions, break the dynamic equilibrium produced spontaneously by the interdependence of the forces of nature and modify the regulatory mechanisms that, under normal conditions, maintain or renew natural resources and life on Earth.

It is not to be against progress, but to promote and harmonize the economic and social development with minimum environmental requirements, using and conserving the natural resources and commiserating synchronously (at the present time) and diachronically (through successive times) with all humanity. The fate of future generations is, thus, in the hands of present generations.

It is true that such international laws have the mission of transformation of the global mentality. But it is also true that the attention given to them is not the most satisfying and does not even make big differences in the situation.

The Kyoto Protocol, for example, was a very positive initiative in theory, but in practice it did not bring great results, since most countries did not comply and will not be able to meet its goals and others do not even come to sign it, as the United States.

The decrease or increase in the emission of greenhouse gases turns out to be much more related to public policies of national or local governments than actually to international agreements or treaties.

To understand the legal systematic of climate change and what is being done to combat them through laws, it is necessary to first understand the environmental legislation.

The specific case addressed in this chapter is the Brazilian one, whose federal legislation on environment has many commendable points, but its application in everyday life does not achieve the expected results. This could end up meaning that a country that has enormous potential to be strategic and decisive in mitigating the effects of the uncontrolled environmental situation, end up turning over a polluter country.

## **Brazil's Environmental and Legal Contexts**

The environmental issue in Brazil presents a slightly different situation from the global context. Despite being one of the first countries to formalize strict laws in the sphere of protection of environment, its territorial extent, the lack of political will and oversight, and insufficient resources for maintenance and expansion of certain state measures preclude effective implementation of law.

Already in 1967 there was the enactment of the Law n. 5197, which deals with the protection of wildlife (Brasil 1967). Many other laws came before the 1980s, a period in which there was a spread of environmental discourse, however, without actually producing effects in the real world.

What is considered the major mark in the Brazilian environmental legislation, and particularly interesting in this analysis of climate change, is the creation of the Law n. 6938, of August 31, 1981, which established the National Environment Policy (Brasil 1981).

This law provides incentives for environmental protection and defense against pollution, in order to balance the environment and preserve the biota, air, natural resources, etc. Despite not specifically addressing climate change in the conceptualization of the law, one can understand that they fall into the category of environmental degradation (Art. 3, II), as denoting “adverse change in the characteristics of the environment.”

There is also needed to emphasize that some principles in the existing Law n. 6938/81 are related directly to the combat against climate change. They are presented in Art. 2 of that law and are listed as items. Let us look at the most important for this issue: I, government actions to maintain the ecological balance, considering the environment as a public asset to necessarily be secured and protected in order to allow its collective use; II, rationalization of land use, water, and air; VI, encouraging study and research oriented to the technologies for the rational use and protection of environmental resources; VII, monitoring the state of environmental quality; and X, environmental education at all levels of instruction, including community education, aiming to enable communities to participate actively in environmental protection.

It happens that this statute, although advanced for the time, only received regulation nearly nine years after its enactment, with the Decree 99.274/90 (Brasil 1990), which brought the form with which the National Environmental Policy could be implemented. For nine years,

the law has had its effectiveness limited by the fact that it provided “what to do,” but did not provide “how to do”.

So it has been the rhythm of environmental policies in Brazil and is not different in relation to climate change. Emission control is regulated by the National Council of the Environment – CONAMA – through resolutions (a kind of normative with legal value reduced, compared to the laws). This greatly hinders the access of citizens to the rules, because it is necessary that it has a very specific legal knowledge to seek regulations conducted by environmental agencies.

However, this is not a prediction of the 1988 Constitution (Brasil 1988). In its Art. 225, the Constitution says: “Everyone has the right to an ecologically balanced environment, property of common use to people and essential to a healthy quality of life, imposing upon the Government and the community the duty to defend and preserve it for present and future generations.” This is called the “principle of participation” which talks about the need for civil society to participate in the preservation, discussions, decisions, and surveillance.

This provision is important, but with the way it operates the Brazilian government today, it has not been fulfilled as it should. How to participate if the population has no access to effective legislation and regulation? How to help in the preparation of laws and regulations, if the competent organs are dressed of technicality but are influenced by economic power?

The Brazilian environmental doctrine (Milaré 2009, p. 194) states that there are three forms of popular participation in the protection of the environment:

The planning and management of the environment are thus shared between the Government and society, since the environment as a resource for the development of mankind, is, of course, one of the highest expressions of the “common good.”

There is a need therefore to examine in what extent the Brazilian legislation contemplates public participation in environmental protection.

Álvaro Mirra, in excellent exposition on the subject, points out three basic means by which social group can act:

- (i) Participating in the process of creating the Environmental Law;
- (ii) Participating in the formulation and implementation of environmental policies, and
- (iii) Acting through the judiciary.

However, it is almost impossible to have direct participation of the population in environmental issues. Not to be long on a subject that is important to this chapter, but it is not your main theme, we will analyze the situation of acting through the judiciary. There are



five types of judicial actions, which are very rare to be used by the population. The main reasons for this are related to technical or specific legal issues (for example, it is difficult to find a lawyer specialized in environmental law or afford to pay one), and the legitimacy to propose a lawsuit in this field.

Not only the citizens do not have money to afford the costs of a lawsuit, as in almost all cases, the population does not know where to turn. The five possible actions are: direct action of unconstitutionality of a law or normative act; public civil action; popular action; collective writ; and writ of injunction. In the large majority of cases, the active role (legitimacy) is carried by the Public Ministry, which overloads the prosecution, and does not solve the situation. One has to make the observation that despite not being legitimized by law, doctrine and jurisprudence can claim to be bringing collective writ by the Public Ministry.

This reflects that although the five judicial means are celebrated by the doctrine (that considers them a meaningful intervention of population), in practice this popular participation through judiciary does not exist. One of the reasons that explain this situation is amount of bureaucracy to sue with a direct action of unconstitutionality, popular action, or writ of injunction. It is very common that people would rather give up before the action. In most cases, citizens don't know who are the authorities that have the legitimacy to propose the lawsuit.

This is one of the types of political influence on the environmental determination, and they exist in all forms of public policies for the environment.

There is much political influence in the decisions of an environmental nature that Brazil has limitations for emissions of harmful gases to human health, such as carbon monoxide, but has not yet established limits to vehicular emission of greenhouse gases such as carbon dioxide. The lack of this regulation is the opposite of all global policies aimed to minimize the degradation of the environment. In addition to this, the lack of emission control does not allow that cars circulating in Brazil are more economical and efficient, which, besides polluting the atmosphere and harming the climate, imposing more costs to Brazilians, both in private cars or public transport.

Regulating vehicle emissions is not as complicated as it sounds, even in the case of the Brazilian automotive industry. The manufacturing facilities in Brazil produce engines for several countries that have already established emission limits. The Brazilian automakers

have the technology to build more economical engines, but they do not make them available to the domestic market due to a possible decrease in the profit margin, as the pieces for more efficient cars encumber production. As the cars sold in Brazil are already the most expensive in the world, market hardly would accept higher prices, which would force declining corporate earnings.

Something that is urgent is being stalled by economic interests. Since the 1980s there are discussions about the need to reduce vehicle emissions of carbon dioxide, but governments do not show concern in addressing this demand. Environmental congresses invoke that need for at least 10 years, but there is no practical advance in the regulations. Anfavea (National Association of Automobile Manufacturers) presses the government to postpone the limitations and thus gain time, as Anfavea did to delay turning airbags into required items of security, for example, or to increase the taxes for imported cars. Attitudes like these, as well as highly reprehensible, are extremely harmful to the environment, to consumers, and to the market.

We must mention that it is very important to change habits and tailor products to the needs of preserving and avoid catastrophic climate events to come, and for this reason, the limitation of vehicular emissions of pollutants of all kinds is so necessary. More economical and efficient cars pollute less, and if they do not solve completely the problem, they would help to mitigate some aspects of climate change.

Another element that draws attention in Brazil is the kind of pollutant emissions. There are considerable emissions in agricultural activities, in deforestation, fires, transport, power generation (since the policy established by the governments of Lula and Dilma directed to energy sources privileging thermoelectric power plants), etc.

The main source of emissions of greenhouse gases in Brazil is deforestation that is being decreased for five consecutive years, and in 2012 Brazil registered the least amount of these gases in 20 years. The worrying fact is that the high emissions in all other branches mentioned above was alarming, especially in the energy sector with an increase of 126 % between 1990 and 2012 (Miranda 2013).

To worse this scenario even more, after years of decline in deforestation, between 2012 and 2013, there was an increase of 28 % in the deforested area (Miranda and Nublát 2013), which incurs more emissions and worsening climate change.

The Brazilian Federal Government fails to invest in environmental enforcement, not to restrain conduct detrimental to the environment and not to encourage the prevention of environmental damage. It does not stimulate popular participation in environmental protection and also does not promote environmental education in schools. In the long term this is extremely harmful, since mankind races against time and tries to remedy the damage already installed on the grounds of lack of appreciation of the importance of the environment and climate balance.

However, some measures have enabled local governments amazing changes in this pessimistic scenario.

### **The Effects and Side Effects of Public Policies**

In addition to the principles laid down in the Constitution, it is necessary to articulate public policies in all sectors in order to make possible to solve social problems, protect the environment, and develop the economy.

These three points mentioned above are the basis for sustainable development. It is hard to achieve the point of balance between them, but it enables real progress as it combines advances in all relevant areas to society.

Brazilian public policies in general, have failed in recent years, especially considering the catastrophic results of federal government interventions since the end of the 1950s until the present time.

On becoming president of Brazil, Juscelino Kubitschek – loved or hated political figure in Brazil – motivated by interests which are not ours to comment on this chapter, encouraged what would be the biggest mistake of Brazilian history since the proclamation of the republic: the destruction of railroads and their replacement by roads. Began the works starting in Brasilia and trying to interconnect it with other cities, Juscelino did the federal government getting numerous debts – which are still being paid – for the construction of several roads to major Brazilian cities, called BRs.

The intention was to develop the national automobile industry, which until then only produced the “refined” Romi Isetta (version BMW Isetta) and Fusca (VW Beetle), both with 100 % of imported parts. Indeed, the creation of highways has greatly increased the

production, sale, and diversity of national car models; however, the negative effects were extremely devastating.

There was degradation of the Amazon forest, with numerous fires, eliminating several green areas and the beginning of landholdings in the region. This degradation affected strongly the environmental biodiversity, delivered over the years, at least hundreds of millions of tons of carbon into the atmosphere.

Some of these roads were created within areas of native vegetation, native forest that is absolutely necessary for the ecological balance. It happens that these roads ultimately attract people who did not have land in other regions of Brazil, to occupy marginal lands to BRs. The state of Pará was one of the most affected and still suffers from the almost uncontrollable deforestation. The majority of municipalities in this federal unit were created as a consequence of this road expansion, because there were no such settlements before installation of roads.

One of these newborn cities is Paragominas, Pará, near the BR-010, called the Belém-Brasília road. Planned from one of the defeated projects for the construction of the Federal Capital, Paragominas was a small town, but because of its diverse forest, mineral resources and its strategic location began growing faster than its frame stand (like Belém after the construction of the highway), and the chaos was settled.

Paragominas was known internationally by the number of homicides, by the increasing violence, environmental degradation, and the high rate of deforestation. As a way of getting this scenario worse, another activity developed in the region was the production of charcoal, highly polluting and greenhouse gas emitter.

This city was the example of chaos and lack of public intervention, both in environmental and climate issues. The emission of gases arising from fires and charcoal production contributed not only to the increase of global temperature but also to the occurrence of respiratory problems in the population, especially in the summer season (in the Amazon there is only summer and winter), when the proliferation of smoke coming from those predatory activities was common.

However, with a well-succeeded articulation between the city government, the state government, farmers, and population, Paragominas radically changed its course. Currently, it is known as a fine example of the performance of the government that can change the

reality of a place and positively modify the relationship between man and nature. The deforestation started to be near to zero, and the deforestation area was 0.032 % in 2012 (Instituto Ethos et al. 2013).

Government intervention occurred in several areas, as has been well elucidated by a Brazilian magazine of general circulation (Barbosa 2011):

Over time, the project that was born of a social pact was expanding partnerships with government institutions and the private sector. Then Paragominas decided to be the first municipality in Pará to monitor and verify deforestation, in a partnership with the Institute of Man and Environment of Amazon (Imazon). In one year they achieve a reduction of almost 90 % in deforestation. In March 2010, the Ministry of Environment announced the exclusion of Paragominas from the list of the largest Amazon loggers.

Currently, the city has 66 % of preserved forests and vast extension of Permanent Protection Areas in agricultural properties. Inspired by the social and environmental transformation of Paragominas, 94 other municipalities of Pará today develop similar initiatives.

“Before, to grow, we were destroying the forest. Now, we are the municipality that restores more green areas in the Amazon,” boasts Demachki. The importance of preserving the environment is diffused by a program of environmental education in schools. “It is our mission and converge arms and minds towards social development and environmental preservation,” says.

This successful example was adopted as a reference to 11 other cities in Pará (Carvalho 2011), which joined the Green Cities Program of the state government in order to get out of the list of cities that most deforest the Amazon forest.

The most important lesson that can be drawn from the case of Paragominas is that it is possible to recover highly environmentally degraded areas, help the planet, and interfere positively to the reduction of global warming, without harming economic growth. The ones who visit the city have a good surprise to find that it is a lively, cheerful, well-urbanized, organized city, with a dynamic and growing economy, where the population have excellent quality of life.

However, such results would be much easier to achieve if they would not be dependent on the political will. What occurred in that city is a reflection of a good relationship between all sectors of society, with the collective effort to balance a state of degradation.

The global challenge of public policies related to climate change is exactly the same that was in Paragominas: changing paradigms of using natural resources so that people can live better. Although, in a global scale, local differences between political groups are replaced by very expressive differences between countries and economic forces, which defend at all costs to maintain current dynamics that cause environmental problems.

Something has to be done urgently. However, one cannot expect that people individually can solve the problem of climate change, because the major causes for greenhouse gas emissions are not only the individuals. Governments need to intervene in an integrated and systematic way. But it seems that countries are waiting to see who will be the first to take steps in this direction. No nation is truly committed to tackling climate change without first checking if other competing countries will.

The restriction of pollutant emissions is often misunderstood because it's seen as implying a decrease in industrial capacity and production of a country. But this is not true, if we observe that what is needed is to check the other alternatives and doing so to prevent recession or economic downturn.

Paragominas reached a stable social and economic level, even without degrading nature, and keeping their activities into new ecological standards. If it was possible there, it is possible globally. Undoubtedly it was possible using a tool often overlooked and discredited, called "public policy".

## **Conclusions**

National environmental laws, combined with effective and integrated public policies created by the dialogue between producers, investors, local power, and population, can effectively contribute to an improvement in climate change solutions.

International law and treaties will only have effect if built on a structural transformation of industrial production and ways to maintain, or improve, economic context of the signatory countries, never forgetting that there are indeed less polluting alternatives and viable solutions.

Paragominas managed to continue growing and producing wealth, however, without destroying and degrading the municipal area, preserving the environment and health of all citizens. This is possible globally, if there is the participation of companies and local governments, sharing good examples and building a more positive reality for all.

## References

Alves F, Caeiro S, Leal Filho W, Azeiteiro U (eds) (2014) Special issue on “Lay rationalities of climate change”. *International Journal of Climate Change Strategies and Management*, vol. 6 n. 1, pp. 2–4. Emerald

Barbosa V (2011) Paragominas: inspiração verde no Pará. Available in: <http://planetasustentavel.abril.com.br/noticia/desenvolvimento/paragominas-inspiracao-verde-645308.shtml>

Brasil (1967) Lei 5197, de 3 de Janeiro de 1967. Available in: [http://www.planalto.gov.br/ccivil\\_03/leis/15197.htm](http://www.planalto.gov.br/ccivil_03/leis/15197.htm).

Brasil (1981) Lei 6938, de 31 de agosto de 1981. Available in: [http://www.planalto.gov.br/ccivil\\_03/leis/16938.htm](http://www.planalto.gov.br/ccivil_03/leis/16938.htm)

Brasil (1988) Constituição da República Federativa do Brasil de 1988, promulgada em 05 de outubro de 1988. Available in: [http://www.planalto.gov.br/ccivil\\_03/constituicao/constituicao.htm](http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm)

Brasil (1990) Decreto nº 99.274, de 6 de junho de 1990. Available in: [http://www.planalto.gov.br/ccivil\\_03/decreto/antigos/d99274.htm](http://www.planalto.gov.br/ccivil_03/decreto/antigos/d99274.htm)

Carvalho C (2011) Onze cidades já seguem modelo de Paragominas contra o desmatamento da Amazônia. Available in: <http://oglobo.globo.com/politica/onze-cidades-ja-seguem-modelo-deparagominas-contradesmatamento-da-amazonia-2687290>

Geertz C (1983) *Local knowledge: further essays in interpretive anthropology*. Basic Books, New York.

Instituto Ethos, Rede Nossa São Paulo, Rede Social Brasileira por Cidades Justas e Sustentáveis (2013) Paragominas combate o desmatamento e vira exemplo de sustentabilidade na Amazônia. Available in: <http://www.cidadessustentaveis.org.br/boas-praticas/paragominas-combate-odesmatamento-e-vira-exemplo-de-sustentabilidade-na-amazonia>

Milaré É (2009) *Direito do Ambiente: a gestão ambiental em foco*. Revista dos Tribunais, São Paulo

Miranda G (2013) Emissões de gases-estufa no Brasil em 2012 foram as menores em 20 anos. Available in: <http://www1.folha.uol.com.br/ambiente/2013/11/1368065-emissoes-de-gasesestufa-no-brasil-em-2012-foram-as-menores-em-20-anos.shtml>. São Paulo

Miranda G, Nublát J (2013) Desmatamento na Amazônia sobe 28 % em 2013. Available in: <http://www1.folha.uol.com.br/ambiente/2013/11/1371434-desmatamento-na-amazonia-sobe-28-em-2013.shtml>. São Paulo

## **Publication 2**

**“Public Policies and Education for Biodiversity: Brazilian Challenges in a New Global Context”**, published in “Biodiversity and Education for Sustainable Development”, 2016.

Thiago Lima Klautau de Araújo



# **Public Policies and Education for Biodiversity: Brazilian Challenges in a New Global Context**

Thiago Lima Klautau de Araújo

## **Abstract**

This chapter aims to analyze Brazilian education and public policies for environment and biodiversity through three main points of view: (I) legal, by collecting and reviewing laws and other types of norms; (II) organizational and administrative, by considering the regulation of the subject through the creation of agencies, decisions of investments and planning to operate the public environmental policy, through an analysis using Game Theory and Marginalism; and (III) participation by the population, analyzing their contributions to the environmental field. This review allows us to understand the possibilities of environmental education (formal and informal) in the Brazilian context and the challenges that require a transformation of the present paradigm. To illustrate a good example of an integrated environmental education system, the Escola Bosque was chosen, as an internationally awarded initiative for its positive impact on education for biodiversity and the environment. Finally, new trends and some possible changes in public policies for environment and environmental education are suggested.

**Keywords:** Environmental law; Education for biodiversity; Public policies; Game theory; Brazil.

## **1 Introduction**

With a significant number of ecosystems, Brazil is considered to be the richest country in terms of biodiversity, with 25 % of all species existing on the planet (Kageyama 2009). The Amazon, Pantanal, and Atlantic Forest are three examples among many others that contain hundreds of thousands of animal and plant species. These biomes correspond to 49.29, 1.76, and 13.06 % of the Brazilian territory, respectively (IBGE 2004). For that reason, ecologists from all over the world try to study Brazil's diversity before deforestation takes over and eliminates an incalculable number of those species and others still undiscovered (Fig. 1).



(Fig. 1 - Mapa de Biomas do Brasil. IBGE 2004)

Pressures from the international community and Brazilian society forced the Brazilian State to change environmental laws and include this subject in the new Constitution. However, despite the rhetorical advances in those laws, very few—or none—have become reality. For that reason, Brazilian environmental and biodiversity policy has failed and many doubts remain about the ways Brazil is dealing with environmental dilemmas and challenges, as will be seen in this chapter. Deforestation, for example, is still growing and its consequences are devastating not only locally, but also globally because it affects living ecosystems on the planet.

After the “Plano Real” (creation of a new currency and other public policies to deal with inflation, in 1994) investments in the environmental area increased, but the results have not lived up to expectations. Currently, with its economic and political crisis, Brazil is facing problems with its public budget, which lead to financial cuts, including in environmental policies. At this moment, there is thus a huge degree of uncertainty about the future.

This chapter provides an analysis based on Brazil’s environmental law system and its public policies in order to establish a general overview about what has been done until the present, also identifying new trends for the future. Although the focus is on environmental and

biodiversity education, an effort will be made to understand the functioning of that system as one of the decisive dimensions of public policies.

In this context, this chapter is organized into five points. The first performs an analysis of the current legal system and its peculiarities, in order to identify the changes (or lack of changes) in paradigms. The second questions the efficiency of environmental public policies in dealing with Brazilian environmental challenges, particularly deforestation and environmental degradation. The third analyzes the interactions between environmental agencies and their efficiency using the Game Theory and Marginalism. The fourth point is a reflection about environmental education, its role and the means for implementing it. Finally, the last one will highlight possible ways for adjusting those policies in the near future.

## **2 Brazilian Environmental Law: A New Perception (?)**

The new environmental context that has emerged all over the world in the last four decades, especially concerning climate change and biodiversity preservation, has compelled the Brazilian legal system to adapt itself to the new trends. Law 6938/81 and the new Brazilian Constitution (CF/88), enacted on October 5th, 1988, brought a new perspective to environmental law and to biodiversity. Fauna, flora, and ecosystems were raised to another level of protection, and from that moment on they were considered as important to all society and as a common right. Before these two legal milestones, nature was protected in most cases merely as a thing, as property of the government. Thus, the protection goal was to save economic interests and not to conserve nature (Chiuviute 2010). Especially with the CF/88, popular participation in the process of drafting public policies, laws, surveillance against pollution (of all kinds), and deforestation began to be taken into account. From a legal point of view and according to CF/88, art. 225, society, along with the government, began to be holder of such rights and duties. This constitutional article, by the way, is the main environmental law reference in the Constitution. However, its assumptions were conditioned by the need to create supplementary enabling regulations, and that is one of the biggest problems with the Brazilian legal system. The Constitution brought a significant innovation to environmental preservation by introducing the need for new relations between governments (Federal, States, and Cities), society, and nature. Even with this new approach, constitutional provisions could not be applied instantaneously. Just to mention the case of

this article (CF/88, art. 225), its complementary regulation came almost twelve years later, with law 9985/2000. A few years later came MP 2186-16/2001 (substituted by law 13123/2015) and law 11105/2005. Those norms represent the main regulatory system for the environmental law provided in the Constitution. As it can be seen, there was a vacuum between the first steps and the possibility of enforcing constitutional rules. Nevertheless, deforestation and environmental degradation have not been halted during all those years since the new Constitution, and even after this complex system was implemented, the results in this area reveal that biodiversity in Brazil is still highly endangered.

Despite all the legislative efforts, the higher number of laws has not been translated into an eco-friendlier situation in the Brazilian dynamic. As said at the beginning of this point, since the 1980s the law system has brought a new and different perception about the environment. But the complexity of the instruments for conserving fauna, flora, ecosystems, and natural resources is so high that the results are totally the opposite of the original law's purposes. Participation by the community is limited because although citizens can contribute to building a better way to manage nature in their home areas, in most cases, they lack the technical knowledge for interacting with the government or for taking legal or out-of-court action (Klautau de Araújo 2014).

It is important to highlight the fact that the regions in Brazil that own the largest share of biodiversity are among the poorest and most disconnected from large urban areas. In those places, populations suffer from lack of schools, health centers, electricity, roads, piped water, sewerage, sanitation and also internet, television, phones and cell phones. It is not possible that environmental preservation will be a priority for populations in this context where basic needs are still not satisfied.

More than the government's desire to be modern, laws must be adjusted to the social and economic situation, in order to have the needed connection with the "real" world, not to mention the necessity of being feasible. Otherwise, the law will be simply a wish list, without any effectiveness. Those two sine qua non conditions do not always receive the proper attention from the authorities. It is time for an important reflection: is Brazilian legislation really evolving its perception in order to solve environmental problems, or is it merely an outward change to ease the pressure made by environmentalists and other sectors of society?

### **3 Public Policies for Biodiversity: Is Brazil Really Doing All that Is Needed?**

The answer to the last question of the previous topic is not found in the laws, but arises when one analyzes public policies. Very few actions have been taken to turn legal provisions into concrete results. This reveals an unexpected side to those laws: the government's evasion of its responsibilities. As awkward as the last phrase may sound, the different levels of government in Brazil are receiving considerable pressure from all parts of society and from the international community, both worried about increasing deforestation, losses of genetic assets, climate change, etc. As a response to those critics, the government did create laws, but did not execute them properly, or did not create instruments to make their enforcement possible. Equipped with a huge and strong bureaucracy, the different levels of government in Brazil do not display a disposition to turn legal provisions into reality. For example, the National Solid Waste Policy—law 12305/2010—in its art. 54 set a deadline for extinguishing solid waste dumps. This deadline expired in August 2014, at which time 60 % of the cities in Brazil had still not complied with the law (Torres 2015). Examples like this are numerous. Brazil still has a legal culture that views laws as a priority and the solution for all institutional problems. Things are indeed changing, but this conception that laws in themselves can bring about change remains very present today.

The law itself is not a solution, especially when it is related with the environment. Without surveillance, prevention, repression, and other investments such as education, it is impossible to stop environmental degradation. The law is merely a legislative framework to be combined with duly planned and appropriately adjusted public policies. Perpetual investments are needed for protecting Brazilian biomes, and a considerable portion of the criticisms leveled at the governments are directed exactly to the issue of financial resources applied to nature conservation. Despite that, the federal government has recently announced a 72 % reduction to the budget against deforestation in the Amazon Forest (Leite 2015), even after a 282 % increase in deforestation seen in February 2015 compared with the same month in 2014 (de Castro 2015). The future is really uncertain, as the political and economic crisis advances in Brazil in 2015, and other cuts in the budget for 2016 and the following years have already been announced.

The main problem with public policies in Brazil—in general, and not only related with environmental issues—against deforestation, the results of one policy can appear quickly,

but can be that they are not considered as a State Policy, but as the Policy of a specific Government. That means a lack of planning and vision in the long term. The way Brazilian Governments, at different levels, treat some problems is often by giving them “solutions” that can be managed in four or eight years (the time for one term of office, or two if the president, governor or mayor is reelected). But it is incorrect to think that this way of acting will solve the structural problems we are facing concerning environment and biodiversity. In some subjects such as protection only be maintained if there is a long-term planning to keep that policy working. In other cases, the results only appear many years later, as it is the case of reforestation. However, in almost all situations related to environmental and biodiversity law, investments and planning must emphasize long-term strategies and actions to achieve, but above all, to maintain results, since it is easier to prevent damage than to recover from it because environmental recovery is not always possible.

This instability is not the only guilty scenario for the failure in Brazil’s environmental public policies. The segregation between related areas contributes to results to be even weaker. What is the point of having separately a National Environmental Policy (law 6938/81), Law of Access to Brazilian Genetic Assets (“Biodiversity Legal Framework”, Law 13123/2015), National Policy for Environmental Education (Law 9795/99), and Climate Change National Policy (Law 12187/2009), among other related public policies/laws? All of them approach different aspects of the same subject: environmental law and nature conservation. If one of those actions is taken without consulting the other parts, its effects will probably not be as accurate as they should. If the different government sectors act in different ways, their public policies may nullify each other.

When analyzing the issue more in depth, we can see there is an almost total overlap of responsibilities between the components of SISNAMA (National Environmental System), established by art. 3 of Decree 99274/90. For example, ICMBio (Chico Mendes Institute for Biodiversity Conservation), whose purpose is listed in article 1 of Law 11516/07 is almost identical to the duties of IBAMA (Brazilian Institute of Environment and Renewable Natural Resources), set out in article 2 of Law 7735/89. There are also: the SBF (Brazilian Forest Service), with functions similar to those of the previous institutions, but restricted to forest issues (art. 55 of Law 11284/2006) and the Environmental Education Governing Body (arts. 2 and 3 of Decree 4281/2002). In addition to these, there is CONAMA (National Environment Council), a consultative and deliberative body, which has its tasks set out in

art. 7 of Decree 99274/90. There are many other agencies that play very similar roles to those, but with more specific and limited competences.

This is not to say that the specifics of these organisms in the environmental problem approach should be forgotten. On the contrary, they must be promoted in an integrated, articulated, multidimensional system that meets the specific characteristics and their interdependencies without losing sight of the whole.

For those reasons, what are the advantages of having so many public agencies with almost the same functions? For example, IBAMA and ICMBio have police powers and duties that involve monitoring, protection, preservation, and promoting environmental education. With the exception of police power, the SBF has the same functions for forestry. Assignments that distinguish these three agencies are perfectly amenable of being performed by only one of them. The segregation of duties brings huge financial losses, lack of efficiency and harm to the public, and above all, to nature. The financial losses are due to the maintenance of multiple separate institutions that perform similar functions involving additional infrastructural expenses as well as commissioned positions, and other administrative costs that do not contribute to improve the quality of the public service. The loss of efficiency due to this separation is evident by the fact that specialization, in some cases, is so great that the lack of communication between the agencies can cause damage and raise barriers to public policies implemented by the same government. Also, agencies that have the same competence when working separately, as demonstrated by the Brazilian experience, not only do not improve performance, but also decrease it. The damage to the population can be checked through the increase in deforested areas; the enormous amount of time and bureaucracy that is needed to license environmental projects, lack of environmental law enforcement, and others. This is loss for local populations and a global loss for humanity.

The lack of tools that enable law enforcement brings severe consequences to the effectiveness of the proposed measures. Even when there is enforcement (which does not always happen), the flexibility of Brazilian law ends up generating a high rate of impunity for polluters and those who harm biodiversity. Between 2011 and 2014, only 8.7 % of the total amount of fines imposed by IBAMA were paid (Geraque and Mena 2015), which shows that offenders benefit from system's slowness and extreme bureaucracy, which drags out payment of fines for years. However, even if those fines were paid promptly, that would not

be enough to curb avoidable environmental damage because their amounts are very low. Some data show that it is much cheaper to pay fines than to take measures to prevent environmental damage as we may see in the recent example of the environmental disaster that occurred in November 2015, in the city of Mariana, Minas Gerais. A catastrophe resulting from a dam holding toxic waste was breached, and the resulting mud advanced along the Rio Doce and reached the sea; Samarco (the mining company responsible for the barrage) was fined in R\$362 million (approximately US\$100 million), while the insurance would have cost US\$1 billion (Oliveira 2015).

The Mariana case is emblematic for several reasons. The damage to the environment and populations is incalculable, as many experts believe that the life of Rio Doce was decimated by heavy metals found in the river water (Redação G1 2015). Water cannot be used for irrigation and drinking, and the mud spot already extends for several kilometers along the ocean shore, also threatening marine biodiversity. The first information conveyed by the media reported that the breach occurred due to the negligence of the company with dam conservation and lack of control by the competent state bodies. This should be investigated in more depth, but all indications suggest that these assumptions are real. Brazil currently has 16 high-risk dams, which, if breached, can affect the basins of the Paraguay River (in the Pantanal), the Amazon River (in the Amazon Forest) and the São Francisco River (Sanchez 2015). If there is an incident, we will probably witness an environmental apocalypse in Brazil.

So, while the environmental legislation does not fit Brazil's reality and ways for applying it are not created, situations like the Samarco disaster will occur and the damage will be irreversible, with harm to future generations. Especially in what concerns biodiversity, investments in environmental education will be useless if the government does not act in environmental preservation. Concerned citizens are fundamental for the improvement of environmental conditions, but they cannot replace the role of the state.

In a new global context, where societies demand more efficiency from governments (do more, spending less), maintaining different committees, consultants and executive authorities, and hundreds of public employees working in related roles in an uncoordinated way is not only unnecessary but also counterproductive. It would be much more effective and cheaper if the government creates a special agency to manage environmental issues in a



coordinated, planned, and unified manner, joining forces to implement responsible public policies that show awareness of environmental problems and all their implications for the communities involved. Of course, it is necessary to ensure two aspects in this conception: the focus in planning and execution must combine all dimensions of environment, promoting coordinated actions in order to deal with current challenges; there is also the need to decentralize the decision process, providing a real opportunity to involve local communities in participating in the establishment of public policies, that must be rooted in the specific contexts where they will be performed. This last point is essential in Brazil's case, as the huge territory has its specificities that cannot, under any circumstances, be disregarded at the risk of causing incalculable harm. This has been the case with the Amazon Forest in the past (Klautau de Araújo 1995). In Brazil, at this moment we may observe the opposite: planning and execution are dispersed, and the decision-making processes are centralized.

Nature and biodiversity must not be seen as a duty or a heavy weight for all society to carry, but as an opportunity to grow economically and provide equality in social issues, while preserving nature. These are the three aspects of sustainable development. Destroying natural resources is the shortest route to the bottom in all aspects. Nowadays, Brazil is exploiting its forests, minerals, and oil without creating a productive chain that will make it possible to create jobs, adding more value to the products and providing financial resources to the government. Only this sustainable strategy that integrates the population's needs with responsible natural resources management and their preservation can help to reduce the need for forest devastation.

#### **4 Game Theory, Marginalism and the Inefficiency of Environmental Agencies in Brazil**

The Brazilian Constitution of 1988 raised Environmental Law to another level. One way to promote the environment preservation was to assign supervisory tasks and responsibilities to various federal agencies, states, and municipalities, as well as to the citizens and the Public Prosecution Service. In other words, the environmental issue has been expanded in order to all of society be able to participate in their conservation, preservation and restoration. Federal environmental agencies end up having their obligations and powers coinciding. In the view of the legislator, all of these shared responsibilities could actually provide ways for improving environmental surveillance and enforcement.

	B – with umbrella	B – without umbrella
A – with umbrella	0, 0	0, 1
A – without umbrella	1, 0	-1, -1

(Table 1 – The umbrella game)

Nearly thirty years after promulgation of the new Constitution, there have been many advances in environmental issues, but still far from what was expected. Environmental agencies are extremely criticized for their inefficiency by environmentalists and other sectors of society. But, how can the expansion of supervisory responsibility to many other agents reduce efficiency? Game theory and Marginalism can help in understanding this problem.

One can characterize the existence of numerous agents with similar functions in solving the same issues as a cooperative game, given that the performance of any of them can be influenced by the others. In short, this is similar to the Battle of Sexes Game (McAdams 2008) or a variety of the Umbrella Game (Fudenberg and Tirole 1991). Mixing elements of these two games, let us suppose a situation where two people in the same building will meet and go out, the possibility of rain is uncertain, and beyond the fact that they can get wet, there is also the inconvenience of carrying the umbrella. If there is no communication about the subject between the players, the game would go this way, on the assumption that, in fact, it will rain (Table 1).

Taking the umbrella implies getting less wet but carrying it is a disadvantage, so it is valued as 0. If neither of them brings the object, both players will get wet so the value is  $-1$ . But if one of them takes the umbrella and the other does not, the one who does not carry achieves a better result, because he will still be relatively dry, but did not have the effort of taking the object. For that reason, the best possible result for A or B only occurs for one of them if there is no action by one and the other simultaneously acts. Therefore, the most likely outcome of the interaction is that both get wet, as the best outcome involves the omission of conduct. This is the total opposite of the legislators' intention when the Constitution and laws were made. Instead of providing an increase in enforcement, there has been a lack of accountability for the environmental agencies.

Analyzing the performance and overlapped competences imposed on different environmental agencies it is possible to draw a parallel between this situation and the Umbrella Game. In matters in which agencies A and B have concurrent jurisdiction (a choice made in the legislation so that both can monitor and act), the most likely outcome is that

neither of them will fulfill their role. This is because action by the agencies against environmental degradation generates budgetary costs and institutional and political friction. Furthermore, the text of the legislation is vague, the population is unaware of the legal system in most cases, and there is a plethora of agencies with environmental responsibilities in Brazil (besides the federal level, there are 26 states, the Federal District, and 5570 municipalities). So, it is quite easy for them to avoid accusations of inaction or incompetence by dodging their responsibilities and passing them on to other agencies.

On the other hand, the Marginalism approach could also provide a basis for understanding the inefficiency of numerous environmental agencies, whose numbers have actually increased over the years. In short, one of the assumptions with Marginalism is that the addition of a factor, at a certain point, begins to reduce its efficiency until it loses its usefulness and begins having a negative contribution to the system/individual/production (Marshall 1996). In an analogy with the Brazilian environmental system, the dispersion of investments among different players, instead of strengthening a limited number of environmental agencies, may be a hindering factor and significantly reducing the efficiency of public policy in the sector.

### **5 Education for the Environment and Biodiversity: The Way Beyond the Classrooms**

Disrupting educational paradigms is a complex task. When one adds the fact that the system is immersed in a scenario of unstable planning and disjointed (or even contradictory) public policies, those paradigms become almost insurmountable barriers. Brazil is not able to meet its goals for improving education indicators and is also failing to provide an acceptable education to the population. Many schools in the countryside have lack of teachers, school meals, and basic structure in classrooms, not to mention the frequent lack of transportation to the schools. How can a child have a good school performance if she or he has to face hours getting to school, braving mud, rain, sun, and even dangers along the way? In such a chaotic scenario, it is unthinkable to have an education with quality for biodiversity and environmental protection.

Only with an educational system that works properly it is possible to establish an efficient environmental education for biodiversity. The classroom is the first step in order to prepare future ecological citizens in a context where basic needs are guaranteed. That is not the case

in Brazil. There are many things to be done, many involving investments in several areas mentioned earlier in this chapter: conservation, forest management, biodiversity research, offering economic alternatives for local people, labor qualification, environmental monitoring, improving life conditions, integrated vision of public policies, etc. It is necessary to create conditions for environmental education to flourish and these conditions at present are far from being achieved.

The law for the promotion of environmental education was created in 1999 (Law 9795/99) and has been harshly criticized by some authors, namely Antunes (2010). Since that law was passed, very little has been done with its new guidelines in order to integrate them into formal and informal Brazilian education. Another situation that deserves attention and reflection is that there was no provision (in the law) for creating a school curriculum in “Environmental Education” (Machado 2014).

Brazil is too large to have standardized policies for all regions, especially in environmental education. Consequently, it is rather common to teach other regions contents and specificities. However, it is very important to wake students’ interest with issues closest to their reality, namely achieving an appreciation of the country’s biodiversity. It turns out that this centralization of decisions ends up transforming environmental education into something very distant and unattractive for children and young people. In the long run, there is even disunity between regions. The North, Northeast and Central West have various topics about the South and Southeast in their content, but the reverse is not true. So those three more marginal regions are truly unknown to the South-Southeast, the wealthiest part of the country.

The main challenge in implementing environmental education is, therefore, the practical definition of what should be done to make it happen. The legislation is extremely vague, both in concepts and in establishing policies, and does not point the agents to their specific purposes. Instead of it, the law makes all actors responsible for everything. In fact, the wording of the legislation exempts agencies from responsibility, so that they do not act on the assumption that the other co-guardians will act. However, even if the agencies were responsible for specific parts of the implementation of an environmental education policy, the situation would hardly change, since in practice this policy is nothing more than a letter

of intent that has no substance to be transformed into reality, due to the law's imprecision and lack of enabling instruments that can materialize it.

Within this context there are only a few individual examples of success. Among the experiences in environmental education and biodiversity in Brazil, the "Escola Bosque" deserves to be highlighted. Initially created to be installed in the city of Belém, Pará, the concept was also taken to the archipelago of Bailique, Amapá in the Amazon River estuary. The latter effort was more successful in maintaining longer the social-environmental method developed by sociologist Mariano Klautau (Klautau de Araújo and Lima 1997a). The Escola Bosque won numerous national and international awards for innovations adopted, from planning and execution until the formation of the first classes. The population has always participated in decision-making, which was an important factor for the community to embrace the project and its guidelines were laid down privileging the location of the town and the population involved (Klautau de Araújo and Lima 1997b). Later, the school was built based on six points, four of which are highlighted: (1) integration of the buildings architecture in the landscape, using local materials and improving local construction techniques; (2) local recruitment of workers; (3) disciplines focused on learning aspects of the locality in addition to conventional educational curriculum; and (4) implement training plans for community teachers (Klautau de Araújo and Lima 1997c). These features, added to the fact that the school was sustainable, taking advantage of the sunlight, rainwater and its area to plant foods, transformed the school into an attractive hub for the whole community. Families participated in numerous activities, sharing and building knowledge with students, and some courses were geared to families, such as new planting techniques and crops, use of leftover food, composting, recycling, etc.

As a result, the project made possible the reduction of environmental degradation and child and families malnutrition, combined with an improvement in school indicators and health indices. Another aspect to be noted is that young people were no longer forced to move to the state capital if they wanted to continue their studies (Lima 2013). They could stay in Bailique and obtain professional qualification in addition to regular education, in areas such as Flora or Fauna Management, Ecotourism, Mineralogy, Archeology, Traditional Fishing, and others (Klautau de Araújo and Lima 1997a). The dynamic generated by this educational project for the environment was an example of sustainable development.

The Escola Bosque was a revolutionary project, but it was implemented as a Government Policy and at the end of the governor's term in Amapá the project was closed with regard to its primary philosophy, and the social-environmental method was discontinued. The Hotel Escola Bosque, for eco-tourism and hotel management training was also abandoned. The building was ready and equipped, only awaiting the formal opening. Today it lies in ruins in the jungle (Lima 2013).

This is the fate of all public policies that are not assimilated as State Policies. It has to be understood that Brazil is larger than any political dispute and that every day that we lack a coherent and sustainable public policy for biodiversity we lose an invaluable amount of species and natural resources that will be missed in the future.

## **6 Possible New Paths for Preserving Brazil's Biodiversity**

As seen in the previous topics of this chapter, there may be numerous alternatives for the preservation of biodiversity, but almost all of them require effective public participation. More than listening to people or winning their adherence to the projects and actions to be taken, it is very important to involve them in all the stages of the process in order to promote their understanding of public policies that are designed to protect the interest of all society. When citizens engage they become the main protectors and inspectors of nature, supporting the state in vigilance against environmental damage. In addition to this fact, there is also the important aspect that changes in individual behavior and interaction with nature that on a larger scale are crucial for achieving the status of an ecological society.

However, for such targets to be met, all levels of government in Brazil need to organize their public policies and join efforts in carrying out public policies and achieving paradigm shifts. After observing the current policies and system failures, some ideas are provided here to highlight suggestions for possible future paths.

The first measure that can be suggested is the creation of a unified law broadly covering the environmental issue. As there is a Civil Code, Criminal Code, etc., it is necessary to create an Environmental Code. Milaré (2014) states that codification of environmental law in Brazil will be a necessary step for providing legal certainty to this area. Considering this context, the mentioned need is highlighted by the fact that the sparse legislation, in its current state, causes two major problems: disarticulation between the different environmental policies,

because they are treated as entirely separate issues for each one of the laws; and the great difficulty with handling such legislation, because it requires expertise that is not readily accessible to the population. The law itself does not solve environmental issues, but bringing in a more streamlined legislation can democratize access to it. There are several cases where people commit environmental crimes simply because they do not have information about the law, and it is quite common for people not to know whom to seek out when they become aware of any irregularity.

An advanced technical knowledge is required, and the cost of hiring a lawyer with experience in environmental law is high, which may make it impossible for some people to do so (Klautau de Araújo 2014). There are cases where political organizations fund the hiring of such professionals, but merely as a means of political bargaining and to influence those populations. This politicization of environmental issues causes damages in the implementation of environmental law and creates prejudice against the needed awareness among some part of the population and law professionals. Thus, the creation of codified legislation could facilitate people's access to rules and authorities, untangling the procedures and making the mechanisms of state action more transparent.

The second suggestion is the creation of a government body that concentrates the State's actions in the environmental and biodiversity areas: e.g. preventive and educational actions, enforcement and surveillance, application of fines, regulations, etc. From planning to execution and evaluation of public policies, this body would concentrate both advisory and executive roles. This concentration of competencies is crucial to correct the present lack of coordination of public policies.

In other words, this institution would require the fusion of the existing ones, as CONAMA, IBAMA, ICMBio, SBF, as well as other environmental agencies, consultative and deliberative, with the aim of developing public policies and join forces towards maximizing the efficiency of State action. Currently, the budget for environmental policies is so dispersed among several government bodies that their performances are increasingly restricted. By incorporating all institutions into a single one, there will be savings with costs, maintenance, and commissioned positions, decreasing administrative expenses, enabling investment to achieve its primary function: preservation of the environment, biodiversity, and promotion of environmental education.

This is essential in the current situation in which Brazil finds itself. The government is going through great difficulties to control its spending and avoiding finishing 2016 with a deficit of more than R\$30 billion (Martello and Passarinho 2015). One of the areas that suffered a budget cut, as mentioned earlier in this chapter, was the fight against deforestation. Reducing investments in environmental protection while maintaining administrative spending is an almost surefire recipe for a future environmental disaster. Instead, the costs could be optimized with this alternative unification of environmental agencies.

The third suggestion is to create a public company for the administration of all products and ecosystem services obtained from Brazil's biodiversity and biodiversity research. This is essential to achieve nature conservation. The exploitation of these resources, if not managed by the State, will be handled by private companies, irregularly and without adequate financial return for the country. The rich Brazilian biodiversity is the passport to a future of development, quality of life, and good public services. Thus, much more than an environmental issue, the management of genetic resources is essential to national sovereignty.

Law 13123/2015 in its art. 20 provides that the payment of royalties in return for the use of genetic resources, will be up to 1 % of gross revenue, but can be reduced to 0.1 %. In the current legal scenario, this insignificant amount goes through an intricate system—that will never work in practice—and the country will give away its rich genetic heritage almost for free.

Once Petrobras was created it contributed decisively to the scientific and economic development of the country, a public company that manages the genetic heritage can earn billions of dollars, and assist in environmental conservation and economic development of the regions that hold biodiversity. One has to understand that decisions of this scale cannot be postponed: either Brazil takes on a new position and begins profiting from biodiversity resources as a way to preserve nature, or Brazilian biodiversity will be lost without leaving any concrete benefit for the country.

It is not possible to predict the future, but the current indicators are very disturbing. The decrease of forests in Brazil has begun to have consequences even for large cities, as seen in the water crisis faced by the Southeast. Studies show that deforestation in the Amazon Forest lowers the flow of moisture from the air inside Brazilian territory, which reduces rainfall in



the Southeast (Carvalho 2014). The paths followed so far have been seriously distorted from their original purposes. Brazil continues failing to accomplish environmental education; the forests degradation is increasing; the population still does not get involved; time keeps ticking and the situation only gets worse. The presented suggestions highlight a new Environmental Law that supports an integrated and multidimensional intervention as an alternative to a system with serious operational limitations that needs to be simplified urgently, in order to become closer to reality.

## **7 Conclusions**

Brazil has an advanced legislation for the environment. However, the complexity of terms and the high numbers of laws, decrees, and other regulations, turn Brazil's environmental law system into a truly inaccessible instrument to enable society to cooperate with the state and cope with environmental challenges. More than that, the governments have not been able to implement legislation.

One of the reasons why this happened was the lack of coordination between different environmental agencies. Erroneously it was thought in the 1980s that more institutions taking care of the environment would represent more efficiency in nature conservation. Almost thirty years after the New Constitution, the results have proved that this conception is very expensive and has not achieved expectations.

All of the structure, complexity, and inefficiency of Brazilian environmental law and public policies systems are disabling implementation of environmental education. For that reason, a deeper reflection is needed to involve society in this process and to build a more ecological society, where biodiversity and the environment are important to the educational system.

There are many possible paths that Brazil may find to solve these problems. This chapter has pointed to three feasible options, but the debate is always open in order to refine the environmental scenario in Brazil. A better and more sustainable country can be a reality in a near future if society wants that. Many reforms have to be made. Brazil is a reference in terms of its natural wealth and can become an example of nature conservation, ecological economic growth, and satisfactory living conditions.

## References

- Antunes, P. B. (2010). *Direito Ambiental* (12th ed.). Rio de Janeiro: Lumen Juris.
- Brasil. (1981). Lei nº 6938, de 31 de agosto de 1981. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Leis/L6938.htm](http://www.planalto.gov.br/ccivil_03/Leis/L6938.htm)
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988, promulgada em 05 de outubro de 1988. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Constituicao/Constituicao.htm](http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm)
- Brasil. (1989). Lei nº 7735, de 22 de fevereiro de 1989. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/leis/17735.htm](http://www.planalto.gov.br/ccivil_03/leis/17735.htm)
- Brasil. (1990). Decreto nº 99274, de 06 de junho de 1990. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/decreto/antigos/d99274.htm](http://www.planalto.gov.br/ccivil_03/decreto/antigos/d99274.htm)
- Brasil. (1999). Lei nº 9795, de 27 de abril de 1999. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/leis/19795.htm](http://www.planalto.gov.br/ccivil_03/leis/19795.htm)
- Brasil. (2000). Lei nº 9985, de 18 de julho de 2000. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Leis/L9985.htm](http://www.planalto.gov.br/ccivil_03/Leis/L9985.htm)
- Brasil. (2001). Medida Provisória no 2.186-16, de 23 de agosto de 2001. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/MPV/2186-16.htm](http://www.planalto.gov.br/ccivil_03/MPV/2186-16.htm)
- Brasil. (2005). Lei nº 11105, de 24 de março de 2005. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_Ato2004-2006/2005/Lei/L11105.htm](http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2005/Lei/L11105.htm)
- Brasil. (2006). Lei nº 11284, de 02 de março de 2006. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2004-2006/2006/lei/11284.htm](http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/11284.htm)
- Brasil. (2007). Lei nº 11516, de 28 de agosto de 2007. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2007/lei/11516.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/11516.htm)
- Brasil. (2009). Lei nº 12187, de 29 de dezembro de 2009. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2009/lei/12187.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/12187.htm)
- Brasil. (2010). Lei nº 12305, de 02 de agosto de 2010. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2010/lei/12305.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/12305.htm)
- Brasil. (2015). Lei nº 13123, de 20 de maio de 2015. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_Ato2015-2018/2015/Lei/L13123.htm](http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13123.htm)
- Carvalho, E. (2014, October 30). Novo estudo liga desmatamento da Amazônia à seca no país. Retrieved from: <http://g1.globo.com/natureza/noticia/2014/10/novo-estudo-ligadesmatamento-da-amazonia-seca-no-pais.html>
- Castro, F. (2015, March 21). Desmatamento aumentou 282 % na Amazônia Legal em Fevereiro. Retrieved from: <http://www.estadao.com.br/noticias/geral,desmatamento-aumentou-282-naamazonia-legal-em-fevereiro,1655430>
- Chiuvite, T. B. S. (2010). *Direito Ambiental*. São Paulo: Barros, Fischer & Associados.

- Fudenberg, D., & Tirole, J. (1991). *Game theory*. Cambridge, MA: MIT Press.
- Geraque, E., & Mena, F. (2015, November 22). Infratores ambientais pagam só 8,7 % das multas aplicadas pelo Ibama. Retrieved from: <http://www1.folha.uol.com.br/cotidiano/2015/11/1709460-infratores-ambientais-pagam-so-87-das-multas-aplicadas-pelo-ibama.shtml>
- Instituto Brasileiro de Geografia e Estatística. (2004, May 21). IBGE lança o Mapa de Biomas do Brasil e o Mapa de Vegetação do Brasil, em comemoração ao Dia Mundial da Biodiversidade. Retrieved from: <http://www.ibge.gov.br/home/presidencia/noticias/21052004biomashtml.shtm>
- Kageyama, P. Y. (2009). Biodiversidade e Biopirataria: contradição entre a biodiversidade e a pobreza no mundo. In A. Aleixo, C. Azevedo-Ramos, E. Camargo, P. Y. Kageyama, M. C. Maio, D. M. Nascimento, & N. S. Oliveira (Eds.), *Amazônia e Desenvolvimento Sustentável*. Rio de Janeiro: Fundação Konrad Adenauer.
- Klautau de Araújo, J. M. (1995). *Caligrafias de Belém – vol. I: a dimensão insular*. Belém: Imprensa Oficial do Estado do Pará.
- Klautau de Araújo, J. M., & Lima, D. M. B. (1997a). *Projeto Escola Bosque do Amapá – Centro de Referência em Educação Ambiental da Ilha de Santana*. Macapá: Governo do Estado do Amapá.
- Klautau de Araújo, J. M. K., & Lima, D. M. B. (1997b). *Projeto Escola Bosque do Amapá – O método sócio-ambiental*. Macapá: Governo do Estado do Amapá.
- Klautau de Araújo, J. M., & Lima, D. M. B. (1997c). *Projeto Escola Bosque do Amapá – Projeto de Socialização*. Macapá: Governo do Estado do Amapá.
- Klautau de Araújo, T. L. (2014). Environmental law, public policies, and climate change: A social-legal analysis in the Brazilian context. In Leal Filho, W. (Eds.), *Handbook of climate change adaptation* (pp. 973–982). Berlin: Springer. doi:10.1007/978-3-642-40455-9\_115-1; ISBN: 978-3-642-40455-9
- Leite, M. (2015, March 31). Dilma Corta 72 % da verba contra desmatamento na Amazônia. Retrieved from: <http://www1.folha.uol.com.br/ambiente/2015/03/1610479-dilma-corta-72-da-verba-contra-desmatamento-na-amazonia.shtml>
- Lima, D. M. B. (2013). The Escola Bosque project: Building ways to an ecological society. In *Proceedings 7th World Environmental Education Congress, Marrakech, Morocco, June 9–14, 2013*.
- Machado, P. A. L. (2014). *Direito Ambiental Brasileiro* (22th ed.). São Paulo: Malheiros Editores.
- Marshall, A. (1996). *Princípios de Economia: Tratado Introdutório – (Vol. I)*. São Paulo: Nova Cultural.
- Martello, A., & Passarinho, N. (2015, September 14). Governo anuncia pacote de corte de gastos e volta da CPMF. Retrieved from:

<http://g1.globo.com/economia/noticia/2015/09/governoanuncia-bloqueio-de-gastos-no-orcamento-de-2016.html>

McAdams, R. H. (2008). Beyond the prisoner's dilemma: Coordination, game theory and the law. Retrieved from: <http://www.law.uchicago.edu/files/files/LE437.pdf>

Milaré, É. (2014). Direito Ambiental (12th ed.). São Paulo: Revista dos Tribunais.

Oliveira, M. (2015, November 24). Pagar multa custa menos que prevenir dano ambiental. Retrieved from: <http://economia.estadao.com.br/noticias/geral,pagar-multa-custa-menos-queprevenir-dano-ambiental,10000002788>

Redação G1. (2015, November 13). É oficial: o Rio Doce está completamente morto. Retrieved from: <http://revistagalileu.globo.com/Ciencia/Meio-Ambiente/noticia/2015/11/e-oficial-o-riodoce-esta-completamente-morto.html>

Sanches, M. (2015, November 22). Barragens de alto risco ameaçam 540 mil pessoas. Retrieved from: <http://oglobo.globo.com/brasil/barragens-de-alto-risco-ameacam-540-mil-pessoas-18111236>

Torres, A. (2015, August 6). Maioria dos Municípios Brasileiros não cumpre a Lei que proíbe os lixões. Retrieved from: <http://g1.globo.com/jornal-nacional/noticia/2015/08/maioria-dosmunicipios-brasileiros-nao-cumpre-lei-que-proibe-os-lixoes.html>

### **Publication 3**

**“Environmental Assets and Carbon Markets: Could It Be Amazônia’s New *Belle Époque*?”**, published in “Climate Change-Resilient Agriculture and Agroforestry”, 2019.

Thiago Lima Klautau de Araújo, Amadeu Mortágua Velho da Maia Soares  
and Ulisses Manuel Miranda Azeiteiro

## **Environmental Assets and Carbon Markets: Could It Be Amazônia's New *Belle Époque*?**

Thiago Lima Klautau de Araújo, Amadeu M. V. M. Soares and Ulisses M. Azeiteiro

### **Abstract**

The Carbon and the Environmental Assets Markets are not regulated in Brazil. They are pointed out by experts and activists as sustainable alternatives of wealth generation and forest valuation. But will they be enough to make Amazônia able to experience once again a time of economic prosperity related to environmental preservation, just like in the Belle Époque (the golden time of Amazônia, supported by the rubber extraction)? This paper intends to discuss several issues— currently ignored—about the subject, considering historical, legal, social, environmental, economic and political backgrounds. Besides those contexts, there is an assessment of the public policies, current studies on regulation, and legislative trends about the environmental issues, the Carbon and the Environmental Assets Markets. Several inconsistencies/weaknesses were found in the legal system and if they are not properly considered, they might threaten the success of those markets and/or even preclude the social and economic return for the local populations, especially from Amazônia, in a possible future regulation. Without due care, instead of becoming an alternative of environmental preservation with economic development and decrease in social and regional inequalities, they may become another example of financial conglomerates income concentration, at the expense of the region.

Keywords: Amazônia; Law and economics; Public policies; Environmental assets; Carbon markets.

### **1 Introduction**

The last century (particularly in its second half) has presented a major dilemma to Brazil: economic growth or environmental conservation? Up until recent years, undoubtedly, the unsustainable and irresponsible economic growth prevailed over biodiversity issues, environmental and social affairs (Pinho et al. 2014), or even over justice and fraternity among the states of Federation, existing values in the successive Brazilian Constitutions. Amazônia, a long and uncharted territory, has been characterized by the most perverse government interventions. Not properly planned and truly ignoring the reality of the region,

it were based on the eagerness for economic “progress” and began a process of social and environmental degradation (Klautau de Araújo 1995), land conflicts and political disputes<sup>1</sup>.

Initially fueled by Juscelino Kubistchek’s developmental policies in the 1950s, followed by national integration initiatives of the military dictatorship<sup>2</sup> (Paulino 2014), and, finally, leading to the disregard from the governments after the redemocratization, Amazônia faces, nowadays, a real environmental, social and economic disruption. However, it was one of the richest and most important regions in Brazil between the second half of the 19th century and the first half of the 20th century. More recently, increased attention was therefore paid to the process of environmental, social and economic degradation of the region, which shelters the most relevant and significative storehouses of the planet’s biodiversity.

Despite several isolated initiatives, not only governmental ones, but also, and, mainly, from the civil society and international organizations, the social and environmental situation<sup>3</sup> from Amazônia continues to deteriorate. The inefficient work by the successive governments and the environmental agencies can be pointed out, as well as the incoherence and weaknesses of the Brazilian Legal System— from the Constitution to other assorted regulatory provisions—the failure of the environmental education policies, illegal practices, forest exploration with predatory economic activities (for instance: mining, logging, agriculture and cattle) and the extreme poverty of the populations from the region are considered to be some of the major determinants that contribute to aggravate the situation.

In addition to the aforementioned elements of that disrupted context, the existing political resistance regarding the elaboration of appropriate public policies to environmental preservation<sup>4</sup> is noticeable.

---

<sup>1</sup> Which triggered, for instance, several break-up states projects and a popular referendum on the division of Pará State in three other ones (Pará, Carajás e Tapajós), in 2011, that was rejected, above all, by the dissenting vote of the people who live in the metropolitan zone of the capital of the state, Belém. In the affected areas by the creation of the new states, the votes in favor of the division were more than 90%.

<sup>2</sup> Both have proved disastrous because not only the proposals were not achieved (creation of transport infrastructures, road links to urban centers of other regions, creation of agrarian settlements, among other initial intentions), but it also created several economic and social problems that had never existed before.

<sup>3</sup> An increase is observed not only in the number of conflicts, but also in the violence rate. Despite the fact that the North Region has a small population if compared to other Brazilian areas, it sees a serious increase of the violence rate, much faster than the more populated regions (FBSP and IPEA 2016).

<sup>4</sup> The already low level of funding for fighting against deforestation had been reduced in 72% between 2010 and 2014 (Leite 2015) and in 2017, there was a reduction of more than 50% in the Ministry of the Environment’s budget—from 911 million (Ministério da Fazenda 2017), to R\$ 446 million (Gesisky 2017; Moutinho and Guerra 2017). Meanwhile, the Federal Government has provided R\$ 190.25 billion to the Agricultural and livestock plan 2017/2018, more than the R\$ 185 billion available for the 2016/2017 Plan

The political forces from Amazônia are considered to be tiny if compared to the ones from South and Southeast states.<sup>5</sup> Therefore, there is no political pressure or bargaining power<sup>6</sup> since the representation is clearly small and fragmented among the recognizable opponents, including those who are against the environmental actions because, according to their point of view, they would hinder the economic growth.

To make things worse, Amazônia has the largest mineral province of the planet, located in the state of Pará, with significant production of iron ore, gold, bauxite (and its by-products alumina and aluminum), nickel, copper, kaolin, among others. That exploration results in environmental and/or social damage, without financial compensation. This is because, according to Article 155, §2º, X, of the Constitution of the Federative Republic of Brazil from 1988 (CF/88), the products intended for export cannot be taxed by the states. In other words, the ICMS (tax over operations related to the circulation of goods and interstate and intercity transport and communication services), main state tax in Brazil, cannot be charged by the states on the mineral extraction activity to export, which corresponds almost entirely to the total of the mineral exploitation. There is, also, oil and natural gas production in Amazonas state and it is likely that there are oil stocks on the Pará's Coast.

For those reasons, several political agents are still convinced that the environmental preservation, especially in Amazônia, is a strong obstacle to the Brazilian economic growth. Nevertheless, it is necessary to highlight that the environmental preservation may be an important complement of the economic growth and development of the region—and vice versa—like the one we have seen in the past, in the most relevant moments of Amazônia history.

---

(Peduzzi 2017). The amounts invested in the agricultural plan represent more than 426 times the current budget of the Ministry of the Environment, which is the responsible for the federal environmental monitoring of the whole country, not only of the Amazônia.

<sup>5</sup> The North Region, that corresponds to almost the total of the Brazilian Legal Amazônia, has seven states, representing 45.25% of the national territory (IBGE 2016); however, it relies only on 65 of the 513 parliamentarians from the House of Representatives, since the population is proportionately represented, but this number is outdated and does not match the actual population— Amazônia would have more deputies if the division of places was updated. Nowadays, only the state of São Paulo has more than 70 representatives, 5 more than all states from the North Region together.

<sup>6</sup> Weinstein (1993), describing the negative fall in the prices of rubber latex in the international market, during the first decades from the 20th century, demonstrates that the lack of political power from the North Region is an old problem in Brazil: “(...) It is essential to consider the political component of the economic obstacles from the region. Since it needs political support at the national level, the elite of Amazônia failed many times in offering support to programs that intended to combat the devastating effects of price fluctuations. Moreover, their appeals for emergency assistance right after the collapse were largely ignored”.



This paper intends, therefore, to discuss about alternatives for Amazônia's development, the context of the current laws, the terms for establishing markets and the challenges for doing so. Despite the fact that the Carbon Market is the fashionable one, we comprehend that it is, in the context of Amazônia, just one of many renewable and non-predatory possibilities of rational use from the existing natural resources in that region. Due to those reasons, as we shall debate it later, we suggest the regulation, also, of the Environmental Assets Market (and the Carbon capture, obviously, is one of them), so that there can be established the maximum use of Amazônia potential, with the environmental preservation, climate context improvement and development for the region and its local populations.

## **2 Amazônia, the Belle Époque and the Environmental Assets**

The Environmental Assets, some of the greatest Amazon riches, have fundamental importance to the sustainable development<sup>7</sup> of the region. As a matter of fact, the history of Amazônia shows two examples in which the economic growth was directly associated to the use of those environmental assets without forest damage: at the beginning of the colonization in that region, with the so-called backland drugs; and with the latex exploration, also called “rubber boom”, divided into two phases, one during the 19th century and the other one during the 20th century.

The backland drugs were the main reason of Amazônia colonization, since Portugal could not control the Indian spices route, it then attempted to use Amazônia products as substitutes, among them, the cocoa, *pau-cravo* and achiote; that led to the cities and villages foundation in order to control the territory and the transit of foreigners in Amazônia. Belém, the capital of Pará, was founded and expanded in that context of monitoring, due to its geographic location and strategic importance, seen as one of the main entry doors for Amazônia (Cardoso 2015).

The rubber cycle, in turn, consisted in the exploitation of latex from Amazônia rubber tree *Hevea brasiliensis*. Its widespread use in the industry for a variety of purposes and its exclusiveness of production in the states in Brazil's North Region would promptly bring prosperity to the region and then enrich it, fact that made Belém one of the main (if not the

---

<sup>7</sup> Based upon the economic growth, environmental preservation and improvement of the social conditions.

main) financial center of the country in the second half of 19th century, not only due to the wealth brought by the rubber, but also due to its strategic proximity to Europe and the United States of America.<sup>8</sup>

All that abundance culminated in the building of imposing palaces, houses, parks, avenues, hotels, theaters, cities planning, development of significative infrastructure works like ports, railroads, public illumination, electricity, trams, among other various ventures that took the latest technologies to Amazônia. Clearly, all things worked and were built with European influence,<sup>9</sup> especially from Paris, hence the designation used for that period: Belle Époque, being Belém affectionately nicknamed as “Paris n’America”.<sup>10</sup> The sumptuousness of the buildings and the ingenuity of the urban solutions were really impressive, especially if we consider the logistical and geographical challenges still found up to the present. Undoubtedly, it was Amazônia’s Golden Era.

The first rubber cycle ended at the beginning of the 20th century because British Government Officials smuggled rubber trees seeds and established huge plantations in Malaysia (Garfield 2009), where did not exist the plagues that blocked the development of large fields of rubber trees in Amazônia, so they could reduce the costs of production and it led the Amazonian rubber plantations to the decline, followed up by their abandonment, since they were more expensive, with tricky logistic lines and more time-consuming collection and distribution, regarding the dispersed trees throughout the forest.<sup>11</sup>

However, the Malaysia rubber plantations were under the Nazis’ control during the World War II, which led to three situations: the shortage of material, the consequent rise in latex price in the international market and the weakening of the Allies’ armies (and their economies) due to the lack of this essential raw material for the industry. Hence, the rubber

---

<sup>8</sup> The geographic importance of Belém was demonstrated, for instance, by the air links to Europe and to the USA, which were set up from Belém and not from São Paulo.

<sup>9</sup> With particular situations like, for example, rich families from Belém used to have the laundry done in Paris (Weinstein 1993) and the use of large and warm clothing in a region where the temperatures remain constantly above 30 °C during the whole year.

<sup>10</sup> Curiously, that is the name of a traditional store, which still works at the same place since 1900 in a building in the downtown of Belém.

<sup>11</sup> Regarding the existing problems in Amazônia for the wealth coming from the latex transition to a more industrialized economy—as it did not turn out to be, see Weinstein (1993).

exploitation in Amazônia restarted, with shorter duration at that time, but brought fresh air to the economy of the region.<sup>12</sup>

There was, over those periods of time, an unmistakable direct relation between the produced wealth and the forest preservation.<sup>13</sup> Naturally, on account of the indigenous labor (during the backland drugs period) and the use of slave labor or slave-like terms or even low wages (in latex production),<sup>14</sup> it is not possible to talk about sustainable development, since the social component was not covered, especially because those practices were common and legal at that time. However, despite the reprehensible and inadmissible practices related to social and labor terms, the mentioned times demonstrate that the maximum use of the Amazon potentials can occur not only with activities that do not deforest the region, but also can quite possibly be a complement to combat environmental degradation.

### **3 The Negative Change in the Amazônia Path**

Despite the clear propensity of the region in considering a non-predatory use of the environmental assets,<sup>15</sup> the economic, political and infrastructural models applied in Amazônia since the 1950s did not consider basic cultural, natural and social characteristics of the place. That caused serious damage to the environment and to the society (Klautau de Araújo 1995, 2014; Paulino 2014). The Brazilian governments imposed solutions previously used in other states which were successful, but that, obviously, did not work in Amazônia

---

<sup>12</sup> For more details on the relationship between Brazil and the USA, due to the importance of Amazônia for producing rubber latex during the World War II and the immigrating and economic impact to the region, see Garfield (2009, 2010).

<sup>13</sup> Different from other events in the Brazilian history, as in Pau Brasil exploitation (*Caesalpinia echinata*), that almost made that specie disappear, or as in the economic situation of Amazônia itself, which has been destroyed for soy-plantation, cattle breeding and timber extraction.

<sup>14</sup> Weinstein (1993) states that it was the main reason behind the economic decline in Amazônia with the rubber price collapse, if compared to São Paulo, which also suffered from the coffee crisis effects, but it became industrialized: with no internal market of products, based upon wage labor, Amazônia did not have other options besides the latex extraction. That excessive dependency on a single product, without establishing a productive market, led it to its economic ruin.

<sup>15</sup> The proof lies in the fact that the richest period of time of the region history was based in a renewable and non-predatory product, with almost no deforestation, and without serious environmental impacts. On the other hand, currently the environmental degradation is noticeable, either because of mining, livestock or logging activities, while the population remains miserable.

because its environmental features demanded—and still demand—carefully conceived and personalized choices.<sup>16</sup>

Therefore, it was ignored the necessity to treat unequals unequally to achieve justice—Aristotle’s thought plentifully discussed over the years.<sup>17</sup> Thus, there was no participation of the local populations in the definition of laws and public policies to Amazônia, or in their corresponding implementation and monitoring.<sup>18</sup> The region was treated merely as a new border for changing problems from the main urban centers of the country and also seen as a solution for housing the farmers who did not have lands in other regions.<sup>19</sup>

Under the slogan of national integration, with a development-oriented policy, the government of Juscelino Kubitschek promoted roads construction without proper planning, intending to connect the North Region with the whole country and with the new federal capital. In continuity, the military governments built more roads<sup>20</sup> and started a disordered

---

<sup>16</sup> Amazônia is unique and, therefore, different from other Brazilian realities. The soil type, the rivers dimensions, the features of the weather are, sometimes, impossible challenges to solve traditionally. Examples of failed initiatives that did not take into account those elements are several: Madeira-Mamoré railway, which was not concluded due to project problems that brought a huge distress initially and due to the death of several workers who developed tropical diseases; Balbina hydroelectric, in the state of Amazonas, which has a reservoir similar to the one of Tucuruí hydroelectric power plant, in Pará, but that has about 3,3% of the energy produced in Tucuruí; the roads BR-163 (Cuiabá-Santarém) and BR-230 (Transamazônica) with no completion until nowadays, besides many other examples.

<sup>17</sup> The debate on the topic has begun with Aristotle, who considered it in the “Nicomachean Ethics”, especially in Chaps. 4 and 5 of its 5th book. Still on that, there are works like the “Discours sur l’origine et les fondements de l’inégalité parmi les hommes” by Jean-Jacques Rousseau, e “A Theory of Justice”, by John Rawls. In the Brazilian context, it is important to mention “Oração aos Moços” (Addressing the Young), by Rui Barbosa.

<sup>18</sup> Until these days, the effective popular participation is a huge democratic challenge, even in developed regions. In Amazônia, it is particularly difficult, and there are studies and proposals with possible replication, as the one carried out by Folhes et al. (2015). However, it is necessary to emphasize that Amazônia is diversified and that not all designed models for it will have the same effects in different zones. Moreover, the participation model has to be defined properly and planned along with the community, considering each case specifically (Klautau de Araújo and Lima 1997a, b).

<sup>19</sup> Wolford (2016) points out some notes about the used strategies by the military governments for Colonization in Amazônia: “INCRA was created on July 9, 1970, as an autonomous agency tied to the Ministry of Agriculture (Decree-Law 1110, Article 4, July 9, 1970). The military government in power at the time created the agency to oversee the colonization and settlement of Brazil’s vast and “underpopulated” northwestern frontier. The march westward was expected to fulfill Brazil’s promise as a developed, modern nation, which meant extinguishing peasant protests in the Northeast and dealing with the presumed threat of communist guerrillas known to be hiding out in the Amazon rain forest (Martins 1984, 41; Bunker 1985). Colonization was also a means of combating external influence; the slogan “*integrar para não entregar*” (integrate to avoid delivering [the Amazon to foreigners]) was part of the substantial publicity campaign that accompanied frontier development (Reel 2010, 36). In the early 1970s, Brazilian theaters showed films weekly documenting the bulldozers and trucks cutting through the jungle to build new highways (Drosdoff 1986, 60–74). (...) Buttressed by a sense of manifest destiny, INCRA employees moved west to settle “men without land in a land without men,” carving out thousands of 100-hectare plots, building houses and towns, and leading markets into relatively untapped regions of the Amazon rain forest (Hecht and Cockburn 1989, 108)”.

<sup>20</sup> Including two that have left a trail of unprecedented environmental destruction: the Transamazônica and the Cuiabá-Santarém roads, already mentioned in the footnote 16.

landholding colonization process, under the motto “land without men for men without lands”, and arguing that the settlement of the area could protect the national territory, safeguarding the national sovereignty. However, the attempt of landholding colonization without any support by the public agencies, lacking adequate infrastructure and even no researches on the soil types of the region<sup>21</sup> demonstrated that it was not an attempt to solve the Brazilian agrarian problem (taking into account that, until the present moment, the Land Reform in Brazil has not been enacted), but it was a political way to keep the popular pressure away. At no time, any of the plans or government interventions had considered the social-environmental aspects or eventual externalities that ended up occurring.<sup>22</sup> Concerning the national security, the argument has also fallen down because the Amazônia frontiers are still opened for the trafficking of arms, drugs, animals, human organs and people. The increase in population did not bring any benefits, neither to the region, nor to the local populations or even to the immigrants. Moreover, there was a worsening of the social conditions and deforestation.

The roads construction is also linked to the migratory flows towards the surrounding regions, where people would be attracted by the promise of economic development and jobs, since the landholding colonization programs had failed. The population growth with no basic structures like health, education, security, sanitation and other State services has set up a complex socioenvironmental context. The successful options have been marked by binding together both society and the governments, searching for a broader integrated understanding of the local situation,<sup>23</sup> instead of isolated mitigation measures, as it has commonly been done.

---

<sup>21</sup> “The endless soil fertility of Amazônia, announced by natives and visitors of the region, has proven to be one of the several legends fostered by the luxurious and thick forests from the region. As a matter of fact, the soil of Amazônia highland, like the tropical soil in general, is thin and with nutrients easily exhausted as soon as the forest cover exposes it to the rain. After that, only the intense fertilizer application will facilitate the growing/cultivation. Regarding the small part of Amazônia surface classified as alluvial plain, that is less susceptible to leaching and hardening than the ‘dry land’, but can also burn out under intensive cultivation” (Weinstein 1993).

<sup>22</sup> Even though the described facts have occurred during the military dictatorship time, lack of concern about Amazônia features still remains, and the governments, successively, keep on ignoring the basic aspects of the region context. Recently, for example, school buses were donated to Afuá city, in Marajó archipelago, Pará; but in Afuá, known as “Marajoara Venice”, there are no streets, since all its buildings are on stilts and there are lowland soils and floodplains in which the use of motor vehicles is forbidden (Meirelles Filho 2015).

<sup>23</sup> As in Paragominas, State of Pará, where with strong participation from the mayor, managers and society, the context of social and environmental degradation of the city was changed, and Paragominas is an interesting example to be examined. See more in Klautau de Araújo (2014).

Another important aspect to be highlighted is that the built roads did not work as an alternative to the existing railroads, but rather as substitutes. Nowadays, the road transport corresponds to 61.1% of the transport of goods and to 95% of the transport of people (CNT; SEST; SENAT 2016). The concentration of cargo and people transportation in the road model, apart from being more expensive and polluting, is also slower.<sup>24</sup> It partly explains the difficulties in creating a local productive chain for Amazônia goods: the distance from major consumer centers of the country in addition to the lack of faster, safe and cheaper transport alternatives have reduced the interest of investments in that region. The establishment of companies could certainly contribute for generating jobs, income, local technology and for promoting a closer interaction between the populations and the production of non-predatory items derived from the forest, which arouses an increasing interest to conserving the environment. That would be an interesting option for adding value and regional development around its main potential: the forest; nowadays, nearly all Amazônia's products are exploited to be manufactured in other states or countries, leaving so little or nothing to the local people, leading to an understandable declining interest in environmental issues in the face of the current poverty.

#### **4 Environmental Assets: A “New” Hope for Sustainable Development in Amazônia**

Considering that context, the environmental assets can be decisive elements for changing the socioenvironmental situation. As we have already mentioned in this paper, the creation of productive chains for Amazônia products could lead to the economic and social development of the region. Fostering the Environmental Assets and considering the possibility of using them as an enhancing instrument for the forest are widely discussed alternatives (Ministério do Meio Ambiente 2016; Birdsall et al. 2014; CGD 2015; Seymour and Busch 2016), even before the consolidation of the use of that terminology.<sup>25</sup>

---

<sup>24</sup> And, if we consider the terrible road construction, especially in Amazônia, the numbers are more negative: due to the bad quality of the pavement, more than 77,488 million liters of diesel fuel are spent unnecessarily every year, which represents 2.07 MtCO<sub>2</sub> of additional emissions (CNT; SEST; SENAT 2016).

<sup>25</sup> The sociologist José Mariano Klautau de Araújo started to debate about the need of the Environmental Assets sustainable use in Amazônia since the 1970s, when the projects for national integration and settlement were at the top. His discussions, subsequently published on books and papers, added to the Socioenvironmental Method, written by him, are interesting points of reference to understand the historical and institutional background of public policies for Amazônia since the 1950s until nowadays. The Socioenvironmental Method

Amazônia is rich in environmental assets of all kinds,<sup>26</sup> and if is made the most of that potential, with the local populations engagement, the possibilities for the sustainable wealth generation in that region are feasible. For instance, by addressing some infrastructure issues, it is possible to develop the ecotourism, an alternative that remains unexplored in the area, or expand the food, pharmaceutical and cosmetics industry<sup>27</sup> which use the regional products.<sup>28</sup> Everything depends on the way that the environmental assets and their possible markets are regulated, conceived and defined, as well as the underlying issues discussed up to this point.

## **5 Current Legal Brazilian Situation Concerning the Carbon Market, Environmental Assets, Mitigation and Adaptation to Climate Change**

The Brazilian environmental laws are dispersed, confusing, bureaucratic and complicated to deal with, due to their gaps, shortcomings and lack of regulation (Klautau de Araújo 2014, 2016). The few existing legal devices regarding the Environmental Assets trading, including the carbon, or related to the climate change are in that same direction, as well as the current legislative proposals and public policies.

As the main legal basis for that issue, the Law 12187/2009 (National Policy on the Climate Change), in spite of being recognized as an important legislative framework (Milaré 2014; Lopes et al. 2015; Pinheiro Pedro et al. 2015) comes up a bit short of the expected. In its art. 4º, VII, it is established the fostering to the development of the Brazilian Emissions Reduction Market, which would open the national Carbon Market and would contribute to the clearer participation of Brazil in the international market, but it does not mention how

---

was the pedagogical foundation for Escola Bosque, an initiative awarded internationally and that can be read in much more details in Klautau de Araújo and Lima (1997a, b, c), Klautau de Araújo (2016) and Lima (2013).

<sup>26</sup> As it can be seen in more depth in Seymour and Busch (2016), according to the different types of environmental assets classified by the authors.

<sup>27</sup> A huge Brazilian cosmetics company was accused of using, without permission, traditional knowledge from herb medicine women from the Ver-o-Peso market, in Belém (Weis 2006; Soares 2016); after a great controversy, there was then a refund for that (Soares 2016), and a soap and essential oils factory from that company was opened in the metropolitan region, in 2014 (Kafruni 2014).

<sup>28</sup> Products like açaí, cupuaçu, cumaru, camapu, among other fruits, plants, herbs and seeds derived from Amazônia have awakened a great international interest due to their nutritional, aesthetic and therapeutic properties. However, the most part of those products, with rare exceptions, is collected in the region, and the end products are produced somewhere else, with no return to the local people.

that aim would be reached (nor even the Decree 7390/2010, which regulates parts of the above-mentioned law).

In the art. 9º, the Law 12187/2009 grants carbon credits (here mentioned in a broad sense) of legal nature of securities and requires them to be traded in the stock exchange,<sup>29</sup> being the Securities Exchange Commission (Comissão de Valores Mobiliários—CVM) the responsible for monitoring it; however, the CVM disagrees with the classification established by the National Policy on Climate Change.<sup>30</sup> Since the articles 4º, VIII and 9º are too superficial and were not regulated by the mentioned decree, the Carbon Market has not yet been satisfactorily implemented in Brazil<sup>31</sup> because it is not as significant as it could be and it does not offer sufficient legal guarantees to the investors. Last but not least, the art. 12 establishes voluntary reduction from 36.1% to 38.9% based on the projected emissions until 2020,<sup>32</sup> but it does not say how it should be done either,<sup>33</sup> not even mentioning the metrics to be used to verify the results.

Therefore, if there is no commitment to the targets, no solid legal basis to create the Carbon Market, to reduce the emissions, to implement concrete measures to be taken by the public authorities, the Law 12187/2009 and the Decree 7390/2010 seem to be only intentions that the federal government may not be interested in putting in practice.<sup>34</sup>

---

<sup>29</sup> In this context, the BM&F Bovespa

<sup>30</sup> The problem in this case was the legal system inconsistency. That was because the Law 6385/76, about the securities, has a strict list in its art. 2º. Therefore, the Securities and Exchange Commission expressed its opinion, asserting that “Carbon Credits are securities issued by an organization associated with the United Nations which represent no-emission of certain amount of gas that cause global warming. The CVM discusses matters related to the carbon credits and why they must not be considered derivatives or collective investment securities—thus, they are not securities, but assets and they are marketed to reach the targets of carbon emission reduction or aiming the investment. In addition, The CVM understands that it would be inconvenient to classify the carbon credits as securities through the edition of the law regarding the arrangement of those instruments. The Securities and Exchange Commission also discusses the features of some financial products derived from the carbon credits, that, depending on their characteristics, might be defined as securities. The assessment of each financial product will be done by the Securities and Exchange Commission” [highlighted by us] (CVM 2009). Although that issue may appear to be a simple detail, it may be decisive in the future concerning the tax matters, fundraising from the Carbon Market and the legal certainty/validity of the contracts. More than that, by failing to amend the Law 6385/76 or to consult the Securities and Exchange Commission about the legal nature of an obligation modality that would be ruled by that institution shows the regulator’s negligence and weakens the applicability of the law.

<sup>31</sup> Although Brazil holds 5% of the world’s Carbon Market, while 20% was expected initially (Brasil 2012).

<sup>32</sup> That, according to the art. 6º of the Decree 7390/2010, means to reduce between 1168 million of tonCO<sub>2</sub>eq and 1259 million of tonCO<sub>2</sub>eq of emissions.

<sup>33</sup> The art. 6º, §1 of Decree 7390/2010 lists ten actions to be taken to make feasible the accomplishment of the goal, being foreseen and implemented by sectorial plans.

<sup>34</sup> Lopes et al. (2015) and Pinheiro Pedro et al. (2015) emphasize the importance of the Law 12187/2009 to the establishment, at first, of a voluntary market and of a mandatory one later, after adopting the compulsory measures of emissions reduction. Nevertheless, we understand that the enactment of the above mentioned law



Regarding other aspects of combat, mitigation or adaptation to climate change, there are: Law 12114/2009, which creates the National Fund on Climate Change, regulated by the Decree 7343/2010; Law 11284/2006, which is “about the public forest management for sustainable production; it establishes, on the basis of Ministry for the Environment, the Brazilian Forestry Service; it creates the National Forest Development Fund”, among other measures, as well as its regulatory Decrees 6063/2007 and 7167/2010; the Decree 6527/2008, which is about Fundo Amazônia; the Decree 8576/2015, which “establishes the National Commission to Reduce the Greenhouse Gas Emissions Resulting from Deforestation and Environmental Degradation, Forest Carbon Stocks Conservation, Sustainable Forest Management and Enhancement of Forest Carbon Stocks—REDD+”; Some of the Forest Code provisions (Law 12651/2012),<sup>35</sup> especially the Article 41, which is about the Environmental Assets. Also, there are two National Congress Bills, in progress: the 212/2011 draft legislation, which intends to set up the “national system of reducing emissions from deforestation and forest degradation, conservation, sustainable forest management, maintenance and enhancement of forest carbon stocks (REDD+)”,<sup>36</sup> and the 95/2012 draft legislation, which intends “to determine the securities trading in the Brazilian Emissions Reduction Market related to the avoided greenhouse gas emissions verified in indigenous lands must be previously authorized by FUNAI”.

## 5.1 Legislative Trends

As previously observed, there were several laws and regulations concerning environmental and climate change issues and there are new ones already being planned. In other words,

---

was only an attempt of political response to the national and international pressures/expectations and not a practical step indeed. The Brazilian legal experience in the last decades demonstrates that law enactments without regulation (or their ineffective regulation) has been a strategy of the governments in order to avoid the responsibility of polemic or complex issues (Klautau de Araújo 2014, 2016). Due to that, we believe that a norm with inconsistencies, omissions and inaccuracies is not able to substantiate a whole system of combating measures, mitigation and adaptation to climate change.

<sup>35</sup> One of the legislative provisions of the Forestry Code is the Environmental Reserve Quota (CRA), that consists in a portion of non-deforested land which exceeds the law requirements. It may be considered as an Environmental Asset because it may be negotiated with other landowners who have not fulfilled the minimal legal size of vegetation in their areas. It is provisioned by the articles 44 to 50 of the law 12651/2012. There is a recent study developed by Brito (2017) about more efficient regulations of that legal institute so that there is not an excess supply, pulling down the prices and inhibiting the restoration of the areas, taking Pará state as a reference for additional regulation to the recommended by the Forestry Code.

<sup>36</sup> Although there is not any law project about it, we should consider the ENREDD+, the “REDD strategy development” planned by the Ministry of the Environment (Ministério do Meio Ambiente 2016).

there is a tendency for legal provisions and sparse regulations that makes the legal system tricky. That tends to decrease the efficiency of implementation, the legal compliance and laws inspection, as well as to difficult the citizens' understanding on the Law field, if compared to the issues that are arranged in codes or in few and concise laws (Klautau de Araújo 2016). Milaré (2014) claims that the codification of the environmental issues can give legal security to the area, and we may infer that the same would happen if applied to the Environmental Assets Market. The same way that the environmental issues have been regulated, it became very difficult for citizens to participate in the elaboration, enforcement and, mainly, monitoring of the laws, since they do not know the technical terms, do not have resources or even because there is such a complex bureaucracy involved (Klautau de Araújo 2014).

Besides the regulation issues and the scattered laws, there is a worrying trend to weaken the federal environmental norms, despite the increase in deforestation. The text of the new Forest Code ended up confirming irregular deforestation before 2008.<sup>37</sup> In May 2017, the House of Representatives and the Senate ratified two provisional measures that reduced in 597 thousand hectares Pará and Santa Catarina states preserved areas. 587 thousand hectares of this reduction were only in the Jamanxim National Forest and in the Jamanxim National Park, located in Pará (Maisonave 2017a, b).<sup>38</sup>

A data entry carried out by WWF indicates that bills in course in Congress reduce the protection of approximately 80,000 km<sup>2</sup><sup>39</sup> (Maisonave 2017a). There is, also, another Law Draft (3729/2004), with 18 included projects, in course, that aims to relax the environmental license regulations, which has been pushed through to be approved (Miranda 2017).

The most recent environmental debate was derived from the edition of Decree 9142, from August 22, 2017, which extinguished The National Reserve of Copper and Associates

---

<sup>37</sup> Legal devices like the articles 61-A, §§ 5º e 6º, 67, 68, among others from the new Forestry Code, reduce or leave behind the demand for reforestation of the Legal Reserve (minimum of native vegetation to be kept on the estate) or Permanent Protection Area (vegetation surrounding rivers and sources, for example) for several contexts, which means relaxation of the environmental rules and legalization of the irregular situations. The message to be understood is that the environmental rules may be not followed, since, at any time, there will be tolerance of validations of the illegalities in the name of the economic issues.

<sup>38</sup> However, after extreme national and international pressure, the President Michel Temer has gone back on his own proposal and has vetoed provisional measures 756 e 758, that established the reduction of the area. In a new twist, the Government sent a proposed law to the National Congress, reducing once again the area of Jamanxim National Forest, not in 486,000 hectares, but now in 349,000 hectares, that will be protected areas, with a few restrictions, if the project is approved (G1 PA 2017).

<sup>39</sup> Near Portugal's territory dimension, which has a little bit more than 90,000 km<sup>2</sup>, including its islands.

(Renca)—an area between Pará and Amapá states with a forest area over 4 million hectares—and opened part of the reserve to mining. It had a great impact and the Government edited a new Decree (9147, from August, 28, 2017) revoking the previous one, remaining the extinction, but addressing few points in detail which had been contested in Decree 9142; The Government and some experts say that the reserve has already been occupied by illegal loggers and miners, who extract the Brazilian resources avoiding taxes and polluting the rivers, also exposing fish and watercourses to mercury contamination, promoting deforestation, and the mining regulation would control the impact of those activities (Schreiber 2017). However, the polemic persisted throughout, the public opinion was overwhelmingly against the reserve extinction and, shortly after, the Federal Justice decided to suspend the Decree. There was another suspension order by the Supreme Court that determined the government to clarify the issue in 10 days. For those reasons, the Ministry of Mines and Energy (MME) published a Directive on September 5th, 2017, suspending the legal effects of the Decree 9147 during 120 days in order to broaden the discussion on the subject (G1 2017). On September 25th, 2017, the President decided to revoke the extinction of Renca, with the Decree 9159. The Ministry of Mines and Energy published a note affirming that: “(...) The country needs to grow and generate jobs, attract investments to the mineral sector, including to exploit the economic potential of the region. The MME reaffirms its commitment and of the entire government to the preservation of the environment, with the safeguards provided for in the environmental protection and preservation legislation, and that the debate on the subject must be taken up at a later time and must be extended to more people in the most democratic way possible” (Ministério de Minas e Energia 2017). It seems that the results of this story are far away, especially if we consider that the environmental question is, apparently, being used as an exchange for political power and support.

Nowadays, as it can be seen, there is an overall weakening trend—rather than a strengthening one—of the Brazilian environmental legislation. Added to that, there are international uncertainties related to the success or to the failure of the countries cooperation against climate change,<sup>40</sup> endangering the Carbon and the Environmental Assets Markets in Brazil.

---

<sup>40</sup> Especially after the withdrawal of the United States from Paris Treaty. It is early to analyze the impacts and consequences of that decision, even with the response of leaders in the European Union and China reaffirming their commitment to the international agreement (Lusa 2017; Gomes 2017).

Without a mandatory setting of a limit of emissions and a legal system efficient for punishing irregularities,<sup>41</sup> there will scarcely be any interest or economic feasibility of the markets. Moreover, regarding the Environmental Assets Market, directly affects the very existence of the assets to be traded.

## **6 Technical Challenges and Possible Distribution Models Originated from the Carbon and Environmental Assets Markets**

### **6.1 Challenges—Not So New as They Seem**

The economic development of Amazônia through activities linked to the regional vocation and to the sustainable management of the existing environmental resources is fundamental to equalize the social and environment preservation issues (Klautau de Araújo 1995, 2016). That is because Amazônia, currently, does not have the least necessary structure of transports, health, basic sanitation and education, with a few alternatives of decent livelihood remaining to the populations of its remote areas, who end up preying on the environment in exchange for some living, specifically (but not only limited to) cutting down the forest illegally for selling timber; with no guarantees for human dignity to the local populations, it is impossible to demand their support to the government against environmental degradation, or even expect that they worry about preserving Amazônia (Klautau de Araújo 2016). That situation fits within Paul A. Samuelson's argument (1976) about Economics of Forestry and the extinction of certain animal species.<sup>42</sup>

The current policies of forest preservation are not only based upon a confusing and flawed system, but also transform the forests in a source of expenses, not of possible income, since the environmental protection is not well regarded by the governments (Klautau de Araújo 2016). Some environmental assets, like the Carbon Market—which generates wealth through the simple preservation of environmental areas—can change this context, adding

---

<sup>41</sup> The bureaucracy, the low values charged by the fines, added to the almost endless possibility of lodging an appeal create a sense of impunity and, at times, is more profitable to do something illegal and then pay or contest the possible fines (Klautau de Araújo 2016).

<sup>42</sup> “When people in a poor society are given a choice between staying alive in lessened misery or increasing the probability that certain species of flora and fauna will not go extinct, it is understandable that they may reveal a preference for the former choice. Once a society achieves certain average levels of well-being and affluence, it is reasonable to suppose that citizens will democratically decide to forego some calories and marginal private consumption enjoyments in favor of helping to preserve certain forms of life threatened by extinction.” (Samuelson 1976).

value to the forest as heritage sites to be preserved not only due to its ecological, climate and biodiversity aspects, but also due to its inherent social and economic potential.

The environmental issue is not—and it has never been—into Brazilian political focus. In a particularly troubled moment for the Federal Public Management, with discussions and debates on electoral, political, labor and social security reforms and so many corruption scandals, the concern with the environment is far from being a priority. Another relevant aspect is the continuous disinvestment in the environmental monitoring sector, which has worsened over recent years (Klautau de Araújo 2016). Arousing the economic interests in maintaining the green areas is a way to bridge the gap between the environmental issues and legislators and governments.

Therefore, despite the existing limitations to the Environmental Assets, they are considered to be, in Amazônia context, the most feasible alternative at the moment, since they offer the possibility to generate wealth, income, employment, life conditions with dignity to the local populations and, simultaneously, the forest preservation. However, in the Brazilian case, despite all the problems pointed out by some scholars, the Environmental Assets, particularly the Carbon Market, do not face great difficulties in the international scenery or even in terms of long-term economic viability, but in the legal system. Maybe this is the most significant barrier for the implementation of a comprehensive policy focused on the sustained use of those resources.

The Brazilian legal system is extremely confusing and disconnected, making the procedures too bureaucratic, long and difficult. For instance, the first practical difficulty in the implementation of a Carbon Market in Brazil would be a more precise definition of land ownership. Odd as that may seem, there is no consensus on the exact public land delimitation and dimension for each one of the federal entities, setting judicial disputes among the states<sup>43</sup> and between The State and private individuals. One of the reasons for that is the lack of clarity (and/or regulation) of the art. 20, I to XI and §2º, and art. 26 of the 1988 Federal Constitution, as well as the art. 16 of the Transitory Constitutional Disposition Act.<sup>44</sup> Added to it, the Land Reform in Brazil has not been enacted, fact that brings legal uncertainty,

---

<sup>43</sup> Acre and Amazonas are disputing a 12,000 km<sup>2</sup>, while Mato Grosso contests for 22,000 km<sup>2</sup> with Pará, and Ceará complains about 2821 km<sup>2</sup> with Piauí (Mariani et al. 2016).

<sup>44</sup> Referring to the public land ownership.

which gives ground to frauds against individual and state patrimonies.<sup>45</sup> Lastly, the lack of data links among registries makes the system even less reliable.

Defining public and individual land ownership in Brazil is essential to make the most out of the Environmental Assets potential, but in particular to make the Carbon Market feasible for the national territory. Without knowing which areas belong to whom, it is not possible to estimate neither how much land each market player (especially the public bodies) has for carbon absorption, nor how many tons might be absorbed. Moreover, without solving this problem several judicial disputes may occur focusing the money raised in market, leading purchasers' migration to other markets.

Although it is a complicating factor and that certainly will bring many practical difficulties and legal disputes over the years, that issue does not block the Brazilian Carbon Market from being implemented.<sup>46</sup> The purchasers, naturally, will seek for agents appropriately settled and they will select those who will remain or will leave the market. Something to worry about is that Brazil, until this moment, was not able to carry out structural adjustment reforms and any regulation arranged will only be a slight repair over a confusing and inconsistent legal system.

It is necessary to remember that the 1988 Federal Constitution—as has dealt with the public land ownership—established the environmental protection in a general way, regarding as a joint competence the environmental protection, air pollution combating, forest, flora and fauna preservation to the Member States, to Federal District and to the municipalities,<sup>47 48</sup> Added to that, there is a constitutional determination on the preservation of the environment contained in Art. 225<sup>49</sup> from CF/88, and its paragraphs, in which the expression “Public

---

<sup>45</sup> Without the Agrarian Reform and a standardization of the securities, all proofs of ownership modalities are accepted, if the necessary requirements at the time of the alleged purchase are met. It happens that, if there is no control of the registers, it is possible, for example, to have a land title document from the sixteenth century validated. That is one of the reasons why a very common fraudulent practice in Brazil used to be the document forgery, putting the papers inside drawers with crickets, because their secretion would make them appear older than they actually are. That practice was called “grilagem”, a nickname given, nowadays, to all kinds of fraudulent attempts of land regulation.

<sup>46</sup> Especially because it already exists, but it is not based on laws, as we will confirm later in this paper.

<sup>47</sup> Art. 23, VI and VII of the 1988 Federal Constitution.

<sup>48</sup> There is also legislative concurrent competence/authority to the Union, states and Federal District, regarding “forest, hunting, fishing, fauna, conservation of nature, soil and natural resources preservation, protection of the environment and pollution control”, according to the art. 24, VI from 1988 Federal Constitution.

<sup>49</sup> “Art. 225. Everyone has the right to an ecologically balanced environment, which is an asset of common use and essential to a healthy quality of life, and both Governments and community shall have the duty to defend and preserve it for present and future generations.”

Power” is used in the broadest sense of the term. It means that all power spheres are responsible, conformity with their respective competences, for the environmental protection. The legislative intent was good: by expanding the number of the responsible ones for monitoring, the efficiency of surveillance would increase. But the results did not meet the expectations and the attempt to generically share the responsibility for the environmental monitoring caused the opposite effect.<sup>50</sup>

As we have already mentioned, in theory, if the Carbon Market, generates revenues, instead of being a burden for the State budget, the forest would be a source of income which would increase the interest for its conservation.<sup>51</sup> What happens is that the collection of taxes and revenues is strongly controlled by the Federal Government, but the charges of environmental monitoring belong to everyone.

If there is not any system restructuring of the environmental agencies and the clear liabilities establishment, the problem will remain unsolved, despite the influx in revenue of the Carbon Market.<sup>52</sup>

Another reason why the regulation must be a careful process is that the sale of carbon credits is, all in all, an offset, since it keeps a reduced economic activity in order to preserve the forests. Nowadays, the Brazilian cities that present the lowest human development indicators are located in Amazônia. Brazil shows extremely serious regional disparities and the Environmental Assets sustainable exploitation is one of the few available alternatives to reduce the disparities without further aggravating environmental degradation.<sup>53</sup>

---

<sup>50</sup> In another study (Klautau de Araújo 2016), by the use of the game theory and an adaptation of one game, it was pointed out that when all the constitutional powers are generically shared it is likely that none of the agencies act. That is because all tasks might be shared, but not the budgets. Without a clear division of competences and tasks, it is almost impossible to demand an agency responsibility in case of default since it is stated that you cannot blame a single absent agency for the unsuccessful public policies when other agencies did not act either.

<sup>51</sup> Not only for public entities, but also for individuals. The Carbon Market is an alternative for obtaining economic income from preserved areas required by law inside the states, as the Legal Reserve, which currently are unpaid. Concerning that, the then-Senator and current foreign minister Aloysio Nunes stated that: “the Carbon Market would be a stimulus for the grower to maintain his legal reserve, so that he can generate income from that. It would fulfill our goals not only internationally, but also inside Brazil, implementing an important law, welcome by the whole world, that is the Forestry Code law” (Altafin 2016).

<sup>52</sup> In the discussions on this topic, this point was also raised by Senator Jorge Viana: “who can trade the carbon absorption in the forests? Is that the country and in a centralized manner? Or are the states, which are guardians of the forests? There is almost no regulation of it. It is a new market, not widely-known, which is part of climate change” (Altafin 2016).

<sup>53</sup> The areas with higher biodiversity in Brazil are those in which the people have lower incomes and little provision of public services (Kageyama 2009; Klautau de Araújo 2016).

Therefore, we point out four possibilities of collecting and distributing revenues from Carbon Market—or, why not, from the Environmental Assets market? — if the Brazilian regulation is possibly established.

## **6.2 Possible Methods for Collecting and Distributing Revenues**

### **6.2.1 Federal Government Revenue Collection and Distribution of the Total Value or a Portion of It Proportionally**

That hypothesis would consist of the Carbon Market values centralized in the hands of Federal Government and further distribution proportionally among the States and cities.

In this model, the Federal Government would be the only entity of public power able to make trades—as it is already seen, for example, in the capital market. There are strong chances to adopt that option, since it is about repeating the existing practices in which the power is centered at the Federal level and the shares are distributed in a standard way, taking into account the region of the federative entity and the income per capita.<sup>54</sup> However, with that regulation form neither the regional inequalities in Brazil will be reduced, nor the forest conservation will be encouraged. This is because in the distribution according to the previous criteria, the states with the highest capacity to absorb Carbon<sup>55</sup> will have to divide the main compensation for maintaining their forest area. However, all the conservation burden will remain individualized. Therefore, a scenario of strong regional differences is eternalized, enhancing those differences, due to the fact that the forest conservation duty is imposed (involving costs and the forgoing of tax revenues) in exchange for specified economic benefits that will be shared.

We could consider a possible comparison between that model and the regulation of royalty payments related to oil and natural gas exploration, ruled by the Laws 9478/97, 12351/2010 and 12858/2013. There is a share of the royalties aimed at the producing states and cities and a shared aimed at the Federal Government and other non-producers, what may seem unfair

---

<sup>54</sup> As it is used, for instance, in the division of the State Participation Fund (FPE) and in the Municipalities Participation Fund (FPM). For further details, read: art. 159 of the 1988 Federal Constitution; art. 34, §2º, I, II and III of the Transitory Constitutional Disposition Act; the arts. 90, 91 e 92 of the Law 5172/66 (National Tax Code); and the Complementary Laws 62/89 and 91/ 2001.

<sup>55</sup> Consequently, with less economic activity, lower GDP (gross domestic product) growth, and higher monitoring costs and forest conservation.



at first. But the oil exploration creates a lot of jobs and attracts investments, which is the opposite of the Carbon Market: you pay for the forest maintenance by using credits derived from the option of not making economic activities. Moreover, the oil and the places where the exploration is more common belong to the Federal Government, according to the Article 20 V, VI e IX of the 1988 Federal Constitution. The states, the Federal District and the municipalities are allowed to participate in the results of those resources exploration or they can be compensated by the exploration itself if it takes place in their area, according to the §2º of the fore-mentioned article, but the property is still of the Federal Government. That is why that analogy is not valid, considering that in the Carbon Market the land ownership to be conserved for CO<sub>2</sub> capture is assured, and it may belong to the Federal Government, to the states, to the Federal District, to the cities or even to individuals.

Thus, that model is unwelcome because it would disregard the individual capacity of Carbon absorption and the negotiation of federative entities and individuals in the Market. It also would increase the regional inequalities by not compensating economic activity decrease (or little maintenance) of the states where there are preservation areas.

### **6.2.2 Federal Government Revenue Collection and Distribution Among the Entities in Their Proper Quotas**

In this system there is a similarity between what happens in the capital market and the previous model, the only one entity of public power able to operate in the Carbon Market would be the Federal Government, but the difference is the way of sharing the funds after raising them. Sharing without regarding the proportional criteria of population, location of the states and per capita income, but considering the actual results of environmental preservation and carbon absorption, there would be a more effective offset for the carbon absorption and a greater economic interest of the states and the Federal Government in the environment preservation. Therefore, this option could be more fitting and fairer than the first one.

In order to distribute the amount collected by the Federal Government in the Carbon Market to the states and the cities, there are two options: carbon trading assignment of rights of the

federal entities to the federal government and payment for the proper quotas<sup>56</sup> or the royalties payment of the Union to the states and cities regarding their preserved areas, in a similar system of the Financial Compensation for the Exploration of Mineral Resources (CFEM).<sup>57</sup>

The bureaucracy involved, however, is the problem of the last modality because it gives grounds for corruption<sup>58</sup> due to the excessive centralization of powers of some agencies and political players.<sup>59</sup>

Besides those difficulties, there are also complications in budget planning of the states and the cities in the context of this model. That is because depending on the Union transfer of resources, it is not entirely clear when and how much will be available in the states and cities coffers.<sup>60</sup> Due to all these uncertainties and to the insistence on imposing a model of powers centralization, we believe that this alternative would not fit properly within the Brazilian context, especially regarding Amazônia sustainable development.

### **6.2.3 Linking of Earnings for Sustainable Development Projects in the Region**

There are strong indications that this hypothesis could be confirmed, maybe, as a complementary manner to others, especially because it has already been used in the regulamentation of the oil royalties, but to a fund for Education and Health. It would be interesting to use part of the revenue obtained by the Union through Carbon Market as an

---

<sup>56</sup> What, in practice, would work as though the Union had bought the carbon credits from the states and cities and had resold them in the market with its own credits.

<sup>57</sup> This system is regulated by the law 7990/89 and 8001/90 and distribute the royalties obtained with mining as it follows: 65% to the cities where the production occurs (and to the Federal District, if applicable), 15% to the states (or the Federal District) where the production occurs, 15% to the cities and to the Federal District affected by the mining activity, and 10% divided between Federal Agencies. Observe that, different from the oil royalties, only the producer states and cities (and those which are not producers, but are directly affected by mining infrastructures) receive a financial compensation

<sup>58</sup> In 2016, a serious corruption scheme was uncovered involving the National Department of Mineral Production (DNPM), dismantled by the Federal Police, through Operação Timóteo, in 11 states and the Federal District (G1 DF 2016; Affonso et al. 2016). This department is responsible for collecting and distributing the mining royalties in Brazil and handled approximately R\$ 1.6 billion in 2015. In this specific case, the corruption scheme was related to the amounts which would be allocated directly to municipalities.

<sup>59</sup> Klautau de Araújo (2016) points out that one of the biggest problems of the public policies implementation process in Brazil is the centralization in the planning and decision-making processes and the dispersion of the implementation. In that context, the situation is similar: the concentration of power in few agents attracts strong political interest, makes the proper use of the money difficult and increases the possible deviations from ethical conduct.

<sup>60</sup> The event at the National Department of Mineral Production had to do with it: there were late payments and the agents from the department received bribes (concealed by law and consultancy offices) in order to speed up the money deposits and to increase the values.

investment for environmental preservation, for sustainable development of regions with rich biodiversity and natural resources as well as for restoring degraded areas. Here, that possible regulation is attractive because it qualifies the purpose of those obtained values, otherwise, there would be common revenues.

Thus, the repetitive discourse which affirms that the environmental preservation sucks resources dry and that it blocks the economic growth is not valid, and with this alternative, this narrative loses its meaning, because providing funds to the country may boost the economy and safeguarding part of revenue to invest in environmental recovery and protection makes the system self-contained. By promoting sustainable development, apart from social conditions improvements, there is a chance for Brazil to develop economically, heading towards a more environmentally friendly production with a strong focus on the rational and conscious use of the natural resources. The path towards an environmentally friendly economy is neither about loss of competitiveness nor about impoverishment,<sup>61</sup> but it needs more investments and also a paradigm shift in the relationship between State and society, as well between those and the nature.

However, for the same reasons presented in the previous alternative, there are strong evidences that it would be a failure as the main model. That would happen because the resource centralization in a single fund, besides leading to the greed of malicious public managers,<sup>62</sup> will also lead to the problem of over-centralization pointed out by Klautau de Araújo (2016). More than that, it is important that the environmental assets can be seen as attractive business opportunities, as well as income generation and job creation opportunities. The advantage of using them in a coordinated manner is that they can complement each other. That means it is possible to generate wealth, for instance, through ecotourism or adventure tourism, extraction and cultivation of medicinal herbs, flowers and

---

<sup>61</sup> If we analyze the examples of the developed countries, the technology, the productive processes, the entrepreneurial dynamics, the environmental awareness and planning are more connected to the success of the economy than to the plenty of natural resources. Japan, for instance, relies on few natural resources, has a rough ground, hard to be used, besides being a group of islands, what would make its development difficult. However, despite all those facts, it is one of the most developed economies, a balanced society and with low level of poverty.

<sup>62</sup> Even though the study of Public Administration in Law courses, most of the times, recommends to consider corruption in the spheres of government as an exception, not as a rule, the Brazilian experience shows us that the reality is different and that the current political system has many examples of a corrupt governance. There are denouncements against all the political spectra and against almost all political parties. Therefore, the planning of alternatives to the country must be designed in a way that the flaws may be minimized and the public funds may be protected.

fruits from Amazônia, to achieve the carbon absorption and to sell securities on the Market, all those things by using the same area. The allocation of revenue to a single fund (even though if it would be only the public one) obtained from a specific environmental asset would reduce the flexible usage of sustainable environmental assets and mutually complementary. Consequently, their competitiveness and attractiveness for the private sector would also be reduced.

Specifically in the case of Amazônia, the community and individuals deep involvement will be necessary since the area to be monitored is very large, the governments do not have sufficient means to be present throughout the territory (even if they had, the costs would be extremely high), and the current methods are more repressive than preventive.<sup>63</sup> Moreover, the failures in implementing public policies in Amazônia in previous experiences, as we have already discussed in this paper have demonstrated the need for understanding, agreement, contribution and participation of local populations in the decision-making and executive process. Without that, it is almost impossible to think about monitoring and managing such a large and difficult access area like Amazônia.

#### **6.2.4 License for Individuals and Public Entities to Operate Freely in the Market**

For the given reasons in the previous topic, the participation of the local people and of all the federative entities is necessary for finding solutions to the environmental issue. There are many doubts concerning the possible ways of arousing the interest. By allowing a broad participation of public and private entities in those markets, increasing their profitability with the natural resources conservation and biodiversity, there is a clear valorization of the forest and growing interest of the individuals in taking part in the initiatives for conservation.

Thus, the model we believe to be the most interesting for implementing the Carbon Market in Brazil is a hybrid model of collection, distribution and allocation of the obtained revenue, in which all the federative entities and individuals could freely participate, making their rights, duties and obligations clear, (topic that will be discussed further in this paper), also considering some part of the revenue allocated to a supervisory, monitoring, conservation and reforestation fund.

---

<sup>63</sup> The satellite surveillance, inspection activities, among others, intend to punish the responsible for the environment damage, what is valid, but if the damage has already been done, the environmental restoration is hard, even with the modern procedures of reforestation, due to the maintenance of ecological balance and biodiversity, it is best to keep the original wood instead of reforesting a cleared area.

## 7 Practical Challenges

Besides all the technical challenges, in order to design a management model of the Environmental Assets that work efficiently and to make the Carbon and the Environmental Assets Markets reach the goals of economic and social sustainability, it is necessary to regard some practical challenges, namely: fostering an economic interest for conservation and maintenance of forests; designing a regulation system appropriate for the reality and accessible to the interested people, in which there is an understanding of the protected legal assets importance, the duties, obligations and rights of the parties involved in this market, whether they are small rural landowners or major corporations; and the strengthening of the educational system, especially the environmental education.

The first challenge is to find ways that make the Environmental Assets viable sustenance alternatives so that the local people cease predatory practices and become interested in maintaining and preserving the forests. In addition, engage them in the sense of not allowing third parties to make predatory activities. It means to make the local populations and the State partners in the monitoring of forests and ecosystems. It is necessary to note that the Environmental Assets may be economically attractive, as stated above in this paper, because it is possible to combine the exploitation of several environmental assets simultaneously, increasing their profitability.

The second challenge is to communicate effectively with those populations, making them access, in a real and not fictitious way, the legal documents and legal regulations about the issue.<sup>64</sup>

It is not appropriate to use a very technical language (as it has been used) with terminologies which people do not know and can barely understand. Most of the times, it is necessary to

---

<sup>64</sup> A brief comment on the popular participation and interaction effectiveness is welcome: they are possible only if there is an open, transparent and accessible language. The overuse of technical terms, jargons, acronyms and abbreviations makes the documents reading unpleasant and sets up a bar for any person who is not in the limited circle of “specialists”. Even the Law or Environmental field professionals who are unfamiliar with the Carbon Market and the Environmental Assets experience serious difficulties when dealing with this topic due to the language unnecessarily tight, the challenge is greater to, for instance, a person from Amazônia countryside with poor education and with no access to public services, a very common profile found in the local community (brought about by the indifference of the governments). In order to make those people—who have so much to contribute to the understanding and preservation of their areas—participate in the debate, clarity, respect and transparency from the specialists are demanded and they may learn a lot about Amazônia with its natives. Unfortunately, until the present moment, frequently, the decision-making processes and the explanations of open initiatives to the participation of local people are not arranged in that way, resembling an accession model in which the “knowledge” is taken to the people; there is no dialogue, there is no participation.

have appropriate knowledge of the field in order to communicate with the people responsible for the studies and the regulation projects. For this reason, on behalf of honesty, transparency and good faith of the decision-making processes and enforcement proceedings, the communication must be improved. A context in which the regulation of a sector is not understood by almost any of the interested parties is an enabling environment for the spread of corrupt practices and vested interests that do not fit the exercise of citizenship and democracy.

The third one is the implementation of a qualified education system for the populations. That is the key component to make children, teenagers, young people and future generations environmentally aware, even for those who are not inserted into the forest reality, so that they will be able to help in the environment preservation.

If some of those things (especially the communication with the population) fail, the effectiveness and efficiency of that action as a sustainable way to Amazônia and other Brazilian biomes that are endangered will possibly be reduced, since the three presented components complement each other. Nevertheless, the tackling of those issues depend on a regulation system suited for the specificities of Brazil and its regions in order to arrange the Carbon and Environmental Assets Markets as economic development alternatives, not only as simple chances of some groups to make money out of the natural resources that are of interest to the society.

Especially because the Carbon and Environmental Assets Markets are not going to save Amazônia—or the world, but they are sustainable alternatives for economic diversification and natural resource use. Overly concentrating investments and to pay attention exclusively to that possibility is risky and reckless. Doing that is like getting back to Belle Époque but for bad reasons: that excessive economic dependency on the rubber led Amazônia to chaos with a decrease in that product prices in the international market.<sup>65</sup> If the Carbon and the Environmental Assets markets are not used as an instrument for the region to find two ways

---

<sup>65</sup> Weinstein (1993), regarding the Belle Époque period, highlights that: “The fast growth of the main port of the area established a market for some few local industries; it promoted, also, the development of public works and of municipal improvements that transformed Belém in one of the most impressive capitals of state of Brazil. However, it seems to have created an interest larger in non-productive activities, such as the real estate speculation and the import of luxury goods`. That concentration of activities, which made the collapse of the rubber cycle even worse, with no alternative economic sectors was due to the close monitoring of the rubber elite on the poorest population that was involved in the productive chain and that acted against any development that could transform the extractive economy (Weinstein 1993).

of sustainable development, the same past negative outcome may happen once again.<sup>66</sup> But the consequences may be even worse: without appropriate rules, a steep rise of the values may lead to a land purchase race,<sup>67</sup> fact that would evict or marginalize the local populations,<sup>68</sup> and that would increase risks to fraud for obtaining land.

All those issues cannot be dropped off the market regulation proposal, but the studies have been mostly carried out focusing the market functioning. That, over the years, can become a problem, since the external or secondary issues and the interaction of market and its surroundings is essential for its development.

The manner the legal regulation will be arranged may mean the success or the failure of this alternative and the real participation, or not, of the local people. According to what present proposals and studies establish, there are few chances for this effective participation. Most of the suggested forms are based upon existing models in other countries, what can lead to the great financial conglomerates, once more, profiting from Amazônia. That is, obviously, a failed path, designed to failure in few years. Since they do not have local connections, after taking profits on the situation or, maybe, if there is not any interest, those huge companies will leave the region, creating a big social and economic empty hole.<sup>69</sup> Thus, what was conceived for this opportunity will not be designed and required: a model of sustainable development, with the decrease of social disparities in Amazônia and in the rest of the country, and at the same time, the forest preservation, an issue of international interest.

---

<sup>66</sup> That is the reason why we also understand that international donations for preservation funds, such as the donation of US\$ 1 Billion from Norway to the Amazônia Fund—assessed by some scholars (Birdsall et al. 2014)—is not as beneficial as it sounds. This is because the donation of values from other countries is a one-off aid, which causes dependence on the outside, without generating value for the forest, and without causing the necessary cultural change on the value of living forest for the local populations. Governments may need money to keep the forests preserved. However, people living in these places need sustainable alternatives to avoid predated the forest, living with dignity and helping to preserve the environment. An Environmental Assets Market can provide this; international donations, no. Donations without other supports (scientific, medical or technological) may cause dependence of the poor countries, and it may hinder their development (Deaton 2017).

<sup>67</sup> There are, also, bills that seek to allow the purchase of lands for foreigners, almost without limits (Estadão Conteúdo 2017). The content of the proposals does not include that permission when the biomes demand Legal Reserve of 80%, that it is the case of Amazônia, but for being just of a project, that provision can be dropped easily.

<sup>68</sup> As it was seen in the areas where there was mining, for instance, or huge agricultural projects. The population was no longer the owner of the lands and experienced living on activities related to the flow of people attracted by the area. However, that flow of people brought violence, overload of the facilities and of the public services, marginalizing the local populations.

<sup>69</sup> Such as that seen in the second rubber cycle, in Fordlândia project (Pará), in the exploration of manganese at Serra do Navio (Amapá), amongst other examples.

## 8 Conclusions

In this paper, we have tried to discuss several issues related to the Environmental Assets and Carbon Markets as sustainable alternatives for Amazônia (if regulated), in a multi and interdisciplinary perspective. Considering all the gathered data and data analysis, as well as the authors' professional and personal experience, we believe that the environmental issue, in Brazil, is not properly regulated and ruled. Moreover, the success of those markets establishment and their potential of social and economic transformation in the region will depend upon the way the regulation will be arranged. It is a valuable and unique opportunity and perhaps the last chance to preserve and value Amazônia Forest. However, if its regulation is not well arranged, there is a risk of concentrating, even more, the riches of the region in the hands of large corporations, making, once more, the local people helpless.

Also, we have raised the issue of the Carbon Market as a relevant alternative but not the only one available to Amazônia. We have suggested the Environmental Assets Market regulation, so that there will possibly be a coordinated, intelligent and systematic valorization towards the social, economic and environmental development of the region, free from the dependency of a single activity. That all hinges upon the participation of local people and on the manner the subject will be regulated.

## References

- Affonso J, Macedo F, Fabrini F, Serapião F (2016) Operação Timóteo investiga esquema de corrupção em cobrança de royalties. Retrieved from: <http://bit.ly/2ICQAe9>
- Altafin I (2016) Participação brasileira no mercado de carbono será analisada na CMA. Retrieved from: <http://bit.ly/2yGIF9L>
- Aristóteles (2009) *Ética a Nicômaco*. Tradução de Antônio de Castro Caeiro. Atlas, São Paulo
- Barbosa R (1999) *Oração aos Moços – Edição popular anotada por Adriano da Gama Kury*. 5ª edição. Rio de Janeiro: Fundação Casa de Rui Barbosa
- Birdsall N, Savedoff W, Seymour F (2014) The Brazil-Norway agreement with performance-based payments for forest conservation: successes, challenges, and lessons. Retrieved from: <http://bit.ly/2y34KKr>
- Brasil (1966) Lei nº 5172, de 25 de outubro de 1966. Retrieved from: <http://bit.ly/2vZZveQ>



Brasil (1976) Lei nº 6385, de 7 de dezembro de 1976. Retrieved from: <http://bit.ly/2yGE3PY>

Brasil (1988) Constituição da República Federativa do Brasil de 1988, promulgada em 05 de outubro de 1988. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Constituicao/Constituicao.htm](http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm)

Brasil (1989) Lei Complementar nº 62, de 28 de dezembro de 1989. Retrieved from: <http://bit.ly/2xk8o3h>

Brasil (1989) Lei nº 7990, de 28 de dezembro de 1989. Retrieved from: <http://bit.ly/2fL0awx>

Brasil (1990) Lei nº 8001, de 13 de março de 1990. Retrieved from: <http://bit.ly/2velUIb>

Brasil (1997) Lei Complementar nº 91, de 22 de dezembro de 1997. Retrieved from: <http://bit.ly/2xA8Bi0>

Brasil (1997) Lei nº 9478, de 6 de agosto de 1997. Retrieved from: <http://bit.ly/1tfLEPg>

Brasil (2004) Projeto de Lei nº 3729/2004. Retrieved from: <http://bit.ly/2iCpMwQ>

Brasil (2006) Lei nº 11284, de 02 de março de 2006. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2004-2006/2006/lei/11284.htm](http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/11284.htm)

Brasil (2007) Decreto nº 6063, de 20 de março de 2007. Retrieved from: <http://bit.ly/2yLjZts>

Brasil (2008) Decreto nº 6527, de 1º de agosto de 2008. Retrieved from: <http://bit.ly/2y2M2Hr>

Brasil (2009) Lei nº 12114, de 9 de dezembro de 2009. Retrieved from: <http://bit.ly/2zMO5N9>

Brasil (2009) Lei nº 12187, de 29 de dezembro de 2009. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2009/lei/12187.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/12187.htm)

Brasil (2010) Decreto nº 7167, de 5 de maio de 2010. Retrieved from: <http://bit.ly/2gHbsDh>

Brasil (2010) Decreto nº 7343, de 26 de outubro de 2010. Retrieved from: <http://bit.ly/2leoold>

Brasil (2010) Decreto nº 7390, de 9 de dezembro de 2010. Retrieved from: <http://bit.ly/2yNja39>

Brasil (2010) Lei nº 12351, de 22 de dezembro de 2010. Retrieved from: <http://bit.ly/1rcaWMI>

Brasil (2011) Projeto de Lei do Senado nº 212, de 2011. Retrieved from: <http://bit.ly/2gBnWZ7>

Brasil (2012) Entenda como funciona o mercado de crédito de carbono. Retrieved from: <http://bit.ly/2htE1lb>

Brasil (2012) Lei nº 12651, de 25 de maio de 2012. Retrieved from: <http://bit.ly/1zecCID>

Brasil (2012) Projeto de Lei do Senado nº 95, de 2012. Retrieved from: <http://bit.ly/2gzIFN1>

- Brasil (2013) Lei nº 12858, de 9 de setembro de 2013. Retrieved from: <http://bit.ly/2xloGbO>
- Brasil (2015) Decreto nº 8576, de 26 de novembro de 2015. Retrieved from: <http://bit.ly/2iz1t39>
- Brasil (2016) Medida Provisória nº 756, de 19 de dezembro de 2016. Retrieved from: <http://bit.ly/2z68aRF>
- Brasil (2016) Medida Provisória nº 758, de 19 de dezembro de 2016. Retrieved from: <http://bit.ly/2y3AGDa>
- Brasil (2017) Decreto nº 9142, de 22 de agosto de 2017. Retrieved from: <http://bit.ly/2g5fkgv>
- Brasil (2017) Decreto nº 9147, de 28 de agosto de 2017. Retrieved from: <http://bit.ly/2vHFaKr>
- Brasil (2017) Decreto nº 9159, de 25 de setembro de 2017. Retrieved from: <http://bit.ly/2lgebor>
- Brito B (2017) Potential trajectories of the upcoming forest trading mechanism in Pará State, Brazilian Amazon. PLoS ONE 12(4):e0174154. <https://doi.org/10.1371/journal.pone.0174154>
- Cardoso A (2015) Especiarias na Amazônia portuguesa: circulação vegetal e comércio atlântico no final da monarquia hispânica. Revista Tempo 21(37):116–133
- CGD—Center for Global Development (2015) Look to the Forests: how performance payments can slow climate change. CGD, Washington, DC. Retrieved from: <http://bit.ly/2w6pVyQ>
- CNT; SEST; SENAT (2016) Pesquisa CNT de Rodovias 2016: relatório gerencial. 20ª ed. Brasília: CNT.
- CVM (2009) CVM comunica seu entendimento sobre créditos de carbono e produtos que deles derivam. Retrieved from: <http://bit.ly/2i18xlc>
- Deaton A (2017) A grande saída: saúde, riqueza e a origem das desigualdades. Intrínseca, Rio de Janeiro.
- Estadão Conteúdo (2017) Projeto para permitir venda de terra a estrangeiro vai ao Congresso. Retrieved from: <https://glo.bo/2zMHIcF>
- FBSP; IPEA (2016) Atlas da violência 2016; nota técnica. Brasília: Instituto de Pesquisa Econômica Aplicada – IPEA. Retrieved from: <http://bit.ly/1R16zsQ>
- Folhes R et al (2015) Multi-scale participatory scenario methods and territorial planning in the Brazilian Amazon. Futures 73:86–99
- G1 DF (2016) PF desarticula esquema de corrupção na cobrança de royalties de mineração. Retrieved from: <https://glo.bo/2y3ans0>
- G1 PA (2017) Governo envia ao Congresso projeto de lei que reduz floresta nacional no Pará. Retrieved from: <https://glo.bo/2yMS3qH>

- Garfield S (2009) A Amazônia no imaginário norte-americano em tempo de guerra. In: Revista Brasileira de História, v. 29, nº 57, pp. 19–65. São Paulo
- Garfield S (2010) The environment of wartime migration: labor transfers from the Brazilian Northeast to the Amazon during World War II. J Soc Hist Summer 2010 (George Mason University Press, Fairfax)
- Gesisky J (2017) Meio Ambiente perde metade dos recursos para 2017. Retrieved from: <http://bit.ly/2zA0wuP>
- Gomes M (2017) China reafirma compromisso com o Acordo de Paris. Retrieved from: <http://bit.ly/2ldCWlk>
- IBGE—Instituto Brasileiro de Geografia e Estatística (2016) Área Territorial Brasileira. Retrieved from: <http://bit.ly/2xxyleQ>
- Kafruni S (2014) Natura inaugura complexo industrial na Amazônia e gera 500 empregos. Retrieved from: <http://bit.ly/2h4B49Y>
- Kageyama PY (2009) Biodiversidade e Biopirataria: contradição entre a biodiversidade e a pobreza no mundo. In: Aleixo A, Azevedo-Ramos C, Camargo E, Kageyama PY, Maio MC, Nascimento DM, Oliveira NS (eds) Amazônia e Desenvolvimento Sustentável. Fundação Konrad Adenauer, Rio de Janeiro
- Klautau de Araújo JM (1995) Caligrafias de Belém – vol I: a dimensão insular. Imprensa Oficial do Estado do Pará, Belém
- Klautau de Araújo JM, Lima DMB (1997a) Projeto Escola Bosque do Amapá – Centro de Referência em Educação Ambiental da Ilha de Santana. Governo do Estado do Amapá, Macapá
- Klautau de Araújo JM, Lima DMB (1997b) Projeto Escola Bosque do Amapá – O método sócio-ambiental. Macapá: Governo do Estado do Amapá
- Klautau de Araújo JM, Lima DMB (1997c) Projeto Escola Bosque do Amapá – Projeto de Socialização. Macapá: Governo do Estado do Amapá
- Klautau de Araújo TL (2014) Environmental law, public policies, and climate change: a social-legal analysis in the Brazilian context. In: Leal Filho W (eds) Handbook of climate change adaptation. Springer, Berlin, pp 973–982. [https://doi.org/10.1007/978-3-642-40455-9\\_115-1](https://doi.org/10.1007/978-3-642-40455-9_115-1); ISBN: 978-3-642-40455-9
- Klautau de Araújo TL (2016) Public policies and education for biodiversity: Brazilian challenges in a new global context. In: Castro P, Azeiteiro UM, Bacelar Nicolau P, Leal Filho W, Azul AM (eds) Biodiversity and education for sustainable development. Springer, Berlin, pp 219–235.
- Leite M (2015) Dilma Corta 72% da verba contra desmatamento na Amazônia. Retrieved from: <http://bit.ly/2yOPbd9>

- Lima DMB (2013) The Escola Bosque project: building ways to an ecological society. In Proceedings 7th world environmental Education Congress, Marrakech, Morocco, June 9–14, 2013
- Lopes L et al (2015) Estudos sobre Mercado de Carbono no Mercado de Carbono no Brasil: Análise Legal de Possíveis Modelos Regulatórios. Banco Interamericano de Desenvolvimento, Monografia No. 307. BID, Washington, DC
- Lusa (2017) Juncker alerta Trump: “Os norte-americanos não podem sair sem mais nem menos do acordo de Paris”. Retrieved from: <http://bit.ly/2yOzfrB>
- Maisonnave F (2017a) Câmara aprova reduzir proteção de áreas de conservação no PA e em SC. Retrieved from: <http://bit.ly/2zzHUen>
- Maisonnave F (2017b) Senado ratifica redução na proteção de áreas de conservação na Amazônia. Retrieved from: <http://bit.ly/2xkIOea>
- Mariani D, Demasi B, Almeida R (2016) Três disputas de território entre os Estados brasileiros. Retrieved from: <http://bit.ly/2zzX3wi>
- Meirelles Filho J (2015) Quem sabe do lugar é quem vive nele, in Revista Página 22, nº 98, set/out 2015. São Paulo: Fundação Getúlio Vargas
- Milaré É (2014) Direito Ambiental, 12th edn. Revista dos Tribunais, São Paulo
- Ministério da Fazenda—Brasil (2017) Despesas Contingenciáveis na LOA 2017. Retrieved from: <http://bit.ly/2zM5cyy>
- Ministério de Minas e Energia – Brasil (2017) Governo revoga decreto que extingue a Renca. Retrieved from: <http://bit.ly/2h7dE3O>
- Ministério do Meio Ambiente – Brasil (2016) ENREDD+ - Estratégia Nacional para Redução das Emissões Provenientes do Desmatamento e da Degradação Florestal, Conservação dos Estoques de Carbono Florestal, Manejo Sustentável de Florestas e Aumento de Estoques de Carbono Florestal. Retrieved from: <http://bit.ly/2yMm607>
- Miranda G (2017) Projeto de lei quer afrouxar licenciamento ambiental no Brasil. Retrieved from: <http://bit.ly/2itPiVj>
- Moutinho P, Guerra R (2017) O vexame de cortar pela metade a ínfima verba para o Meio Ambiente. Retrieved from: <http://bit.ly/2y2grWz>
- Paulino E (2014) The agricultural, environmental and socio-political repercussions of Brazil’s land governance system. Land Use Policy 36:134–144
- Peduzzi P (2017) Governo anuncia R\$ 190,25 bilhões para Plano Agrícola e Pecuário 2017/2018. Retrieved from: <http://bit.ly/2sg2100>
- Pinheiro Pedro A et al (2015) Organização do Mercado Local de Carbono: Sistema Brasileiro de Controle de Carbono e Instrumentos Financeiros relacionados. Retrieved from: <http://bit.ly/2yK49ix>

- Pinho P et al (2014) Ecosystem protection and poverty alleviation in the tropics: perspective from a historical evolution of policy-making in the Brazilian Amazon. *Ecosyst Serv* 8:97–109
- Rawls J (2008) *Uma teoria da Justiça*, 3ª edn. Martins Editora, São Paulo
- Rousseau J-J (2008) *Discurso Sobre a Origem e os Fundamentos da Desigualdade Entre os Homens*. LP&M Pocket, São Paulo
- Samuelson P (1976) Economics of forestry in an evolving society. *Econ Inq* XIV
- Schreiber M (2017) Reação ao fim da Renca foi ‘histeria’, ‘infantilidade’ e ‘desinformação’, dizem geólogos. Retrieved from: <http://bbc.in/2yJPI0B>
- Seymour F, Busch J (2016) *Why Forests? Why Now? The science, economics, and politics of tropical forests and climate change*. CGD, Washington, DC
- Soares G (2016) Proteção dos conhecimentos tradicionais e repartição de benefícios: uma reflexão sobre o caso da empresa Natura do Brasil e dos erveiros e erveiras do mercado Ver-o-Peso. Retrieved from: <http://bit.ly/2z4OIo5>
- Weinstein B (1993) *A borracha na Amazônia: expansão e decadência (1850-1920)*. Editora da Universidade de São Paulo, São Paulo
- Weis B (2006) Polêmica entre Natura e Ver-o-peso expõe dilemas na proteção de conhecimentos tradicionais no Brasil. Retrieved from: <http://bit.ly/2yKb4bE>
- Wolford W (2016) The casa and the causa: institutional histories and cultural politics in Brazilian Land Reform. In: *Latin American research review*, vol 51, No 4. Latin American Studies Association, Austin

## **Publication 4**

**“Brazilian Amazônia, deforestation and environmental degradation: analyzing the process using game, deterrence and rational choice theories”**, submitted to the Environmental Science and Policy Journal, 2019.

Thiago Lima Klautau de Araújo, Pedro Sousa, Ulisses Manuel de Miranda Azeiteiro and Amadeu Mortágua Velho da Maia Soares

## **Brazilian Amazônia, deforestation and environmental degradation: analyzing the process using game, deterrence and rational choice theories**

Thiago Lima Klautau de Araújo, Pedro Sousa, Ulisses Manuel de Miranda Azeiteiro and Amadeu Mortágua Velho da Maia Soares

### **Abstract**

This paper aims to assess causes and the interactions between decision making, stakeholders and individuals, law and public policies to build a more precise overview of the relations, the possible results and the factors which can interfere on environmental conditions and dynamics in Brazilian Amazônia. To better elucidate the issue, rational choice and deterrence theories were used, and a model based on game theory was built. It shows that non-cooperative Nash solution is compatible with the full depletion of the Brazilian Amazônia's resources and the tragedy of the commons could be certain. The lack of incentive for greener practices and deficiencies in Brazilian law system can be pointed as two of the main causes for the current non-collaborative interactions between the agents that lead to environmental degradation in the region. However, other aspects and circumstances are being disregarded in Brazilian environmental law and policies.

**Key-words:** Brazilian Amazônia; Environmental Law; Environmental Degradation; Game Theory; Deterrence Theory.

### **1 Introduction**

Brazilian Amazônia is facing challenging environmental problems and they have been increasing since the 1960s. It is a systemic situation in which deforestation has become one of the most prominent problems to solve, especially in Brazilian Amazon (Klautau de Araújo, 1995, Paulino, 2014), where public policies seem to have been failing on the last decades.

Several studies have addressed different aspects of this problem, for example: environmental degradation and cattle production (Muchagata et al. 2003), land use (Aguiar et al. 2007),

transition to a disturbance-dominated regime (Davidson et al. 2012), disturbance and carbon balance (Espírito-Santo et al. 2015), land colonization and agrary expansion (Wolford 2016), deforestation and socioeconomic aspects (Lavelle et al. 2016), land use and poverty (Garrett et al. 2017), challenges to assess biodiversity (Ritter et al. 2017), deforestation, urbanization, public investments, and agriculture (Silva et al. 2017), small-scale deforestation (Kalamandeen et al. 2018), drought and vulnerability to increasing heat (Gloor 2019).

Amazônia is a rich biodiversity reserve and the biggest tropical forest in the world. Its uncontrolled dilapidation is a major threat to new scientific discoveries, to climate stability of the globe and to endogenous and rare species (Klautau de Araújo 2019). Brazil concentrates 60% of Amazônia rainforest area (IBGE 2004), and the outcomes of interventions made in its territory can influence the whole biome. Nonetheless, large areas in that region are still being deforested. Such problem calls for a systemic collaboration of efforts involving governmental institutions and agencies and population (Campos-Silva et al 2018). The results of these interactions are different from the ones observed by the neighbor countries (Armenteras et al 2017), what can reinforce that the political choices have been shaping the social and environmental situation of the region.

Policies centered only in surveillance, the establishment of multiple environmental agencies and the enacting of sophisticated laws (but not totally adequate for the Brazilian reality) do not seem to achieve their goals. Those mechanisms are not capable to stop and to reverse the current scenario: some authors consider it not only inefficient, but also counterproductive (Pereira and Jorge 2003). In fact, the raising of deforestation rates in recent years brings doubts about the long-term sustainability of the measures taken (Schielein and Börner 2018), as it is approached in the next topics of this paper. Fighting deforestation can bring temporary better environmental results but will not solve the roots of the problem. More and better coordination between the agencies (and a clear understanding of the causes of the problem), is needed for governmental and institutional actors.

This paper aims to analyze the current environmental problems in the Brazilian Amazônia. To do so, three complementary approaches are jointly considered. Environmental degradation dynamics is modeled with a very basic game theory model. Without intervention, the non-cooperative Nash solution is compatible with the full exploitation of the Brazilian Amazônia's resources and the tragedy of the commons could be certain.



Solutions for this tragedy require less use of common resources by individuals, which could be accomplished (according to classic proposed suggestions) through direct governmental control or privatization of the common resources. Alternatively, a solution could be found by modifying incentives, which is explained jointly considering inputs from the rational choice theory and from deterrence theory. Thus, game theory, rational choice theory and deterrence theory can explain many issues of the environmental situation in Amazônia, but only few studies have applied it to the region like it is done in this paper. As exceptions: Börner et al. (2014) who assessed the deterrent effect of surveillance in the region and created a model to analyze the cost-benefit of investments in the sector; and Schmitt (2015) who assessed the environmental fines issued by IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) and created a model to find the general deterrence value.

When combined, those three branches can better elucidate the relation of causes and consequences in environmental degradation, as well to predict the probable outcomes. Knowing the causes and the likely results, it is possible to plan and to adapt public policies, as well as the legal framework in order to achieve better results for the environment.

## **2 Game Theory and The Tragedy of the Commons: explaining Environmental Degradation dynamics**

Presenting a mathematical taxonomy of social and organizational life, Game Theory gives us insights to predict how individuals and/or organizations may interact with each other, what decisions they are expected to take and what is the likely outcome of that interaction. By doing so, it is possible to analyse the likely impacts of variations of the strategic circumstances on the final result of the interactions.

It has been used in several scenarios regarding cooperation between agents and/or countries in different situations and conditions, namely environmental issues: environmental assessment (Bond et al. 2016) fisheries (Grønbaeka et al. 2017) environmental risk mitigation (Gao et al. 2018), pollution (Halkos and Papageorgiou 2018) and socio-ecological systems (Oraby et al. 2018).

The most frequently used game, especially in this context, is the Prisoner's Dilemma. The standard outcome of it is a strictly dominant strategies equilibrium (and a pure strategy Nash

equilibrium) in which both suspects betray the partner (e.g., Osborne, 2004). It is known as a dilemma as the Nash equilibrium is inefficient because both players in equilibrium choose not to cooperate (both denounce the partner), despite identifying gains from cooperation (a Pareto superior outcome would be achieved if both do not confess), because each one has an incentive to free ride.

Created by Albert W. Tucker, this example of a game is very popular as it resembles very well many other circumstances where strategic decisions are interdependent, e.g., the common property exploitation. In this case, two farmers, sharing a common land, decide on how many sheep they will put grazing the common land. Each farmer prefers more sheep than fewer, as the marginal (additional) benefit of each extra sheep for the farmer is higher than the marginal cost that is internalized by the farmer – whereas all the benefits revert to that farmer, all the costs are spread among all of them. If both farmers decide similarly, the likely outcome is overexploitation of the common resources, which would lead to total degradation of the area and losses for both.

Extending the two farmers' situation to a multiplayer version in which there are several individuals exploiting the common resources, society faces a social dilemma, specifically named by Hardin (1968) as the 'Tragedy of the Commons'. In practice, the lack of cooperation can lead not only to overexploitation but also to accelerate this process, as it motivates the other agents to speed up the exploration of resources to take more advantage than the other players. This tragedy, applied to the case of Amazônia, can be explained with a model as it follows.

## **2.1 Amazônia and the Tragedy of the Commons**

In Amazonia, an amount of  $A$  natural resources is exploited by  $n$  individuals. Each individual  $i$  chooses how much effort will spend in the exploitation of those resources. Depending on that effort, natural resources will be depleted by individual  $i$  in the amount of  $a_i$ .

In each period, individual  $i$  earns revenues which correspond to satisfaction from individually consumed natural resources (forest) and from the natural resources that are left over after all explorers had consumed their part, as the remaining forest allows greater well-being (e.g., renewed air).

Thus, assuming a logarithmic utility function, which represents how individual satisfaction varies with consumed and not consumed resources, the payoff function of the individual  $i$  is defined by:

$$(1) \quad \pi_i(a_i, a_{-i}) = \ln a_i + \ln(A - \sum_{j=1}^{n-1} a_j - a_i)$$

This function implicitly assumes diminishing marginal utility: although increasing, satisfaction resulting from the consumption of natural resources progresses at decreasing rates.

Individual  $i$  will choose  $a_i$  that maximizes his payoff function. The first order condition (F.O.C.) of this problem is defined by:

$$(2) \quad \frac{\partial \pi_i(\cdot)}{\partial a_i} = \frac{1}{a_i} + \frac{-1}{A - \sum_{j=1}^{n-1} a_j} = 0$$

In as much as the F.O.C. of individual  $i$  depends on the decisions  $a_j$  of the other  $n-1$  individuals, there are conditions for considering this framework as a strategic one and to define the best response of individual  $i$  (to decisions of the other individuals) as:

$$(3) \quad a_i^* = \frac{A - \sum_{j=1}^{n-1} a_j}{2}$$

Assuming that all the individuals' efforts result in the same amount of consumed natural resources, the best response for each of them is defined as well by:

$$(4) \quad a^* = \frac{A - \sum_{j=1}^{n-1} a^*}{2} = \frac{A - (n-1) \cdot a^*}{2}$$

Solving for  $a^*$ , it is possible to find the symmetric Nash equilibrium of this interaction:

$$(5) \quad a^* = \frac{1}{n+1} \cdot A$$

As a result, in equilibrium, all the  $n$  individuals will exploit the following total amount of natural resources expressed by (6):

$$(6) \quad n \cdot a^* = \frac{n}{n+1} \cdot A$$

This is the total loss supported by society in the circumstance of no cooperation between  $n$  individuals.

Alternatively, one can consider the possibility of cooperation decisions (even though forced by law). In that case, all individuals, together, choose their individuals exploitation efforts, maximizing the aggregate utility function:

$$(7) \quad \pi_i(a_1, a_2, \dots, a_n) = \sum_{i=1}^n \ln a_i + n \cdot \ln(A - \sum_{i=1}^n a_i)$$

In this case of cooperation, for the generic individual  $i$ , the F.O.C. of this maximization problem would be:

$$(8) \quad \frac{\partial \pi_i(\cdot)}{\partial a_i} = \frac{1}{a_i} + \frac{-n}{A - \sum_{i=1}^n a_i} = 0$$

$$n \cdot a_i = A - \sum_{j=1}^n a_j \Leftrightarrow n \cdot a_i = A - \sum_{j=1}^{n-1} a_j - a_i \Leftrightarrow (n+1) \cdot a_i = A - \sum_{j=1}^{n-1} a_j$$

Considering the same  $a_i$  for all individuals, (8) can be written as:

$$(9) \quad a^* = \frac{1}{n+1} \cdot A - \frac{n-1}{n+1} \cdot a^* \quad \text{and simplifying:}$$

$$(10) \quad a_i^* = \frac{1}{2n} \cdot A$$

Thus, in case of cooperation between all the exploiters, the total amount of consumed natural resources would be equal to:

$$(11) \quad n \cdot a^* = \frac{1}{2} \cdot A, \quad \text{which is lower than the Nash equilibrium outcome } \left( \frac{n}{n+1} \cdot A, n > 1 \right).$$

This exploitation outcome is lower than the Nash equilibrium outcome in the absence of cooperation between individuals and, because of that, it can be considered better in Pareto.

Hardin (1968) argued that the solution to this tragedy would be to restrict individuals from using common resources. He argued in favour of “relinquishing the freedom to breed, and that very soon”. For that, two approaches could be used: the direct government control, that is, higher regulation, or the privatization of the common resources, that is higher deregulation.

According to Ostrom (1999), there is a third approach that consists in achieving or promoting self-regulation by the individuals who are exploiting the natural resources.

All these approaches work by changing adequately individuals' payoffs and, by that way, the incentives they face, to obtain the better Pareto outcome. Faysse (2005) discusses several ways to promote a cooperative setting.

## **2.2 Practical results of this interaction**

The tragedy of the commons theoretically explained in the previous topic impacts in a total depletion of the environmental resources. The reality in Amazônia and in other regions is that this process is already ongoing. As a signal of that, by 2018, Mata Atlântica (a biome in Brazil) only had 12.4% of its original forest cover (SOSMA and INPE, 2019).

In Brazilian context, a mix of factors can be influencing the present environmental situation: lack of legal tools (or inefficiency of the existing ones) and insufficient surveillance (Klautau de Araújo 2014, 2016); poverty, lack of incentives to greener practices and low infrastructure (Muchagata 2003, Pereira and Jorge 2003, Lavelle et al. 2016, Garret et al. 2017, Silva et al. 2017); absence of legal framework to promote and to value environmental assets (Klautau de Araújo et al. 2019), among others.

Currently, public policies in Brazil concerning the subject do not seem to be clearly focused. The three aforementioned approaches (regulation, deregulation and decentralization) are used, but with no apparent coordination: 1. there are national public areas without enough surveillance, due to scarce human and financial resources (Campos-Silva et al 2015, Schmitt 2015, CGU 2019); 2. part of environmental and mineral assets is explored by private agents, but without real commitment to efficiency, to good practices and to reduce externalities (e.g. the collapse of Mariana and Brumadinho dams, or the leaks in mineral complexes in Amazônia); 3. and the community solutions exist, like the work developed by some non-governmental organizations in small villages that aim to reduce poverty and environmental impact by improving production methods. However, not in a scale that can change significantly the general result, as the Human Development Index (HDI) ranking shows: all the 15 worst evaluations in Brazil are from cities located in Amazônia (UNDP; IPEA; FJS 2013).

Perhaps, the best results in Brazilian case would be achieved by a proper combination of aspects from the three approaches, with clearly defined rules and analysing the concrete cases. It is needed to rethink Brazil's legal system for the environment and for private property, as well as the institutional arrangements for the public policies. However, it is important to highlight that the acting of the state to combat environmental degradation must not be reduced to combat deforestation itself. It is necessary to go further, with interventions to improve socioeconomic conditions and socio-ecological resilience of the local populations. These alternatives are going to be discussed in the following topics and in future research.

### **2.3 The influence of law and public policies on big agent's behaviour**

Klautau de Araújo (2016) and Klautau de Araújo et al. (2019) describe some of the problems in Brazil's legal system and its public policies for environment: lack of cohesion between environmental agencies; difficulties for the population to deal and to understand the norms; low fines and sanctions for environmental crimes; long time for these penalties to be actually paid to the state; poor surveillance; insufficient incentive to greener activities for the population; strong difficulty to identify exactly what are the public areas from the Federal Government, states and cities, as well as the private areas; and lack of communication with local populations (participation and governance). These elements were pointed out to be some of the most likely explanations for the current environmental dynamics in Brazil. Other authors indicate one or more of this factors as liabilities in other contexts (eg. Cohen 2000, Lynch et al 2016) or in Brazil (Pereira and Jorge 2004).

More elements can be included on this list. For instance, the impossibility of finding the real ownership of huge forest areas (especially in Amazônia) causes a great difficulty to find the responsible for deforestation: between 2002 and 2009, "68.6% of total forest loss was detected in areas with limited or no knowledge of property boundaries" (Börner et al. 2014). Added to that fact, currently, a meaningful part of public areas in Brazil do not have a specific destination. That is, they are not environmental reserves, protected or controlled economic exploitation areas. In this way, without supervision or specific use, they become an easy target for deforestation and for the occurrence of illegal predatory activities.

The insufficient surveillance, combined with deficiencies in regulation, generates a phenomenon directly related to situations expressed in the equations (5) and (6): by

degrading all the resources of a given area, extracting wood, plants, herbs and animals, the illegal loggers move to other areas, and repeat the process. If there are no barriers, the costs are minimum if compared to the economic benefits from the activity, as it will be addressed in the next topics. Commonly, degraded areas at first are turned into cattle run to maintain their occupation and then are used for speculative purposes, since it is a low-risk and low cost activity (Garrett et al., 2017).

But why does this happen? Without economic, legal, or surveillance barriers, the perpetrators of deforestation – be they companies or individuals – have no economic advantage in recovering degraded areas and there are no costs to move to neighboring areas to restart the process.

Another factor that influences the scenario and the rates of illegal deforestation may be, in addition to the law *per se*, the future expectation about the law or public policies. For example, between August and October 2018 (period of Brazilian presidential elections), there was an increase of 48.8% in the deforested area (INPE 2019) and the speeches delivered by political actors may have influenced the increase in deforestation before the start of government and in January 2019, when there was an increase of 54% over the same month in 2018 (Imazon 2019). Deforestation had a reduction of 57% in February (Fonseca et al., 2019a), 77% in March (Fonseca et al., 2019b), and 10% in April (Fonseca et al. 2019c) when compared to the same period of the previous year. However, still comparing to the same month in 2018, there was an increase of 34% in May and 88% in June (INPE 2019).

The description above shows that, as it was pointed out by several studies (eg. Aimer & Goeschl 2010, Cohen 2000, Lynch et al 2016, OECD 2004, Rechtschaffen 1998), law itself is not enough to restrain illegal deforestation or the uncontrolled exploitation of natural resources. There are way more factors influencing this subject than law and surveillance, and public policies can be failing regarding that.

Expectations (to have economic gains, or to be able to legalize illegal deforested areas), discourses and political statements about the loosening of environmental actions (before the implementation of a public policy) can impact the behavior of the agents in a negative way. This phenomenon has happened before (for example, when the New Forest Code was approved), in situations where land regularization was less rigorous than previously predicted. It was recognized by Brazilian Federal Government, when the former Minister of

Environment stated (during a seminar in the House of Representatives in July, 5<sup>th</sup>, 2017) that the amnesty of environmental fines established by the New Forest Code can be one of the reasons for higher illegal deforestation rates. By having clear signs that not only there are no economic barriers or surveillance against illegal practices, but also that soon there will be no legal issues, the scenario tends to get worse.

### **3 Brazilian Law System and Environmental Deterrence**

Although the point addressed in the previous topic is more closely linked to expectations of future changes in the law, those elements can be related to the importance of increasing law enforcement when law itself is not enough. According to the rational choice theory (Becker 1968), the decision to commit an offense would be something ‘rationally’ decided: one will choose not to commit a crime in the case expected compliance benefits outweigh expected penalties. Applying to firms, they will follow environmental regulations only if the expected cost of the penalties is higher than the cost of compliance. In order to better disentangle this issue and especially understanding better the penalties part, one can learn from a criminological based theory – the deterrence theory. When one thinks about law, it is always the promised sanction and its severity that seems to be more important. Nevertheless, however severe the law may be, criminological deterrence theory holds that two other classical variables are equally or even more important in changing behavior: certainty and celerity. This theory was largely discussed in studies that have analyzed how severity, certainty and celerity would interfere more or less to dissuade people not to commit crimes (for example, as assessed by Howe and Brandau 1998 or by Tonry 2017). This theory has also been used to analyze specifically environmental crimes and in which extent law and public policies can reduce – or not – environmental harm or crimes, as it has been thoroughly discussed by Rechtschaffen (1998), Cohen (2000) and Lynch et al (2016), for example.

A report made by the Office of the Comptroller General (Controladoria Geral da União) (CGU 2019a) about the administrative process related to environmental fines in IBAMA, the main agency responsible for environmental law enforcement in Brazil, has shown several deficiencies in this public institution, for example: 1. The average time for a final decision in the processes inside the agency is 3.6 years for fines up to R\$ 500,000, 5.7 years for fines from R\$ 500,000 to R\$ 10 million and 4.4 years to fines higher than R\$ 10 million. 2. 77%



of the process started between 2008 and 2017 are currently stopped, waiting to be digitalized; this corresponds to 96,485 of the 126,082 processes analyzed, or R\$ 20,814,602,073 (around US\$ 5.5 billion, on July 10<sup>th</sup>, 2019 exchange rate) of the R\$ 29,728,943,248 in fines to be paid. The procedures only can be judged if they are in digital format. 3. There are no human resources or infrastructure to scan the physical processes, or to decide about the already digitalized ones in reasonable time; 4. Because of this, the auditors state that “This scenario leads to the risk of extinction of processes as a result of the limitation period, as well as non-compliance with the chronological criterion, to the extent that there is a long list of processes waiting to be scanned”. 5. Conditions that assure impartiality and independent on the decisions are missing, and 6. Added to those facts, there is also an incentive for the criminals not to pay the fines and a rise in the administrative costs of the agency.

Schmitt (2015) states that the general deterrence value (GDV) in Amazônia is R\$ 38,54, while the benefits for illegal deforestation for cattle raising, for example, is R\$ 3000 per hectare. In some states, this value is even lower: Pará, the second biggest state in Brazil, has the GDV of R\$ 8,98. The author also points that only 10% of fines were paid, which represents 0.2% of the full value of them (inside a group of 11,823 fines issued in Amazônia, between August, 2008 and July, 2013).

Even after the conclusion of the administrative process, the offenders can file a lawsuit against the decisions in the judiciary and appeal to higher courts. With this strategy, the payment can be postponed for decades after the occurrence of the environmental damage.

These numbers, added to the softness of punishments can motivate individuals to commit predatory acts, not the opposite, as it is expected. The fines enforced usually are lower than the economic profit of the illegal activity, as it is the case shown by Schmitt (2015), and the punishments almost never take someone that committed an environmental crime to the prison; the lack of surveillance makes criminals more comfortable to do illegal activities; in the eventuality of fines to be applied, the lawsuits can take several years to be concluded and, in the end, there is a great possibility that the State will not be paid (Schmitt 2015, Klautau de Araújo 2016, CGU 2019).

Schmitt (2015) and CGU (2019a) agree that this inability to punish the individuals that committed environmental crimes decimates the deterrent effect of governmental actions

against deforestation. This can be translated in worse environmental results, less efficiency of the resources spent in surveillance and also damages to the image of the institutions.

The study carried out by Lynch et al. (2016), related to environmental crimes in the United States, points out that are rare cases of imprisonment or high punishment: “(...) the rational offender would continue to violate environmental law in pursuit of monetary gain, rather than desist to avert penalty”. It seems that the Brazilian environmental law system, may have developed a similar pattern (insufficient surveillance, fines are lower than the profit obtained with the illegal activity and procedure reasons, as limitation period) since the perceived low severity, low certainty about the punishment and low celerity.

As an exception to the predictions of the application of the rational choice theory and of the deterrence theory, some companies can, even though, comply with the law spontaneously, even if it leads to losses, situation known as the Harrington Paradox. Several studies have been carried out in different contexts, discussing evidence for the rational choice theory or for the (in)existence of the paradox (e.g. Heyes & Rickman 1999, OECD 2004, Nyborg & Telle 2006, Aimer & Goeschl 2010), giving strong support that the level of compliance is not related only to specific laws, surveillance or a policy, but also with how the legal system is structured.

Related to that, Brazilian case has many peculiarities. The institutions may be seen as weak, fragile and distrustful, especially when they are not able to punish the law offenders. The population does not have an identification with the State and the companies see it as an obstacle for entrepreneurship; this is completely understandable: the bureaucracy impedes the establishment of new enterprises or innovative approaches (Pereira and Jorge 2003), but it is unable to stop degrading activities or to punish the ones who committed illegalities. For example, CGU (2019b) recommends less bureaucracy and automation on the processes and operational routines in IBAMA, as “there are no effective management, surveillance and assessment tools for the environmental sanctioner process”. Furthermore, many other social and economic factors are also influencing environmental results, although they have been frequently disregarded.

#### 4 Final Comments

This paper tried to analyze the current environmental problems in the Brazilian Amazônia, using the inputs of three approaches – game theory, rational choice theory and deterrence theory.

The repetition of the interactions with the same circumstances as we have in the present will probably lead to a marked depletion of the environmental assets in Amazônia, as it can be seen inside the mathematical game theory model. Incentives for cooperation (even when forced by law) would be the natural response to correct the paths. Current social and environmental conditions are also interfering negatively in these interactions. Considering that, hardening the law, improving legal procedures and investing in surveillance are not enough to stop the degradation process and to reverse the scenario, especially when Brazil's budget limitation is considered.

New, innovative and broader measures must be suggested and analyzed as solutions for the future. The legal system is still the beginning point and it is inseparable from new approaches that can improve cooperation between multiple agents. Nevertheless, economic and social aspects, combined with the participation of communities in this process need to be considered in this equation as well, in order to improve the results.

The contribution of the present paper on the advance of the discussion is to systemize, organize, analyze and to make a diagnosis through different aspects and theories the process which is ongoing. Much has been said about the reasons for the environmental degradation in Brazil, but first it is needed to have the real dimension of the situation before presenting suggestions.

As presented in previous topics, Brazil was considered to be successful case in reduction of deforestation, but the raising rates in the last years have shown that the situation cannot not be taken for granted. Another important point is that although deforestation rates were lower, especially in Amazônia, during some years, it is not possible to say that the general environmental condition was necessarily improved, as there are many other factors to be considered.

The mathematical models elaborated on this paper can show evidence of where and in which point the interactions and process are failing or can be improved. Combined with state-of-art of the discussion presented in this text it is possible to outline future research. The next

steps are to pass from the stages of “where” and “when” to act to “what can be done” to improve the environmental picture.

## References

Aguiar, A.P.D., Câmara, G., Escada, M.I.S. (2007). Spatial statistical analysis of land-use determinants in the Brazilian Amazonia: Exploring intra-regional heterogeneity. *Ecological Modelling*, 209, Issues 2-4, pp. 169-188. doi: <https://doi.org/10.1016/j.ecolmodel.2007.06.019>

Aimer, C & Goeschl, T. (2010). Environmental Crime and Punishment: Empirical Evidence from the German Penal Code. *Land Economics* 86(4), 707-726. University of Wisconsin Press.

Armenteras, D, Murcia, U, González, TM, Barón, OJ, & Arias, JE. (2019). Scenarios of land use and land cover change for NW Amazonia: Impact on forest intactness. *Global Ecology and Conservation*, 17. doi:10.1016/j.gecco.2019.e00567

Becker, G. (1968). Crime and Punishment: An Economic Approach, in *Journal of Political Economy*, 76 (2): 169–217.

Bond, A, Pope, J, Morrison-Saunders, A, & Retief, F. (2016). A game theory perspective on environmental assessment: What games are played and what does this tell us about decision making rationality and legitimacy? *Environmental Impact Assessment Review*, 57, 187–194. doi: <https://doi.org/10.1016/j.eiar.2016.01.002>

Börner, J., Wunder, S., Wertz-Kanounnikoff, S., Hyman, G., & Nascimento, N. (2014). Forest law enforcement in the Brazilian Amazon: Costs and income effects. *Global Environmental Change*, 29, 294–305. doi: <https://doi.org/10.1016/j.gloenvcha.2014.04.021>

Campos-Silva, JV, Fonseca Junior, SF, Peres, CAS. (2015). Policy reversals do not bode well for conservation in Brazilian Amazonia. *Natureza & Conservação - Brazilian Journal of Nature Conservation*, 13, issue 2, pp. 193-195. <https://doi.org/10.1016/j.ncon.2015.11.006>.

Campos-Silva, JV, Hawes, JE, Andrade, PCM & Peres, CA. (2018). Unintended multispecies co-benefits of an Amazonian community-based conservation programme. *Nature Sustainability*, 1(11), 650–656. doi:10.1038/s41893-018-0170-5

CGU – Controladoria Geral da União. (2019a). Relatório de Avaliação do Processo Sancionador Ambiental - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA. Brasília: CGU. Retrieved from: <https://auditoria.cgu.gov.br/download/12741.pdf>. Accessed July 10th, 2019.

CGU – Controladoria Geral da União. (2019b). Infográfico da Avaliação do Processo Sancionador Ambiental – IBAMA. Retrieved from:

<https://www.cgu.gov.br/noticias/2019/04/cgu-avalia-desempenho-e-gestao-do-processo-sancionador-ambiental-do-ibama/infografico-ibama.pdf>. Accessed July 11<sup>th</sup> 2019.

Cohen, M. A. (2000). Empirical Research on the Deterrent Effect of Environmental Monitoring and Enforcement. *The Environmental Law Reporter*, 30. Environmental Law Institute: Washington, DC.

Davidson, EA, Araújo, AC, Artaxo, P, Balch, JK, Brown, IF, Bustamante, MMC, Coe, MT, DeFries, RS, Keller, M, Longo, M, Munge, JW, Schroeder, W, Soares-Filho, BS, Souza, CM & Wofsy, SC. (2012). The Amazon basin in transition. *Nature*, 481 (7381), pp. 321–328. doi:10.1038/nature10717.

Espírito-Santo, FDB, Gloor, M, Keller, M, Malhi, Y, Saatchi, S, Nelson, B, Oliveira Junior, RC, Pereira, C, Lloyd, J, Frolking, S, Palace, M, Shimabukuro, YE, Duarte, V, Mendoza, AM, López-González, G, Baker, TR, Feldpausch, TR, Brienen, RJW, Asner, GP, Boyd, DS & Phillips, OL. (2015). Size and frequency of natural forest disturbances and the Amazon forest carbon balance. *Nature Communications*, 5(1). doi:10.1038/ncomms4434

Faysse, N. (2005). Coping with the tragedy of the commons: Game structure and design of rules. *Journal of Economic Surveys*, 19(2), 239-261.

Fonseca, A, Justino, M, Cardoso, D, Ribeiro, J, Salomão, R, Souza Jr, C, & Veríssimo, A. (2019a). *Boletim do desmatamento da Amazônia Legal (fevereiro de 2019) SAD* (p. 1). Belém, Brazil.

Fonseca, A, Justino, M, Cardoso, D, Ribeiro, J, Salomão, R, Souza Jr, C, & Veríssimo, A. (2019b). *Boletim do desmatamento da Amazônia Legal (março 2019) SAD* (p. 1). Belém, Brazil.

Fonseca, A, Justino, M, Cardoso, D, Ribeiro, J, Salomão, R, Souza Jr, C, & Veríssimo, A. (2019c). *Boletim do desmatamento da Amazônia Legal (abril 2019) SAD* (p. 1). Belém: Imazon.

Gao, Y, Li, Z, Wang, F, Wang, F, Tan, RR, Bi, J, & Jia, X. (2018). A game theory approach for corporate environmental risk mitigation. *Resources, Conservation and Recycling*, 130, pp. 240–247. doi: <https://doi.org/10.1016/j.resconrec.2017.12.009>

Garrett, R, Gardner, TA, Fonseca, T, Marchand, S, Barlow, J, Ezzine de Blas, D, Ferreira, J, Lees, AC & Parry, L. (2017). Explaining the persistence of low income and environmentally degrading land uses in the Brazilian Amazon. *Ecology and Society*, 22 (3):27. <https://doi.org/10.5751/ES-09364-220327>.

Gloor, E. (2019). The fate of Amazonia. *Nature Climate Change*, volume 9, pp. 355–356. doi:10.1038/s41558-019-0465-1

Grønbaek, L, Lindroos, M, Munro, G & Pintassilgo, P. (2018). Game theory and fisheries. *Fisheries Research*, 203, 1–5. doi: <https://doi.org/10.1016/j.fishres.2017.11.027>

- Halkos, GE & Papageorgiou, GJ. (2018). Pollution, environmental taxes and public debt: A game theory setup. *Economic Analysis and Policy*, 58, 111–120. <https://doi.org/doi:10.1016/j.eap.2018.01.004>
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.
- Heyes, A & Rickman, N. (1999). Regulatory dealing - revisiting the Harrington paradox. *Journal of Public Economics*, 72(3), pp. 361-378. [https://doi.org/10.1016/S0047-2727\(98\)00098-X](https://doi.org/10.1016/S0047-2727(98)00098-X)
- Howe, ES & Brandau, CJ. (1988). Additive Effects of Certainty, Severity, and Celerity of Punishment on Judgments of Crime Deterrence Scale Value. *Journal of Applied Social Psychology*, 18(9), 796–812. doi: <https://doi.org/10.1111/j.1559-1816.1988.tb02356.x>
- IBGE – Instituto Brasileiro de Geografia e Estatística. (2004). *Mapa de Biomas do Brasil*. Brasília: IBGE. Retrieved from: <https://bit.ly/2L0n0KC>. Accessed July 11<sup>th</sup>, 2019
- Imazon. (2019). *Boletim do desmatamento da Amazônia Legal (janeiro 2019) SAD*. Retrieved from: <https://imazon.org.br/publicacoes/boletim-do-desmatamento-da-amazonia-legal-janeiro-2019-sad/>. Accessed June 10<sup>th</sup>, 2019.
- Kalamandeen, M, Gloor, E, Mitchard, E, Quincey, D, Ziv, G, Spracklen, D, Spracklen, B, Adami, M, Aragão, LEOC & Galbraith, D. (2018). Pervasive Rise of Small-scale Deforestation in Amazonia. *Scientific Reports*, 8(1). doi: <https://doi.org/10.1038/s41598-018-19358-2>
- Klautau de Araújo, JM. (1995). *Caligrafias de Belém – vol. I: a dimensão insular*. Belém: Imprensa Oficial do Estado do Pará.
- Klautau de Araújo, TL. (2014). Environmental law, public policies, and climate change: A social-legal analysis in the Brazilian context, in Leal Filho, W. (Eds.), *Handbook of Climate Change Adaptation*, pp. 973–982. Berlin: Springer. doi: [https://doi.org/10.1007/978-3-642-40455-9\\_115-1](https://doi.org/10.1007/978-3-642-40455-9_115-1).
- Klautau de Araújo, TL. (2016). Public Policies and Education for Biodiversity: Brazilian Challenges in a New Global Context, in Castro, P., Azeiteiro, U.M., Bacelar Nicolau, P., Leal Filho, W., Azul, A.M. (Eds.) – *Biodiversity and Education for Sustainable Development*. Berlin: Springer, pp. 219-235.
- Klautau de Araújo T.L. (2019). Brazilian Amazônia and Climate Change: Barriers and Pathways for Forthcoming Sustainability. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) *Climate Action. Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. doi: <https://doi.org/10.1007/978-3-319-71063-1>.
- Klautau de Araújo TL, Soares AMVM & Azeiteiro UM. (2019). Environmental Assets and Carbon Markets: Could It Be Amazônia’s New *Belle Époque*?. In: Castro P, Azul A, Leal Filho W, Azeiteiro U. (eds) *Climate Change-Resilient Agriculture and Agroforestry. Climate Change Management*. Springer, Cham. [https://doi.org/10.1007/978-3-319-75004-0\\_28](https://doi.org/10.1007/978-3-319-75004-0_28).

Lavelle, P, Dolédec, S, Sartre, XA, Decaëns, T, Gond, V, Grimaldi, M, Oszwald, J, Hubert, B, Ramirez, B, Veiga, I, Simão de Souza, S, Assis, WS, Michelotti, F, Martins, M, Feijoo, A, Bommel, P, Castañeda, E, Chacon, P, Desjardins, T, Dubs, F, Gordillo, E, Guevara, E, Fonte, S, Hurtado, MP, Lena, P, Lima, T, Marichal, R, Mitja, D, Miranda, I, Otero, T, Praxedes, C, Pocard, R, Robert, P, Rodriguez, G, Sanabria, C, Tselouiko, S, Velasquez, A, Velasquez, E & Velasquez, J. (2016). Unsustainable landscapes of deforested Amazonia: An analysis of the relationships among landscapes and the social, economic and environmental profiles of farms at different ages following deforestation. *Global Environmental Change* 40, pp. 137-155. doi: <http://dx.doi.org/10.1016/j.gloenvcha.2016.04.009>

Lynch, MJ, Barrett, KL, Stretesky, PB & Long, MA. (2016). The Weak Probability of Punishment for Environmental Offenses and Deterrence of Environmental Offenders: A Discussion Based on USEPA Criminal Cases, 1983–2013. *Deviant Behavior*, 37:10, 1095-1109. doi: <https://doi.org/10.1080/01639625.2016.1161455>

INPE – Instituto Nacional de Pesquisas Espaciais. (2019) *TerraBrasilis Desmatamento*. Retrieved from: <http://terrabrasilis.dpi.inpe.br/app/map/deforestation?hl=pt-br>. Accessed in July 11<sup>th</sup> 2019.

Muchagata M & Brown K. (2003). Cows, colonists and trees: rethinking cattle and environmental degradation in Brazilian Amazonia. *Agricultural Systems* 76, pp. 797–816. [https://doi.org/10.1016/S0308-521X\(02\)00015-X](https://doi.org/10.1016/S0308-521X(02)00015-X)

Nyborg, K & Telle, K. (2006). Firms' Compliance to Environmental Regulation: Is There Really a Paradox?, in *Environmental & Resource Economics*, vol. 35, issue 1, 1-18. <https://doi.org/10.1007/s10640-006-9001-7>

OECD. (2004). Background Paper on Economic Aspects of Environmental Compliance Assurance, in OECD, *Economic Aspects of Environmental Compliance Assurance - Proceedings from the OECD Global Forum on Sustainable Development 2-3 December 2004*. Paris: OECD.

Oraby, T, Bauch, CT & Anand, M. (2018). The Environmental Kuznets Curve Fails in a Globalized Socio-Ecological Metapopulation: A Sustainability Game Theory Approach, in Rao, ASRS and Rao, CR, *Handbook of Statistics*, Volume 39, pp. 315-341. doi: <https://doi.org/10.1016/bs.host.2018.05.003>

Osborne, M. (2004). *An Introduction to Game Theory*. New York: Oxford University Press.

Ostrom, E. (1999). Self-governance and forest resources. *CIFOR Occasional Paper* 20, Bogor, Indonesia.

Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economics Perspectives*, 14, 137-158.

Paulino, E. (2014). The agricultural, environmental and socio-political repercussions of Brazil's land governance system. *Land Use Policy*, 36, 134-144. doi: <https://doi.org/10.1016/j.landusepol.2013.07.009>

- Pereira, GNDP & Jorge, MMP. (2004). Governing Approaches Ensuring Environmental Compliance: A Brazilian Perspective, in OECD, *Economic Aspects of Environmental Compliance Assurance - Proceedings from the OECD Global Forum on Sustainable Development 2-3 December 2004*. Paris: OECD.
- Rechtschaffen, C. (1998). Deterrence vs. Cooperation and the evolving theory of Environmental Enforcement. *71 S. Cal. L. Rev. 1181*. Golden Gate University School of Law.
- Ritter, CD, McCrate, G, Nilsson, RH, Fearnside, PM, Palme, U & Antonelli, A. (2017). *Environmental impact assessment in Brazilian Amazonia: Challenges and prospects to assess biodiversity*. *Biological Conservation*, 206, 161–168. doi: <https://doi.org/10.1016/j.biocon.2016.12.031>
- Schielein, J., & Börner, J. (2018). Recent transformations of land-use and land-cover dynamics across different deforestation frontiers in the Brazilian Amazon. *Land Use Policy*, 76, 81–94. doi: <https://doi.org/10.1016/j.landusepol.2018.04.052>
- Schmitt, J. (2015). *Crime sem castigo: a efetividade da fiscalização ambiental para o controle do desmatamento ilegal na Amazônia*. Brasília: UNB. Retrieved from: [http://repositorio.unb.br/bitstream/10482/19914/1/2015\\_JairSchmitt.pdf](http://repositorio.unb.br/bitstream/10482/19914/1/2015_JairSchmitt.pdf)
- Silva, JMC, Prasad, S & Diniz-Filho, JAF. (2017). The impact of deforestation, urbanization, public investments, and agriculture on human welfare in the Brazilian Amazonia. *Land Use Policy* 65, pp. 135-142. doi: <http://dx.doi.org/10.1016/j.landusepol.2017.04.003>.
- SOSMA – Fundação SOS Mata Atlântica & INPE – Instituto Nacional de Pesquisas Espaciais. (2019). Atlas dos Remanescentes Florestais da Mata Atlântica. São Paulo, Brazil.
- Tonry, Michael. (2017). An Honest Politician's Guide to Deterrence: Certainty, Severity, Celerity, and Parsimony, in Nagin, DS, Cullen, F, & Jonson, CL (eds.) *Deterrence, Choice, and Crime: Contemporary Perspectives*. New York: Routledge.
- UNDP; IPEA; FJS. (2013). *Atlas do Desenvolvimento Humano no Brasil – Ranking*. Retrieved from: <http://bit.ly/1TPFUDZ>
- Wolford, Wendy. (2016). The casa and the causa: institutional histories and cultural politics in Brazilian Land Reform. *Latin American Research Review*, Vol. 51, No. 4. Austin: Latin American Studies Association.



## **Publication 5**

**“Brazilian Amazônia, deforestation and environmental degradation: finding ways for a sustainable future”**, submitted to the Environmental Science and Policy journal, 2019.

Thiago Lima Klautau de Araújo, Amadeu Mortágua Velho da Maia Soares,  
Ulisses Manuel de Miranda Azeiteiro

## **Brazilian Amazônia, deforestation and environmental degradation: finding ways for a sustainable future**

Klautau TL, Soares AMVM, Azeiteiro UMM

### **Abstract**

Klautau de Araújo et al (2019) created a Game Theory mathematic model about interactions between agents and the likely results of it in Brazilian Amazônia. The results have shown that the repetition of the current context may lead to the Tragedy of the Commons in the region. Based on that paper and in the model, we built a discussion about strategies that can help to improve cooperation. Divided in three basic aspects (popular participation, correction of deficiencies in legal system and economic changes), we present possible solutions for a more sustainable, ecofriendly and socially fair society in Brazilian Amazônia.

Key-words: Brazilian Amazônia. Sustainable development. Popular participation. Environmental conservation. Public Policies. Law and Economics.

### **1 Introduction**

The eyes of the international community have been turned to Brazilian Amazônia. Its importance for climate stability is rising, as it is the biggest tropical forest and its problems are getting preeminent. By 2016, land use and deforestation fires totalized more than half of all Brazilian emissions (Azevedo and Angelo 2018). In 2019, from August, 1<sup>st</sup> to September, 1<sup>st</sup>, there were registered 1,058,743 fire spots in Brazil, 61,2% of it only in Amazônia biome (INPE 2019a).

The recent fires and the controversy about some statements of Federal Government shocked common citizens and caused protests of organized groups, boycotts and discussions between leaders of other countries.

However, the problem is not recent or simple. Data show that the highest number of fires happened in previous years (INPE 2019b), although the attention of international community and social media is higher now. Environmental degradation is a process that is ongoing for many decades (Klautau de Araújo 1995, Paulino 2014, Wolford 2016). Although deforestation, fires (Amaral et al 2019) and destruction of biodiversity may be the most popular and know problems of the region, they are only a part of a way more complex and intricate system of interactions that are causing not only environmental, but also deep social

problems (Loureiro and Pinto 2005, Lavelle et al 2016, Silva et al 2017, Klautau de Araújo et al 2019b)

With more than 5 million square kilometers (IBGE 2014) and more than 28 million inhabitants (IBGE 2019), Brazilian Legal Amazônia is not and cannot be considered as a sanctuary. It is not possible just to close it or to prohibit economic activities.

Part of the environmental degradation is related to the poverty in the region and the possible failure of surveillance efforts can be due to lack of interaction with local populations; weak punishments and lack of incentive for greener practices are also a part of this equation (Klautau de Araújo et al 2019b).

It is needed to find innovative and more comprehensive solutions to the problem. Isolated, surveillance, harden laws, popular participation and economic development may change partially and temporarily the environmental results. But to achieve sustainable and long-lasting shift in this scenario, it is imperative to combine these solutions. In the present paper we suggest some possible alternatives.

## **2 Game Theory and The Tragedy of the Commons in Brazilian Amazônia**

Using Game Theory, Klautau de Araújo et al (2019b) created a mathematic model that represents the interaction between different agents in Amazônia. Some factors were considered: current low barriers against the overusing or overharvesting of common goods, lack of incentive for greener practices and deficient surveillance, among others. As a result, this model shows that the repetition of these interactions will probably lead to a total depletion of Brazilian Amazônia's resources. The Tragedy of the Commons is ongoing.

Harding (1968) argues that the solution to the tragedy would be restrict individuals to access and use of these resources. The approaches may be direct governmental control of the resources (more regulation) or privatization of the common resources (more deregulation). Ostrom (1999) suggests a decentered governance of those goods, by the self-regulation of the communities that use them.

The authors of the model point out that there were uncoordinated attempts of using the three approaches mentioned, but the two classical ones failed and the third one, although had some interesting outcomes, could not change the general environmental result.

Brazilian Legal Amazônia has more than 5 million square kilometers (IBGE 2014). Considering this huge area, the heterogeneity inside it and the lack of structure and communications (great part of the region does not have internet or electricity) it is extremely hard to replicate any model and to assess the results, especially in decentered governance.

For those reasons, our research tried to analyze and to propose possible solutions combining aspects of the three approaches, as we consider that each one of these approaches has advantages, but in an isolated way, they would not be enough.

### **3 Improving cooperation between agents is imperative**

In this context of non-cooperative interaction between individuals, it is needed to find solutions that can improve cooperation, even if it is forced by law. After analyzing literature, legal issues and practical aspects of public policies in Brazil, we divided suggestions of interventions in three different areas that can positively interfere in this non-cooperative scenario: popular participation in surveillance; economic alternatives for the region; improving legal and governance aspects.

Over the years it can be seen that measures were taken in isolated manner. Attempts of economic growth or land colonization that failed (Wolford 2016), small scale that tried to enhance population in the management and surveillance of their communities (Campos-Silva et al 2018) and different strategies of surveillance throughout different governments in Brazil.

However, there are no registers of combination of those three points, and although some attempts were successful in reducing deforestation or environmental degradation, the social crisis persists and leads to more environmental problems (Klautau de Araújo 2019a), and the legal issues and deficiencies permit that illegal practices stay unpunished (Schmitt 2015, CGU 2019a and 2019b, Klautau de Araújo 2016, Klautau de Araújo et al 2019b)

These structural problems existing in Brazil affect not only Amazônia, but other endangered biomes, as Cerrado and Mata Atlântica, as they are under the same legal system. Changing these perspectives and paradigms can have a broader impact also in the rest of the country, not being restricted only to the region of our study.

In the following topics we deepen the discussion about each solution proposed.

#### **4 Enhancing popular participation for more accurate policies and better surveillance**

Enhancing local people's participation in environmental planning/monitoring/surveillance as way of preserving nature and having better environmental governance results is almost unanimous in scientific research about environment and society (Chess and Purcell 1999, Bockstael et al 2016, Welvaert and Caley 2016, Bezerra and Bitoun 2017, Sinclair and Diduck 2017, Udofia et al 2017, Camprodon et al 2019, Holifield and Williams 2019, Tu et al 2019, Yew and Zhu 2019, Zhang et al 2019). Especially in Brazilian Amazônia, concerning to the immense territory and the practical difficulties of access, this participation reaches an even higher level of importance.

Local population play a key-role in this context, as they are the closest ones to the places where predatory activities occur. They can warn public agents about illegal practices, reporting situations and giving the exact locations of it, or be themselves to interfere in some cases. They also can be the main agents of the shift of the paradigm on land use and boost sustainable activities.

These communities also can provide relevant information and help to improve the decision making and the plans for public policies. Currently, planning and decisions in Brazil are centralized, and their execution is decentralized, when it should be the opposite (Klautau de Araújo 2014, 2016). In a huge and diverse territory, the same solution has different results across the country and inside the same region. Brazilian Amazônia is extremely heterogeneous between its different subregions, and its completely different from the rest of Brazil. That is why so many decisions made by the Federal Government – that did not consider the reality of the region – had disastrous results, with consequences that are seen until now (Klautau de Araújo 1995, Loureiro and Pinto 2005, Paulino 2014, Wolford 2016).

The participation of local populations can bring more perspectives and problem solving knowledge to different situations that may appear during the enforcement of law and execution of plans.

However, two great obstacles are hiding it: bureaucracy (Klautau de Araújo 2014, 2016) and poor living conditions.

Bureaucracy turns everything more difficult in the popular participation. If the citizens do not know to who report illegal practices or the competent authority (which sometimes it is hard to know), commonly the person gives up on continuing to try to report it.

What concerns to poor living conditions, the biodiversity/poverty paradox (Kageyama 2009) can be verified also in Brazil. Great part of the cities located in Amazônia are among the poorest or the ones with lowest quality of life (UNDP; IPEA; FJS 2013). All the states of Legal Amazônia, with the exception of Mato Grosso, had less than 70% of Brazilian GDP *per capita* in 2015 (IBGE 2017).

Other conditions, as basic sanitation (SNIS 2017), education (INEP 2016; OECD 2016), health system (Ministério da Saúde 2012) are also below the national average.

These elements influence the participation and the interactions of the population with nature. Samuelson (1976) states that a richer population is more willing to give up a bit of its resources to help environment, when poorer population have more difficulty to do it. In Amazônia's case, basic needs of the locals are not fulfilled and this triggers environmental degradation.

In exchange of survival, many of the inhabitants exploit natural resources of the region in a predatory way. Illegal loggers frequently use local labor, sometimes in slavery-like conditions (Loureiro and Pinto 2005, Girardi et al 2014), to extract wood and later use the deforested area to extensive cattle and/or real estate speculation (Bowman et al 2012, Paulino 2014, Schmitt 2015), even when it is a public land.

It turns into a vicious circle, as the living conditions trigger environmental degradation, and the environment crisis worsen the living conditions, as food, wood and other resources that were abundant in the region start to get scarce. In a changing climate scenario, the situation is even more serious, as these populations, in addition to the poor conditions, also become more vulnerable to extreme climate events, especially droughts and floods.

Cooperation with these populations is complicated in the present system and institutional structure of Brazilian Government. Agencies must be closer to the local populations in order to absorb knowledge of the reality of the region and also to improve planning and governance (García-Reyes and Benyei 2019).

## **5 Legal context and what can be done about it**

Much has been said about enforcement, surveillance and hardening the law as a way to improve Brazilian law system's efficiency, especially concerning to environmental field.

Indeed, low severity, and/or certainty and/or celerity can harm the deterrent effect (eg. Howe and Brandau 1998, Tonry 2017), notably in environmental aspects (Rechtschaffen 1998, Cohen 2000, Lynch et al 2016). Currently, Brazil has problems to establish those three aspects (Klautau de Araújo et al 2019b).

In Brazilian case, but especially in what refers to Amazônia, the financial resources to surveillance are scarce and have been cut over the past years. However, what makes the discussion more complex is the intricate relation between priorities of the country, political interests, decision makers, local populations and budget limitations.

The trend of weakening of environmental law also stimulates unsustainable practices (Klautau de Araújo 2019a), deforestation and land grabbing (Brito et al 2019).

In this context, only more surveillance does not seem to be enough. Hardening punishments for environmental damages also would not be a complete answer in legal terms. Those facts are important and lead to a deterrent effect that can improve the expected results. Their combination would be positive in the extent that they would raise the general deterrence value. Currently, this value is extremely low, especially in Amazônia (Schmitt 2015), what may encourage the occurrence of illegal activities against natural resources, fauna and flora: while the general deterrence value in the region is R\$ 38.54, the revenues with cattle (the less profitable of the activities, but the most common one related to deforestation) reaches R\$ 3000.00, in average.

The lack of coordination and cooperation between environmental agencies is another factor that raises the costs, jeopardizes the results of surveillance actions, lowers the efficiency of the public budget spent on the area and complicates the participation of the population with environmental agencies. This problem, originated with Brazilian Constitution has been addressed in Klautau de Araújo (2016). The author also criticizes the fact that the decisions are centralized and the execution of public policies is decentralized, which can harm the results twice.

Brazilian Amazônia has a historical problem of centralized decisions that did not consider the peculiarities of the region, did not succeed in their initial purposes and caused more problems (Weinstein 1993, Klautau de Araújo 1995, Paulino 2014, Wolford 2016). It would be interesting if the decisions and the public policies for the region have popular participation and take into account peculiarities of the subregions and their needs. This would help to

enhance local people collaboration on surveillance actions and to combat environmental degradation, what is limited today for the lack of proper communication with communities and strong bureaucracy.

However, what seems to be the biggest issue in environmental law enforcement in Brazil is the low level of payment of the environmental fines (TCU 2015, TCU 2017, CGU 2019a and 2019b). But this has nothing to do directly with environmental law, surveillance or with the government. It is something more complex: it is related with procedure law, the Constitution and the organization of Judiciary.

Although there was a new Civil Law Procedure Code, with the enact of the law 13105 (Brasil 2015), which simplified lawsuits and the system of appeals, there is still an intricate and extreme complex list of procedures, deadlines and possibilities of appealing to higher courts several times, for example.

Brazilian Constitution (Brasil 1988) treats these possibilities as system of guarantees of the citizen against potential violations of rights committed by the State. It is comprehensible, as the Constitution was enacted just after a dictatorial period. However, the impact of those guarantees to the law enforcement is superlative, as lawsuit can last decades and end up with no punishment at all, due to limitation period, for example. Law offenders can use these breaches in the law to be free of criminal or civil punishments. What was meant to be a constitutional guarantee turned into red tape. What concerns to the environment, it is not different, as environmental fines can be discussed in administrative level to be ready to be paid and, after that, the defendant can fill a lawsuit against the decision.

Between 2011 and 2013, only 10.43% of the environmental fines were paid to IBAMA (the biggest environmental agency in Brazil), but it only represents 0.30% of the total value due (TCU 2015). 77% of the processes started between 2008 and 2017 concerning environmental fines in IBAMA are currently stopped, waiting to be digitalized (CGU 2019a). It corresponds to almost US\$ 5.5 billion (around 70% of total value due to the Government) of environmental fines that can never be paid, for the risk of exceeding the limitation period. For those reasons, the Office of the Comptroller General (Controladoria Geral da União), who provided those numbers, considers that “there are no effective management, surveillance and assessment tools for the environmental sanctioner process” in IBAMA, and



recommends more automation on the processes and operational routines, as well as less bureaucracy (CGU 2019b).

However, other data shows that the problem is not exclusive of environmental law, but to the legal system and to failing procedures: considering 14 federal agencies (not including IBAMA), between 2011 and 2014, the value of the fines paid was 6,03% of the total fines issued (TCU 2017).

CGU (2019a) and Schmitt (2015) state that this context of impunity compromises the deterrent effect of public policies against environmental degradation.

Without changing the procedure law to make it faster and more efficient, investing high amounts in surveillance and law enforcement can be a misapplication of public budget, as the money of the fines is not coming back to the government and the results of these actions are seriously jeopardized: there is no real punishment or compensation for the damages.

## **6 New economic alternatives must be put into this equation**

With high level of poverty, low level of Human Development Index (HDI) in great part of the cities (UNDP; IPEA; FJS 2013), basic sanitation system that reaches only 50% of the population (SNIS 2017), alarming level of violence and many other relevant and urgent social problems, environmental degradation and deforestation can be seen as delicate and serious problems, but hardly will be casted as priorities by common citizens in Brazil.

The high cost of surveillance is another point that caused controversies between different political groups over the last years. There was (and still is) a great resistance by some politicians and parties about the impact of environmental surveillance on the public budget. Narratives that this environmental protection would harm Brazilian economic growth are still common. As cattle and agriculture are still responsible for a big part of Brazil's GDP, this argument finds support in part of the population.

Brazil had an economic growth and appeared between the world's biggest economies during some years. However, this process, based on commodities and on low or non-manufactured products did not bring development to the country (as it can be seen on previous paragraphs), or reduced regional inequalities. In fact, the differences between Brazilian regions has raised,

and parts like Amazônia are in worst social conditions comparatively than they were decades ago (Klautau de Araújo 2017).

Moreover, as it is discussed in Klautau de Araújo et al (2019a and 2019b), the surveillance is important, but it must be considered that it does not constitute an investment, but a cost. So, the population gets used to the rhetoric that the forest is a burden, not a solution. The same authors also discuss the possibility of the sustainable use of the environmental assets as a way to promote nature conservation in Brazilian Amazônia case. The economic and social development of Amazônia seems to be a key-factor to environmental conservation. Eliminating or reducing the poverty in the region can also reduce environmental degradation, as the local communities would not need to commit predatory acts in exchange of money for their survival.

Environmental assets have been discussed several times about their possible economic or non-economic gains (eg. Karp et al 2013, Wunder 2013, Seymour and Busch 2016, Tortato et al 2017, Klautau de Araújo 2019b), or its limitations (eg. Muradian et al 2013). They are (among the creation of a production chain of those goods) the most promising path (Klautau de Araújo et al 2019a, Klautau de Araújo 2019a), as they can bring double benefits for the region and for environmental conservation at once.

First, those types of assets can raise sharply the income of families, small farmers and communities, being possible to combine, in the same area, multiple incomes from different environmental assets. Ecotourism, food and medicines (Rönnbäck 1999, Golden et al 2012, Angelsen et al 2014), sustainable certified timber production; non-timber products, as seeds, roots, fruits, oils and herbs (Guimarães et al 2019); carbon storage, ecosystem services (Guo et al 2000, Brandon 2014, Mullan 2014, Saenz et al 2014), among others. Added to that, a production chain that processes and manufactures the forest goods may not only bring more wealth, higher quality jobs and economic development to the region, but also can impact positively carbon emissions, as the transportation strategies can be more efficient.

Cattle production, for example, if certified, combined with sustainable practices and reforestation of degraded areas, could be a good alternative to replace the current predatory practices of this activity in Amazônia. The creation of a productive chain related to cattle would also be interesting for the region, as it can aggregate more value, create jobs and reduce the pressure on forest resources (Klautau de Araújo 2019a). Currently, oxen are

transported alive, giving away the opportunity to process all the other products derived from it, related to several types of industries: food, fashion, cosmetics, pharmaceutical, construction, automotive, among many others. The population would have economic alternatives to survive without degrading the forest.

Garrett et al (2017) suggest less predatory activities instead of cattle, as production of fruits, for example. However, the infrastructure of Brazilian Amazônia is still an obstacle for that. Besides it, certified activities can bring more income, but also better governance and reputational benefits, justifying the cost of certification (Carlson and Palmer 2016).

In what concerns to reputation, the recent fires in Brazil and the international repercussion can cause a significant loss to Brazilian economy, as several boycotts were announced and it can complicate the negotiations between the country and the European Union for a free trade deal, besides the losses caused by pollution, destruction of timber and non-timber products, etc.

Secondly, the monetization of environmental assets can make local communities aware that the forest is way more profitable standing than felled, and that the biodiversity is extremely important. It would create a feeling of caring and attachment that can improve environmental conservation, bringing the population to participate on surveillance.

For example, the study carried out by Tortato et al (2017) reveals that the revenues related to jaguar ecotourism reach 52 times the value of damage cause by those animals to livestock. Karp et al (2013) state that birds help to prevent losses between US\$ 75 and US\$ 310 per hectare in coffee crops in Costa Rica. It also boosts ecotourism, attracting birdwatchers from all over the world, what can be another opportunity for economic development (Glowinski 2008). In Colombia, this activity has the potential of bringing US\$ 46 million per year and creating more than 7500 jobs (Maldonado et al 2018).

Combined to it, environmental education and propaganda can spread the importance of the ecosystem services that may not directly benefit financially the populations, but are important to human activities, eg.: prevention of diseases (Myers et al 2013), erosions and silting, clean air, pollination, control of the rain cycle, reduction of the vulnerability concerning to floods and extreme weather events (Brandon 2014).

Sustainable economic alternatives are essential to create a new, innovative and broader approach to the conservation of Amazônia. Surveillance is important. Legal measures to

punish individuals that commit environmental crimes are needed. But a long term solutions pass by finding ways of reducing poverty and developing the region. Brazilian Amazônia is not only an immense and diverse biome: it is also need to be seen as a complex social space that is going through social and economic crisis that boost environmental degradation.

## **7 Conclusions**

The possible answers for environmental problems are never easy. However, Brazilian case has many peculiarities that highly increase the complexity of the issues and the solutions needed.

Many factors interfere in environmental dynamics, as we already addressed in other topics: poverty, lack of incentives for greener activities, bureaucracy, incoherence in the legal system, big extension of the territory, among others. The recent budget cuts in surveillance may be partially responsible for the raising in deforestation. However, it seems incorrect to think that exists an inversely proportional relation between investments in surveillance and deforestation. First, because of the marginal utility (that progresses in decreasing rates); and second, if we analyze according to deterrence theory, surveillance is only one part (certainty), while severity and celerity would still be missing.

Considering the present picture in Amazônia, the mathematic model presented in Klautau de Araújo et al (2019b) shows that the tendency is the complete depletion of Brazilian Amazônia's resources, leading to the Tragedy of the Commons.

To change these trends, it would be necessary to improve cooperation between agents, even if it is forced by law. Nevertheless, for all the reasons already addressed in this paper, a forced cooperation can help, but will not solve the problem in a sustainable way.

Surveillance or harder laws will not be able to solve the problem of the poverty, that also triggers environmental degradation. Creating economic alternatives will not punish the ones who committed environmental crimes (or prevent illegal activities). Strengthening regulation or promoting deregulation will not affect directly social problems, especially education and health care.

Without a comprehensive, complete and systemized solution that takes into account the multiple scenarios and nuances of the region, any intervention has the probable destiny of

failing. The sustainability of any solution is directly related to its capacity of combining social, economic and legal aspects, with decentered decisions and integrated execution. It is needed to consider that Brazilian Amazônia is a dynamic region that has an important forest for the globe, but that also has a population that has been excluded from the decision making in the past decades and of the development of the country.

## References

Amaral SS, Costa MAM, Soares Neto TG, Costa MP, Dias FF, Anselmo E, Santos JC, Carvalho Jr JA. (2019). CO<sub>2</sub>, CO, hydrocarbon gases and PM<sub>2.5</sub> emissions on dry season by deforestation fires in the Brazilian Amazonia. *Environmental Pollution*, 249, pp. 311-320. doi: <https://doi.org/10.1016/j.envpol.2019.03.023>

Angelsen A, Jagger P, Babigumira R, Belcher B, Hogarth NJ, Bauch S, Börner J, Smith-Hall C, Wunder S (2014) Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Development*, 64, pp. S12-S28. doi: <https://doi.org/10.1016/j.worlddev.2014.03.006>

Azevedo TR, Angelo C (2018) *Emissões de GEE no Brasil e suas implicações para políticas públicas e a contribuição brasileira para o Acordo de Paris*. São Paulo: Sistema de Estimativas de Emissões de Gases de Efeito Estufa. Retrieved from: <http://seeg.eco.br/wp-content/uploads/2018/08/Relatorios-SEEG-2018-Sintese-FINAL-v1.pdf>

Bezerra ACV and Bitoun J (2017) Participatory methodology as an instrument for the territorialization of Environmental Surveillance actions. *Ciênc. saúde coletiva*, vol.22 no.10. doi: <http://dx.doi.org/10.1590/1413-812320172210.17722017>

Bockstael E, Bahia NCF, Seixas CS, Berkes F (2016) Participation in protected area management planning in coastal Brazil. *Environmental Science & Policy*, 60, pp. 1-10. doi: <https://doi.org/10.1016/j.envsci.2016.02.014>

Bowman MS, Soares-Filho BS, Merry FD, Nepstad DC, Rodrigues H, Almeida OT (2012) Persistence of cattle ranching in the Brazilian Amazon: A spatial analysis of the rationale for beef production. *Land Use Policy*, 29(3), pp. 558-568. doi: <https://doi.org/10.1016/j.landusepol.2011.09.009>

Brandon K (2014) *Ecosystem Services from Tropical Forests: Review of Current Science*. CGD Working Paper 380. Washington, DC: Center for Global Development. Retrieved from: <http://www.cgdev.org/publication/ecosystem-services-tropical-forests-review-currentscience-working-paper-380>

Brasil (1988) *Constituição da República Federativa do Brasil de 1988*, promulgada em 05 de outubro de 1988. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Constituicao/Constituicao.htm](http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm)

Brasil (2015) Lei nº 13.105, de 16 de março de 2015. *Código de Processo Civil*. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2015-2018/2015/lei/l13105.htm](http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13105.htm)

Brito B, Barreto P, Brandão Jr A, Baima S, Gomes PH (2019) Stimulus for land grabbing and deforestation in the Brazilian Amazon. *Environmental Research Letters*, 14. doi: 10.1088/1748-9326/ab1e24

Campos-Silva, JV, Hawes, JE, Andrade, PCM & Peres, CA. (2018). Unintended multispecies co-benefits of an Amazonian community-based conservation programme. *Nature Sustainability*, 1(11), 650–656. doi:10.1038/s41893-018-0170-5

Camprodon G, González O, Barberán V, Pérez M, Smári V, Heras MA, Bizzotto A (2019) Smart Citizen Kit and Station: An open environmental monitoring system for citizen participation and scientific experimentation. *HardwareX*, 6. doi: <https://doi.org/10.1016/j.ohx.2019.e00070>

Carlson A, Palmer C (2016) A qualitative meta-synthesis of the benefits of eco-labeling in developing countries. *Ecological Economics*, 127, pp. 129-145. doi: <https://doi.org/10.1016/j.ecolecon.2016.03.020>

CGU – Controladoria Geral da União. (2019a). Relatório de Avaliação do Processo Sancionador Ambiental - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA. Brasília: CGU. Retrieved from: <https://auditoria.cgu.gov.br/download/12741.pdf>. Accessed July 10th, 2019.

CGU – Controladoria Geral da União. (2019a). Relatório de Avaliação do Processo Sancionador Ambiental - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA. Brasília: CGU. Retrieved from: <https://auditoria.cgu.gov.br/download/12741.pdf>. Accessed July 10th, 2019.

CGU – Controladoria Geral da União. (2019b). Infográfico da Avaliação do Processo Sancionador Ambiental – IBAMA. Retrieved from: <https://www.cgu.gov.br/noticias/2019/04/cgu-avalia-desempenho-e-gestao-do-processo-sancionador-ambiental-do-ibama/infografico-ibama.pdf>. Accessed July 11<sup>th</sup> 2019.

CGU – Controladoria Geral da União. (2019b). Infográfico da Avaliação do Processo Sancionador Ambiental – IBAMA. Retrieved from: <https://www.cgu.gov.br/noticias/2019/04/cgu-avalia-desempenho-e-gestao-do-processo-sancionador-ambiental-do-ibama/infografico-ibama.pdf>. Accessed July 11<sup>th</sup> 2019.

Chess C and Purcell K (1999) Public Participation and the Environment: Do We Know What Works? *Environmental Science & Technology*, 33(16), pp. 2685-2692. doi: <https://doi.org/10.1021/es980500g>

Cohen MA (2000) Empirical Research on the Deterrent Effect of Environmental Monitoring and Enforcement. *The Environmental Law Reporter*, 30. Environmental Law Institute: Washington, DC.

Garrett, R, Gardner, TA, Fonseca, T, Marchand, S, Barlow, J, Ezzine de Blas, D, Ferreira, J, Lees, AC & Parry, L. (2017). Explaining the persistence of low income and environmentally

degrading land uses in the Brazilian Amazon. *Ecology and Society*, 22 (3):27. <https://doi.org/10.5751/ES-09364-220327>.

Girardi EP, Mello-Théry NA, Théry H, Hato J (2014) Mapeamento do trabalho escravo contemporâneo no Brasil: dinâmicas recentes. *Espaço e Economia – Revista brasileira de geografia econômica*, 4. doi: 10.4000/espacoeconomia.804

Glowinski, SL (2008) Bird-watching, ecotourism, and economic development: A review of the evidence. *Applied Research in Economic Development*, 5(3), 65–77. Available at: [http://ocean.otr.usm.edu/~w301497/teaching/advice\\_teaching/docs/glowinski\\_2008v5n3.pdf](http://ocean.otr.usm.edu/~w301497/teaching/advice_teaching/docs/glowinski_2008v5n3.pdf).

Golden CD, Rasolofoniaina BJR, Benjamin R, Young SL (2012) Pica and Amylophagy Are Common among Malagasy Men, Women and Children. *Plos One*, vol 7, 10. doi: 10.1371/journal.pone.0047129

Guimarães J, Amaral P, Pinto A and Gomes I (2019) *Preços de Produtos da Floresta: uma década de pesquisa e divulgação*. Belém: Imazon.

Guo Z, Xiao X, Li D (2000) An Assessment of Ecosystem Services: Water Flow Regulation and Hydroelectric Power Production. *Ecological Applications*, 10(3), pp. 925-936. doi: [https://doi.org/10.1890/1051-0761\(2000\)010\[0925:AAOESW\]2.0.CO;2](https://doi.org/10.1890/1051-0761(2000)010[0925:AAOESW]2.0.CO;2)

Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.

Holifield R and Williams KC (2019) Recruiting, integrating, and sustaining stakeholder participation in environmental management: A case study from the Great Lakes Areas of Concern. *Journal of Environmental Management*, 230, pp. 422-433. doi: <https://doi.org/10.1016/j.jenvman.2018.09.081>

Howe ES & Brandau CJ (1988) Additive Effects of Certainty, Severity, and Celerity of Punishment on Judgments of Crime Deterrence Scale Value. *Journal of Applied Social Psychology*, 18(9), 796–812. doi: <https://doi.org/10.1111/j.1559-1816.1988.tb02356.x>

IBGE – Instituto Brasileiro de Geografia e Estatística (2014) Áreas Especiais – Cadastro de Municípios localizados na Amazônia Legal. Retrieved from: <https://bit.ly/2vc3NQT>

IBGE – Instituto Brasileiro de Geografia e Estatística (2017) *Sistema de Contas Regionais: Brasil 2015*. Retrieved from: <https://bit.ly/2UJCKFu>

IBGE – Instituto Brasileiro de Geografia e Estatística (2019) *Cidades*. Retrieved from: <https://cidades.ibge.gov.br/>

INEP – Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (2016) *IDEB – Resultados e Metas*. Retrieved from: <https://bit.ly/1qoxrdS>

INPE – Instituto Nacional de Pesquisas Espaciais (2019a) *Banco Dados de Queimadas*. Retrieved from: <http://queimadas.dgi.inpe.br/queimadas/bdqueimadas>. Accessed in September, 11th, 2019.

INPE – Instituto Nacional de Pesquisas Espaciais (2019b) *Monitoramento dos Focos Ativos por Bioma*. Retrieved from: [http://queimadas.dgi.inpe.br/queimadas/portal-static/estatisticas\\_estados/](http://queimadas.dgi.inpe.br/queimadas/portal-static/estatisticas_estados/). Accessed in September, 11th, 2019.

Kageyama PY (2009) Biodiversidade e Biopirataria: contradição entre a biodiversidade e a pobreza no mundo, in Aleixo A, Azevedo-Ramos C, Camargo E, Kageyama PY, Maio MC, Nascimento DM & Oliveira NS (Eds.), *Amazônia e Desenvolvimento Sustentável*. Rio de Janeiro: Fundação Konrad Adenauer.

Karp DS, Mendenhall CD, Sandí RF, Chaumont N, Ehrlich PR, Hadly EA, Daily GC (2013) Forest bolsters bird abundance, pest control and coffee yield. *Ecology Letters* 16(11), pp. 1339–1347. doi: <https://doi.org/10.1111/ele.12173>

Klautau de Araújo TL (2014) Environmental law, public policies, and climate change: a social-legal analysis in the Brazilian context. In: Leal Filho W (ed) *Handbook of climate change adaptation*. Springer, Berlin, pp 973–982. doi: [https://doi.org/10.1007/978-3-642-40455-9\\_115-1](https://doi.org/10.1007/978-3-642-40455-9_115-1).

Klautau de Araújo TL (2016) Public policies and education for biodiversity: Brazilian challenges in a new global context. In: Castro P, Azeiteiro UM, Bacelar Nicolau P, Leal Filho W, Azul AM (eds) *Biodiversity and education for sustainable development*. Springer, Berlin, pp 219–235.

Klautau de Araújo TL (2017) Constituição económica e desigualdades regionais: uma análise comparada dos ordenamentos Brasileiro e Português. Retrieved from: <https://bit.ly/2viSWo5>

Klautau de Araújo TL (2019a) Brazilian Amazônia and Climate Change: Barriers and Pathways for Forthcoming Sustainability. In: Leal Filho W, Azul A, Brandli L, Özuyar P, Wall T (eds) *Climate Action. Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. doi: <https://doi.org/10.1007/978-3-319-71063-1>.

Klautau de Araújo TL (2019b) Environmental Assets and Carbon Markets: Opportunities and Challenges for a Greener and Sustainable Economy in Brazil. In: Leal Filho W, Azul A, Brandli L, Özuyar P, Wall T (eds) *Climate Action. Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. doi: <https://doi.org/10.1007/978-3-319-71063-1>.

Klautau de Araújo TL, Soares AMVM, Azeiteiro UM (2019a) Environmental assets and carbon markets: could it be Amazônia's new belle Époque? In: Castro P, Azul A, Leal FW, Azeiteiro U (eds) *Climate change-resilient agriculture and agroforestry*. *Climate Change Management*. Springer, Cham. doi: [https://doi.org/10.1007/978-3-319-75004-0\\_28](https://doi.org/10.1007/978-3-319-75004-0_28)

Klautau de Araújo TL, Sousa P, Soares AMVM, Azeiteiro UM (2019b) Brazilian Amazônia, deforestation and environmental degradation: analyzing the process using game, deterrence and rational choice theories. Submitted.

Klautau de Araújo JM. (1995). *Caligrafias de Belém – vol. I: a dimensão insular*. Belém: Imprensa Oficial do Estado do Pará.



Lavelle, P, Dolédec, S, Sartre, XA, Decaëns, T, Gond, V, Grimaldi, M, Oszwald, J, Hubert, B, Ramirez, B, Veiga, I, Simão de Souza, S, Assis, WS, Michelotti, F, Martins, M, Feijoo, A, Bommel, P, Castañeda, E, Chacon, P, Desjardins, T, Dubs, F, Gordillo, E, Guevara, E, Fonte, S, Hurtado, MP, Lena, P, Lima, T, Marichal, R, Mitja, D, Miranda, I, Otero, T, Praxedes, C, Pocard, R, Robert, P, Rodriguez, G, Sanabria, C, Tselouiko, S, Velasquez, A, Velasquez, E & Velasquez, J. (2016). Unsustainable landscapes of deforested Amazonia: An analysis of the relationships among landscapes and the social, economic and environmental profiles of farms at different ages following deforestation. *Global Environmental Change* 40, pp. 137-155. doi: <http://dx.doi.org/10.1016/j.gloenvcha.2016.04.009>

Loureiro VR and Pinto JAN (2005) A questão fundiária na Amazônia. *Estudos Avançados*, 19(54). doi: <http://dx.doi.org/10.1590/S0103-40142005000200005>

Lynch MJ, Barrett KL, Stretesky PB & Long MA (2016) The Weak Probability of Punishment for Environmental Offenses and Deterrence of Environmental Offenders: A Discussion Based on USEPA Criminal Cases, 1983–2013. *Deviant Behavior*, 37:10, 1095-1109. doi: <https://doi.org/10.1080/01639625.2016.1161455>

Maldonado JH, Moreno-Sánchez RP, Espinoza S, Bruner A, Garzón N, Myers J (2018) Peace is much more than doves: The economic benefits of bird-based tourism as a result of the peace treaty in Colombia. *World Development*, 106, pp. 78-86. doi: <https://doi.org/10.1016/j.worlddev.2018.01.015>.

Ministério da Saúde (2012) Índice de Desenvolvimento do Sistema Único de Saúde. Retrieved from: <https://bit.ly/2Ui6DBZ>

Mullan K (2014) *The Value of Forest Ecosystem Services to Developing Economies*. CGD Working Paper. Washington, DC: Center for Global Development. Retrieved from: <http://www.cgdev.org/publication/value-forest-ecosystem-services-developingeconomies-working-paper-379>

Muradian R, Arsel M, Pellegrini L, Adaman F, Aguilar B, Agarwal B, Corbera E, Ezzine de Blas D, Farley J, Froger G, Garcia-Frapolli E, Gómez-Baggethun E, Gowdy J, Kosoy N, Le Coq JF, Leroy P, May P, Méral P, Mibielli P, Norgaard R, Ozkaynak B, Pascual U, Pengue W, Perez M, Pesche D, Pirard R, Ramos-Martin J, Rival L, Saenz F, Van Hecken G, Vatn A, Vira B, Urama K (2013) Payments for ecosystem services and the fatal attraction of win-win solutions. *Conservation Letters*, 6(4), pp. 274–279. doi: <https://doi.org/10.1111/j.1755-263X.2012.00309.x>

Myers SS, Gaffikin L, Golden CD, Ostfeld RS, Redford KH, Ricketts TH, Turner WR, Osofsky SA (2013) Human health impacts of ecosystem alteration. *Proceedings of the National Academy of Sciences*, 110(47), pp. 18753-18760. doi: <https://doi.org/10.1073/pnas.1218656110>

OECD (2016) Brasil no Pisa 2015: análises e reflexões sobre os estudantes brasileiros. Fundação Santillana, São Paulo

Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economics Perspectives*, 14, 137-158.

- Paulino, E. (2014). The agricultural, environmental and socio-political repercussions of Brazil's land governance system. *Land Use Policy*, 36, 134-144. doi: <https://doi.org/10.1016/j.landusepol.2013.07.009>
- Rechtschaffen C (1998) Deterrence vs. Cooperation and the evolving theory of Environmental Enforcement. *71 S. Cal. L. Rev.* 1181. Golden Gate University School of Law.
- Reyes-García V, Benyei P (2019) Indigenous knowledge for conservation. *Nature Sustainability*, 2, pp. 657-658. doi: <https://doi.org/10.1038/s41893-019-0341-z>.
- Rönnbäck P (1999) The ecological basis for economic value of seafood production supported by mangrove ecosystems. *Ecological Economics*, 29, pp. 235-252. doi: [https://doi.org/10.1016/S0921-8009\(99\)00016-6](https://doi.org/10.1016/S0921-8009(99)00016-6).
- Sáenz L, Mulligan M, Arjona F, Gutierrez T (2014) The role of cloud forest restoration on energy security. *Ecosystem Services*, 9, pp. 180-190. doi: <https://doi.org/10.1016/j.ecoser.2014.06.012>
- Samuelson P (1976) Economics of forestry in an evolving society. *Econ Inq* XIV:466–492.
- Schmitt, J. (2015). *Crime sem castigo: a efetividade da fiscalização ambiental para o controle do desmatamento ilegal na Amazônia*. Brasília: UNB. Retrieved from: [http://repositorio.unb.br/bitstream/10482/19914/1/2015\\_JairSchmitt.pdf](http://repositorio.unb.br/bitstream/10482/19914/1/2015_JairSchmitt.pdf)
- Seymour F, Busch J (2016) Why forests? Why now? The science, economics, and politics of tropical forests and climate change. CGD, Washington, DC
- Silva, JMC, Prasad, S & Diniz-Filho, JAF. (2017). The impact of deforestation, urbanization, public investments, and agriculture on human welfare in the Brazilian Amazonia. *Land Use Policy* 65, pp. 135-142. doi: <http://dx.doi.org/10.1016/j.landusepol.2017.04.003>.
- Sinclair AJ and Diduck AP (2017) Reconceptualizing public participation in environmental assessment as EA civics. *Environmental Impact Assessment Review*, 62, pp. 174-182. doi: <https://doi.org/10.1016/j.eiar.2016.03.009>
- SNIS – Sistema Nacional de Informações sobre Saneamento (2017) *Série Histórica*. Retrieved from: <https://bit.ly/2UsmdXJ>
- TCU – Tribunal de Contas da União (2015) Acórdão 1215/2015 – Plenário. Processo 019.872/2014-3. Relator: Raimundo Carreiro. Retrieved from: <https://bit.ly/2lz3UEI>
- TCU – Tribunal de Contas da União (2017) Acórdão 1970/2017 – Plenário. Processo 029.688/2016-7. Relator: Aroldo Cedraz. Retrieved from: <https://bit.ly/2IOaHu3>
- Tonry M (2017) An Honest Politician's Guide to Deterrence: Certainty, Severity, Celerity, and Parsimony, in Nagin, DS, Cullen, F, & Jonson, CL (eds.) *Deterrence, Choice, and Crime: Contemporary Perspectives*. New York: Routledge.

Tortato FR, Izzo TJ, Hoogesteijn R & Peres CA (2017) The numbers of the beast: Valuation of jaguar (*Panthera onca*) tourism and cattle depredation in the Brazilian Pantanal. *Global Ecology and Conservation*, vol. 11, pp. 106-114. doi: <https://doi.org/10.1016/j.gecco.2017.05.003>

Tu Z, Hu T, Shen R (2019) Evaluating public participation impact on environmental protection and ecological efficiency in China: Evidence from PITI disclosure. *China Economic Review*, 55, pp. 111-123. doi: <https://doi.org/10.1016/j.chieco.2019.03.010>

Udofia A, Noble B and Poelzer G (2017) Meaningful and efficient? Enduring challenges to Aboriginal participation in environmental assessment. *Environmental Impact Assessment Review*, 65, pp. 164-174. doi: <https://doi.org/10.1016/j.eiar.2016.03.009>

UNDP, IPEA, FJS (2013) *Atlas do Desenvolvimento Humano no Brasil – Ranking*. Retrieved from: <http://bit.ly/1TPFUDZ>

Weinstein B (1993) *A borracha na Amazônia: expansão e decadência (1850-1920)*. Editora da Universidade de São Paulo, São Paulo

Welvaert M and Caley P (2016) Citizen surveillance for environmental monitoring: combining the efforts of citizen science and crowdsourcing in a quantitative data framework. *Springerplus*, 5(1): 1890. doi: 10.1186/s40064-016-3583-5

Wolford W (2016) The casa and the causa: institutional histories and cultural politics in Brazilian Land Reform. In: *Latin American research review*, vol 51, No 4. Latin American Studies Association, Austin

Wunder S (2013) When payments for environmental services will work for conservation. *Conservation Letters*, 6(4), pp. 230–237. doi: 10.1111/conl.12034

Yew WL and Zhu Z (2019) Innovative autocrats? Environmental innovation in public participation in China and Malaysia. *Journal of Environmental Management*, 234, pp. 28-35. doi: <https://doi.org/10.1016/j.jenvman.2018.12.081>

Zhang G, Deng N, Mou H, Zhang ZG, Chen X (2019) The impact of the policy and behavior of public participation on environmental governance performance: Empirical analysis based on provincial panel data in China. *Energy Policy*, 129, pp. 1347-1354. doi: <https://doi.org/10.1016/j.enpol.2019.03.030>.

## **Section D – Final Comments**

### **What went (and still is) wrong in Brazilian policies for environment?**

Evaluating and defining exactly what is sustainable development is extremely complicated. Although there are several definitions, as presented in the Introduction, it can be everything – or nothing at all. For the purpose of our research, sustainability was considered as the combination of environmental conservation, improvement of social conditions and economic growth.

From this definition, it was easier to identify the problems and deficiencies in law and public policies and to suggest ways to correct it. However, the challenges in Brazilian reality are more complicated. Brazil still has primitive issues, as lack of basic sanitation or access to minimal infrastructures are constant problems in the biggest part of the country, especially in the regions with higher biodiversity.

The recent public indignation about the fires or the environmental degradation is not reflected in a real pressure on politicians or parties to change current public policies for environment. The protests were mainly in social networks, and as the fires were losing the highlights in media, public opposition is fading away.

However, even if the society requests were accepted by the congress and government, they would not be enough, as the changes would be related exclusively to the policies directed to environment.

That is the main point of the present thesis: policies exclusively related to environment do not work and are not sustainable in long term. Focusing only on it can create a temporary reduction on deforestation, but will not solve the situation.

A Brazilian/Portuguese expression is a good definition to policies with these characteristics: “*enxugar gelo*”, which means, literally “to be drying an ice block”. As soon as there is budget cut in surveillance or higher demand for farming commodities, deforestation rises. In terms of efficiency and rational aspects of budget execution, if considered all the constraints to public resources in Brazil over the last years, it is a really bad choice.

If not accompanied by other solutions related to education, infrastructure, economic activities, improvement of families' income and a more coherent and efficient legal system, surveillance is just an expensive way of dealing with the problem.

However, as it was analyzed on the publications, surveillance and theoretical solutions were the main options for environmental law and public policies. The sustainable alternatives (mentioned many times in environmental legislation and regulation) were not treated as priority – and this has a huge cost for nature and for Brazilian tax payers.

Even if the surveillance system was efficient, well equipped and capable of stopping deforestation and environmental degradation, with the confusing, bureaucratic and failed legal system, the collection of fines would still be low. As it was addressed in the publications 4 and 5, the problem is not related to environmental law, but to procedure law, to management of the environmental agencies, to the administration of justice and to bureaucracy.

It is always important to highlight that the current process of depletion of resources in Brazil is not restricted only to deforestation. There are forest fires and contamination of the rivers with mercury and other heavy metals used for illegal gold digging and discarded in water courses. Leaking and collapse of dams or intentional releasing of toxic materials coming from the big mineral projects also occurred in the last years. This represents not only environmental degrading and dangerous activities that can affect public health, but it is also stealing and destroying Union assets and it has to be treated both as environmental and common crimes.

### **What can be done?**

The current scenario is full of problems and points that can be improved. The main contribution of this thesis was to identify these points and to suggest combined solutions that can improve these aspects.

Although worrying, Brazilian environmental context is full of good opportunities. Before deforestation and climate change became preminent, social and economic condition were degraded in many regions in Brazil, especially in Amazônia.

The need of new and innovative solutions is a great chance of changing current irrational and unsustainable exploitation of the resources of the region. A more sustainable future means better conditions for local communities and less social and regional inequalities.

To sum up the main suggestions from the results obtained on this research, there are aspects related to legal, administrative, economic and social participation issues.

Legally, it is necessary to provide improvements in procedure law and criminal law. The punishments for environmental crimes are not hard enough, and their economic benefits are high. So it is necessary to rethink it. The procedure related to crimes or to environmental fines also needs to be simplified, in order to make it more efficient and quicker, to avoid limitation period and impunity.

The current legal and constitutional provisions of almost unending appeals to higher courts, that postpone the process indefinitely should be reviewed and corrected. They have the purpose to guarantee that injustices can be reversed, but instead of it, they are being twisted by the ones that committed environmental crimes for them to remain without punishment.

It is necessary to proceed the legal arrangements to create and make viable the Carbon and Environmental Assets Markets. These adaptations must encompass less bureaucracies and more incentives for greener and sustainable practices. By that, it is possible to reduce the profitability of illegal and environmental degrading practices and, at the same time, to enhance sustainable activities and provide them priority on the policies. Doing so, the changes can be quicker, spreading the interest in adopting greener models.

In terms of management, it would be more adequate to have less environmental agencies. The dispersed efforts not only consume more resources, but make the action of the Governments less precise and efficient, as the agencies are not totally coordinated.

It is necessary to simplify internal procedures inside the environmental agencies and to improve celerity on charging environmental fines. The judiciary should do the same and prioritize these types of cases, as in big environmental occurrences, such as the collapse of the dams of Mariana and Brumadinho, Minas Gerais, or the leaks of toxic materials in Barcarena, besides the environmental fines to be paid, there are also the compensations for the affected local populations.

Economically, new ways of improving income of the families by taking advantage of the areas already used, but in a sustainable way, are needed. It means the combination of different environmental assets, as ecotourism, carbon sequestration, reforestation projects, non-timber products (eg. herbs, seeds, flowers, fruits), sustainable exploration of medicinal goods derived from biodiversity, agroforestry management (the combined use of different species to reduce or eliminate the use of pesticides and diversify the production), among others. Raising the productivity is another key-factor to reduce the pressure on forest areas.

Get the most out of the goods created from Brazilian biodiversity is another important point for the Governments. Multiply cooperation between universities and the companies that explore these assets, or to create Public-Private partnerships or a company with State participation to explore these assets are some of the possibilities that need to be better studied.

Enhancing social participation is another relevant point not only to improve the efficiency and the accuracy of the public policies for the regions, but also to the long term success of these initiatives and to build up a partnership between the Government and local communities.

### **Future research paths**

It is necessary to deepen each one of the contributions here suggested in order to make them ready to be applied.

Concerning legal issues, the natural next step would be the writing and construction of law and constitutional amendment bills with necessary changes to harden the punishments, to simplify the processes or to open and to regulate Carbon and Environmental markets. Then, addressing it to the government, to deputies or to senators in order to be proposed to the parliament.

Another possibility is the identification of the already existing law drafts, suggesting adaptations and inclusions, to make this process faster.

What refers to economic aspects, one promising path for future work is to expand the research concerning market mechanisms that can help environmental conservation and sustainable development.

It is necessary to develop studies about practical strategies to implement combination of multiple activities related to the environmental assets mentioned on the previous topic, or the elaboration of suggestions of public policies to implement it in partnership with local communities. It is also needed to create strategies in order to spread these alternatives and to capacitate populations with appropriate techniques and materials to do so.

By last, another possible way is to do further research about viable models of participation that can be replicated in different contexts inside Amazônia and other regions of Brazil.



## References for Introduction

- Azevedo TR, Angelo C (2018) *Emissões de GEE no Brasil e suas implicações para políticas públicas e a contribuição brasileira para o Acordo de Paris*. São Paulo: Sistema de Estimativas de Emissões de Gases de Efeito Estufa. Retrieved from: <http://seeg.eco.br/wp-content/uploads/2018/08/Relatorios-SEEG-2018-Sintese-FINAL-v1.pdf>
- Cardoso A (2015) Especiarias na Amazônia portuguesa: circulação vegetal e comércio atlântico no final da monarquia hispânica. *Revista Tempo* 21(37):116–133
- Cook J, Nuccitelli D, Green SA et al. (2013) Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environ. Res. Lett.*, 8, p. 24024.
- De Graaf HJ., Musters CJM & ter Keurs WJ (1996) Sustainable development: looking for new strategies. *Ecological Economics*, 16(3), 205–216. doi: 10.1016/0921-8009(95)00088-7
- Finn C (2013). AGU Updates climate change position statement. *Eos Trans. Am. Geophys. Union*, 94, p. 301. doi: 10.1002/2013EO340006
- Garrett, R, Gardner, TA, Fonseca, T, Marchand, S, Barlow, J, Ezzine de Blas, D, Ferreira, J, Lees, AC & Parry, L. (2017). Explaining the persistence of low income and environmentally degrading land uses in the Brazilian Amazon. *Ecology and Society*, 22 (3):27. <https://doi.org/10.5751/ES-09364-220327>.
- Gudmundsson H & Höjer M (1996). *Sustainable development principles and their implications for transport*. *Ecological Economics*, 19(3), 269–282. doi:10.1016/s0921-8009(96)00045-6
- Hartert J, Hamilton LC, Boag AE et al (2018) Does it matter if people think climate change is human caused? *Climate Services*, 10, p. 53-62. doi: <https://doi.org/10.1016/j.cliser.2017.06.014>
- INPE – Instituto Nacional de Pesquisas Espaciais. (2019) *TerraBrasilis Desmatamento*. Retrieved from: <http://terra-brasilis.dpi.inpe.br/app/map/deforestation>. Accessed in July 11<sup>th</sup> 2019
- IPCC - Intergovernmental Panel on Climate Change (2007) *Climate change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC*. Cambridge University Press, Cambridge, United Kingdom. Retrieved from: [https://www.ipcc.ch/site/assets/uploads/2018/03/ar4\\_wg2\\_full\\_report.pdf](https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg2_full_report.pdf)
- IPCC - Intergovernmental Panel on Climate Change (2013) *Climate Change: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom. Retrieved from: [https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5\\_all\\_final.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_all_final.pdf)
- Kageyama, P. Y. (2009). Biodiversidade e Biopirataria: contradição entre a biodiversidade e a pobreza no mundo. In A. Aleixo, C. Azevedo-Ramos, E. Camargo, P. Y. Kageyama, M.

C. Maio, D. M. Nascimento, & N. S. Oliveira (Eds.), *Amazônia e Desenvolvimento Sustentável*. Rio de Janeiro: Fundação Konrad Adenauer.

Klautau de Araújo JM (1995) *Caligrafias de Belém – vol. I: a dimensão insular*. Belém: Imprensa Oficial do Estado do Pará.

Lavelle, P, Dolédec, S, Sartre, XA, Decaëns, T, Gond, V, Grimaldi, M, Oszwald, J, Hubert, B, Ramirez, B, Veiga, I, Simão de Souza, S, Assis, WS, Michelotti, F, Martins, M, Feijoo, A, Bommel, P, Castañeda, E, Chacon, P, Desjardins, T, Dubs, F, Gordillo, E, Guevara, E, Fonte, S, Hurtado, MP, Lena, P, Lima, T, Marichal, R, Mitja, D, Miranda, I, Otero, T, Praxedes, C, Pocard, R, Robert, P, Rodriguez, G, Sanabria, C, Tselouiko, S, Velasquez, A, Velasquez, E & Velasquez, J. (2016). Unsustainable landscapes of deforested Amazonia: An analysis of the relationships among landscapes and the social, economic and environmental profiles of farms at different ages following deforestation. *Global Environmental Change* 40, pp. 137-155. doi: <http://dx.doi.org/10.1016/j.gloenvcha.2016.04.009>

Leal Filho, W, Skanavis C, Kounani A, Brandli LL, Shiel C, Paço A, Pace P, Mifsud M, Beynaghi A, Price E, Salvia AE, Will M, Shula K. (2019). The role of planning in implementing sustainable development in a higher education context. *Journal of Cleaner Production*. doi: 10.1016/j.jclepro.2019.06.322

Loureiro VR and Pinto JAN (2005) A questão fundiária na Amazônia. *Estudos Avançados*, 19(54). doi: <http://dx.doi.org/10.1590/S0103-40142005000200005>

Melillo JM, Richmond TC, Yohe GW (Eds.) (2014) *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, Washington, DC.

Morton S, Pencheon D, & Bickler G (2019) The sustainable development goals provide an important framework for addressing dangerous climate change and achieving wider public health benefits. *Public Health*, 174, 65–68. doi: 10.1016/j.puhe.2019.05.018

Mourão L (1989) *Memória da indústria paraense*. Federação das Indústrias do Estado do Pará, Belém

NOAA – National Oceanic and Atmospheric Administration (2019) *Global Climate Report - July 2019*. Retrieved from: <https://www.ncdc.noaa.gov/sotc/global/201907>

Nobre CA, Sampaio G, Borma LS, Castilla-Rubio JC, Silva JS and Cardoso M (2016) Land-use and climate change risks in the Amazon and the need of a novel sustainable development paradigm. *PNAS*, 113(39), p. 10759-10768. doi: <https://doi.org/10.1073/pnas.1605516113>

Oreskes N (2004) The scientific consensus on climate change. *Science*, 306, p. 1686. doi: 10.1126/science.1103618.

Paula DA (2000) *As ferrovias no Brasil: análise do processo de erradicação de ramais*. *Actas del II Congreso de Ferrocarriles*. Aranjuez, 2000. Retrieved from: <http://www.docutren.com/historiaferroviaria/Aranjuez2001/pdf/22.pdf>

Paulino, E. (2014). The agricultural, environmental and socio-political repercussions of Brazil's land governance system. *Land Use Policy*, 36, 134-144. doi: <https://doi.org/10.1016/j.landusepol.2013.07.009>

SOSMA – Fundação SOS Mata Atlântica & INPE – Instituto Nacional de Pesquisas Espaciais. (2019). Atlas dos Remanescentes Florestais da Mata Atlântica. São Paulo, Brazil.

UN – United Nations (2019) About the Sustainable Development Goals. Retrieved from: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>. Accessed sep 20<sup>th</sup> 2019.

WCED – World Commission on Environment and Development (1987) Report of the World Commission on Environment and Development: Our Common Future. Retrieved from: <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>

Wolford W (2016) The casa and the causa: institutional histories and cultural politics in Brazilian Land Reform. In: Latin American research review, vol 51, No 4. Latin American Studies Association, Austin

## References for Publication 1

Alves F, Caeiro S, Leal Filho W, Azeiteiro U (eds) (2014) Special issue on “Lay rationalities of climate change”. *International Journal of Climate Change Strategies and Management*, vol. 6 n. 1, pp. 2–4. Emerald

Barbosa V (2011) Paragominas: inspiração verde no Pará. Available in: <http://planetasustentavel.abril.com.br/noticia/desenvolvimento/paragominas-inspiracao-verde-645308.shtml>

Brasil (1967) Lei 5197, de 3 de Janeiro de 1967. Available in: [http://www.planalto.gov.br/ccivil\\_03/leis/l5197.htm](http://www.planalto.gov.br/ccivil_03/leis/l5197.htm).

Brasil (1981) Lei 6938, de 31 de agosto de 1981. Available in: [http://www.planalto.gov.br/ccivil\\_03/leis/l6938.htm](http://www.planalto.gov.br/ccivil_03/leis/l6938.htm)

Brasil (1988) Constituição da República Federativa do Brasil de 1988, promulgada em 05 de outubro de 1988. Available in: [http://www.planalto.gov.br/ccivil\\_03/constituicao/constituicao.htm](http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm)

Brasil (1990) Decreto nº 99.274, de 6 de junho de 1990. Available in: [http://www.planalto.gov.br/ccivil\\_03/decreto/antigos/d99274.htm](http://www.planalto.gov.br/ccivil_03/decreto/antigos/d99274.htm)

Carvalho C (2011) Onze cidades já seguem modelo de Paragominas contra o desmatamento da Amazônia. Available in: <http://oglobo.globo.com/politica/onze-cidades-ja-seguem-modelo-deparagominas-contradesmatamento-da-amazonia-2687290>

Geertz C (1983) *Local knowledge: further essays in interpretive anthropology*. Basic Books, New York.

Instituto Ethos, Rede Nossa São Paulo, Rede Social Brasileira por Cidades Justas e Sustentáveis (2013) Paragominas combate o desmatamento e vira exemplo de sustentabilidade na Amazônia. Available in: <http://www.cidadessustentaveis.org.br/boas-praticas/paragominas-combate-odesmatamento-e-vira-exemplo-de-sustentabilidade-na-amazonia>

Milaré É (2009) Direito do Ambiente: a gestão ambiental em foco. Revista dos Tribunais, São Paulo

Miranda G (2013) Emissões de gases-estufa no Brasil em 2012 foram as menores em 20 anos. Available in: <http://www1.folha.uol.com.br/ambiente/2013/11/1368065-emissoes-de-gasesestufa-no-brasil-em-2012-foram-as-menores-em-20-anos.shtml>. São Paulo

Miranda G, Nublat J (2013) Desmatamento na Amazônia sobe 28 % em 2013. Available in: <http://www1.folha.uol.com.br/ambiente/2013/11/1371434-desmatamento-na-amazonia-sobe-28-em-2013.shtml>. São Paulo

## References for Publication 2

Antunes, P. B. (2010). Direito Ambiental (12th ed.). Rio de Janeiro: Lumen Juris.

Brasil. (1981). Lei nº 6938, de 31 de agosto de 1981. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Leis/L6938.htm](http://www.planalto.gov.br/ccivil_03/Leis/L6938.htm)

Brasil. (1988). Constituição da República Federativa do Brasil de 1988, promulgada em 05 de outubro de 1988. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Constituicao/Constituicao.htm](http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm)

Brasil. (1989). Lei nº 7735, de 22 de fevereiro de 1989. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/leis/17735.htm](http://www.planalto.gov.br/ccivil_03/leis/17735.htm)

Brasil. (1990). Decreto nº 99274, de 06 de junho de 1990. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/decreto/antigos/d99274.htm](http://www.planalto.gov.br/ccivil_03/decreto/antigos/d99274.htm)

Brasil. (1999). Lei nº 9795, de 27 de abril de 1999. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/leis/19795.htm](http://www.planalto.gov.br/ccivil_03/leis/19795.htm)

Brasil. (2000). Lei nº 9985, de 18 de julho de 2000. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Leis/L9985.htm](http://www.planalto.gov.br/ccivil_03/Leis/L9985.htm)

Brasil. (2001). Medida Provisória no 2.186-16, de 23 de agosto de 2001. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/MPV/2186-16.htm](http://www.planalto.gov.br/ccivil_03/MPV/2186-16.htm)

Brasil. (2005). Lei nº 11105, de 24 de março de 2005. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_Ato2004-2006/2005/Lei/L11105.htm](http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2005/Lei/L11105.htm)

Brasil. (2006). Lei nº 11284, de 02 de março de 2006. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2004-2006/2006/lei/11284.htm](http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/11284.htm)

- Brasil. (2007). Lei nº 11516, de 28 de agosto de 2007. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2007/lei/11516.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/11516.htm)
- Brasil. (2009). Lei nº 12187, de 29 de dezembro de 2009. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2009/lei/112187.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/112187.htm)
- Brasil. (2010). Lei nº 12305, de 02 de agosto de 2010. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2010/lei/112305.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/112305.htm)
- Brasil. (2015). Lei nº 13123, de 20 de maio de 2015. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_Ato2015-2018/2015/Lei/L13123.htm](http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13123.htm)
- Carvalho, E. (2014, October 30). Novo estudo liga desmatamento da Amazônia à seca no país. Retrieved from: <http://g1.globo.com/natureza/noticia/2014/10/novo-estudo-ligadesmatamento-da-amazonia-seca-no-pais.html>
- Castro, F. (2015, March 21). Desmatamento aumentou 282 % na Amazônia Legal em Fevereiro. Retrieved from: <http://www.estadao.com.br/noticias/geral,desmatamento-aumentou-282-naamazonia-legal-em-fevereiro,1655430>
- Chiuvite, T. B. S. (2010). Direito Ambiental. São Paulo: Barros, Fischer & Associados.
- Fudenberg, D., & Tirole, J. (1991). Game theory. Cambridge, MA: MIT Press.
- Geraque, E., & Mena, F. (2015, November 22). Infratores ambientais pagam só 8,7 % das multas aplicadas pelo Ibama. Retrieved from: <http://www1.folha.uol.com.br/cotidiano/2015/11/1709460-infratores-ambientais-pagam-so-87-das-multas-aplicadas-pelo-ibama.shtml>
- Instituto Brasileiro de Geografia e Estatística. (2004, May 21). IBGE lança o Mapa de Biomas do Brasil e o Mapa de Vegetação do Brasil, em comemoração ao Dia Mundial da Biodiversidade. Retrieved from: <http://www.ibge.gov.br/home/presidencia/noticias/21052004biomashtml.shtml>
- Kageyama, P. Y. (2009). Biodiversidade e Biopirataria: contradição entre a biodiversidade e a pobreza no mundo. In A. Aleixo, C. Azevedo-Ramos, E. Camargo, P. Y. Kageyama, M. C. Maio, D. M. Nascimento, & N. S. Oliveira (Eds.), *Amazônia e Desenvolvimento Sustentável*. Rio de Janeiro: Fundação Konrad Adenauer.
- Klautau de Araújo, J. M. (1995). *Caligrafias de Belém – vol. I: a dimensão insular*. Belém: Imprensa Oficial do Estado do Pará.
- Klautau de Araújo, J. M., & Lima, D. M. B. (1997a). *Projeto Escola Bosque do Amapá – Centro de Referência em Educação Ambiental da Ilha de Santana*. Macapá: Governo do Estado do Amapá.
- Klautau de Araújo, J. M. K., & Lima, D. M. B. (1997b). *Projeto Escola Bosque do Amapá – O método sócio-ambiental*. Macapá: Governo do Estado do Amapá.
- Klautau de Araújo, J. M., & Lima, D. M. B. (1997c). *Projeto Escola Bosque do Amapá – Projeto de Socialização*. Macapá: Governo do Estado do Amapá.

Klautau de Araújo, T. L. (2014). Environmental law, public policies, and climate change: A social-legal analysis in the Brazilian context. In Leal Filho, W. (Eds.), Handbook of climate change adaptation (pp. 973–982). Berlin: Springer. doi:10.1007/978-3-642-40455-9\_115-1; ISBN: 978-3-642-40455-9

Leite, M. (2015, March 31). Dilma Corta 72 % da verba contra desmatamento na Amazônia. Retrieved from: <http://www1.folha.uol.com.br/ambiente/2015/03/1610479-dilma-corta-72-da-verba-contra-desmatamento-na-amazonia.shtml>

Lima, D. M. B. (2013). The Escola Bosque project: Building ways to an ecological society. In Proceedings 7th World Environmental Education Congress, Marrakech, Morocco, June 9–14, 2013.

Machado, P. A. L. (2014). Direito Ambiental Brasileiro (22th ed.). São Paulo: Malheiros Editores.

Marshall, A. (1996). Princípios de Economia: Tratado Introdutório – (Vol. I). São Paulo: Nova Cultural.

Martello, A., & Passarinho, N. (2015, September 14). Governo anuncia pacote de corte de gastos e volta da CPMF. Retrieved from: <http://g1.globo.com/economia/noticia/2015/09/governoanuncia-bloqueio-de-gastos-no-orcamento-de-2016.html>

McAdams, R. H. (2008). Beyond the prisoner’s dilemma: Coordination, game theory and the law. Retrieved from: <http://www.law.uchicago.edu/files/files/LE437.pdf>

Milaré, É. (2014). Direito Ambiental (12th ed.). São Paulo: Revista dos Tribunais.

Oliveira, M. (2015, November 24). Pagar multa custa menos que prevenir dano ambiental. Retrieved from: <http://economia.estadao.com.br/noticias/geral,pagar-multa-custa-menos-queprevenir-dano-ambiental,10000002788>

Redação G1. (2015, November 13). É oficial: o Rio Doce está completamente morto. Retrieved from: <http://revistagalileu.globo.com/Ciencia/Meio-Ambiente/noticia/2015/11/e-oficial-o-riodoce-esta-completamente-morto.html>

Sanches, M. (2015, November 22). Barragens de alto risco ameaçam 540 mil pessoas. Retrieved from: <http://oglobo.globo.com/brasil/barragens-de-alto-risco-ameacam-540-mil-pessoas-18111236>

Torres, A. (2015, August 6). Maioria dos Municípios Brasileiros não cumpre a Lei que proíbe os lixões. Retrieved from: <http://g1.globo.com/jornal-nacional/noticia/2015/08/maioria-dosmunicipios-brasileiros-nao-cumpre-lei-que-proibe-os-lixoes.html>

### References for Publication 3

Affonso J, Macedo F, Fabrini F, Serapião F (2016) Operação Timóteo investiga esquema de corrupção em cobrança de royalties. Retrieved from: <http://bit.ly/21CQAe9>

Altafin I (2016) Participação brasileira no mercado de carbono será analisada na CMA. Retrieved from: <http://bit.ly/2yGIF9L>

Aristóteles (2009) Ética a Nicômaco. Tradução de Antônio de Castro Caieiro. Atlas, São Paulo

Barbosa R (1999) Oração aos Moços – Edição popular anotada por Adriano da Gama Kury. 5ª edição. Rio de Janeiro: Fundação Casa de Rui Barbosa

Birdsall N, Savedoff W, Seymour F (2014) The Brazil-Norway agreement with performance-based payments for forest conservation: successes, challenges, and lessons. Retrieved from: <http://bit.ly/2y34KKr>

Brasil (1966) Lei nº 5172, de 25 de outubro de 1966. Retrieved from: <http://bit.ly/2vZZveQ>

Brasil (1976) Lei nº 6385, de 7 de dezembro de 1976. Retrieved from: <http://bit.ly/2yGE3PY>

Brasil (1988) Constituição da República Federativa do Brasil de 1988, promulgada em 05 de outubro de 1988. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Constituicao/Constituicao.htm](http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm)

Brasil (1989) Lei Complementar nº 62, de 28 de dezembro de 1989. Retrieved from: <http://bit.ly/2xk8o3h>

Brasil (1989) Lei nº 7990, de 28 de dezembro de 1989. Retrieved from: <http://bit.ly/2fL0awx>

Brasil (1990) Lei nº 8001, de 13 de março de 1990. Retrieved from: <http://bit.ly/2velUIb>

Brasil (1997) Lei Complementar nº 91, de 22 de dezembro de 1997. Retrieved from: <http://bit.ly/2xA8Bi0>

Brasil (1997) Lei nº 9478, de 6 de agosto de 1997. Retrieved from: <http://bit.ly/1tfLEPg>

Brasil (2004) Projeto de Lei nº 3729/2004. Retrieved from: <http://bit.ly/2iCpMwQ>

Brasil (2006) Lei nº 11284, de 02 de março de 2006. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2004-2006/2006/lei/11284.htm](http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/11284.htm)

Brasil (2007) Decreto nº 6063, de 20 de março de 2007. Retrieved from: <http://bit.ly/2yLjZts>

Brasil (2008) Decreto nº 6527, de 1º de agosto de 2008. Retrieved from: <http://bit.ly/2y2M2Hr>

Brasil (2009) Lei nº 12114, de 9 de dezembro de 2009. Retrieved from: <http://bit.ly/2zMO5N9>

Brasil (2009) Lei nº 12187, de 29 de dezembro de 2009. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2007-2010/2009/lei/12187.htm](http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/12187.htm)



Brasil (2010) Decreto nº 7167, de 5 de maio de 2010. Retrieved from: <http://bit.ly/2gHbsDh>

Brasil (2010) Decreto nº 7343, de 26 de outubro de 2010. Retrieved from: <http://bit.ly/2leoold>

Brasil (2010) Decreto nº 7390, de 9 de dezembro de 2010. Retrieved from: <http://bit.ly/2yNja39>

Brasil (2010) Lei nº 12351, de 22 de dezembro de 2010. Retrieved from: <http://bit.ly/1rcaWMI>

Brasil (2011) Projeto de Lei do Senado nº 212, de 2011. Retrieved from: <http://bit.ly/2gBnWZ7>

Brasil (2012) Entenda como funciona o mercado de crédito de carbono. Retrieved from: <http://bit.ly/2htE1lb>

Brasil (2012) Lei nº 12651, de 25 de maio de 2012. Retrieved from: <http://bit.ly/1zecCID>

Brasil (2012) Projeto de Lei do Senado nº 95, de 2012. Retrieved from: <http://bit.ly/2gzIFN1>

Brasil (2013) Lei nº 12858, de 9 de setembro de 2013. Retrieved from: <http://bit.ly/2xloGbO>

Brasil (2015) Decreto nº 8576, de 26 de novembro de 2015. Retrieved from: <http://bit.ly/2iz1t39>

Brasil (2016) Medida Provisória nº 756, de 19 de dezembro de 2016. Retrieved from: <http://bit.ly/2z68aRF>

Brasil (2016) Medida Provisória nº 758, de 19 de dezembro de 2016. Retrieved from: <http://bit.ly/2y3AGDa>

Brasil (2017) Decreto nº 9142, de 22 de agosto de 2017. Retrieved from: <http://bit.ly/2g5fkgv>

Brasil (2017) Decreto nº 9147, de 28 de agosto de 2017. Retrieved from: <http://bit.ly/2vHFaKr>

Brasil (2017) Decreto nº 9159, de 25 de setembro de 2017. Retrieved from: <http://bit.ly/2lgebor>

Brito B (2017) Potential trajectories of the upcoming forest trading mechanism in Pará State, Brazilian Amazon. PLoS ONE 12(4):e0174154. <https://doi.org/10.1371/journal.pone.0174154>

Cardoso A (2015) Especiarias na Amazônia portuguesa: circulação vegetal e comércio atlântico no final da monarquia hispânica. Revista Tempo 21(37):116–133

CGD—Center for Global Development (2015) Look to the Forests: how performance payments can slow climate change. CGD, Washington, DC. Retrieved from: <http://bit.ly/2w6pVyQ>

CNT; SEST; SENAT (2016) Pesquisa CNT de Rodovias 2016: relatório gerencial. 20ª ed. Brasília: CNT.



- CVM (2009) CVM comunica seu entendimento sobre créditos de carbono e produtos que deles derivam. Retrieved from: <http://bit.ly/2i18xlc>
- Deaton A (2017) A grande saída: saúde, riqueza e a origem das desigualdades. Intrínseca, Rio de Janeiro.
- Estadão Conteúdo (2017) Projeto para permitir venda de terra a estrangeiro vai ao Congresso. Retrieved from: <https://glo.bo/2zMHIcF>
- FBSP; IPEA (2016) Atlas da violência 2016; nota técnica. Brasília: Instituto de Pesquisa Econômica Aplicada – IPEA. Retrieved from: <http://bit.ly/1R16zsQ>
- Folhes R et al (2015) Multi-scale participatory scenario methods and territorial planning in the Brazilian Amazon. *Futures* 73:86–99
- G1 DF (2016) PF desarticula esquema de corrupção na cobrança de royalties de mineração. Retrieved from: <https://glo.bo/2y3ans0>
- G1 PA (2017) Governo envia ao Congresso projeto de lei que reduz floresta nacional no Pará. Retrieved from: <https://glo.bo/2yMS3qH>
- Garfield S (2009) A Amazônia no imaginário norte-americano em tempo de guerra. In: *Revista Brasileira de História*, v. 29, nº 57, pp. 19–65. São Paulo
- Garfield S (2010) The environment of wartime migration: labor transfers from the Brazilian Northeast to the Amazon during World War II. *J Soc Hist Summer 2010* (George Mason University Press, Fairfax)
- Gesisky J (2017) Meio Ambiente perde metade dos recursos para 2017. Retrieved from: <http://bit.ly/2zA0wuP>
- Gomes M (2017) China reafirma compromisso com o Acordo de Paris. Retrieved from: <http://bit.ly/2ldCWlk>
- IBGE—Instituto Brasileiro de Geografia e Estatística (2016) Área Territorial Brasileira. Retrieved from: <http://bit.ly/2xxyleQ>
- Kafruni S (2014) Natura inaugura complexo industrial na Amazônia e gera 500 empregos. Retrieved from: <http://bit.ly/2h4B49Y>
- Kageyama PY (2009) Biodiversidade e Biopirataria: contradição entre a biodiversidade e a pobreza no mundo. In: Aleixo A, Azevedo-Ramos C, Camargo E, Kageyama PY, Maio MC, Nascimento DM, Oliveira NS (eds) *Amazônia e Desenvolvimento Sustentável*. Fundação Konrad Adenauer, Rio de Janeiro
- Klautau de Araújo JM (1995) *Caligrafias de Belém – vol I: a dimensão insular*. Imprensa Oficial do Estado do Pará, Belém
- Klautau de Araújo JM, Lima DMB (1997a) *Projeto Escola Bosque do Amapá – Centro de Referência em Educação Ambiental da Ilha de Santana*. Governo do Estado do Amapá, Macapá

Klautau de Araújo JM, Lima DMB (1997b) Projeto Escola Bosque do Amapá – O método sócio-ambiental. Macapá: Governo do Estado do Amapá

Klautau de Araújo JM, Lima DMB (1997c) Projeto Escola Bosque do Amapá – Projeto de Socialização. Macapá: Governo do Estado do Amapá

Klautau de Araújo TL (2014) Environmental law, public policies, and climate change: a social-legal analysis in the Brazilian context. In: Leal Filho W (eds) Handbook of climate change adaptation. Springer, Berlin, pp 973–982. [https://doi.org/10.1007/978-3-642-40455-9\\_115-1](https://doi.org/10.1007/978-3-642-40455-9_115-1); ISBN: 978-3-642-40455-9

Klautau de Araújo TL (2016) Public policies and education for biodiversity: Brazilian challenges in a new global context. In: Castro P, Azeiteiro UM, Bacelar Nicolau P, Leal Filho W, Azul AM (eds) Biodiversity and education for sustainable development. Springer, Berlin, pp 219–235

Leite M (2015) Dilma Corta 72% da verba contra desmatamento na Amazônia. Retrieved from: <http://bit.ly/2yOPbd9>

Lima DMB (2013) The Escola Bosque project: building ways to an ecological society. In Proceedings 7th world environmental Education Congress, Marrakech, Morocco, June 9–14, 2013

Lopes L et al (2015) Estudos sobre Mercado de Carbono no Mercado de Carbono no Brasil: Análise Legal de Possíveis Modelos Regulatórios. Banco Interamericano de Desenvolvimento, Monografia No. 307. BID, Washington, DC

Lusa (2017) Juncker alerta Trump: “Os norte-americanos não podem sair sem mais nem menos do acordo de Paris”. Retrieved from: <http://bit.ly/2yOzfrB>

Maisonnave F (2017a) Câmara aprova reduzir proteção de áreas de conservação no PA e em SC. Retrieved from: <http://bit.ly/2zzHUen>

Maisonnave F (2017b) Senado ratifica redução na proteção de áreas de conservação na Amazônia. Retrieved from: <http://bit.ly/2xkIOea>

Mariani D, Demasi B, Almeida R (2016) Três disputas de território entre os Estados brasileiros. Retrieved from: <http://bit.ly/2zzX3wi>

Meirelles Filho J (2015) Quem sabe do lugar é quem vive nele, in Revista Página 22, nº 98, set/out 2015. São Paulo: Fundação Getúlio Vargas

Milaré É (2014) Direito Ambiental, 12th edn. Revista dos Tribunais, São Paulo

Ministério da Fazenda—Brasil (2017) Despesas Contingenciáveis na LOA 2017. Retrieved from: <http://bit.ly/2zM5cyy>

Ministério de Minas e Energia – Brasil (2017) Governo revoga decreto que extingue a Renca. Retrieved from: <http://bit.ly/2h7dE3O>

Ministério do Meio Ambiente – Brasil (2016) ENREDD+ - Estratégia Nacional para Redução das Emissões Provenientes do Desmatamento e da Degradação Florestal,

- Conservação dos Estoques de Carbono Florestal, Manejo Sustentável de Florestas e Aumento de Estoques de Carbono Florestal. Retrieved from: <http://bit.ly/2yMm607>
- Miranda G (2017) Projeto de lei quer afrouxar licenciamento ambiental no Brasil. Retrieved from: <http://bit.ly/2itPiVj>
- Moutinho P, Guerra R (2017) O vexame de cortar pela metade a ínfima verba para o Meio Ambiente. Retrieved from: <http://bit.ly/2y2grWz>
- Paulino E (2014) The agricultural, environmental and socio-political repercussions of Brazil's land governance system. *Land Use Policy* 36:134–144
- Peduzzi P (2017) Governo anuncia R\$ 190,25 bilhões para Plano Agrícola e Pecuário 2017/2018. Retrieved from: <http://bit.ly/2sg2100>
- Pinheiro Pedro A et al (2015) Organização do Mercado Local de Carbono: Sistema Brasileiro de Controle de Carbono e Instrumentos Financeiros relacionados. Retrieved from: <http://bit.ly/2yK49ix>
- Pinho P et al (2014) Ecosystem protection and poverty alleviation in the tropics: perspective from a historical evolution of policy-making in the Brazilian Amazon. *Ecosyst Serv* 8:97–109
- Rawls J (2008) *Uma teoria da Justiça*, 3ª edn. Martins Editora, São Paulo
- Rousseau J-J (2008) *Discurso Sobre a Origem e os Fundamentos da Desigualdade Entre os Homens*. LP&M Pocket, São Paulo
- Samuelson P (1976) Economics of forestry in an evolving society. *Econ Inq* XIV
- Schreiber M (2017) Reação ao fim da Renca foi 'histeria', 'infantilidade' e 'desinformação', dizem geólogos. Retrieved from: <http://bbc.in/2yJPI0B>
- Seymour F, Busch J (2016) *Why Forests? Why Now? The science, economics, and politics of tropical forests and climate change*. CGD, Washington, DC
- Soares G (2016) Proteção dos conhecimentos tradicionais e repartição de benefícios: uma reflexão sobre o caso da empresa Natura do Brasil e dos erveiros e erveiras do mercado Ver-o-Peso. Retrieved from: <http://bit.ly/2z4OI05>
- Weinstein B (1993) *A borracha na Amazônia: expansão e decadência (1850-1920)*. Editora da Universidade de São Paulo, São Paulo
- Weis B (2006) Polêmica entre Natura e Ver-o-peso expõe dilemas na proteção de conhecimentos tradicionais no Brasil. Retrieved from: <http://bit.ly/2yKb4bE>
- Wolford W (2016) The casa and the causa: institutional histories and cultural politics in Brazilian Land Reform. In: *Latin American research review*, vol 51, No 4. Latin American Studies Association, Austin

## References for Publication 4

- Aguiar, A.P.D., Câmara, G., Escada, M.I.S. (2007). Spatial statistical analysis of land-use determinants in the Brazilian Amazonia: Exploring intra-regional heterogeneity. *Ecological Modelling*, 209, Issues 2-4, pp. 169-188. doi: <https://doi.org/10.1016/j.ecolmodel.2007.06.019>
- Aimer, C & Goeschl, T. (2010). Environmental Crime and Punishment: Empirical Evidence from the German Penal Code. *Land Economics* 86(4), 707-726. University of Wisconsin Press.
- Armenteras, D, Murcia, U, González, TM, Barón, OJ, & Arias, JE. (2019). Scenarios of land use and land cover change for NW Amazonia: Impact on forest intactness. *Global Ecology and Conservation*, 17. doi:10.1016/j.gecco.2019.e00567
- Becker, G. (1968). Crime and Punishment: An Economic Approach, in *Journal of Political Economy*, 76 (2): 169–217.
- Bond, A, Pope, J, Morrison-Saunders, A, & Retief, F. (2016). A game theory perspective on environmental assessment: What games are played and what does this tell us about decision making rationality and legitimacy? *Environmental Impact Assessment Review*, 57, 187–194. doi: <https://doi.org/10.1016/j.eiar.2016.01.002>
- Börner, J., Wunder, S., Wertz-Kanounnikoff, S., Hyman, G., & Nascimento, N. (2014). Forest law enforcement in the Brazilian Amazon: Costs and income effects. *Global Environmental Change*, 29, 294–305. doi: <https://doi.org/10.1016/j.gloenvcha.2014.04.021>
- Campos-Silva, JV, Fonseca Junior, SF, Peres, CAS. (2015). Policy reversals do not bode well for conservation in Brazilian Amazonia. *Natureza & Conservação - Brazilian Journal of Nature Conservation*, 13, issue 2, pp. 193-195. <https://doi.org/10.1016/j.ncon.2015.11.006>.
- Campos-Silva, JV, Hawes, JE, Andrade, PCM & Peres, CA. (2018). Unintended multispecies co-benefits of an Amazonian community-based conservation programme. *Nature Sustainability*, 1(11), 650–656. doi:10.1038/s41893-018-0170-5
- CGU – Controladoria Geral da União. (2019a). Relatório de Avaliação do Processo Sancionador Ambiental - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA. Brasília: CGU. Retrieved from: <https://auditoria.cgu.gov.br/download/12741.pdf>. Accessed July 10th, 2019.
- CGU – Controladoria Geral da União. (2019b). Infográfico da Avaliação do Processo Sancionador Ambiental – IBAMA. Retrieved from: <https://www.cgu.gov.br/noticias/2019/04/cgu-avalia-desempenho-e-gestao-do-processo-sancionador-ambiental-do-ibama/infografico-ibama.pdf>. Accessed July 11<sup>th</sup> 2019.
- Cohen, M. A. (2000). Empirical Research on the Deterrent Effect of Environmental Monitoring and Enforcement. *The Environmental Law Reporter*, 30. Environmental Law Institute: Washington, DC.

- Davidson, EA, Araújo, AC, Artaxo, P, Balch, JK, Brown, IF, Bustamante, MMC, Coe, MT, DeFries, RS, Keller, M, Longo, M, Munge, JW, Schroeder, W, Soares-Filho, BS, Souza, CM & Wofsy, SC. (2012). The Amazon basin in transition. *Nature*, 481 (7381), pp. 321–328. doi:10.1038/nature10717.
- Espírito-Santo, FDB, Gloor, M, Keller, M, Malhi, Y, Saatchi, S, Nelson, B, Oliveira Junior, RC, Pereira, C, Lloyd, J, Frohking, S, Palace, M, Shimabukuro, YE, Duarte, V, Mendoza, AM, López-González, G, Baker, TR, Feldpausch, TR, Brienen, RJW, Asner, GP, Boyd, DS & Phillips, OL. (2015). Size and frequency of natural forest disturbances and the Amazon forest carbon balance. *Nature Communications*, 5(1). doi:10.1038/ncomms4434
- Faysse, N. (2005). Coping with the tragedy of the commons: Game structure and design of rules. *Journal of Economic Surveys*, 19(2), 239-261.
- Fonseca, A, Justino, M, Cardoso, D, Ribeiro, J, Salomão, R, Souza Jr, C, & Veríssimo, A. (2019a). *Boletim do desmatamento da Amazônia Legal (fevereiro de 2019) SAD* (p. 1). Belém, Brazil.
- Fonseca, A, Justino, M, Cardoso, D, Ribeiro, J, Salomão, R, Souza Jr, C, & Veríssimo, A. (2019b). *Boletim do desmatamento da Amazônia Legal (março 2019) SAD* (p. 1). Belém, Brazil.
- Fonseca, A, Justino, M, Cardoso, D, Ribeiro, J, Salomão, R, Souza Jr, C, & Veríssimo, A. (2019c). *Boletim do desmatamento da Amazônia Legal (abril 2019) SAD* (p. 1). Belém: Imazon.
- Gao, Y, Li, Z, Wang, F, Wang, F, Tan, RR, Bi, J, & Jia, X. (2018). A game theory approach for corporate environmental risk mitigation. *Resources, Conservation and Recycling*, 130, pp. 240–247. doi: <https://doi.org/10.1016/j.resconrec.2017.12.009>
- Garrett, R, Gardner, TA, Fonseca, T, Marchand, S, Barlow, J, Ezzine de Blas, D, Ferreira, J, Lees, AC & Parry, L. (2017). Explaining the persistence of low income and environmentally degrading land uses in the Brazilian Amazon. *Ecology and Society*, 22 (3):27. <https://doi.org/10.5751/ES-09364-220327>.
- Gloor, E. (2019). The fate of Amazonia. *Nature Climate Change*, volume 9, pp. 355–356. doi:10.1038/s41558-019-0465-1
- Grønbaek, L, Lindroos, M, Munro, G & Pintassilgo, P. (2018). Game theory and fisheries. *Fisheries Research*, 203, 1–5. doi: <https://doi.org/10.1016/j.fishres.2017.11.027>
- Halkos, GE & Papageorgiou, GJ. (2018). Pollution, environmental taxes and public debt: A game theory setup. *Economic Analysis and Policy*, 58, 111–120. <https://doi.org/doi:10.1016/j.eap.2018.01.004>
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.
- Heyes, A & Rickman, N. (1999). Regulatory dealing - revisiting the Harrington paradox. *Journal of Public Economics*, 72(3), pp. 361-378. [https://doi.org/10.1016/S0047-2727\(98\)00098-X](https://doi.org/10.1016/S0047-2727(98)00098-X)

Howe, ES & Brandau, CJ. (1988). Additive Effects of Certainty, Severity, and Celerity of Punishment on Judgments of Crime Deterrence Scale Value. *Journal of Applied Social Psychology*, 18(9), 796–812. doi: <https://doi.org/10.1111/j.1559-1816.1988.tb02356.x>

IBGE – Instituto Brasileiro de Geografia e Estatística. (2004). *Mapa de Biomas do Brasil*. Brasília: IBGE. Retrieved from: <https://bit.ly/2L0n0KC>. Accessed July 11<sup>th</sup>, 2019

Imazon. (2019). *Boletim do desmatamento da Amazônia Legal (janeiro 2019) SAD*. Retrieved from: <https://imazon.org.br/publicacoes/boletim-do-desmatamento-da-amazonia-legal-janeiro-2019-sad/>. Accessed June 10<sup>th</sup>, 2019.

Kalamandeen, M, Gloor, E, Mitchard, E, Quincey, D, Ziv, G, Spracklen, D, Spracklen, B, Adami, M, Aragão, LEOC & Galbraith, D. (2018). Pervasive Rise of Small-scale Deforestation in Amazonia. *Scientific Reports*, 8(1). doi: <https://doi.org/10.1038/s41598-018-19358-2>

Klautau de Araújo, JM. (1995). *Caligrafias de Belém – vol. I: a dimensão insular*. Belém: Imprensa Oficial do Estado do Pará.

Klautau de Araújo, TL. (2014). Environmental law, public policies, and climate change: A social-legal analysis in the Brazilian context, in Leal Filho, W. (Eds.), *Handbook of Climate Change Adaptation*, pp. 973–982. Berlin: Springer. doi: [https://doi.org/10.1007/978-3-642-40455-9\\_115-1](https://doi.org/10.1007/978-3-642-40455-9_115-1).

Klautau de Araújo, TL. (2016). Public Policies and Education for Biodiversity: Brazilian Challenges in a New Global Context, in Castro, P., Azeiteiro, U.M., Bacelar Nicolau, P., Leal Filho, W., Azul, A.M. (Eds.) – *Biodiversity and Education for Sustainable Development*. Berlin: Springer, pp. 219-235.

Klautau de Araújo T.L. (2019). Brazilian Amazônia and Climate Change: Barriers and Pathways for Forthcoming Sustainability. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) *Climate Action. Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. doi: <https://doi.org/10.1007/978-3-319-71063-1>.

Klautau de Araújo TL, Soares AMVM & Azeiteiro UM. (2019). Environmental Assets and Carbon Markets: Could It Be Amazônia's New Belle Époque?. In: Castro P, Azul A, Leal Filho W, Azeiteiro U. (eds) *Climate Change-Resilient Agriculture and Agroforestry. Climate Change Management*. Springer, Cham. [https://doi.org/10.1007/978-3-319-75004-0\\_28](https://doi.org/10.1007/978-3-319-75004-0_28).

Lavelle, P, Dolédec, S, Sartre, XA, Decaëns, T, Gond, V, Grimaldi, M, Oszwald, J, Hubert, B, Ramirez, B, Veiga, I, Simão de Souza, S, Assis, WS, Michelotti, F, Martins, M, Feijoo, A, Bommel, P, Castañeda, E, Chacon, P, Desjardins, T, Dubs, F, Gordillo, E, Guevara, E, Fonte, S, Hurtado, MP, Lena, P, Lima, T, Marichal, R, Mitja, D, Miranda, I, Otero, T, Praxedes, C, Pocard, R, Robert, P, Rodriguez, G, Sanabria, C, Tselouiko, S, Velasquez, A, Velasquez, E & Velasquez, J. (2016). Unsustainable landscapes of deforested Amazonia: An analysis of the relationships among landscapes and the social, economic and environmental profiles of farms at different ages following deforestation. *Global Environmental Change* 40, pp. 137-155. doi: <http://dx.doi.org/10.1016/j.gloenvcha.2016.04.009>

Lynch, MJ, Barrett, KL, Stretesky, PB & Long, MA. (2016). The Weak Probability of Punishment for Environmental Offenses and Deterrence of Environmental Offenders: A Discussion Based on USEPA Criminal Cases, 1983–2013. *Deviant Behavior*, 37:10, 1095-1109. doi: <https://doi.org/10.1080/01639625.2016.1161455>

INPE – Instituto Nacional de Pesquisas Espaciais. (2019) *TerraBrasilis Desmatamento*. Retrieved from: <http://terrabrasilis.dpi.inpe.br/app/map/deforestation?hl=pt-br>. Accessed in July 11<sup>th</sup> 2019.

Muchagata M & Brown K. (2003). Cows, colonists and trees: rethinking cattle and environmental degradation in Brazilian Amazonia. *Agricultural Systems* 76, pp. 797–816. [https://doi.org/10.1016/S0308-521X\(02\)00015-X](https://doi.org/10.1016/S0308-521X(02)00015-X)

Nyborg, K & Telle, K. (2006). Firms' Compliance to Environmental Regulation: Is There Really a Paradox?, in *Environmental & Resource Economics*, vol. 35, issue 1, 1-18. <https://doi.org/10.1007/s10640-006-9001-7>

OECD. (2004). Background Paper on Economic Aspects of Environmental Compliance Assurance, in OECD, *Economic Aspects of Environmental Compliance Assurance - Proceedings from the OECD Global Forum on Sustainable Development 2-3 December 2004*. Paris: OECD.

Oraby, T, Bauch, CT & Anand, M. (2018). The Environmental Kuznets Curve Fails in a Globalized Socio-Ecological Metapopulation: A Sustainability Game Theory Approach, in Rao, ASRS and Rao, CR, *Handbook of Statistics*, Volume 39, pp. 315-341. doi: <https://doi.org/10.1016/bs.host.2018.05.003>

Osborne, M. (2004). *An Introduction to Game Theory*. New York: Oxford University Press.

Ostrom, E. (1999). Self-governance and forest resources. *CIFOR Occasional Paper* 20, Bogor, Indonesia.

Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economics Perspectives*, 14, 137-158.

Paulino, E. (2014). The agricultural, environmental and socio-political repercussions of Brazil's land governance system. *Land Use Policy*, 36, 134-144. doi: <https://doi.org/10.1016/j.landusepol.2013.07.009>

Pereira, GNDP & Jorge, MMP. (2004). Governing Approaches Ensuring Environmental Compliance: A Brazilian Perspective, in OECD, *Economic Aspects of Environmental Compliance Assurance - Proceedings from the OECD Global Forum on Sustainable Development 2-3 December 2004*. Paris: OECD.

Rechtschaffen, C. (1998). Deterrence vs. Cooperation and the evolving theory of Environmental Enforcement. *71 S. Cal. L. Rev. 1181*. Golden Gate University School of Law.

Ritter, CD, McCrate, G, Nilsson, RH, Fearnside, PM, Palme, U & Antonelli, A. (2017). *Environmental impact assessment in Brazilian Amazonia: Challenges and prospects to*



assess biodiversity. *Biological Conservation*, 206, 161–168. doi: <https://doi.org/10.1016/j.biocon.2016.12.031>

Schielein, J., & Börner, J. (2018). Recent transformations of land-use and land-cover dynamics across different deforestation frontiers in the Brazilian Amazon. *Land Use Policy*, 76, 81–94. doi: <https://doi.org/10.1016/j.landusepol.2018.04.052>

Schmitt, J. (2015). *Crime sem castigo: a efetividade da fiscalização ambiental para o controle do desmatamento ilegal na Amazônia*. Brasília: UNB. Retrieved from: [http://repositorio.unb.br/bitstream/10482/19914/1/2015\\_JairSchmitt.pdf](http://repositorio.unb.br/bitstream/10482/19914/1/2015_JairSchmitt.pdf)

Silva, JMC, Prasad, S & Diniz-Filho, JAF. (2017). The impact of deforestation, urbanization, public investments, and agriculture on human welfare in the Brazilian Amazonia. *Land Use Policy* 65, pp. 135-142. doi: <http://dx.doi.org/10.1016/j.landusepol.2017.04.003>.

SOSMA – Fundação SOS Mata Atlântica & INPE – Instituto Nacional de Pesquisas Espaciais. (2019). Atlas dos Remanescentes Florestais da Mata Atlântica. São Paulo, Brazil.

Tonry, Michael. (2017). An Honest Politician's Guide to Deterrence: Certainty, Severity, Celerity, and Parsimony, in Nagin, DS, Cullen, F, & Jonson, CL (eds.) *Deterrence, Choice, and Crime: Contemporary Perspectives*. New York: Routledge.

UNDP; IPEA; FJS. (2013). *Atlas do Desenvolvimento Humano no Brasil – Ranking*. Retrieved from: <http://bit.ly/1TPFUDZ>

Wolford, Wendy. (2016). The casa and the causa: institutional histories and cultural politics in Brazilian Land Reform. *Latin American Research Review*, Vol. 51, No. 4. Austin: Latin American Studies Association.

## References for Publication 5

Amaral SS, Costa MAM, Soares Neto TG, Costa MP, Dias FF, Anselmo E, Santos JC, Carvalho Jr JA. (2019). CO<sub>2</sub>, CO, hydrocarbon gases and PM<sub>2.5</sub> emissions on dry season by deforestation fires in the Brazilian Amazonia. *Environmental Pollution*, 249, pp. 311-320. doi: <https://doi.org/10.1016/j.envpol.2019.03.023>

Angelsen A, Jagger P, Babigumira R, Belcher B, Hogarth NJ, Bauch S, Börner J, Smith-Hall C, Wunder S (2014) Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Development*, 64, pp. S12-S28. doi: <https://doi.org/10.1016/j.worlddev.2014.03.006>

Azevedo TR, Angelo C (2018) *Emissões de GEE no Brasil e suas implicações para políticas públicas e a contribuição brasileira para o Acordo de Paris*. São Paulo: Sistema de Estimativas de Emissões de Gases de Efeito Estufa. Retrieved from: <http://seeg.eco.br/wp-content/uploads/2018/08/Relatorios-SEEG-2018-Sintese-FINAL-v1.pdf>



- Bezerra ACV and Bitoun J (2017) Participatory methodology as an instrument for the territorialization of Environmental Surveillance actions. *Ciênc. saúde coletiva*, vol.22 no.10. doi: <http://dx.doi.org/10.1590/1413-812320172210.17722017>
- Bockstael E, Bahia NCF, Seixas CS, Berkes F (2016) Participation in protected area management planning in coastal Brazil. *Environmental Science & Policy*, 60, pp. 1-10. doi: <https://doi.org/10.1016/j.envsci.2016.02.014>
- Bowman MS, Soares-Filho BS, Merry FD, Nepstad DC, Rodrigues H, Almeida OT (2012) Persistence of cattle ranching in the Brazilian Amazon: A spatial analysis of the rationale for beef production. *Land Use Policy*, 29(3), pp. 558-568. doi: <https://doi.org/10.1016/j.landusepol.2011.09.009>
- Brandon K (2014) *Ecosystem Services from Tropical Forests: Review of Current Science*. CGD Working Paper 380. Washington, DC: Center for Global Development. Retrieved from: <http://www.cgdev.org/publication/ecosystem-services-tropical-forests-review-currentscience-working-paper-380>
- Brasil (1988) *Constituição da República Federativa do Brasil de 1988*, promulgada em 05 de outubro de 1988. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/Constituicao/Constituicao.htm](http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm)
- Brasil (2015) Lei nº 13.105, de 16 de março de 2015. *Código de Processo Civil*. Retrieved from: [http://www.planalto.gov.br/ccivil\\_03/\\_ato2015-2018/2015/lei/113105.htm](http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/113105.htm)
- Brito B, Barreto P, Brandão Jr A, Baima S, Gomes PH (2019) Stimulus for land grabbing and deforestation in the Brazilian Amazon. *Environmental Research Letters*, 14. doi: 10.1088/1748-9326/ab1e24
- Campos-Silva, JV, Hawes, JE, Andrade, PCM & Peres, CA. (2018). Unintended multispecies co-benefits of an Amazonian community-based conservation programme. *Nature Sustainability*, 1(11), 650–656. doi:10.1038/s41893-018-0170-5
- Camprodon G, González O, Barberán V, Pérez M, Smári V, Heras MA, Bizzotto A (2019) Smart Citizen Kit and Station: An open environmental monitoring system for citizen participation and scientific experimentation. *HardwareX*, 6. doi: <https://doi.org/10.1016/j.ohx.2019.e00070>
- Carlson A, Palmer C (2016) A qualitative meta-synthesis of the benefits of eco-labeling in developing countries. *Ecological Economics*, 127, pp. 129-145. doi: <https://doi.org/10.1016/j.ecolecon.2016.03.020>
- CGU – Controladoria Geral da União. (2019a). Relatório de Avaliação do Processo Sancionador Ambiental - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA. Brasília: CGU. Retrieved from: <https://auditoria.cgu.gov.br/download/12741.pdf>. Accessed July 10th, 2019.
- CGU – Controladoria Geral da União. (2019a). Relatório de Avaliação do Processo Sancionador Ambiental - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais

Renováveis – IBAMA. Brasília: CGU. Retrieved from: <https://auditoria.cgu.gov.br/download/12741.pdf>. Accessed July 10th, 2019.

CGU – Controladoria Geral da União. (2019b). Infográfico da Avaliação do Processo Sancionador Ambiental – IBAMA. Retrieved from: <https://www.cgu.gov.br/noticias/2019/04/cgu-avalia-desempenho-e-gestao-do-processo-sancionador-ambiental-do-ibama/infografico-ibama.pdf>. Accessed July 11<sup>th</sup> 2019.

CGU – Controladoria Geral da União. (2019b). Infográfico da Avaliação do Processo Sancionador Ambiental – IBAMA. Retrieved from: <https://www.cgu.gov.br/noticias/2019/04/cgu-avalia-desempenho-e-gestao-do-processo-sancionador-ambiental-do-ibama/infografico-ibama.pdf>. Accessed July 11<sup>th</sup> 2019.

Chess C and Purcell K (1999) Public Participation and the Environment: Do We Know What Works? *Environmental Science & Technology*, 33(16), pp. 2685-2692. doi: <https://doi.org/10.1021/es980500g>

Cohen MA (2000) Empirical Research on the Deterrent Effect of Environmental Monitoring and Enforcement. *The Environmental Law Reporter*, 30. Environmental Law Institute: Washington, DC.

Garrett, R, Gardner, TA, Fonseca, T, Marchand, S, Barlow, J, Ezzine de Blas, D, Ferreira, J, Lees, AC & Parry, L. (2017). Explaining the persistence of low income and environmentally degrading land uses in the Brazilian Amazon. *Ecology and Society*, 22 (3):27. <https://doi.org/10.5751/ES-09364-220327>.

Girardi EP, Mello-Théry NA, Théry H, Hato J (2014) Mapeamento do trabalho escravo contemporâneo no Brasil: dinâmicas recentes. *Espaço e Economia – Revista brasileira de geografia econômica*, 4. doi: 10.4000/espacoeconomia.804

Glowinski, SL (2008) Bird-watching, ecotourism, and economic development: A review of the evidence. *Applied Research in Economic Development*, 5(3), 65–77. Available at: [http://ocean.otr.usm.edu/~w301497/teaching/advice\\_teaching/docs/glowinski\\_2008v5n3.pdf](http://ocean.otr.usm.edu/~w301497/teaching/advice_teaching/docs/glowinski_2008v5n3.pdf).

Golden CD, Rasolofoniaina BJR, Benjamin R, Young SL (2012) Pica and Amylophagy Are Common among Malagasy Men, Women and Children. *Plos One*, vol 7, 10. doi: 10.1371/journal.pone.0047129

Guimarães J, Amaral P, Pinto A and Gomes I (2019) *Preços de Produtos da Floresta: uma década de pesquisa e divulgação*. Belém: Imazon.

Guo Z, Xiao X, Li D (2000) An Assessment of Ecosystem Services: Water Flow Regulation and Hydroelectric Power Production. *Ecological Applications*, 10(3), pp. 925-936. doi: [https://doi.org/10.1890/1051-0761\(2000\)010\[0925:AAOESW\]2.0.CO;2](https://doi.org/10.1890/1051-0761(2000)010[0925:AAOESW]2.0.CO;2)

Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.

Holifield R and Williams KC (2019) Recruiting, integrating, and sustaining stakeholder participation in environmental management: A case study from the Great Lakes Areas of

Concern. *Journal of Environmental Management*, 230, pp. 422-433. doi: <https://doi.org/10.1016/j.jenvman.2018.09.081>

Howe ES & Brandau CJ (1988) Additive Effects of Certainty, Severity, and Celerity of Punishment on Judgments of Crime Deterrence Scale Value. *Journal of Applied Social Psychology*, 18(9), 796–812. doi: <https://doi.org/10.1111/j.1559-1816.1988.tb02356.x>

IBGE – Instituto Brasileiro de Geografia e Estatística (2014) Áreas Especiais – Cadastro de Municípios localizados na Amazônia Legal. Retrieved from: <https://bit.ly/2vc3NQT>

IBGE – Instituto Brasileiro de Geografia e Estatística (2017) *Sistema de Contas Regionais: Brasil 2015*. Retrieved from: <https://bit.ly/2UJCKFu>

IBGE – Instituto Brasileiro de Geografia e Estatística (2019) *Cidades*. Retrieved from: <https://cidades.ibge.gov.br/>

INEP – Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (2016) *IDEB – Resultados e Metas*. Retrieved from: <https://bit.ly/1qoxrdS>

INPE – Instituto Nacional de Pesquisas Espaciais (2019a) *Banco Dados de Queimadas*. Retrieved from: <http://queimadas.dgi.inpe.br/queimadas/bdqueimadas>. Accessed in September, 11th, 2019.

INPE – Instituto Nacional de Pesquisas Espaciais (2019b) *Monitoramento dos Focos Ativos por Bioma*. Retrieved from: [http://queimadas.dgi.inpe.br/queimadas/portal-static/estatisticas\\_estados/](http://queimadas.dgi.inpe.br/queimadas/portal-static/estatisticas_estados/). Accessed in September, 11th, 2019.

Kageyama PY (2009) Biodiversidade e Biopirataria: contradição entre a biodiversidade e a pobreza no mundo, in Aleixo A, Azevedo-Ramos C, Camargo E, Kageyama PY, Maio MC, Nascimento DM & Oliveira NS (Eds.), *Amazônia e Desenvolvimento Sustentável*. Rio de Janeiro: Fundação Konrad Adenauer.

Karp DS, Mendenhall CD, Sandí RF, Chaumont N, Ehrlich PR, Hadly EA, Daily GC (2013) Forest bolsters bird abundance, pest control and coffee yield. *Ecology Letters* 16(11), pp. 1339–1347. doi: <https://doi.org/10.1111/ele.12173>

Klautau de Araújo TL (2014) Environmental law, public policies, and climate change: a social-legal analysis in the Brazilian context. In: Leal Filho W (ed) *Handbook of climate change adaptation*. Springer, Berlin, pp 973–982. doi: [https://doi.org/10.1007/978-3-642-40455-9\\_115-1](https://doi.org/10.1007/978-3-642-40455-9_115-1).

Klautau de Araújo TL (2016) Public policies and education for biodiversity: Brazilian challenges in a new global context. In: Castro P, Azeiteiro UM, Bacelar Nicolau P, Leal Filho W, Azul AM (eds) *Biodiversity and education for sustainable development*. Springer, Berlin, pp 219–235.

Klautau de Araújo TL (2017) Constituição económica e desigualdades regionais: uma análise comparada dos ordenamentos Brasileiro e Português. Retrieved from: <https://bit.ly/2viSWo5>

Klautau de Araújo TL (2019a) Brazilian Amazônia and Climate Change: Barriers and Pathways for Forthcoming Sustainability. In: Leal Filho W, Azul A, Brandli L, Özuyar P, Wall T (eds) *Climate Action. Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. doi: <https://doi.org/10.1007/978-3-319-71063-1>.

Klautau de Araújo TL (2019b) Environmental Assets and Carbon Markets: Opportunities and Challenges for a Greener and Sustainable Economy in Brazil. In: Leal Filho W, Azul A, Brandli L, Özuyar P, Wall T (eds) *Climate Action. Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham. doi: <https://doi.org/10.1007/978-3-319-71063-1>.

Klautau de Araújo TL, Soares AMVM, Azeiteiro UM (2019a) Environmental assets and carbon markets: could it be Amazônia's new belle Époque? In: Castro P, Azul A, Leal FW, Azeiteiro U (eds) *Climate change-resilient agriculture and agroforestry. Climate Change Management*. Springer, Cham. doi: [https://doi.org/10.1007/978-3-319-75004-0\\_28](https://doi.org/10.1007/978-3-319-75004-0_28)

Klautau de Araújo TL, Sousa P, Soares AMVM, Azeiteiro UM (2019b) Brazilian Amazônia, deforestation and environmental degradation: analyzing the process using game, deterrence and rational choice theories. Submitted.

Klautau de Araújo JM. (1995). *Caligrafias de Belém – vol. I: a dimensão insular*. Belém: Imprensa Oficial do Estado do Pará.

Lavelle, P, Dolédec, S, Sartre, XA, Decaëns, T, Gond, V, Grimaldi, M, Oszwald, J, Hubert, B, Ramirez, B, Veiga, I, Simão de Souza, S, Assis, WS, Michelotti, F, Martins, M, Feijoo, A, Bommel, P, Castañeda, E, Chacon, P, Desjardins, T, Dubs, F, Gordillo, E, Guevara, E, Fonte, S, Hurtado, MP, Lena, P, Lima, T, Marichal, R, Mitja, D, Miranda, I, Otero, T, Praxedes, C, Pocard, R, Robert, P, Rodriguez, G, Sanabria, C, Tselouiko, S, Velasquez, A, Velasquez, E & Velasquez, J. (2016). Unsustainable landscapes of deforested Amazonia: An analysis of the relationships among landscapes and the social, economic and environmental profiles of farms at different ages following deforestation. *Global Environmental Change* 40, pp. 137-155. doi: <http://dx.doi.org/10.1016/j.gloenvcha.2016.04.009>

Loureiro VR and Pinto JAN (2005) A questão fundiária na Amazônia. *Estudos Avançados*, 19(54). doi: <http://dx.doi.org/10.1590/S0103-40142005000200005>

Lynch MJ, Barrett KL, Stretesky PB & Long MA (2016) The Weak Probability of Punishment for Environmental Offenses and Deterrence of Environmental Offenders: A Discussion Based on USEPA Criminal Cases, 1983–2013. *Deviant Behavior*, 37:10, 1095-1109. doi: <https://doi.org/10.1080/01639625.2016.1161455>

Maldonado JH, Moreno-Sánchez RP, Espinoza S, Bruner A, Garzón N, Myers J (2018) Peace is much more than doves: The economic benefits of bird-based tourism as a result of the peace treaty in Colombia. *World Development*, 106, pp. 78-86. doi: <https://doi.org/10.1016/j.worlddev.2018.01.015>.

Ministério da Saúde (2012) Índice de Desenvolvimento do Sistema Único de Saúde. Retrieved from: <https://bit.ly/2Ui6DBZ>

Mullan K (2014) *The Value of Forest Ecosystem Services to Developing Economies*. CGD Working Paper. Washington, DC: Center for Global Development. Retrieved from:

<http://www.cgdev.org/publication/value-forest-ecosystem-services-developingeconomies-working-paper-379>

Muradian R, Arsel M, Pellegrini L, Adaman F, Aguilar B, Agarwal B, Corbera E, Ezzine de Blas D, Farley J, Froger G, Garcia-Frapolli E, Gómez-Baggethun E, Gowdy J, Kosoy N, Le Coq JF, Leroy P, May P, Méral P, Mibielli P, Norgaard R, Ozkaynak B, Pascual U, Pengue W, Perez M, Pesche D, Pirard R, Ramos-Martin J, Rival L, Saenz F, Van Hecken G, Vatn A, Vira B, Urama K (2013) Payments for ecosystem services and the fatal attraction of win-win solutions. *Conservation Letters*, 6(4), pp. 274–279. doi: <https://doi.org/10.1111/j.1755-263X.2012.00309.x>

Myers SS, Gaffikin L, Golden CD, Ostfeld RS, Redford KH, Ricketts TH, Turner WR, Osofsky SA (2013) Human health impacts of ecosystem alteration. *Proceedings of the National Academy of Sciences*, 110(47), pp. 18753-18760. doi: <https://doi.org/10.1073/pnas.1218656110>

OECD (2016) Brasil no Pisa 2015: análises e reflexões sobre os estudantes brasileiros. Fundação Santillana, São Paulo

Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economics Perspectives*, 14, 137-158.

Paulino, E. (2014). The agricultural, environmental and socio-political repercussions of Brazil's land governance system. *Land Use Policy*, 36, 134-144. doi: <https://doi.org/10.1016/j.landusepol.2013.07.009>

Rechtschaffen C (1998) Deterrence vs. Cooperation and the evolving theory of Environmental Enforcement. *71 S. Cal. L. Rev. 1181*. Golden Gate University School of Law.

Reyes-García V, Benyei P (2019) Indigenous knowledge for conservation. *Nature Sustainability*, 2, pp. 657-658. doi: <https://doi.org/10.1038/s41893-019-0341-z>.

Rönnbäck P (1999) The ecological basis for economic value of seafood production supported by mangrove ecosystems. *Ecological Economics*, 29, pp. 235-252. doi: [https://doi.org/10.1016/S0921-8009\(99\)00016-6](https://doi.org/10.1016/S0921-8009(99)00016-6).

Sáenz L, Mulligan M, Arjona F, Gutierrez T (2014) The role of cloud forest restoration on energy security. *Ecosystem Services*, 9, pp. 180-190. doi: <https://doi.org/10.1016/j.ecoser.2014.06.012>

Samuelson P (1976) Economics of forestry in an evolving society. *Econ Inq* XIV:466–492.

Schmitt, J. (2015). *Crime sem castigo: a efetividade da fiscalização ambiental para o controle do desmatamento ilegal na Amazônia*. Brasília: UNB. Retrieved from: [http://repositorio.unb.br/bitstream/10482/19914/1/2015\\_JairSchmitt.pdf](http://repositorio.unb.br/bitstream/10482/19914/1/2015_JairSchmitt.pdf)

Seymour F, Busch J (2016) Why forests? Why now? The science, economics, and politics of tropical forests and climate change. CGD, Washington, DC

Silva, JMC, Prasad, S & Diniz-Filho, JAF. (2017). The impact of deforestation, urbanization, public investments, and agriculture on human welfare in the Brazilian Amazonia. *Land Use Policy* 65, pp. 135-142. doi: <http://dx.doi.org/10.1016/j.landusepol.2017.04.003>.

Sinclair AJ and Diduck AP (2017) Reconceptualizing public participation in environmental assessment as EA civics. *Environmental Impact Assessment Review*, 62, pp. 174-182. doi: <https://doi.org/10.1016/j.eiar.2016.03.009>

SNIS – Sistema Nacional de Informações sobre Saneamento (2017) *Série Histórica*. Retrieved from: <https://bit.ly/2UsmdXJ>

TCU – Tribunal de Contas da União (2015) Acórdão 1215/2015 – Plenário. Processo 019.872/2014-3. Relator: Raimundo Carreiro. Retrieved from: <https://bit.ly/2lz3UEI>

TCU – Tribunal de Contas da União (2017) Acórdão 1970/2017 – Plenário. Processo 029.688/2016-7. Relator: Aroldo Cedraz. Retrieved from: <https://bit.ly/2IOaHu3>

Tonry M (2017) An Honest Politician's Guide to Deterrence: Certainty, Severity, Celerity, and Parsimony, in Nagin, DS, Cullen, F, & Jonson, CL (eds.) *Deterrence, Choice, and Crime: Contemporary Perspectives*. New York: Routledge.

Tortato FR, Izzo TJ, Hoogesteijn R & Peres CA (2017) The numbers of the beast: Valuation of jaguar (*Panthera onca*) tourism and cattle depredation in the Brazilian Pantanal. *Global Ecology and Conservation*, vol. 11, pp. 106-114. doi: <https://doi.org/10.1016/j.gecco.2017.05.003>

Tu Z, Hu T, Shen R (2019) Evaluating public participation impact on environmental protection and ecological efficiency in China: Evidence from PITI disclosure. *China Economic Review*, 55, pp. 111-123. doi: <https://doi.org/10.1016/j.chieco.2019.03.010>

Udofia A, Noble B and Poelzer G (2017) Meaningful and efficient? Enduring challenges to Aboriginal participation in environmental assessment. *Environmental Impact Assessment Review*, 65, pp. 164-174. doi: <https://doi.org/10.1016/j.eiar.2016.03.009>

UNDP, IPEA, FJS (2013) *Atlas do Desenvolvimento Humano no Brasil – Ranking*. Retrieved from: <http://bit.ly/1TPFUDZ>

Weinstein B (1993) A borracha na Amazônia: expansão e decadência (1850-1920). Editora da Universidade de São Paulo, São Paulo

Welvaert M and Caley P (2016) Citizen surveillance for environmental monitoring: combining the efforts of citizen science and crowdsourcing in a quantitative data framework. *Springerplus*, 5(1): 1890. doi: 10.1186/s40064-016-3583-5

Wolford W (2016) The casa and the causa: institutional histories and cultural politics in Brazilian Land Reform. In: *Latin American research review*, vol 51, No 4. Latin American Studies Association, Austin

Wunder S (2013) When payments for environmental services will work for conservation. *Conservation Letters*, 6(4), pp. 230–237. doi: 10.1111/conl.12034

Yew WL and Zhu Z (2019) Innovative autocrats? Environmental innovation in public participation in China and Malaysia. *Journal of Environmental Management*, 234, pp. 28-35. doi: <https://doi.org/10.1016/j.jenvman.2018.12.081>

Zhang G, Deng N, Mou H, Zhang ZG, Chen X (2019) The impact of the policy and behavior of public participation on environmental governance performance: Empirical analysis based on provincial panel data in China. *Energy Policy*, 129, pp. 1347-1354. doi: <https://doi.org/10.1016/j.enpol.2019.03.030>.