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Brazil's Economic Potential with Carbon Credits: A Study of the "Mata Do Buraquinho" - Brazil

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ABSTRACT
Introduction: Public (state) concern about the climate has, in turn, catalyzed the creation between global governments and transnational companies, and these models are subject to risk-consequence type measures, the conduct of which is now known as the voluntary carbon credit market. The article in question deals with one of the most talked-about economic instruments for combating global warming in international politics, the carbon credit market.
Objective: The article in question proposes a reflection on this subject, which has been so much talked about in recent years, focusing on its economic perspective and using a case study methodology to support its results.
Theoretical framework: The mitigation of greenhouse gas (GHG) emissions is a necessary condition to lead to a low-carbon economy, and the best way to achieve this is through the application of economic instruments. Such as putting a price on carbon, making this transition quicker and less costly from a social point of view. In this way, with a higher relative price for pollution, private agents will choose between paying for or reducing pollution, comparing the marginal cost of control with the price of carbon.
Methodology: Initially, a bibliographical review was made of the economic theoretical framework that underpins one of the instruments considered most efficient in combating climate change, the carbon credit market. In another part of this work, a practical application of this mechanism was carried out, using an evaluation methodology for an application of this instrument in the municipality of João Pessoa -PB, which stands out for being one of the most wooded cities in Brazil and for having some conservation units in its territory, such as the one used in the work, the Mata do Buraquinho Wildlife Reserve.
Results: The sale of the ecosystem services that the forest offers, in this case its capacity to absorb CO2, could improve the conditions for maintaining the area and perhaps attract more people to visit it. Thus, the value found for "Mata do Buraquinho" was R$61,968.26.

KEYWORDS: Carbon market; ecosystem services; conservation unit.

1. INTRODUCTION

Various terms have emerged in the heat of discussions involving the pricing and valuation of environmental assets. Concepts such as stakeholders and shareholders have been put to the test over the last two decades, given the urgent need to reduce greenhouse gas emissions. The health of the planet began to take off, in terms of debates, in the 1990s, with the Kyoto Protocol, leading governments and organizations to lead what is called multilateralism and build effective pathways in terms of carbon reduction efforts through carbon offsets, called carbon credits. The mechanisms are mandatory and indispensable global and regional compliance schemes that oblige both countries and their companies to limit carbon emissions. In addition to these schemes, there are others of the compulsory type that see regulatory protection as the solution. Public (state) concern about the climate has, in turn, catalyzed the creation between global governments and transnational companies, and these models are subject to risk-consequence type measures that have as their conduct what is now known as the voluntary carbon credit market. As a result, stakeholders and shareholders are able to generate carbon offsets and trade them as a way of contributing to the removal of carbon from the atmosphere, through projects ranging from simple actions to protect nature's scenery to more voluminous sustainable energy projects.
According to [24] everything we do involves, directly or indirectly, the combustion of fuels, which results in carbon dioxide (CO2) emissions into the atmosphere. CO2 accumulates over many decades, changes the climate, and leads to many potentially harmful

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impacts. And this problem is beginning to be debated more forcefully in the economic sciences, because usually those who produce the emissions don't pay for this damage, and those who are harmed aren't compensated. For example, when a hypothetical consumer buys a stalk of lettuce, they pay the production costs, and the farmers and retailers are compensated for their efforts. However, in order to produce the lettuce, it is necessary to burn fossil fuels, to pump the water that irrigates the lettuce field or to fuel the truck that delivers the lettuce. This represents an important cost that is not covered: the damage caused by the CO2 that is emitted in these activities.

In this sense, climate change presents itself as a special problem involving externalities, as it is a global externality caused by people in other parts of the world in fossil fuel use activities that affect others. For [24], global warming is no different from other externalities and requires affirmative government action to reduce the damage caused by human actions. There is no world government that can demand that everyone around the world can participate in the solution. The fact that climate change is external to markets and global in scale is the central obstacle that policymakers must overcome if they are to slow down and avoid the dangers of climate change in the coming years. With this in mind, the world's main leaders have come up with a mechanism that can reduce the effects of these negative externalities, using both state and market instruments: the carbon credit market.

With this in mind, the article in question proposes a reflection on this subject, which has been so much talked about in recent years, focusing on its economic perspective and using a case study methodology to support its results. Initially, a bibliographical review was made of the economic theoretical framework that underpins one of the instruments considered most efficient in the fight against climate change, the carbon credit market. In another part of this work, a practical application of this mechanism was carried out, using an evaluation methodology for an application of this instrument in the municipality of João Pessoa -PB, which stands out for being one of the most wooded cities in Brazil and for having some conservation units in its territory, such as the one used in the work, the Mata do Buraquinho Wildlife Reserve.

2. THEORETICAL FRAMEWORK

From a neoclassical perspective, costs can take the form of externalities, which for environmental issues materialize in ecological damage. For [26] economic theory began to relate the theory of externalities, which had already been developed since 1920 by Pigou, with an economic interpretation of the emerging environmental movement [26]. In this conception, environmental degradation is seen as an externality of the economic system, which prevents the efficient allocation of resources in society. Therefore, the main solution advocated by this approach is the internalization of externalities in the market price system. In other words, the use of control mechanisms by public authorities, such as fines or taxes, aimed at introducing social and environmental costs into the prices of economic goods and services [28].

In this sense, externality is understood as a market failure. In general, an externality is observed when the actions of an individual affect other people, who do not obtain compensation for the damage suffered by those who receive the benefits of the action. Externality as "a situation in which a private economy lacks sufficient incentives to create a potential market in some good, and the absence of such a market results in a loss of efficiency" [7]. The loss of efficiency referred to by Kenneth Arrow concerns situations in which one person, by acting, causes a benefit or cost to another person without their compensation or consent. For the author, this reality of identifying externalities can only happen within market mechanisms that have a decentralized system and thus facilitate the compensation of benefits or costs caused by the actions of individuals [7].

An externality exists whenever the level of well-being of an individual, whether a firm or a family, depends not only on their actions, but also on the actions of another individual. In the example shown by [34] the increase in pollution in the river caused by the steel industry imposed an external cost on the resort, a cost that the steel company has to internalize in the prices of the goods it produces. These external effects, or externalities, are classified as positive or negative. Historically, the terms external cost (external diseconomy) and external benefit (external economy) have been used to refer, respectively, to situations in which the affected parties are harmed or benefited by external actions. However, external benefits are less observable by the market system due to the fact that agents in the market often do not provide them [34].

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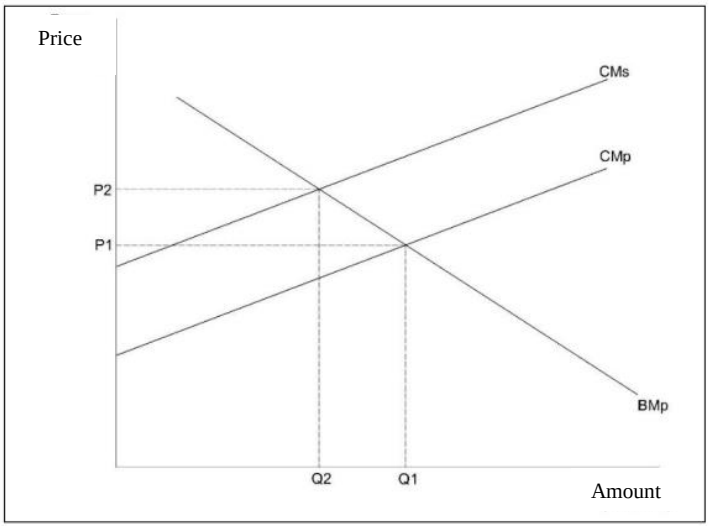

Figure 1- Graphs of marginal costs and marginal benefits for negative externalities.
Source: Authors

The effect of the externality is illustrated in the graph in Figure 1, which shows the marginal benefit function (demand) and the marginal cost function for a hypothetical good. It is assumed that the production of this good inevitably also produces pollution. The demand for this good is shown by the private marginal benefit curve (BMp), and the private marginal cost of its production is represented by the CMp curve. In this case, the marginal cost will not be restricted to the cost of private production, but will include the cost of the pollution generated by production, which will be the social cost, i.e. the social marginal cost will be the private marginal cost plus the cost of controlling the pollution generated by the production of the good. Thus, the social marginal cost function (MCs) will include both costs. For the level of production in which the market has no external control over pollution levels, the quantity of the good to achieve an efficient allocation would be represented by Q1. This choice, in a competitive scenario, would maximize private producers' surplus. However, in this situation where there is an externality in production, production will reach the point of efficient allocation at Q2 [8].

Externalities are defined as impacts on the well-being of those outside a market transaction. The most widely studied example of a negative externality is pollution. Negative externalities are understood as the social and ecological damage caused by pollution, caused by companies' production decisions when operating without regulation, are not internalized in the production process. On the other hand, it can happen that in a market transaction the action of one individual can benefit another who has not paid for the benefit. This is a case of a positive externality. A very important example of a positive externality for environmental preservation is the benefit derived by landowners from planting trees. In addition to the benefits for the landowner themselves, trees can also benefit those who live in the surrounding area and enjoy the scenery, as well as society as a whole through their ability to absorb carbon dioxide and provide habitat for biota [8].

The economics contains a fundamental inconvenient truth about climate change policy: for any policy to be effective in slowing down global warming, it must increase the market price of carbon, which will raise the prices of fossil fuels and consequently of derivative products. Prices can be raised by limiting the number of carbon emission permits that are available (cap-and-trade) or by levying a carbon tax. Following an economic view, [21] considers that it is unrealistic to expect that large reductions in emissions can be achieved through hope, trust, responsible citizenship, environmental ethics, or just guilt. According to this author, the only way to have significant and lasting effects on a sector so large for millions of companies and billions of people and trillions of dollars in spending is to increase the price of carbon emissions [21].

Along the same lines as Nordhaus, [17] considers that in the case of the fight against global warming, mitigating greenhouse gas (GHG) emissions is a necessary condition to lead to a low-carbon economy and, to this end, the best way to achieve this goal is through the application of economic instruments. Such as putting a price on carbon, making this transition faster and less costly from a social point of view. In this way, with a higher relative price for pollution, private agents will choose between paying for or reducing pollution, comparing the marginal cost of control with the price of carbon. Those who control end up having a lower total

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cost of control, making them more competitive [17].

In a document prepared by ICAP (International Carbon Action Partnership), [16] consider that the adoption of these mechanisms will require a change in investment patterns and behaviors, innovation in technologies and infrastructure. From this perspective, for many localities, carbon pricing is encouraging a transformation in the productive matrix of the economy. By trying to reconcile profits with investment and innovation in low-emission technologies, a carbon price can channel private capital flows, mobilize mitigation knowledge within companies and harness the creativity of entrepreneurs in developing low-carbon products and innovations, thus driving progress in reducing emissions. With this, a key concept is the "carbon price", or, more precisely, the price that is attached to carbon dioxide [16].

Both emissions trading (ETS) and the carbon tax aim to internalize the costs that carbon emissions impose on society, putting a price on these emissions that can contribute to changing the behaviour of producers, consumers and investors in order to reduce emissions; stimulate innovation in technology and sustainable practices; generate environmental, health, economic and social benefits with benefits for society as a whole; and provide government revenue that can be used to reduce other taxes or support public spending on climate action or in other areas [16]. The figure below (Figure 2) shows a world map where countries that have implemented, are in the process of implementing or are considering implementing both the ETS and the carbon tax are marked. Through the map, for example, we can see that Brazil is in the study phase for the implementation of both the ETS and the carbon tax.

The main distinction between these two modalities is that with a carbon tax, the government sets the price and allows the market to determine the quantity of emissions, while with emissions trading the government sets the quantity of emissions and allows the market to determine the price. Hybrid systems, which combine elements of both approaches, also exist in different forms, for example an ETS with a minimum and maximum price, or tax regimes that accept emission reduction units to lower tax obligations. In practice, the fact that emissions trading provides confidence about the future level of emissions has served to make it an attractive policy option for many governments. Regardless of which instrument is selected to price carbon, a common set of principles can be applied to guide the project [16].

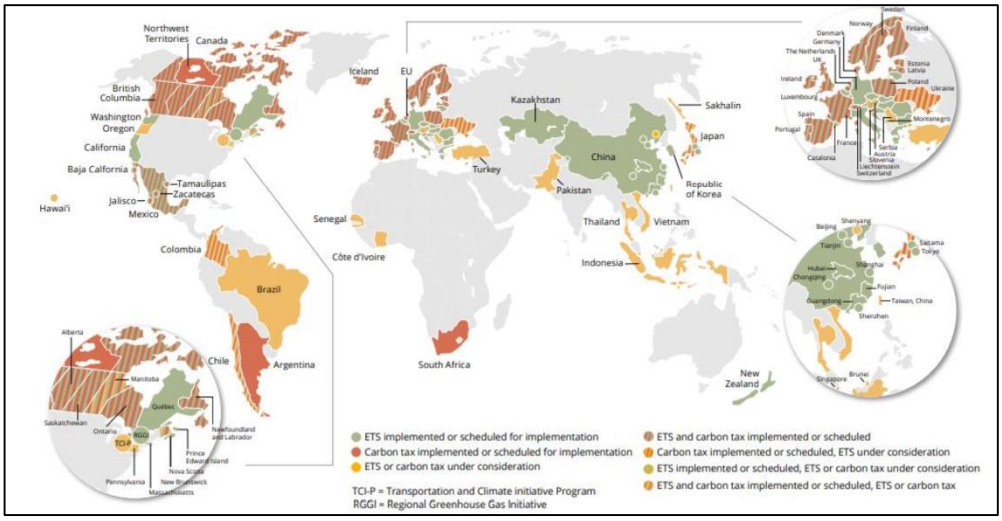

Figure 2- Carbon pricing initiatives around the world.
Source: World Bank, 2022.

3. MATERIALS AND METHODS

3.1. Study area

The area chosen for the empirical study was Mata do Buraquinho, located in the city of João Pessoa -PB. This is a protected area in the Wildlife Refuge category, in accordance with Law No. 9.985/2000, created by Decree 35.195 of July 2014. It covers an area of approximately 519.75 hectares and is considered to be one of the largest Atlantic Forest reserves in an urban perimeter in Brazil. On August 28, 2000, the Botanical Garden, located in Mata do Buraquinho, was created. In addition to cataloging the fauna and flora, it carries out activities aimed at environmental education through activities and interpretive trails throughout the forest.

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Mata do Buraquinho is bordered to the east and south by the BR-230 highway, to the north by Avenida Dom Pedro II, and to the west by the neighborhoods of Cristo Redentor Varjão and Jaguaribe, all within the municipality of João Pessoa/PB.

3.2. Model used

A study carried out by the Totum Institute and the Luiz de Queiroz College of Agriculture (ESALQ) at the University of São Paulo, in partnership with the SOS Mata Atlântica Foundation[1], found that each tree in the Atlantic Forest absorbs 163.14 kg of carbon dioxide equivalent (CO2e) over its first 20 years. The study was based on analyses of samples of native trees planted by the Clickarvore[2] and Florestas do Futuro[3] projects, forest restoration programs run by the SOS Mata Atlântica Foundation. To make the estimate, an average planting of 1,667 plants per hectare was considered. The sample covered trees between 3 and 11 years old, with an expected age of 20 years [2].

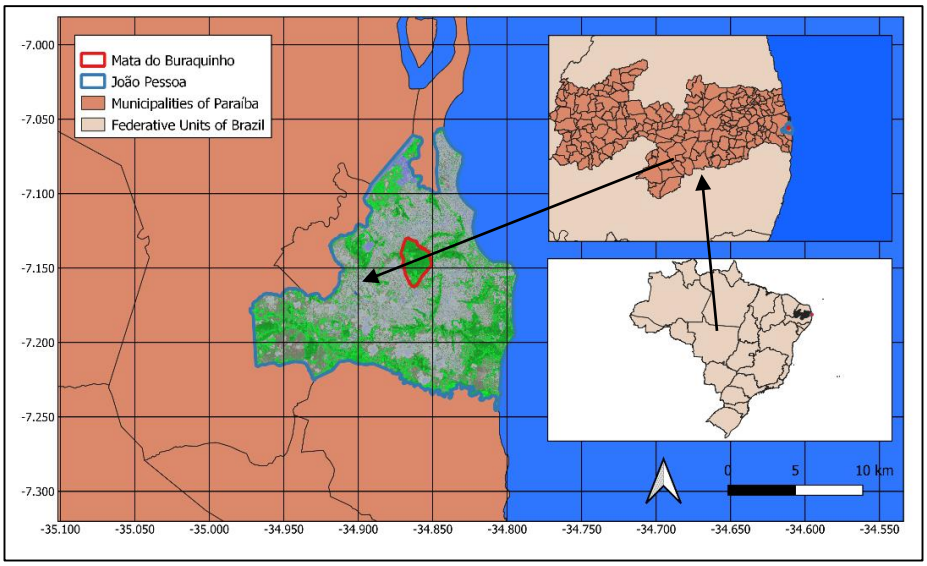

Figure 3- Location Map the Mata do Buraquinho Wildlife Reserve.
Source: Authors

The study also estimated carbon dioxide sequestration since the programs were first implemented. Over 11 years (from 2000 to 2011), the planting of 23,354,266 Clickarvore trees removed around 1.05 million tons of CO2e from the atmosphere, or 7.27 kg of CO2e per tree planted per year. The 3,842,426 trees of Forests of the Future sequestered 194,23 thousand tons of CO2e, which corresponds to an annual removal of 10.11 kg of CO2e per tree, from 2003 to 2011. The differences in CO2e absorption between areas are due to different factors, such as species, climate and soil, which impact on the development of trees at each site assessed [2].

In this case, the research in question opted to use an average of the two results found in the Clickarvore and Florestas do Futuro projects to calculate the estimated value of carbon sequestration for Mata do Buraquinho, finding a value of 8.69 kg of CO2e. This figure indicates that each tree in the Atlantic Forest can sequester 8.69 kg of CO2e. By estimating the total number of trees in the Buraquinho Forest (we used an estimated 1,667 plants per hectare) and knowing that the area is approximately 517.80 hectares, we arrived at a total of 863,172 trees in the forest. By multiplying the total number of trees by the average value of CO2 sequestration per tree unit, we can see that the Buraquinho Forest can generate an approximate value of 7,501 tons of CO2 sequestered in one year.

[1] The SOS Mata Atlântica Foundation is a Brazilian environmental NGO.
[2] Website created by the SOS Mata Atlântica Foundation, the Vidágua Environmental Institute and the Abril Group in 2000 to promote the planting of native trees in deforested areas.

[3] Tokenization is a process that allows transactions of naturally digital assets to be stored and listed on a digital ledger within a blockchain network.

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As Brazil does not yet have a commercial system for carbon credits that is obligatory and defined by state bodies, it was decided to use experiences in the voluntary market for these assets, and one of the initiatives that has been gaining ground around the world is the use of tokenized assets in the commercialization of carbon credits. Here in Brazil, the Moss Carbon Credit experience stands out. Launched in March 2020, Moss Carbon Credit is a climate tech company that uses blockchain technology to create environmental preservation solutions. Its token, the MCO2, is backed by carbon credit that is used to offset CO2 footprints. Using the tokenization strategy, the asset is directed towards projects to preserve the planet, based on offsetting the use of carbon, which every person emits during the day. The purchase of 1 token on the MOSS platform is equivalent to offsetting 1 ton of CO2 emissions. To this end, we used the price data for the MCO2 token, which is available on the coinmarketcap platform for the year 2022 (Figure 4). An average price was calculated for that year, which was US$1.58, equivalent to offsetting 1 ton of CO2 emissions. In this case, converting the values into Brazilian currency, at the 2022 rate for the US dollar, we have a value of R$ 5.23. This gives a price for the MCO2 asset offered on the cryptoasset market of R$8.26 for 1 tCO2e. It can be concluded that total value of 7,501 tons of carbon sequestered for a total area of 517.80 hectares and considering the value of a ton of CO2e for the year 2022 of R$ 8.26, the total value of carbon credits generated by “Mata do Buraquinho” in the year 2022 is R$ 61,958.26.

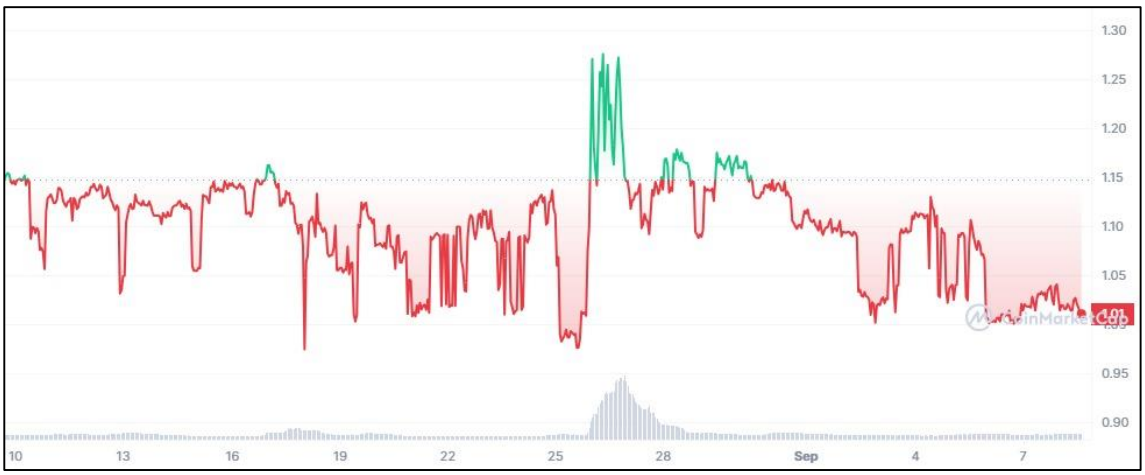

Figure 4- MCO2 price time series.
Source: Coinmarketcap, 2023.

4. DISCUSSION

The carbon credit market is an interesting alternative for reconciling economic development and environmental preservation. The possibility of a preserved forest generating economic value for society is seen as something positive by many people. In the case of the study in question, an Atlantic forest reserve within an urban environment that serves local society in various ways has often high maintenance costs, which can even prevent it from being managed more effectively. In this sense, selling the ecosystem services that the forest offers, in this case its ability to absorb CO2, could improve the conditions for maintaining the area and perhaps attract more people to visit it.

The value found for Mata do Buraquinho of R$61,968.26 still doesn't really reflect all the benefits that this piece of Atlantic forest within a medium to large city offers. The lack of commitment on the part of institutions in Brazil means that the price of CO2e has not yet reached an adequate level for changes in behavior to be felt. But it is a first step towards a change in perspective. On the other hand, the economic valuation of environmental goods can encourage the population to become more environmentally aware, given that when something gains value it becomes better managed and preserved.

5. CONCLUSION

In the light of all the above, we can see an intellectual effort to try to incorporate issues related to environmental problems, such as global warming, into economic themes. Economic models are thus incorporating environmental variables more frequently, and this is due to political and institutional pressures. The carbon credit market appears in this context as an instrument that aims to reconcile the pursuit of economic growth and environmental protection.

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The creation of these mechanisms based on a specific market introduced and established what has come to be known as the international carbon market. The EIT, an international trading program, emerged from the Kyoto Protocol, and allowed industrialized countries with excess, unused carbon allowances to raise funds in the form of allowances from other industrialized countries that had exceeded their limits.

There is still a lot to debate on this issue, and therefore the answers are far from conclusive. Questions of international politics generally have a particular complexity, which is not developed by looking only at the executive nature of laws, but at the way in which international legislation is made. The dynamics of international relations are totally unpredictable and depend on variables that can be controlled little or not at all, such as the customs and traditions of peoples. In this sense, trade is perhaps a common factor for all cultures, which is why this mechanism can have some effectiveness for what it sets out to do.

In order to operationalize the market-based frameworks set up by the Kyoto Protocol, to stimulate the development of the international carbon market, an Emissions Reduction model is needed, using matrices that take into account, such as the ecological footprint, a blockage of the input-output matrix, involving a risk matrix, where emissions are perceived as an impact factor and the consequences of buying carbon, at more stimulating market prices.

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