CASE STUDY

Setbacks, Advances and Continuity of the Sino-Brazilian Satellite Program of Terrestrial Studies (CBERS): an analysis of public policies (1999-2019)

Retrocesos, avances y continuidad del Programa Satélite Sino-Brasileño de Recursos Terrestres (CBERS): un análisis de las políticas públicas (1999-2019)

Recuos, Avanços e Continuidade do Programa de Satélite Sino-Brasileiro de Recursos Terrestres (CBERS): uma análise de políticas públicas (1999-2019)

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ABSTRACT

The article focusing on Brazil seeks, through the evaluation of the current state of the Sino-Brazilian Satellite Program of Terrestrial Resources (CBERS), to identify the main actors concerned, to verify if the objective of the program is being achieved and if there are obstacles to this. Finally, it presents possible paths to public policies aimed at the space sector in Brazil. The 1999 – 2019 time design is based on the first and last satellite launch of the CBERS Program. From the analysis of the data collected it was verified that the program, despite achieving great prestige with the international scientific community, still has a series of obstacles that, even with so many years of existence, have not yet been resolved. Among the main issues diagnosed we highlight the ineffective management of time interval between launches, with recurrent delays, the difficulty of maintaining regularity in the transfer of the budget for the program, in terms of value and periodicity.

Keywords: CBERS. Brazil. China. Public Policies.

RESUMEN

El artículo centrado en Brasil busca, a través de la evaluación del actual estado del Programa de Satélite Sino-Brasileño de Recursos Terrestres (CBERS), identificar los principales actores interesados, verificar si se está logrando el objetivo del programa y si existen obstáculos para ello. Finalmente, presenta posibles caminos para las políticas públicas dirigidas al sector espacial en Brasil. El período 1999-2019 se basa en el primer y último lanzamiento de satélite del Programa CBERS. Del análisis de los datos recogidos se constató que el programa, a pesar de alcanzar un gran prestigio ante la comunidad científica internacional, aún tiene una serie de obstáculos que, aun con tantos años de existencia, aún no han sido resueltos. Entre los principales problemas diagnosticados, destacamos la gestión ineficaz del intervalo de tiempo entre lanzamientos, con retrasos recurrentes, la dificultad de mantener la regularidad en la transferencia del presupuesto asignado al programa, en términos de valor y periodicidad.

Palabras clave: *Brasil. China. Políticas Públicas.*

RESUMO

O artigo com enfoque no Brasil busca, por meio da avaliação do atual estado do Programa de Satélite Sino-Brasileiro de Recursos Terrestres (CBERS), identificar os principais atores interessados, verificar se o objetivo do programa está sendo alcançado e se há obstáculos para isso. Por fim, apresenta possíveis caminhos para as políticas públicas voltadas ao setor espacial no Brasil. O delineamento temporal de 1999-2019 baseia-se no primeiro e último lançamento de satélite do Programa CBERS. A partir da análise dos dados levantados foi verificado que o programa apesar

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Received: 04/24/20 Accepted: 06/19/20

The acronyms and abbreviations contained in this article correspond to the ones used in the original article in Portuguese.

de alcançar grande prestígio junto à comunidade científica internacional, ainda possui uma série de óbices que, mesmo com tantos anos de existência, ainda não foram resolvidos. Entre as principais questões diagnosticadas ressaltamos a gestão ineficaz de intervalo de tempo entre os lançamentos, com recorrentes atrasos, a dificuldade de manter regularidade no repasse do orçamento destinado ao programa, em termos de valor e periodicidade.

Palabras clave: *CBERS. Brasil. China. Políticas públicas.*

1 INTRODUCTION

The cooperation between Brazil and China in the space sector has in the China-Brazil Earth Resources Satellite Program (CBERS - Sino-Brazilian Satellite of Terrestrial Resources) its greatest exponent. Initiated in 1988, cooperation between the National Institute of Space Research (INPE) and the Chinese Academy of Space Technology (CAST) is part of a series of bilateral agreements that the Chinese government maintains with other countries in that same sector.

One of the main differentials of this cooperation was the ability of these two countries to manufacture and launch a satellite together, demonstrating the possibility of success in cooperation between developing countries in advanced areas of knowledge. On this aspect Monserrat Filho (1997, p. 154) points out that this was the first time that two developing countries signed a cooperation agreement in a high-tech sector.

Brazil and China through the CBERS Program strengthen their strategic partnership and, at the same time, through the free supply of images from CBERS satellites, bring impacts to other developing countries, as is the case for some African countries since 2007 (INPE, 2007). The focus of this article is on issues related to Brazil and the methodological perspective adopted is the analysis of public policies. The aim is to present the Brazilian action through an analysis of public policies.

The CBERS Program is part of the Brazilian Space Policy and its permanence for so many years has made this Program reach a priority degree within the reduced budget for Brazilian space activities. Through the evaluation of the present state in which this program is located, this work aims to identify the main actors concerned, verify if the objective of the program is being achieved and if there are obstacles to this. Finally, it presents possible paths for public policies aimed at the space sector in Brazil. The 1999-2019-time design is based on the first and last CBERS satellite launch.

This analysis seeks to provide a general evaluation of this program, focusing on its implementation phase.

Based on the analysis of the data collected, we conclude that CBERS, despite achieving great prestige with the international scientific community, needs to gain greater security in the transfer of resources and better management of the time space between launches. Another finding of this work is that the CBERS Program has consolidated itself, but in a way that is out of step with the development of the Brazilian and Chinese space sector. China and Brazil have trodden several paths in the development of their national policies for the space sector.

The article is structured in two parts: methodology and diagnosis, this has a subitem, CBERS Program, which is divided into two parts, in which one addresses the Stakeholders Model and the other, the Objective Achievement Model. Finally, we present the final considerations with the results found in our evaluation of the CBERS Program.

2 METHODOLOGY

The evaluation of public policies has different approaches. In this work we rely on the definition of Vedung (1997), in which he advocates retrospectively (ex post) a careful evaluation of merit, efficiency and value of administration, impacts and results of government interventions, with the aim of exercising a practical function in the future (VEDUNG, 1997, p. 3). In the delimitation of what we understand by evaluation, we seek to present the evaluation model that we will use.

The use of models to understand social dynamics is a way to delineate the limits of an analysis, operating as a simplification so that some aspect of the world can be better understood (KING; KEOHANE; VERBA, 1994, p. 49).

Given the complexity that surrounds reality, the models are structured by methodological and theoretical choices that seek to give visibility to certain details of reality to the detriment of others. In this sense, the models of evaluation of public policies, as Vedung well noted, seek combinations, creating a tendency of pluralism. Such models do not provide final answers about a policy, but fragments, since the models provide partial perspectives. Thus, Vedung strongly encourages the combination of models when feasible. Seeking to meet this recommendation, this study used two evaluation models: goal-achievement and stakeholder (VEDUNG, 1997, p. 36, 37-49, 69-75; HANSEN; VEDUNG, 2010; VEDUNG, 2017, p. 46; 59-61; 86-90).

3 DIAGNOSIS

3.1 CBERS Program

The CBERS Program was created on July 6, 1988 through a partnership agreement in the technical-scientific space sector that involved the Brazilian government, represented by INPE, and the Chinese government, represented by CAST. The purpose of the agreement was the development of two advanced remote sensing satellites of international level that carry on board imaging cameras, as well as a repeater for the Brazilian Environmental Data Collection System (INPE, 2018).

The costs of the technology used to develop remote sensing satellites are very high, in this sense the program proves to be very important as it represents an attempt to reverse the dependence of the images provided by equipment from a select number of countries (INPE, 2018). Thus, a system of responsibilities was created divided between CAST, responsible for 70%, and INPE, responsible for 30% of the total costs.

And among the main items of the agreement stand out: joint development, based on equivalence and mutual benefits; the use by both parties, when the satellite is flying over each territory, and the use of the satellite by a third country or the sending of images can only occur with the approval of China and Brazil; the project committee, composed of both parties as the highest authority and with the responsibility to organize and implement the project; the final fulfillment of the project when the CBERS is tested, qualified in orbit and available for use; not permission to stop in the implementation, if some of the parties abandon the project, in which the other party will have to be indemnified for all losses; amendment to the project by approval of the Committee; and the technical note attached to the agreement and with the same legal effects after the signature of both (FURTADO et al. 2000, p. 252).

The CBERS-1 and 2, launched in 1999 and 2003, respectively, are identical in their technical constitution, mission in space and in their payloads. The equipment was scaled to meet the needs of the countries and to allow entry into the restricted market of satellite images, dominated by developed nations (INPE, 2018).

In 2002, an agreement was signed for the continuation of the program with the construction of CBERS-3 and 4. Since then, a new division of resource investments has been established – 50% for each country. As the launch of CBERS-3 was only possible after CBERS-2 stopped to work, resulting in losses to both parties of the contract and to the numerous satellite users in 2004, it was decided to build the CBERS-2B and launch it in 2007 (INPE, 2018).

The CBERS-3 and 4 satellites represent an evolution in relation to the previous satellites, because in them four cameras (Panchromatic and Multispectral Camera – PAN, Regular Multispectral Camera - MUX, Multispectral and Thermal Imager - IRS, and Wide Field Camera - WIFI) were used with enhanced geometric and radiometric performances (INPE, 2018). The move to four cameras meant an advance, as it increased the quality of the images generated by CBERS satellites.

CBERS 3 was launched in 2013, but due to a failure that occurred with the Long March 4B launcher vehicle, the satellite was not placed in the intended orbit, which resulted in its re-entry into the Earth's atmosphere. Following this failure, the launch of CBERS-4 – originally scheduled for December 2015 – was brought forward to December 2014 (INPE, 2018).

The main characteristics of CBERS-1 and 2, CBERS 2B and CBERS-3 and 4 can be observed in this table.

Table 1 - Features of CBERS 1, 2, 2B, 3 and 4.

Características	CBERS-1 e 2	CBERS 2B	CBERS-3 e 4
Massa total	1450 kg	1450 kg	2000 kg (máx.)
Potência gerada	1100 W	1100 W	1500 W (mín.)
Dimensões do corpo	1,8 X 2 X 2,2 m	1,8 X 2 X 2,2 m	1,8 X 2 X 2,5 m
Dimensões do painel	6,3 X 2,6 m	6,3 X 2,6 m	6,3 X 2,6 m
Altitude da órbita heliossíncrona	778 km	778 km	778 km
Propulsão	hidrazina	hidrazina	hidrazina
Tempo de vida (confiabilidade de 0,6)	2 anos	2 anos	3 anos
Estabilização	3 eixos	3 eixos	3 eixos
TT&C bandas	UHF, VHF e S	UHF, VHF e S	S

Source: INPE, 2018.

In order to avoid or minimize the interruption in the provision of images to users of CBERS images, since the projected service life for CBERS-4 is 3 years, Brazil and China signed, in 2015, a protocol for the development and launch of a new satellite, the CBERS-4A (INPE, 2018).

The CBERS-4A was designed based on the availability of equipment and models of reserve flight, manufactured for the CBERS-3 and 4, which, through the successful integration and launch of the CBERS-4, did not need to be used. However, for the development of the CBERS-4A it was still necessary to manufacture certain equipment and subsystems (INPE, 2018).

According to Antônio Carlos Pereira, coordinator of CBERS, although CBERS-4A uses remaining parts of CBERS 3 and CBERS 4, from the systemic point of view it is an entirely new and much more complex satellite (BRASIL COM CIÊNCIA, 2018a). In addition, while the other satellites had a projected service life of three years, the latter has a projected service life of five years (BRASIL COM CIÊNCIA, 2018a).

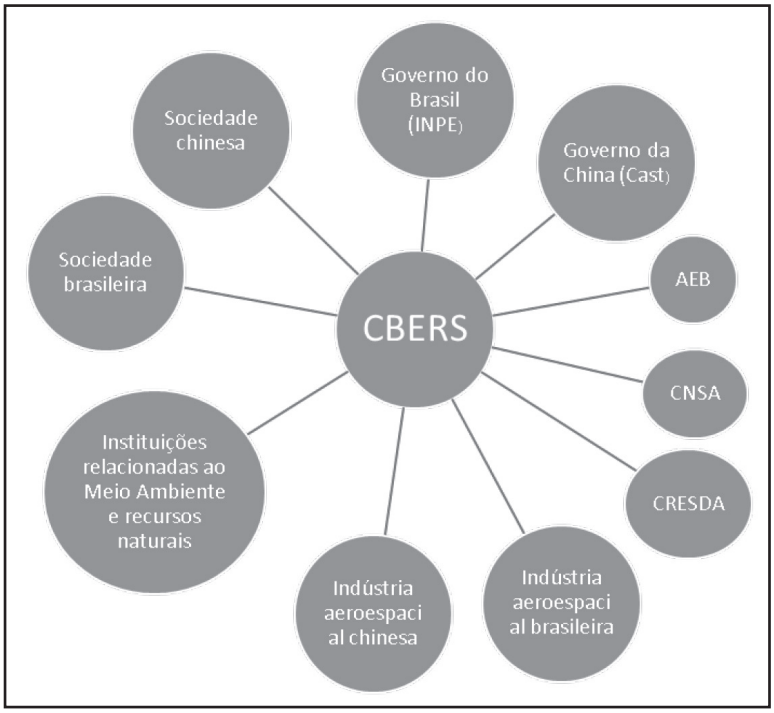
The launch of CBERS-4A, the sixth of the CBERS family, was initially scheduled to take place by the end of 20181. However, Brazil and China decided to readjust the CBERS-4A chronogram. To suit circumstances of the project, the launch was rescheduled for the first half of 20192. After all satellite testing was completed, the CBERS-4A satellite was launched on 20 December, 2019 (INPE, 2019). It is worth noting that, although the projected service life for the CBERS-4 was 3 years, in December 2019 it was still in operation (AEB, 2020).

3.1.1Stakeholders' model applied to CBERS Program

The model of Stakeholders (or evaluation of interested actors) model helps to verify which actors are interested in the public policy being implemented.

The responsibility for the development of the CBERS Program is shared between INPE and CAST. The Brazilian Space Agency (AEB), responsible for "the implementation, coordination and supervision of projects and activities related to satellites and their applications", contributes to the training of the Brazilian industry and the promotion of the autonomy of the space sector (AEB, 2012). The China National Space Administration (CNSA) is China's state space agency. It is responsible for the Chinese space program, so the planning and development of the space activities is its responsibility. The China Center for Resource Satellite Data and Applications

Figure 1 - Stakeholders model applied to the CBERS Program.



Source: The authors.

[1] It is worth noting that "only in November 2016, the presidential sanction was obtained to the Complementary Protocol for the joint development of this satellite" (AGÊNCIA ESPACIAL BRASILEIRA, 2017, p. 3).

[2] During the 13th meeting of the Joint Committee of the CBERS Program, which took place in 2017, "Brazil and China, in view of the current circumstances of the project, decided to reschedule the launch of the satellite for the first half of 2019" (AGÊNCIA ESPACIAL BRASILEIRA, 2018, p. 34).

(CRESDA) works in the solo imaging segment and China Satellite Launch and Tracking General (CLTC), in the solo control segment. The Brazilian and Chinese aerospace industry are also inserted in this layer. They are responsible for the manufacture of the components that are part of CBERS satellites, and a sector that generates a series of direct and indirect economic impacts for society[3].

Currently, in Brazil almost all institutions related to the environment and natural resources (EMBRAPA, ANP, IBGE, ANA, CENSIPAM, CCISE – MD, ANATEL, etc.) are users of satellite images of the CBERS family (BRAZILIAN SPACE AGENCY, 2019. p. 46). The images are used in the control of deforestation and burning in the Legal Amazon, in the monitoring of water resources, agricultural areas, urban growth, land occupation, education and in numerous other applications (INPE, 2018; BRAZILIAN SPACE AGENCY, 2019. p. 46).

It is essential for large national strategic projects, such as the Satellite Legal Amazon Deforestation Monitoring Project (PRODES), the Real-Time Legal Amazon Deforestation Detection System (DETER), and the Satellite Imaging Sugarcane Monitoring System (CANASAT) (INPE, 2018). Brazilian and Chinese society win as a whole, because the country no longer depends on the images provided by equipment from a small number of countries.

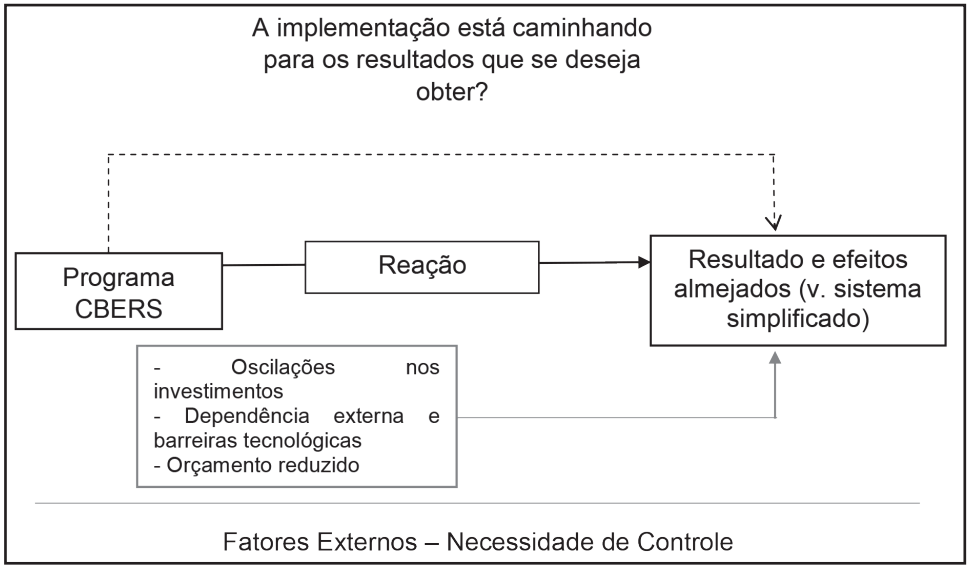
3.1.2 Goal Achievement Model

The objectives achievement model seeks to measure the achievement of the objective and perform the impact assessment of the intervention (VEDUNG, 2013, p. 388). To do this, the objectives are identified to determine the extent to which they are being accomplished, and subsequently, the degree to which the intervention contributed or impaired it to the achievement of the program's goals is verified (VEDUNG, 2013, p. 388).

The objectives of the CBERS Program, according to the 1988 agreement, are to "use advanced remote sensing techniques to inventory, develop, manage and monitor Chinese and Brazilians in agriculture, forestry, geology, hydrology, geography, cartography, meteorology and the environment" and also "promote the development and application of remote sensing technology in China and Brazil" (MONSERRAT FILHO, 1997, p. 160). Through a literature review it was possible to observe the obstacles present in the implementation of the CBERS program. Classified in the model referred to as external factors to be controlled, we highlight, as shown in Figure 2, in: 1) fluctuations in the application of investments foreseen in the CBERS; 2) external dependence and technological barriers, and 3) reduced budget.

With regard to fluctuations in the application of investments foreseen in CBERS, since the beginning of the program, Brazil has had difficulties in delivering its share on time, which caused delays in the processes.

Figure 2 - CBERS Program Objectives Achievement Model.



Fonte: Author's creation with Vedung's adaptation, Vedung, 1997, and Oliveira, G., 2016, p. 179.

[3] On the economic impacts of the CBERS Program, see COSTA FILHO, 2006.

Roberto Abdenur, Brazil's ambassador to China between 1989 and 1993, recalls that soon after the agreement came into force, the change of government took place, period in which the program's investments froze (SILVA, 2014, p.77). In this sense Abdenur stated that:

> On two or three occasions the Chinese were annoyed by the delays and threatened to do everything on their own and take Brazil out of the program (...) so I had to hold the agreement almost by a thread, as they say, arguing that they should have patience with Brazil, because the project would be the fundamental pillar of an important strategic partnership between the two countries (SILVA, 2014, p. 77).

Abdenur's commitment to maintaining the rapprochement between the two countries has undergone a series of tests, mainly due to the difficulty of the Brazilian part ensuring the transfers of resources to the project. In this sense, the budget variation in the Brazilian Space Policy directly compromised the transfers to the CBERS Program. The Fernando Collor government (1990-1992) was critical to the space program, which lost relevance as a strategic program. During this period there were delays in programs such as CBERS and VLS-1 (ROLLEMBERG, 2010, p. 40).

The difficulties of maintenance and regularity of the budget for space scientific and technological development projects are a constant within the Brazilian Space Program. On this aspect, Carvalho (2011) makes the following statement:

> Periods of resource shortage swell into successive schedule delays with consequent infrastructure obsolescence, technological delay dissolving international partnerships and dispersion or loss of personnel. Among the main victims of this situation is the national industrial sector, formed by small and medium-sized enterprises unable to withstand delays in contractual payments or the lack of contracts for a long time (CARVALHO, 2011, p. 24).

Regarding external dependence and technological barriers, this obstacle occurs due to the fact that the most sophisticated electronic components in the program are mostly imported. According to the then president of AEB, José Raimundo Braga Coelho, Brazil still does not manufacture certain electronic components with space qualification, so it needs to import, and there are certain unique satellite technologies that are not worth developing in the country, since they are very expensive and the demand is very low (SILVA, 2014, p. 76). In addition to this issue, there are other obstacles and limitations, in which the resistance of the U.S. State Department to release the sale of components is worth mentioning, since all of them are submitted to the International Traffic in Arms Regulations (ITAR), which considers any orbital platform as armament (SILVA, 2014, p. 76).

Technological constraints are an important barrier in the development of space programs in developing countries. The cooperation between Brazil and China did not attract the attention of the United States in its early years, mainly because the first satellites lacked sophistication (ROLLEMBERG, 2010, p. 55). However,

> with the announcement, in November 2002, of the agreement to produce the CBERS-3 and 4, with divided costs and objective of improving the payload for imaging with resolution of 5 m, the project began to suffer restrictions, with the prohibition of sale of components, which generated delay in the development of CBERS-3. Sixteen years after the creation of the AEB, the rise of civil coordination on the program and the signing of treaties restricting the acquisition of sensitive technologies did not prevent the trade embargo. (ROLLEMBERG, 2010, p. 55).

In addition, according to the 2009 report,

> The delay, in part, is caused by the difficulty in acquiring space-qualified components, due to the control of commercialization of sensitive technologies by the U.S. The difficulty of access to components has entailed changes in the projects of these subsystems, increased costs and postponed the launch. (INPE, 2009, p. 12).

The barriers in the acquisition of components of dual-use equipment is a constant in the process of developing strategic sectors. The so-called technological cutting back "has been used by developed countries to maintain strategic advantages, not only military, but also commercial, achieved thanks to the valuable knowledge they hold through their companies" (LONGO; MOREIRA, 2009, p. 75).

The difficulty of acquiring components slows development, because "to get around the problem, the country tries to nationalize some systems, with still modest success" (ROLLEMBERG, 2010, p. 55). Still on this aspect, Longo and Moreira point out

[4] For Pedone (2009, p. 2), the purpose of ITAR, a unilateral instrument for technological cutting back in the USA, is to control the export of sensitive goods included in the US Munitions List, such as avionics, sensor technology, laser, satellites, computer chips, optical material, among others. Its ultimate goal is to safeguard national security and achieve the objectives of U.S. foreign policy (PEDONE, 2009, p. 2). The interpretation and implementation of ITAR takes place through the State Department.

that countries such as Russia, China and India have developed strategic sectors connected to security and defense. Such countries dominate nuclear technology for defense and long-range missile purposes. In this sense, it is interesting to note that "now they are aligned with those cut back, now they are the ones cutting back, being treated differently, depending on conjuncture factors" (LONGO; MOREIRA, p. 80). The dynamics of technological cutting back contributes to explain the way Brazil faces barriers in the acquisition of components. China, while possessing technology considered sensitive, is unwilling to transfer technology. Thus,

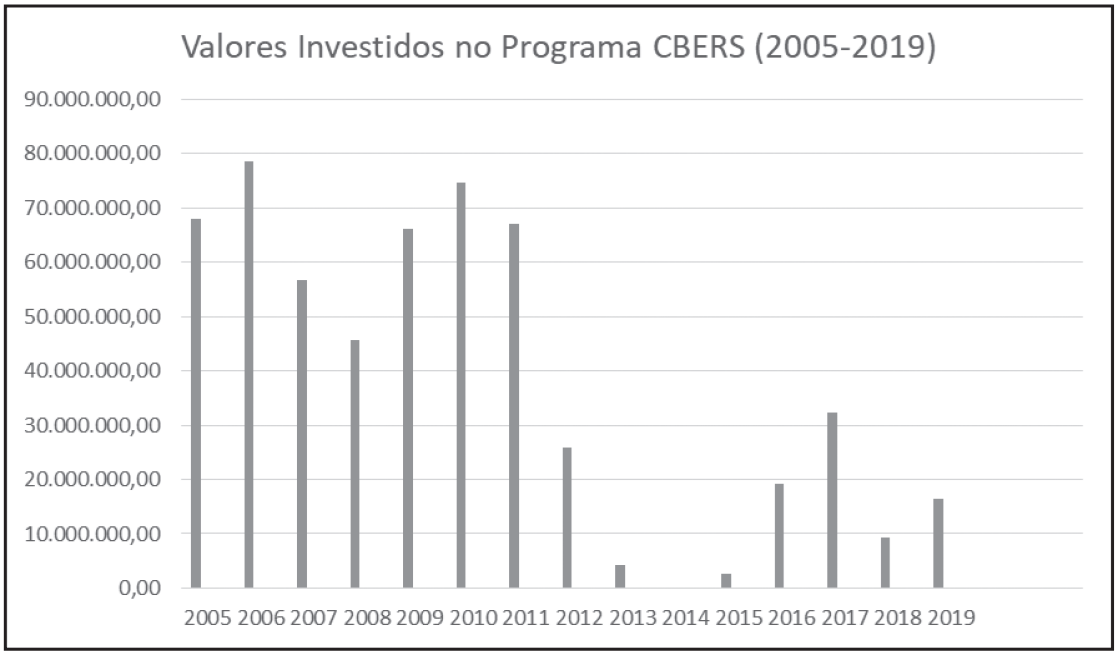
> The international cooperation in the space area is particularly differentiated from the others, because at the same time that most projects are developed under international cooperation, due to the high costs and scarcity of technology, there is no interest on the part of the countries that have this technology in passing it on to other nations. Therefore, the agreements signed between countries in the space area do not mean a guarantee of the transfer of this technology. (BRITO, 2011, p.35; apud COSTA FILHO, 2006).

Finally, to demonstrate the reduced budget, we use Graph 1 that brings the investment data in the CBERS Program over the period 2005 - 2019. Through it, in addition to being able to verify that there has been a decrease in the program budget, it is possible to realize that there is a considerable fluctuation in resources between 2005 – 2011, and 2012 to 2019. About this, it is important to point out that, between the years 2005 and 2013, it appears in the management reports of INPE that the budget destined to the CBERS covered the concomitant investment in equipment for CBERS 3 and 4.

Subsequently, the reports only account for the CBERS-4A. It is also noteworthy that, since the 2015 report, the lack of resources due to contingencies becomes more present. In this sense, it is interesting to note that the documentation points out that the main reasons for the successive delays until 2014 are mainly related to the difficulty of the national industry to meet the specifications of the components of CBERS satellites and the difficulty in obtaining parts without import restrictions by the USA (INPE, 2009, p. 12).

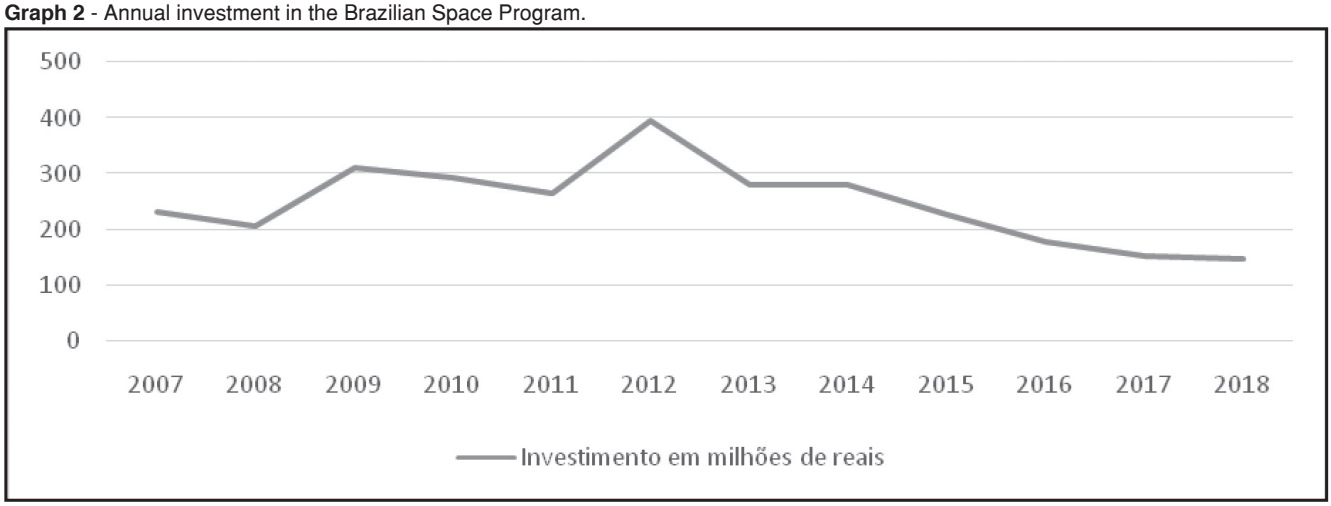
Graph 2 shows national investment over the period 2007 - 2018 in the Brazilian Space Program. This investment refers to the values used in the development of "launchers, launch bases, satellites and their reception and control systems, and data application" (AEB, 2018). It is possible to notice that the amount employed has been decreasing over the last few years. Budget constraints on science and technology projects generate great damage to scientific and technological development.

Graph 1 - Annual investment in the CBERS Program CBERS, in millions of por reais.



Source: Creation of the authors based on data obtained by the Integrated Planning and Budget System of the Government (SIOP) and MANAGEMENT REPORTS of INPE.

Graph 2 - Annual investment in the Brazilian Space Program.



Source: Integrated Government Planning and Budget System (Siop) apud Brazilian Space Agency, 2020.

As a consequence of the external factors to be controlled, there was an increase in the time interval between satellite launches. Although the satellite launch forecast is every two years, successive delays due to technical problems, embargoes on imports of U.S. converters, products with defects or delays in the transfer of resources have hampered the sequence of satellites being put into orbit (SILVA, 2014, p. 99).

Successive delays involving budget problems have brought a number of negative impacts to the CBERS program chronogram. In this sense, Carvalho (2011, p. 24) explains how budget fluctuation has negative impacts on the Brazilian Space Policy:

> The negative impact of this budget variation over time on the program stems from the very nature of space products and services. Indeed, the construction of satellites, rockets and terrestrial infrastructure presents complexity and technological risks, high cost and long development cycles, usually four and eight years. Thus, the management of projects and space activities becomes hostage to the long-term uncertainty of the financial support necessary for the execution of the tasks and contracts involved, which ends up generating constant continuity solutions and exhausting and continuous replanning actions.

With regard to the considerations made in this quotation, it is possible to extend them to the CBERS Program. According to the evaluation made in this article, the CBERS Program suffered from continuous replanning of its execution schedule. From the first years to the last launch in December 2019, one of the main variables that favored successive delays is the floating budget of the Brazilian space sector. However, as has already been pointed out this is not the only variable in course, it is also important to highlight the adverse effects of technological cutting back for developing countries. The increase in intervals and successive replanning are also related and the difficulty of obtaining dual-use components that are often not sold by States that have these technologies. This means that the country that is cut back has to develop the component, which requires time, resources and capacitation. This is a complex process of interaction between dependence, interdependence and autonomy.

The budget issue is highlighted by Ricardo Galvão, former director of INPE: "Brazil is not as well as it could be, mainly because the lack of resources culminates in the problem of lack of human resources in INPE" (BRASIL COM CIÊNCIA, 2018c). The investment in the Brazilian space program has been very small, especially when compared to the budgets of other space programs, for example, the one in India. In this sense, Galvão draws attention to the importance of partnership with other countries, as this allows knowledge that was not acquired in the partnership with China to be acquired (BRASIL COM CIÊNCIA, 2018c).

The first Argentine satellite, for example, was tested in INPE. Argentina has achieved an excellent level of development of its program. That is because although the Argentine economy was not at its best, they maintained resource and ideology of continuous development ideology that gave priority to the program because of its importance to society. The Brazilian government's lack of satellite demand has hurt the Brazilian space industry. This is a point that deserves attention, that lack of demand

and regularity of investment in the space sector is one of the major obstacles to the consolidation of a strong aerospace industry (BRASIL COM CIÊNCIA, 2018c).

Amauri Montes, former engineering general coordinator at INPE, highlights the problem in relation to human resources (BRASIL COM CIÊNCIA, 2018b). According to Montes, we are losing a lot of human resources due to retirement and the fact that there is no investment in the sector[5]; there is no reproduction of these human resources and this causes the loss of learning (BRASIL COM CIÊNCIA, 2018b).

New paths, however, are being opened for the space sector and the global trend is to evolve into smaller satellites. INPE works towards a platform to develop 200-kilo satellites, which could be developed with greater continuity of orders. Although it does not promote a great demand, it enables a continuous demand that allows to keep qualified personnel that has been lost. Through the reformulation of the Brazilian space program and its governance it is possible to consolidate a space program that has great participation of the national industry and maintains employees and knowledge that were acquired (BRASIL COM CIÊNCIA, 2018c).

4 FINAL CONSIDERATIONS

The present work sought to analyze the CBERS Program through the methodology of evaluation of public policies. In this sense, the collection of documentary data provided the necessary data for the application of the evaluation models: stakeholder and goal-achievement. The application of these models contributed to the identification of the main actors concerned and to the verification of the objectives and obstacles of the program.

The results of the analysis presented show that CBERS is a program of economic interest, for its contribution to the monitoring of agriculture and strengthening of the aerospace industry, and social, for its characteristics of monitoring the environment. The partnership with China facilitates the division of costs and favored prestige before the Brazilian government for the entry of resources. In this sense, Brazil and China, throughout the history of CBERS and, mainly, in recent years seek to expand the interest group that has access to the images provided by CBERS. As already mentioned, since 2007, there has been a free availability of images generated by CBERS to African countries, which represents a joint effort of Brazil with China to strengthen the program and, at the same time, increase the number of countries that have access to these images(INPE, 2007).

The analysis of the data on achieving goals showed that, despite being a program that has managed to maintain itself, throughout its trajectory it has encountered, successively and repeatedly, a series of difficulties. Among them the one that stands out is the inability to meet the interval goal between one launch and another. Although CBERS is maintained as a priority within Brazilian space policy, it is still subject to budgetary constraints that contribute to delays in the manufacture of satellite components and equipment.

We conclude, directing to the need to collect more data on the CBERS program, such as aspects of satellite nationalization and the impacts on the Brazilian aerospace industry. The bilateral relationship between Brazil and China in the space sector consolidated the CBERS program as a provider of satellite images, but this did not mean that, throughout the program's history, Brazil was able to monitor its partner's space development.

Nevertheless, it is important to emphasize that both countries were able to improve techniques and knowledge in the sector. Considering that Brazil is no longer at a similar level of knowledge to China in this sector, it would be interesting for Brazil to strengthen cooperation agreements with countries that are still developing their space sector so that a more effective exchange of knowledge occurs in areas where autonomy is sought.

[5] As an example Montes cites the Opto company that lost about 30% of the employees who were invited to work abroad. That is, Brazil forms people to work out there (BRASIL COM CIÊNCIA, 2019).

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