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PROPOSAL OF CREATION OF A PLANETARY DEFENSE OFFICE IN BRAZIL BASED IN EXISTING CAPABILITIES

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ABSTRACT

Over the past decades, global efforts have been undertaken by several countries through their space agencies, Universities, and independent observatories, for the identification, characterization, tracking, and studies of strategies and technologies that can mitigate potential threats from cosmic bodies that present a risk of collision with Earth. Potentially Harzadous Objects (PHOs), or potentially hazardous objects, are a subset of Near Earth Objects (NEOs) that are 30 to 50 meters in length and up to 5 million kilometers from Earth orbit, and pose a real risk of impacting the surface of the planet. Its effects, in case of collision, can be catastrophic (such as mass extinction events or natural disasters in the sidereal realm), and for this reason it has drawn the attention of the international community, mainly due to recent events such as the one that occurred in Russia on February 15, 2013, when the Cheliabinsk asteroid, or Cheliabinsk meteor, entered the Earth's atmosphere undetected, leaving more than 1500 people injured. Since then, initiatives recommended by the Committee on the Peaceful Uses of Outer Space (COPOUS) and endorsed by the UN General Assembly to strengthen the coordination of the international response to a potential NEO impact threat, have been acted upon and an international asteroid warning network has been established, International Asteroid Warning Network (IAWN) and a space mission planning advisory group, Space Mission Planning Advisory Group (SMPAG), which have made satisfactory progress with the development of studies of asteroid deflection technologies, planning, and sidereal disaster prevention. In 2016, the National Aeronautics and Space Administration (NASA) established the Planetary Defense Coordination Office (PDCO) with the goal of managing its planetary defense mission, placing the United States as a global leader in this area. Other countries, represented by their space agencies, also coordinate efforts in this direction, such as the European space agency - ESA, which also created its planetary defense office, the Planetary Defense Office (PDC). In this context, considering that Brazil is a country of continental proportions, regional leader in space activities, and in which cosmic events have been observed in recent years, it has been observed, through research, that there is no mention or official participation of the country in initiatives for planetary defense (other than the discussion in the academic environment). In this sense, the present article aims to present a starting point define some of the essential capabilities so that, in case of a NEO event, Brazil has a defined structure with roles and responsibilities to better respond to this type of sidereal risk.

1. Introduction

In January 2016, in order to reorganize its near-Earth object observation program, NASA created the Planetary Defense Coordination Office - Planetary Defense Coordination Office (PDCO). This new organization aims to fund and coordinate ongoing research efforts, identify strategies to reduce the risk of future impacts, and coordinate emergency response actions with other federal agencies and international partners (CONWAY; YEOMANS; ROSENBURG, 2022). Risk refers to the consequences of an impact, often expressed in terms of human casualties or physical destruction (SCHMIDT, 2019). The PDCO is responsible for coordinating efforts with other nations' space agencies as a member of the global IAWN and SMPAG networks, under the endorsement of UNCOPUOUS. With this strategy, the U.S. positions itself as an international leader in initiatives related to planetary defense, which is a term used to encompass all the capabilities needed to detect the possibility and warn of possible impacts of asteroids or comets with Earth and then prevent them or mitigate their possible effects (NASA, 2023).

The European space agency - European Space Agency (ESA), also has its office for coordination and

activities related to planetary defense, which was established in 2018, the Planetary Defense Office (PDO). The PDO became part of ESA's Space Security Program, but since 2009, the agency has been active in the field of planetary defense, when it started its space situational awareness program by creating a segment for NEOs: the Near-Earth-Object Coordination Centre (NEOCC), is a core element of the agency's planetary defense office, based in Esrin in Frascati, Italy. ESA is a member of IAWN and SMPAG, along with several other space agencies.

Countries such as Germany, Mexico, Italy, Belgium, China, France, Israel, Japan, Russia, Pakistan, Canada, and others are part of the international IAWN and SMPAG networks through universities, institutes, regional observatories, amateur astronomers and space agencies. The goal of these observing programs, according to Schmidt (2019), is to discover and track NEOs so that their orbits can be calculated and approaches for mitigating impacts can be predicted years in advance, before they are close to Earth. Brazil, for its part, is represented by a group of amateur astronomers from the Observatory for Near Earth Asteroids Research (SONEAR), which is based in Oliveira, Minas Gerais, and the Brazilian Meteor Monitoring Network (BRAMON) that is an open and collaborative organization, maintained by volunteers and supporters, a non-profit organization whose mission is to develop and operate a network for monitoring meteors, producing and providing scientific data to the community.

At the international level, Brazil has no representation by an official governmental body: the Brazilian Space Agency (AEB) submitted a letter to become SMPAG member in 2021, but the analysis by SMPAG is still pending. Thus, the subject of Planetary Defense is debated (even if timidly) in the academic environment, through events or specific research groups. On the Federal Government site, the subject has a mention through its IMPACATON project (National Observatory Asteroid Mapping and Research Initiative), conducted by the Astronomical Observatory of the Sertao of Itaparica (OASI), located in the municipality of Itacuruba (PE). This project aims to research and study the small bodies of the solar system, integrating Brazil into international programs for searching and tracking asteroids and comets at risk of collision with Earth. However, the ON (National Observatory) clarifies that its work is not related to locating NEOs: its efforts are directed to studying the physical properties of celestial objects, contributing information about the physical nature of these bodies. The technical limitations of the robotic small-field telescope itself make it unsuitable for the systematic search for NEOs. Therefore, today in Brazil there is no initiative in the official government agenda linked to this theme.

2. Recent initiatives in Brazil space activities

The sovereignty and autonomy of a country are proportionally related to its capacity for technological development. Space technology is undoubtedly the most widespread in this scenario and Brazil has been assuming this commitment to sovereignty and full autonomy, by emphasizing, through the National Program for Space Activities (PNAE), its priorities for integrating space policy into other public policies in execution, undergoing important transformations. [AEB, 2012].

In recent years, in addition to establishing a space program, Brazil has been adopting some measures to maintain and develop space activities. The Brazilian Space Program (PEB) started in the 1960's, when then president Janio Quadros established a study commission that would give rise to INPE (National Institute for Space Research) a few years later. It originated with the creation of the Organization Group of the National Commission for Space Activities (GOCNAE), subordinated to the National Research Council (CNPq), today the National Council for Scientific and Technological Development (CNDCT). The PEB, according to the National Policy for the Development of Space Activities (PNDAE), is a term used to refer to the set of space activities programs, divided into subprograms, projects and activities (Brazil, 1994). In 2008, the PEB was included in one of the Guidelines of the National Defense Strategy in the area of science and technology, with the intention of strengthening the cybernetic and nuclear sectors, besides the space sector (ROLLEMBERG, 2010). The importance of the space sector for a country's sovereignty is well known; and a country that explores space activities increases its political prestige, develops its military power and promotes economic development.

To coordinate the actions involved in conducting the space program, the Brazilian Space Agency (AEB) was created in 1994. It is subordinated to the Ministry of Science and Technology (MCT) and is the central organ of the National System for Development of Space Activities (SINDAE), established by Decree no. 1. 953, of July 10, 1996, responsible for establishing the National Policy for Development of Space Activities (PNDAE), instituted by Decree No. 1.332 of December 8, 1994; and the National Program of Space Activities (PNAE), which defines the lines of action executed by sectoral agencies, with a forecast of revision every ten years (AEB, 2012).

Other initiatives, such as the creation of the Brazilian Space Program Development Committee (CDPEB) through Decree No. 9,279 of February 6, 2018, linked to the Institutional Security Cabinet (GSI) as an advisory instrument to the President of the Republic, propose and supervise the execution of necessary measures to enhance the PEB. In addition, the availability of the new version of the PNAE (PNAE 2022-2031) and the creation

of the working group GT-PNE with the objective of revising the PNDAE and elaborating a proposal for a National Space Strategy (ENE) - instituted by AEB Ordinance No. 107, of May 13, 2019, is consolidated as an important chapter in the national infrastructure since space systems are responsible for enabling practically all economic activities in the country, impacting sectors such as communication, logistics, urban mobility, civil defense, mining, environment, health, education, science, among others. It is through the PNDAE that objectives and guidelines for national space projects are established and integrated with other public policies in execution in Brazil, with the PNAE being its main planning and programming instrument.

According to the Practical Guide for the Use of Federal Government Alerts for Disaster Preparedness Actions (Brazil, 2021), prepared by the Ministry of Regional Development (MDR) - under which the National Center for Risk and Disaster Management (CENAD) and the National Secretariat for Civil Protection (SEDEC) are also subordinated - the monitoring agencies responsible for issuing risk alerts work with the types of disasters catalogued in the Brazilian Classification and Codification of Disasters (COBRADE). In this classification, the natural sidereal disasters considered are those of technological origin, referring to the fall of satellites that have, in their composition, engines or radioactive bodies, not mentioning meteors or asteroids.

In this context, we observe that the planning of Brazilian space activities is focused on internal actions, related to capacity building in order to enable the country to develop and use space technologies in the solution of national problems and for the benefit of the Brazilian society in order to collaborate to improve the quality of life, generating wealth and job offers, besides improving science and developing an awareness of the territory and environmental conditions (BRASIL, 2012). This demonstrates the lack of a plan for disasters of the catastrophic nature of NEO events.

3. General problems related to implement a Planetary Defense program

Planetary Defense is understood to be a multidisciplinary, internationally coordinated effort to protect the Earth and its inhabitants from the impacts of NEOs. Planetary defense involves detecting, monitoring, understanding, and mitigating the impacts that may be caused by them. Mitigation requires the development of strategies for object deflection, as well as the need for advance planning for emergency response to possible impacts. Any planetary defense strategy requires that feasible actions be considered when an asteroid is discovered on a trajectory that risks impacting Earth.

NASA defines a 4 generic phases for a planetary defense system (NASA, 2023):

1. Find (search, detect, object characterization): sponsors projects through its Near-Earth Object (NEO) Observations Program that employ a variety of ground and space based telescopes to search for NEOs, determine their orbits, and measure their physical characteristics. The PDCO is studying possible space-based telescope missions optimized for NEO search and characterization that could accelerate the discovery of the currently undetected NEOs.

2. Warn: is responsible to provide timely and accurate information to the government, the media, and the public on close approaches to Earth by NEOs and any potential for impact. If any NEO is found to pose a significant chance of impacting Earth (greater than 1 percent over the next 50 years), the PDCO will provide notification messages for NASA to send to the Executive Office of the President, the U.S. Congress, and other government departments and agencies

3. Risk mitigation: the PDCO sponsors studies of technologies and techniques for deflecting an asteroid off a predicted impact course with Earth. It is developing missions to demonstrate those technologies and determine their effectiveness in the event that these techniques must be utilized against a predicted asteroid impact threat.

4. Coordinate: The PDCO works with other government agencies to develop and update a National NEO Preparedness Strategy and Action Plan. The PDCO also provides expert input on the nature and effects of asteroid impacts to the Federal Emergency Management Agency (FEMA), so that adequate emergency response can be prepared in the event of an NEO impact that is not possible to avoid.

It is important to emphasize that few countries have the capacity to dominate the entire space production cycle, such as the United States, China, Japan, India, Russia, and France. The high cost of space-related technologies, such as telescopes or space programs, does not allow many countries to participate in initiatives related to planetary defense: the lack of funding dedicated to this topic, ends up being an obstacle to research on the subject, since national grant agencies and strategies differ widely from country to country, and the topic of planetary defense is not yet well understood or widespread worldwide (SCHMIDT, 2019).

Based on this framework (on the generic phases of PD), initial conversations were held with a small group of Brazilian experts representing academic, military, governmental and astronomical fields to create a preliminary understanding of some causes that prevent an official discussion on Planetary Defense in Brazil. The causes raised were grouped into eight topics: legislation, technology, funding, strategy, human resources, infrastructure, policy, and governance.

Outdated space legislation, lack of federal funding, inexistence of a national strategy related to the theme, lack of knowledge of the subject by a large part of federal agencies, no alignment with a global governance for discussion on the theme, conducted in an amateurish

way by independent researchers, dependence on technology from other countries, lack of official representation in international bodies such as SMAPG and IAWN, high cost infrastructure, lack of definition of a responsible federal agency, low probability and long term events, more serious short and medium term problems to be solved

4. An initial purpose for Planetary Defense Office in Brazil considering existing capabilities with its functions and responsibilities

To start the proposal of the PDO in Brazil, the first step was to assume the governmental interest in the theme and the commitment of the stakeholders identified with the program. The second step was to search existing structures in order to build a generic collaboration chart that could meet the requirements of a planetary defense system. The model adopted as a reference was NASA's PDCO.

Following the example of organizations such as NASA and ESA, the planetary defense office was thought to be subject to the Brazilian Space Agency which is responsible for, among other things according to (Brazil, 2023):

I - to execute and enforce the National Policy for the Development of Space Activities - PNDAE and propose guidelines and the implementation of actions resulting therefrom;

[…] IV - promoting the relationship with similar institutions in the country and abroad;

V - to analyze proposals, agreements and international accords, in articulation with the Ministry of Foreign Relations and with the Ministry of Science, Technology, Innovations and Communications, aiming at cooperation in the field of space activities and follow up their execution;

VI - issue opinions concerning matters related to space activities that are object of analysis and discussion in international forums and be represented in them, in articulation with the Ministry of Foreign Relations and with the Ministry of Science, Technology, Innovations and Communications

Figure 1 represents an initial set of the main capabilities identified to compose a Planetary Defense initiative, according to the Brazilian government's description of its competencies:

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Figure 1 represents an initial set of the main capabilities identified to compose a Planetary Defense initiative, according to the Brazilian government's description of its competencies:

- Brazilian Space Agency (AEB)
- Union General Attorney (AGU)
- National Astrophysics Laboratory (LNA)
- National Observatory (ON)
- National Institute for Space Research (INPE)
- Presidency of the Republic
- Institutional Security Office (GSI)
  - ✓ Secretariat of Defense and National Security Affairs (SADSN)
- Ministry of Defense
  - ✓ Armed Forces Joint Staff (EMCFA)
- Nuclear Emergency Response Planning Committee (COPREN)
- National Center for Risk and Disaster Management (CENAD)
  - ✓ Local civil defense agencies
- Ministry of Science, Technology and Innovation (MCTI)

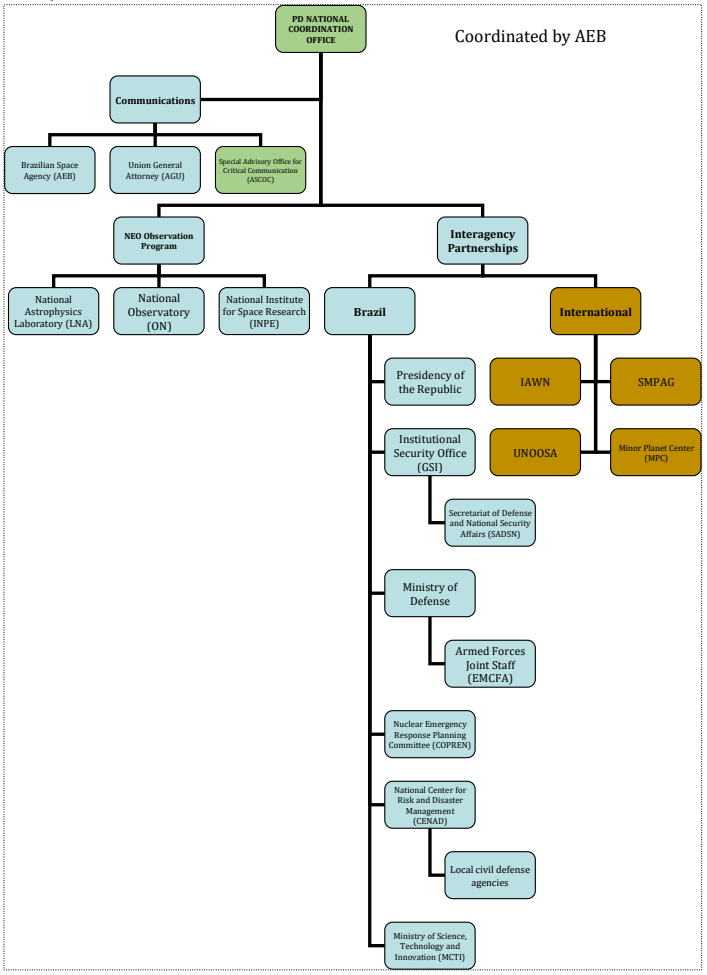

Figure 1: Initial capacity for PDCNO

Among these, it is suggested that other capabilities be created with specific views to Planetary Defense:

• Planetary Defense Office National Coordination (PDONC): this capability would effectively be responsible for centralizing and coordinating efforts related to national Planetary Defense.

• Special Advisory Office for Critical Communication (ASCOC): this capacity would be responsible for planning, coordinating, guiding, and monitoring the communication with the other federal agencies' communication bodies, ensuring transparency, assertiveness, and accountability of the information transmitted to the public, the media, and other bodies.

Of these capabilities, it is worth highlighting some competencies attributed by the Brazilian Executive Branch, defined in (Brazil, 2023) and which were considered for choosing to this approach:

National Astrophysics Laboratory

Responsible for planning, developing, providing, operating and coordinating the adequate means and infrastructure to foster, in a cooperative way, Brazilian observational astronomy.

Institutional Security Office (GSI)

I - directly assist the President of the Republic in carrying out his duties, especially with regard to military and security matters;

II - analyze and monitor issues with potential risk, prevent the occurrence of crises and articulate their management in the event of a serious and imminent threat to institutional stability;

III - coordinate federal intelligence activities;

IV - coordinate information and communications security activities;

[…]

XI - follow up on matters pertaining to critical infrastructures, with priority to those referring to risk assessment

Ministry of Defense

I - national defense policy, national defense strategy and

II - defense and military sectorial policies and strategies;

III - doctrine, planning, organization, preparation and joint and singular employment of the Armed Forces;

IV - special projects of interest to national defense;

V - strategic and operational intelligence in the interest of defense;

VI - military operations of the Armed Forces;

VII - international defense relations;

[...]

XVI - actions of the Armed Forces, when applicable:

a) in the guarantee of law and order, aiming at the preservation of public order and the safety of people and property;

b) in the guarantee of voting and electoral counting; and

c) in the cooperation with national development and civil defense and in the combat against trans-border and environmental crimes;

XVII - defense logistics;

XVIII - military service;

XIX - health care, social assistance and religious assistance of the Armed Forces.

National Center for Risk and Disaster Management (CENAD)

I - monitor and execute monitoring and preparation actions for disasters and response actions at the national level;

[…]

VI - to prepare, consolidate and disseminate reports on risk monitoring and disaster occurrences;

VII - to disseminate disaster alerts and provide preparatory guidance to the States, the Federal District and the Municipalities;

VIII - to propose guidelines and prepare strategic plans for disaster preparedness and response actions, in articulation with other Sinpdec and federal government agencies;

IX - to articulate and integrate the federal government's actions in disaster preparedness and response;

X - to articulate and integrate the federal government's actions in disaster response at the international level, upon demand by the competent bodies;

XI - to analyze requests from the States, the Federal District, and the Municipalities for federal recognition of a state of emergency or a state of public calamity;

[…]

XIV - to analyze and follow up the execution of agreements, terms of commitments, contracts, adjustments, and other similar instruments related to its activities;

XV - to articulate federal support for the development of operational actions for disaster response;

XVI - to propose federal cooperation agreements and joint action protocols, in the scope of Sinpdec, for the coordinated execution of actions related to disaster response operations;

XVII - mobilize and coordinate Sinpdec operational teams in response actions in support of federal entities affected by disasters;

XVIII - mobilizing, supporting and coordinating the activities of the multidisciplinary technical team to act in civil protection and defense actions.

In relation to the international institutions mentioned, which are outside the PDONC coordination, these make up a general predefined communication flow that is outside the scope of this work.

In the flow presented in figure 2, after being informed by the Minor Planetary Center (MPC) where all world-wide observations are collected and cataloged, it is determined whether it is a potentially hazardous object (PHO) and the PDCO is alerted at NASA headquarters. PDCO inform IAWN that alerts SMPAG and, after gathering further technical information, notifies relevant UN entities, like UNCOPUOUS and UNOOSA. In the meantime, SMPAG members work in formulating agreed and supported recommendations that are send from member states to UN with recommended actions to be taken. This flow, is suggested in SMPAG (2018) and it will used as basis for this work. Internally, it is still not clear the internal communication flow to start working on the identified threat, so, at first, we leave it up to AEB and later PDNCO.

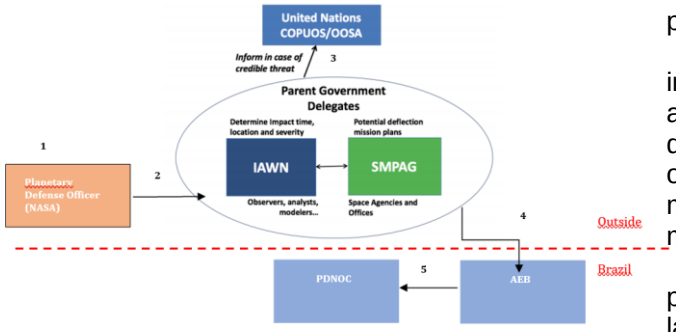

Figure 2: Simplified SMPAG and IAWN functions and information flow for a credible threat with Brazil PDNOC Source: Adapted from SMPG (2018)

It is important to make it clear that Brazil depends on technology from other countries for the search, detection, and characterization of objects in a Planetary Defense initiative. This is also true for the warning and risk mitigation phase, hence the importance of its participation in international collaboration networks.

5. Final considerations

Brazil is a country of continental proportions, regional leader in space activities, and in which cosmic events have been observed in recent years, it has been observed, through research, that there is no mention or official participation of the country in initiatives for planetary defense (other than the discussion in the academic environment). In this sense, the present article aimed to present a starting point to define some of the essential capabilities so that, in case of a NEO event, Brazil has a defined structure with roles and responsibilities to better respond to this type of sidereal risk.

Even being a signatory of relevant space cooperation agreements with countries on all continents, until the date, Brazil don't deal with specific partnerships for issues related to planetary defense, and do not participate of any technical committee or international group involved in detecting, tracking, and characterizing NEOs, such as SMPAG or IAWN.

This initial proposal arose from interviews with experts from various areas who have an interest in the theme and who encounter difficulties in their respective segments to conduct initiatives on the subject in Brazil. To this end, brainstorm sessions were held that classified the main causes of these difficulties into eight groups: legislation, technology, funding, strategy, human resources, infrastructure, policy, and governance.

The next step was to research existing planetary defense office structures, taking NASA's PDCO as a base. Paralleling some of the capabilities already installed in Brazil, through the analysis of their competencies, an initial draft of the main government agencies that should be involved to collaborate in a planetary defense initiative was reached.

It was also pointed out that, given the need for large investments in space technology to be able to dominate all phases of Planetary Defense, Brazil remains dependent on technology from other countries, in a role of consumer of services and technology, being mandatory the accomplishment and participation in multilateral agreements.

It's necessary to emphasize that several interested parties were not consulted due to lack of agenda, or for lack of time while this work was being developed, or they were identified during the course of the work. This way, there is a high probability that other fundamental capabilities are not represented in figure 1.

Besides, this is an academic work, and does not intend to intervene or judge any mechanism already established by the Brazilian government. As a deepening and extension of this work, we see the need to include the technicality of several other stakeholders, specialists and representatives of other specific areas of knowledge such as Law, International Law, International Relations, Public Security, Public Policies, among others, which would be fundamental for the elaboration of a feasible, detailed, realistic planetary defense initiative and that, in fact, meets or directs the mechanisms already established by competent bodies in the response to disasters of any nature.

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