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**COMMUNICATION PROTOCOL ON PHO FOR DISASTER MANAGEMENT BY  
LEGITIMATE BRAZILIAN INSTITUTIONS**

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**ABSTRACT**

In Brazil, the responsibility for managing the risk of natural disasters is defined by the National Plan for Risk Management and Disaster Response (NPRMDR). The CEMADEN (National Center for Monitoring and Early Warning of Natural Disasters) and the CENAD (National Center for Managing Natural Disaster Risks) are, today, the entities in charge of the administration of internal communications in case of catastrophic events, leading the interface with others internal actors in order to give the initial direction to the communications management process of this type of event. According to NPRMDR, the risk communications protocol must meet a decision-making chain composed of federal, state and municipal authorities, in which CEMADEN monitors natural threats in areas of risk and issues disaster alerts, which are forwarded to the CENAD. The CENAD is the official organism in charge of taking preventive civilian protection actions, and the state and municipal civil defenses are in charge of the initial response actions with the population. NPRMDR contemplates natural disasters of hydro meteorological and climatological origin, not covering natural disasters caused by other agents, such as the impact on the Earth's surface of objects from Space, such as celestial bodies (asteroids, comets) or even space debris, that depending on their size and where they reenter, they can cause catastrophic damage, annihilating an entire continent or even causing a collapse of civilization. It is known that objects between 13 and 150 m in diameter could destroy a city in the event of a collision. The size of the damage depends on both the size and the relative speed of the object relative to the Earth. Thus, there is no formal protocol in Brazil today establishing guidelines for risk communications between external and internal bodies, which are in charge of notifying the occurrence of disastrous events, resulted from space threats. Similarly, the country is not party to any specific multilateral international agreement for events of this nature, such as the

International Asteroid Warning Network (IAWN), for instance. Having identified this gap, the present research aims to carry out an investigation about the existing and eligible mechanisms and entities for the exchange of information on the risks of the impact of potentious hazard objects (PHOs) for disaster risk management, using international networks of technical and scientific cooperation already established. Based on this information, after analyzing the characteristics of these mechanisms, a communications protocol will be suggested, preferentially taking advantage of the existing structure for natural disasters. This work will contribute to the advancement of studies regarding the definition of risk communications strategies applied to Planetary Defense.

## 1. Introduction

Chodas (2017) defines NEOs – near earth objects, as minor bodies (comets and asteroids) that orbits the Sun and has an orbital perihelion of <1.3 Astronomical Units (AU) and by contrast, PHOs come much closer and have a minimum orbital intersection distance of less than 0.05 au—about 7.5 million km—from the Earth’s orbit, measuring more than ~140 meters and it could produce a great deal of destruction, but objects smaller than this, could be hazardous and cause many damages. The efforts to avoid this kind of threat, are object of study of a recent new area called Planetary Defense.

According to NASA, *“Planetary defense is the term used to encompass all the capabilities needed to detect the possibility and warn of potential asteroid or comet impacts with Earth, and then either prevent them or mitigate their possible effects”*. It involves *“finding and tracking near-Earth objects that pose of hazard of impacting Earth”*, *“characterizing those objects to determine their orbit trajectory, size, shape, mass, composition, rotational dynamics and other parameters, so that experts can determine the severity of the potential impact event, warn of its timing and potential effects, and determine the means to mitigate the impact”*, and *“planning and implementation of measures to deflect or disrupt an object on an impact course with Earth, or to mitigate the effects of an impact that cannot be prevented. Mitigation measures that can be taken on Earth to protect lives and property include evacuation of the impact area and movement of critical infrastructure”*.

Only in the past century have scientists and the public become aware that our planet is subject to impacts by comets and asteroids, and that these impacts constitute a significant danger to society. Recognition of this hazard required the development of new paradigms in astronomy and geology, together with a long-term perspective on planetary history. Friedman (1997) affirm that, for decades, and in some cases generations, mankind has recognized and responded to the risk of earthquakes, floods, hurricanes, pandemics, etc. but dealing with risk of an asteroid or comet striking the Earth with unprecedented devastation was a great intellectual challenge because of its extraordinarily low annual likelihood.

As the nature of the NEO threat became clearer to the scientific community during the 1980s, the governments of the developed nations gave little attention or priority to mitigation because of the preliminary nature of the data and the unfortunate similarity to scenarios from science fiction, when in early 1989 the asteroid 1989 FC, several orders of magnitude larger than the one which formed Meteor Crater passed Only 400,000 miles from Earth and was only detected well

after its point of closest approach. In 1995, it was proposed by UNOOSA, an expansion of existing observation activities to detect and track NEOs.

Finding, tracking, and characterizing asteroids has grown increasingly sophisticated since then, and NASA created a near-Earth Observation Program in 1998, responding to direction from the U.S. Congress. The NEO Observations Program collaborates with other U.S. government agencies, other national and international agencies, and professional and amateur astronomers around the world. As affirms Billings (2015), NASA works closely with the Federal Emergency Management Agency (FEMA) and the Department of State on NEO impact warning, mitigation and response planning, with the intent of facilitating communications between the science community and the public should any potentially hazardous NEO be discovered, working closely with the United Nations Office of Outer Space Affairs and its Committee on the Peaceful Uses of Outer Space or UNCOPOUS.

In the last decade, UNCOPOUS has sponsored activity to build international capacity, dialogue, and coordination, resulting in the formation in 2014, of an International Asteroid Warning Network (IAWN) and a Space Mission Planning Advisory Group (SMPAG) [SCHIMIDT, 2018]. These are two entities established as a result of the United Nations-endorsed recommendations, and represent important mechanisms at the global level for strengthening coordination in the area of planetary defense. They were created after the recommendations for provide an international response to the NEO-impact threat, agreed and contained in the document A/AC.105/L.330 agreed under the auspices of UNCOPOUS and welcomed by the General Assembly in its resolution 68/75 of December 2013.

According to UNCOPOUS (2018), the purpose was to ensure international information sharing in discovering, monitoring and physically characterizing potentially hazardous NEOs with a view to making all countries aware of potential impact threats, focusing in developing countries, that have limited capacity in predicting and mitigating a NEO impact. Beyond that, they emphasize the need for effective emergency response and disaster management in the event of the discovery of a NEO-impact threat, and it's this existing structure in Brazil that we want to use to suggest a communication protocol of events of this magnitude.

In January 2016, NASA reorganized its Near-Earth Object Observations Program and established a Planetary Defense Coordination Office (PDCO) in response to the NASA Office of Inspector General's 2014 report, "NASA's Efforts to Identify Near-Earth Objects and Mitigate Hazards." The PDCO coordinates efforts with the space agencies of other nations as a member of the multinational IAWN and SMPAG, under the endorsement of the UNCOPOUS.

## **2. International collaboration networks for Planetary Defense**

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].

International partnerships in the space area represent a growing trend, the strengthening of which allows countries to share common interests and objectives, increase investments in their respective space programs, share costs and risks, increase the number of projects and associated joint knowledge, face challenges in a

coordinated way and collaborative, and jointly enjoy the benefits of space science and technology. International cooperation is also an effective way of mitigating the risks of conflict in space, since nations now have shared goals and a greater interest in preserving the peaceful uses of outer space. In this sense, Brazil has relevant space cooperation agreements with countries on all continents, specifically, with eleven countries on cooperation for the peaceful uses of outer space. These agreements are, in principle, precursors of new international instruments and initiatives that lead to the bilateral and multilateral development of the space program and the acquisition of new technologies, but none of them, until the date of this article, deal with specific partnerships for matters related to planetary defense, so that it does not participate, even if it is a signatory to treaties and declarations that originated in COPOUOS, of any technical committee or international group involved in detecting, tracking, and characterizing NEOs, such as SMPAG, or IAWN. Along with the USA, several other countries share observations and research, disseminating data products and services, and collaborating on real-time predictions which could be used to avoid or reduce potential damage to critical technology and infrastructure.

The United States assumed a leadership role in technical international NEO organizations and in fostering global collaboration, and developed a national near earth object preparedness action plan which objective is improve preparedness to address the hazard of NEO impacts by leveraging and enhancing existing national and international assets and adding important capabilities across government. The challenge ahead is that planetary defense cannot be met by any single nation or government alone. Instead, the effort will require international cooperation.

IAWN and SPAG are voluntary collaboration among governments, institutions, observatories, and individuals that enables coordination among astronomers and enables a free and open data exchange. Brazil participates through the SONEAR Observatory, which is an amateur observatory, with no connection to the government, that contributes to NEOs discoveries and is composed by amateur astronomers who inform The Minor Planet Center (MPC), which is a focal point for receipt and distribute positional measurements of minor planets, comets and outer irregular natural satellites of the major planets. The MPC is responsible for the identification, designation and orbit computation for all of these objects, maintaining the master files of observations and orbits, keeping track of the discoverer of each object, and announcing discoveries to the rest of the world via electronic circulars and an extensive website. Amateur observers have had an important role in asteroid discovery and tracking.

### **3. Impact warning communication protocols**

The importance of have a known established procedure for international communication, once you don't have the specific technology for detecting, tracking, and characterizing NEOs, is that you can be provided with timely and accurate reporting of a very close approach or predicted impact of a naturally occurring near-Earth object (NEO). This is such an important thing because a govern has time to articulate with federal agencies and other governments, ways to better deal with the announced special threat, ensuring proper and timely Government response.

Countries and organizations that integrate technological networks like IAWN and SMPG, recognize the importance of being adequately prepared for communications of possible threats to governments, media or population. Part of

them already have developed a protocol of communication, or at least, know the rules for communication in case of the discovery of any PHO, and this communication must be clear, correct, consistent and concise.

Some space agencies and governments have developed standardized threat assessment reports formats that includes essential information based on previous analysis. Impact probability, approach date/time, impact risk corridor, approximate size, expected level of damage if impact occurs and impact prevention feasible, are some type of information that can be found in these reports.

There are several guidelines for the establishment of communication protocols in case of threat of impact of NEOs. Since the UN recommended the establishment of international cooperation networks such as IAWN and SMPAG, and these organisms are internationally recognized as a mean to establish strategies of communication and technical support to face these space threats, the proposed communication protocol involves both, and are based on ESA (2016), NASA (2017) and SMPAG (2018) guidelines.

These guides provided important ideas in relation to possible actors, internal and external, that would need to be involved in case of the need to warn any government regarding a threat carried out by a NEO or PHO, so that it could take the necessary actions to communication and coordination with federal institutions and other competent bodies in the event of a disaster. The most effective way to foster this critical aspect of a planetary defense effort is to establish solid working relationships between the personnel involved in a future response before that response is required. Below are excerpts from these documents that we think are relevant for the definition of the protocol:

1. NASA Policy Directive presents some interesting information about responsibilities and actors that must be informed in case of a confirmed threat: *“The Planetary Defense Coordination Office (PDCO), in SMD’s Planetary Science Division, is the organization responsible for issuing notification that a Potentially Hazardous Object (PHO) has been detected and is a credible potential for impacting the Earth. The responsibility in informing US government agencies, it has to liaise with the Executive Office of the President (EOP) and the Department of Homeland Security’s Federal Emergency Management Agency (FEMA), other Federal organizations, and multi-Agency coordinating groups to support the National Response Plan and other emergency management plan and notify and coordinate with other Federal agencies in the event of any close approach of a PHO.”*

In Brazil, CENAD has the same attributions that FEMA in USA, and it’s actions are coordinated from Civil House. So, these two federal agencies will be part of our communication protocol.

2. ESA Near-Earth Object Information Plan - Distribution of information for a credible asteroid impact threat defines that: *“[...] The actual response to the threat will be the task of the emergency response agencies of the Member States. Information distribution will be handled strictly in collaboration with Member State national or international bodies”*  
*[...] In the case that a non-Member State could be affected by a credible impact threat, ESA will make available relevant information to its contacts in*

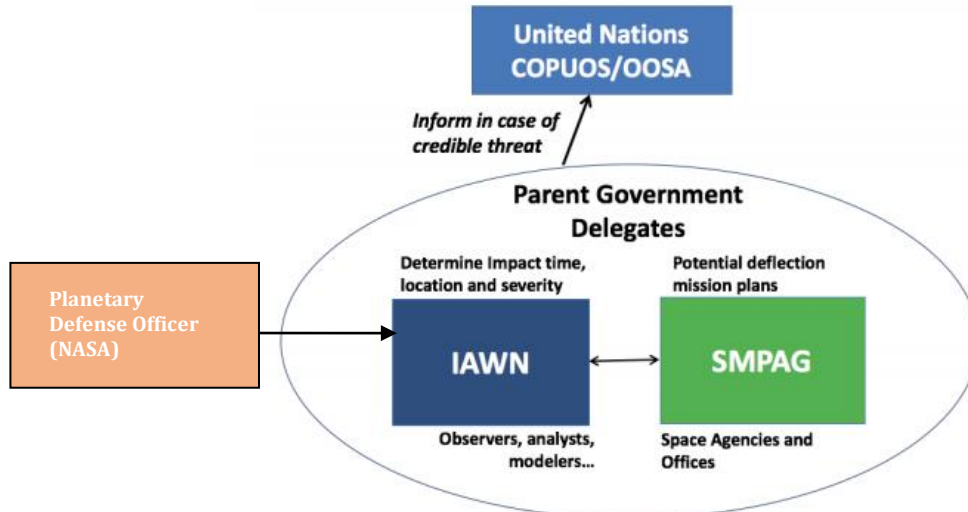
*the non-Member State in question via the International Relations Department.”*

In Brazil, CEMADEN is the disaster management agency that coordinate actions with local civil defense, which is a local emergency response agency. CEMADEN works closely with CENAD, so they will be part of our communication protocol.

3. SMPAG (2018), “Planetary Defense Action Plan (draft)” suggests a communications work flow that involves PDCO, IAWN, SMPAG and UN (UNOOSA, UNCOPOUS): [...] *utilizing UNCOPUOS as a forum to improve coordination as well as the organizational communication of these activities is encouraged. Standardization of the threat assessment content is important to provide suitable inputs for subsequent decisions regarding notification, mitigation, response, and recovery”.*

Brazil is a state member of UN, so it will be used the formal protocol already established por communicating state members, through Brazil local ambassador.

From the content of these sources, there was recognition by the scientific and political community, of three international committees responsible for the asteroid threat: UNCOPUOUS, IAWN and SMPAG. Their functions in an information flow for a credible threat is represented in the figure 2, adapted from SMPAG (2018):



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

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 be used as basis for our protocol.

#### **4. Proposal for an impact warning communication protocol to Brazil**

Brazil is not a member state from SMPAG or IAWN, but is a UN state member and has international cooperation with UNCOPUOS since 1958. In this case, following the UN communication protocol, continuing the flow above, in case of a credible impact threat, called *Impact Warning*, UN would be the responsible for alerting the Brazilian government through already consolidated and standardized mechanisms for official communication.

After the official communication with the Brazilian government through the Brazilian ambassador on site, he officially communicates to the Ministry of Foreign Affairs. The Ministry of Foreign Affairs, known as Itamaraty, is the body of the Executive Branch responsible for Brazil's foreign policy and international relations at bilateral, regional and multilateral levels. Itamaraty advises the President of the Republic in the formulation of Brazil's foreign policy and in the implementation of diplomatic relations with states and international organizations. After being invoked, the Ministry of Foreign Affairs coordinates communication with the State Ministry, in the Institutional Security Office (GSI) of the Presidency of the Republic, an essential organ of the Presidency of the Republic, to whom it is responsible, among other various attributions, according to GovBr (2019):

- 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.*

Given its powers and under its command, the GSI would convene the National Defense Council, with the following members:

- Vice-President of the Republic;
- President of the Chamber of Deputies;
- President of the Federal Senate;
- Minister of Justice;
- Minister of State for Defense;
- Minister of Foreign Affairs;
- Minister of Planning; and
- Commanders of the Navy, Army and Air Force.

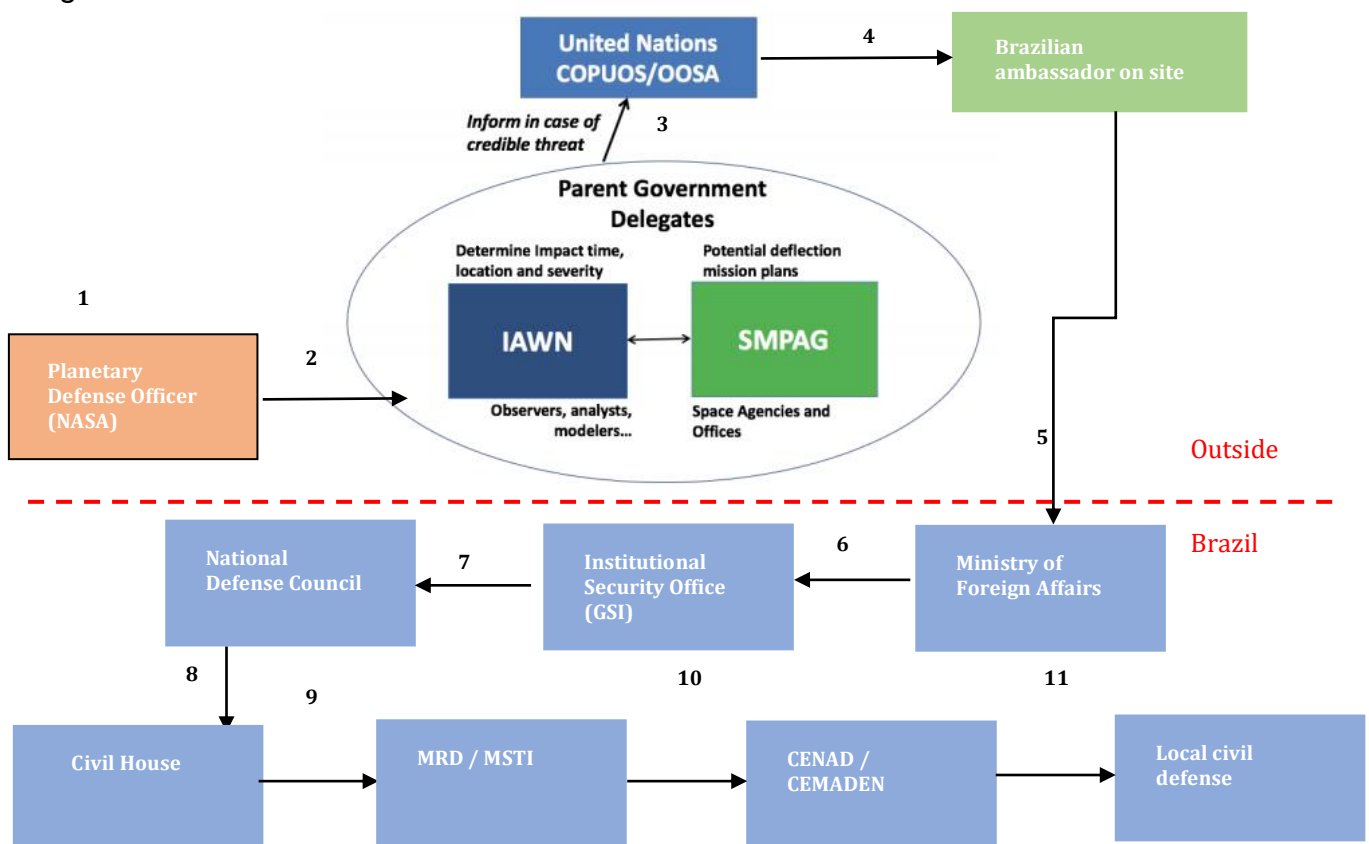
It is incumbent upon the National Defense Council, in article 91 of the 1988 Federal Constitution, to express an opinion on the decree of the state of defense, the state of siege and federal intervention, among others. Provided for in article 136 of CF / 88, the State of Defense seeks to “preserve or promptly restore public order or social peace”.

In this sense, the Constitution foresees two hypotheses of threat: serious and imminent institutional instability and calamities of great proportions in nature, in which we observe the adequacy of the proposed communication protocol. As an

articulation body with other federal agencies, GSI would also be responsible for coordinating communications with CENAD, as it was previously explained above.

In order to follow the communication protocol that already exists in Brazil, today, for issues related to disaster alert, we will assume that the GSI will communicate to the Civil House, an organ linked to the Presidency of the Republic and that is responsible, among other actions, for the coordination and monitoring of the activities of the Ministries and the formulation of projects and public policies. Today, the Civil House is responsible for coordinating the National Plan for Risk Management and Disaster Response (NPRMDR), interfacing directly with Ministry of Regional Development (MRD) and Ministry of Science, Technology and Innovations (MSTI), and them are addressed for the two specialized institutions to disaster response: CENAD and CEMADEN. Once CENAD receives the information, it is up to it to execute the response plan (this step is not the focus of this article), articulating actions with CEMADEN and local Civil Defense. However, in the need of a response plan for disasters caused by the fall of a NEO, it is possible to take advantage of the response plans existing today for natural disasters caused by extreme weather events.

Therefore, in figure 3, it's presented an intermediate impact warning model for communicating, not optimized, but which can serve as a starting point for the discussion on the establishment of a protocol on PHO for disaster management by legitimate Brazilian institutions, could follow the following macro flow, feasible for discussions and improvements by specialists. We emphasize that this proposed model of communication is a suggestion envisioned at the academic level, and does not intend to intervene or judge any mechanism already established by the Brazilian government:



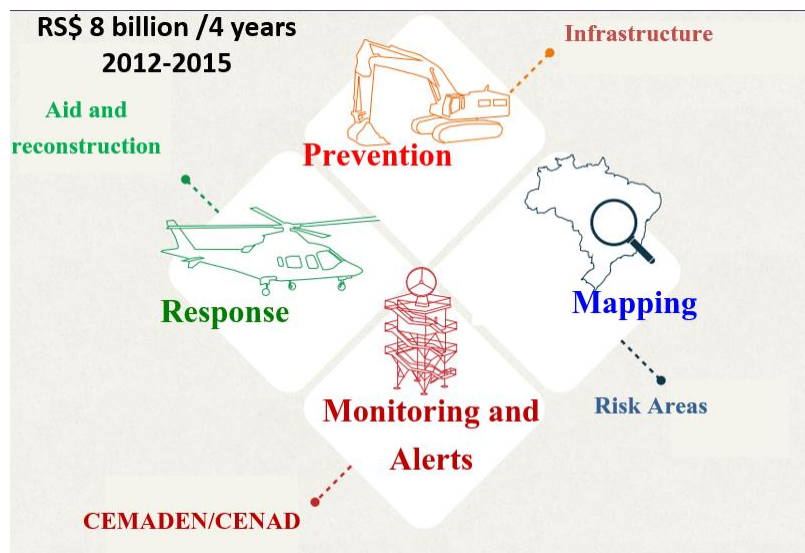
**Figure 3: Suggested communication protocol**  
Source: Author



With this proposal, we intend to reutilize part of existent structure in Brazil for disasters warning and response. Nowadays, Brazil adopts and implements national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030. Within the scope of disaster risk management, Brazil was a signatory to the Hyogo Framework for Action 2005-2015 (UNISDR, 2005) and renewed its commitment through the Sendai Framework 2015-2030 (UNISDR, 2015).

This document continues the actions defined by the Hyogo Framework for Action and seeks to reduce the risks of existing disasters and prevent new risks by implementing integrated and inclusive measures that seek, above all, to strengthen resilience. In this way, at 2012, the federal government established the National Plan for Risk Management and Disaster Response (NPRMDR) (BRASIL, 2012), aimed at managing risk and responding to natural disasters and under the coordination of Civil Office of the Presidency of the Republic.

The NPRMDR is divided into four axes of government action: prevention (infrastructure projects); mapping of risk areas; monitoring and alert system; and response (aid and reconstruction). See Figure 1:



**Figure 1 - National Plan for Risk Management and Disaster Response**  
**Source: Brasil (2012)**

On the axis “Monitoring and Alerts”, two federal public agencies deserve to be highlighted, due to their strategic role within the NPRMDR: National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN) and National Center for Risk and Disaster Management – CENAD.

The CEMADEN has the mission of monitoring natural threats in areas of risk and issuing alerts of risk of natural disasters to municipalities susceptible to occurrence of natural disasters. The CENAD is responsible for managing strategic actions for preparing and responding to disasters in the national territory. He is also responsible for mobilizing human resources to act during the occurrence of natural disasters. Thus, whether a disaster is forecasted, CENAD forwards the risk alerts received from CEMADEN to Civil Defenses, activates the civil defense agencies in states and municipalities and offers support for disaster response actions.

It is also the responsibility of CENAD to consolidate information about risks in the country, data related to the occurrence of natural and technological disasters and

the associated damages. The management of this information allows the Center acts together with others federal, state and municipal agencies in the actions of preparedness (prevention) and response to natural disasters closely with the most vulnerable communities.

## **5. Final considerations**

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.

In case of a hypothetical necessity of being communicated of an impact warning, which would be a possible path to be followed for the Brazilian government to address the necessary actions in a reasonable time? To answer this question, on an exploratory basis, some documents from ESA, NASA and SMPAG were consulted, which discussed conditions, actions and federal agencies and institutes that should be involved in decision-making in the event of an emergency impact from a PHO or a NEO.

Thus, drawing a parallel with some Brazilian institutions, it was presented an intermediate impact warning model for communicating, not optimized, but which can serve as a starting point for the discussion on the establishment of a protocol on PHO for disaster management by legitimate Brazilian institutions.

The main objective was to define possible points of contact between international bodies and Brazilian institutions so that they could, in a timely manner, make decisions and take preventive actions to mitigate the possible damage caused by the impact of a PHO. As previously emphasized, the proposed flow of communication is a suggestion envisioned at the academic level, 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 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 communication protocol 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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