Acta Astronautica 214 (2024) 496–504

Contents lists available at ScienceDirect

Acta Astronautica

journal homepage: www.elsevier.com/locate/actaastro

Diplomatic, geopolitical and economic consequences of an impending asteroid threat

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ARTICLE INFO

Keywords:
NEO
Planetary defense
COPUOS -international space law
Space global governance

ABSTRACT

The Planetary Defense Conference 2023 addressed an asteroid threat scenario as difficult to confront. This article examines potential actions of relevant stakeholders, including States, the International Asteroid Warning Network, the Space Mission Planning Advisory Group, Committee on the Peaceful Uses of Outer Space, and the United Nations Security Council.

To that effect, different sources are taken into consideration in this analyisis, such as the legal international framework, the practice of States in multilateral fora and the opinion of scholars. The conclusions shed light on the challenges that the international community will have to face and proposes a preventive approach to mitigate the impact of such a potential catastrophe.

1. Introduction: The mitigation event

An asteroid impact with Earth is a very low probability event. Yet, if it were to happen, the consequences could be devastating. At the same time, an asteroid impact is the only disaster that can, in principle, be predicted and for which preventive or mitigating measures can be taken with the currently available organizational and technological resources. The key to successfully preventing and mitigating the devastating consequences of an asteroid impact is early detection and a preplanned response.

The PDC 2023 simulation exercise [1]was based on the impact of a large asteroid (approximately 500 m in diameter). An object of this size is difficult, if not impossible, to deflect. It was assumed to be a newly detected near-Earth asteroid, found on 10 January 2023 by the Cerro Tololo Inter-American Observatory (CTIO) in Chile, which had not been visible previously, as its orbit is very similar to the Earth's and was only visible for short periods after sunset.

One week following discovery, the Minor Planet Center (MPC) announced the asteroid's detection and gave it the designation "2023 PDC", emphasizing that it was not a real asteroid, rather was a simulation. The MPC's initial assessment revealed that 2023 PDC's orbit approaches the Earth's orbit within 7.5 million kilometers and that the asteroid is probably at least several hundreds of meters in size. These two determinations implied that 2023 PDC was a Potentially Hazardous Asteroid (PHA). It also meant that the international astronomical community would observe it with telescopes. With additional reported observations, the orbit of 2023 PDC became more certain, and the chances of impact in 2036 increased. The NASA Center for Near Earth Object Studies (CNEOS) Sentry impact monitoring system determined that 2023 PDC had a one-in-ten-thousand chance of impacting Earth in the year 2036. A similar conclusion was reached by ESA's Near-Earth Objects Coordination Center.

On April 3, 2023, as the tracking dataset had grown, the impact probability increased and reached about 1 %. A collision with Earth by 2023 PDC would have severe consequences for the countries in the immediate vicinity near impact, and in the case of an impact in or near the water, there might be a tsunami of a magnitude that would cause substantial damage along the coastlines. It could also influence the global climate, with negative consequences for agriculture and food production, among others.

At that time, on the Palermo Scale, 2023 PDC rated −0.88, sufficiently high to place it at the top of the Sentry Risk list. On the Torino

Abbreviations: PDC, Planetary Defense Conference; COPUOS, Committee on the Peaceful Uses of Outer Space; IAWN, International Asteroid Warning Network; SMPAG, Space Mission Planetary Advisory Group; UN, United Nations.

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https://doi.org/10.1016/j.actaastro.2023.10.052
Received 30 May 2023; Received in revised form 17 October 2023; Accepted 31 October 2023
Available online 9 November 2023

Scale, the asteroid was rated 1 (Green). This means that at that time, the chance of collision was unlikely; not requiring immediate public attention or public concern. However, it was sufficiently high for the planetary defense community to take action. With the information available, if the asteroid were on a collision course with Earth, the date of the impact could be predicted accurately to be 22 October 2036. Thus, the warning time amounted to 12.5 years in advance.

This extensive lead time is an advantage: it allows the planetary defense community to study and analyze the celestial body, determine the precise impact corridor, and the most probable impact time. It would even be possible to send scouting missions to the celestial body, to obtain its composition, structure, and shape. This would help determine the best deflection or mitigation strategy.

The initial impact corridor spanned the area between Mexico, the southern and eastern part of the United States, the North Atlantic, the northwest coast of Africa, and South Africa. The impact corridor went through several densely populated areas, including Washington, DC.

On the other hand, there was also a disadvantage associated with the extensive lead time: the economy in the impact corridor would become severely affected, as investments would probably decrease, real estate values would plummet, banks could become insolvent as the population would try to leave the area. The extensive lead time would be a period of considerable political and economic uncertainty, during which time events would take unpredictable turns. Merchant shipping and other trade routes near the risk corridor would be likely to be discontinued around the time of a possible impact. Delivery chains would be interrupted. In Africa several areas, where important raw materials are being produced, were in danger. In fact, the economy could deteriorate to the point that the production of assets required for the mitigation effort could be put in jeopardy [2].

The midpoint of the impact corridor was determined to be around the Canary Islands and the northwest coast of Africa. Should there be an impact near the Canary Islands, it might produce a tsunami several hundred meters high. This, along with potential fireballs and the high surface winds will devastate the islands and the coastlines of northwest Africa. A tsunami tens of meters in height might pass through the Gibraltar Straits, causing severe damage to the coastal areas. There might be significant damage as far away as the coastlines of the Latin American countries.

The event could also jeopardize the production of food, both locally and, through the injection of large amounts of water vapor, CO2 and/or dust into the atmosphere, reduce the agricultural output in a large area. The Canary Islands would most likely have to be evacuated. Europe would face a massive refugee problem, as large fractions of the population of the potentially affected African countries could be motivated to leave. As a consequence, a state of emergency would be declared in many states. The military and other security forces could, in some countries, take over. If the impact corridor were several thousand kilometers to the east of its predicted location, it would pass through eastern Europe, Belarus, Ukraine, the Black Sea, Turkey, Syria, Lebanon, Israel and Egypt. It is impossible to guess the consequences of the collision event on the relations between countries that are in conflict.

2. Mitigation planning

For several decades the scientific and technical astronomical communities have been observing and studying Main Belt asteroids, i.e., those with orbits between Mars and Jupiter, as well as near-Earth asteroids, that orbit within 7.5 million kilometers from Earth. Beginning in 2001, with the establishment by the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) of the Action Team on Near-Earth Objects (AT-14), governments have become involved in preparations for an international response to the threat of a possible asteroid impact on Earth.

In 2009, AT-14 presented a report to the Scientific and Technical Subcommittee (STSC) of COPUOS with recommendations on the establishment of two international bodies, one to search for and characterize near-Earth asteroids, and the other to take action to deflect an incoming asteroid to prevent it from hitting the Earth [3]. After reviewing work that was being carried out by astronomical observatories and space agencies, in 2013 the STSC recommended, and COPUOS endorsed, that an International Asteroid Warning Network (IAWN) and a Space Mission Planning Advisory Group (SMPAG) should be established [4]. In December of 2013, the United Nations General Assembly welcomed the establishment of IAWN and SMPAG [5]. In January of 2014, IAWN was established as a network of institutions having astronomical facilities, independent of, but associated with, the United Nations [6]. In February of 2014, SMPAG was also established by a group of space agencies, independent of but associated with the United Nations [7]. In support of the work of SMPAG, COPUOS agreed that the United Nations Office for Outer Space Affairs should act as secretariat to SMPAG [8].

IAWN's primary work is to search for and characterize near-Earth asteroids, as well as to become the clearing house for information on asteroids approaching Earth. SMPAG developed a work plan [][][] [9] [] [][] for deflection missions for various scenarios of impact by asteroids having different sizes, and with different warning times before impact. Depending on the time available, SMPAG would examine possibilities of using a "gravity tractor" or a kinetic impact with the asteroid by one or more spacecraft, or could possibly use a nuclear device for deflecting the asteroid. SMPAG also assembled a working group of space legal and policymaking experts to examine the implications for space agencies and their governments related to existing space treaties and the consequences of a failed deflection attempt [10]. Since 2015, both IAWN and SMPAG have reported to the STSC on the work carried out in the previous year.

When the probability of impact by an asteroid of 50 or more meters in size reaches 1 %, IAWN will alert SMPAG. IAWN will also notify COPUOS through the UN Office for Outer Space Affairs, as well as the news media. The governments of the space agencies of SMPAG will notify all countries potentially at risk who would in turn involve their relevant national institutions to evaluate the country's risk, and possible preparatory actions. At the international level, the country of the chair of COPUOS will alert the UN Security Council, who will monitor the events. The United Nations Office for Disaster Risk Reduction and other UN agencies, such as the International Atomic Energy Agency (IAEA), will become involved because of the possibility of a nuclear deflection. In addition, the UN High Commissioner for Refugees will be engaged, as refugees and evacuees will no doubt occur.

Both IAWN and SMPAG are strictly scientific and technical bodies. Their members are institutions under the jurisdiction of their respective governments or governing boards. As a consequence, there will be geopolitical, diplomatic, and economic aspects to consider, first and foremost among the countries which are directly affected, but also among the international community.

While the above chain of events can be foreseen with certainty, there are other aspects that are undetermined, but which will have to be considered, as they affect the global political environment.

These issues might include the following:

1. Which is the appropriate time for action (Overreaction vs. Inaction)?
2. What is the role of schools, universities, social media, Internet and religion (Awareness-Raising vs. Catastrophism)?
3. What is the relevant timeframe for proper legal/policy and institutional mechanisms to be put in place (Preventive Law vs. Reactive Law)?
4. What is needed – who can provide it first: Our neighbors? Our allies? An international fund (Domestic Aid vs. External Assistance)?
5. What is the harm threshold for precautionary action (A Right to Take Precautionary Measures vs. a Duty to Take Precautionary Measures)?
6. What are the evacuation priorities (The Most Vulnerable vs. The Productive Sector)?

7. Is there a responsibility to welcome other citizens in case of disaster (Internal Displacement vs. Cross-Border Displacement)?
8. In a ten-year period (or less), is it possible for a developing country to build its own space capacities to follow up the situation and eventually mitigate the effects (Own Space Capabilities vs. External Reliance)?
9. How would this collision event impact the national/regional/local political process (State of Emergency vs. Business as Usual)?

10. Will the Security Council act? Will it authorize the use of nuclear devices (Non-nuclear vs. nuclear deflection).

3. Geopolitical and legal implications

In case of the impact scenario described above for the PDC 2023 event, there are several issues that pose contradictory courses of action that –depending on certain factors– might be the right way to proceed for those at risk. It should be kept in mind that with additional observations, the risk corridor will become smaller and the danger for some countries will decrease, while for others it will increase. In this article, we designate them as planetary defense response *dilemmas* that might arise when different stakeholders have a role to play. Consequently, it is essential to engage policymakers, diplomats, the scientific astronomical community, academia in many disciplines, the industry and other relevant stakeholders in the discussion on how to deal with a large number of dilemmas. For this article, we have identified a few dilemmas that are addressed below. This list is illustrative:

3.1. Overreaction vs. Inaction

If we assume that the estimated time of impact is 12.5 years in the future, decision makers may decide it not necessary to act immediately, and might instead procrastinate in taking a preventive approach (see below in our list). Such a delay in action may have different reasons:

a) As a consequence of States not recognizing their duties under international law in case of an asteroid impact [11], or when these are vague enough to justify inaction. In that case, the role scientific diplomacy plays in the furtherance of space global governance in the field of planetary defense is of the utmost importance. Global space governance may be interpreted as referring to instruments, institutions, and mechanisms governing and regulating space-related activities [12].

As part of the global governance of space, the SMPAG Ad-Hoc Working Group on Legal Issues provided for a necessary exchange of views and has produced a report on a possible interpretation as to the applicability of the existing international space regime. The identification of legal gaps, the clarification regarding the extent that international space law applies to legal issues emerging from planetary defense, and what the limits are that international nuclear law sets to a potential nuclear response –these are all topics that merit a continuing debate.

b) Another concern is the existing myth that an asteroid collision with Earth is pure science fiction. As long as we continue to see that risk as far away from our daily concerns, it will be very difficult to consider emergency plans either domestically or globally to tackle the problem in advance. The campaign to raise awareness that began in 1995 with the United Nations Conference on Near-Earth Objects was an important milestone that marked a new era in this field. Organized and chaired by John L. Remo, the purpose of the conference was to put into perspective the role of Earth-crossing asteroids as a danger for the extinction of species, and to assess potential threats in the future [13].
One additional relevant precedent is the Third UN Conference on the Exploration and Peaceful Uses of Outer Space of 1999 (UNISPACE III), with its Vienna Declaration on Space and Human Development [14]. In that document, a call was made to improve the "international coordination of activities related to near-Earth objects, harmonizing the worldwide efforts directed at identification, follow-up observation, and orbit prediction, while at the same time giving consideration to developing a common strategy that would include future activities related to near-Earth objects". COPUOS has been an adequate forum for discussions at the intergovernmental and international level in an inclusive fashion on this topic. In fact, the call in the Vienna Declaration led to the establishment of IAWN and SMPAG.
c) A third reason for concern about inaction is the possible difference between policymakers' concerns and those of the general public. Once policymakers are made aware of the need for a strategic plan, they must make sure that society comprehends what these threats are, and how they might change our lives. This is a difficult task when dissemination of related information is not as easily understood as more frequent and familiar events, such as tornadoes, floods, earthquakes. This is an issue that will be further discussed in the next dilemma.
d) Another reason for delayed action might be that the lead time spans three, or even four legislative periods. In countries without a well-developed state space policy, existing legislation on a national response in the case of an asteroid impact threat could be overturned or ignored. Also of significance will be the fact that the asteroid threat will play a role in election campaigns in many countries.

3.2. Awareness-Raising vs. Catastrophism

Awareness-raising and effective communication is vital during the whole emergency cycle: from *pre* to *post facto* -i.e. from the preventive and early warning stages to the relief and rehabilitation phase. As already proposed, a communication strategy is necessary to bring down to Earth the concerns that occupy policymakers. Communication, formal or through the social networks, is not the only fit-for-purpose means. Education serves an important role in how we build more resilient societies. In that regard, it is appropriate to recall that resilience has been defined as:

the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management [15].

At the inter-State level, international cooperation remains critical in assisting developing countries to build their resilience and their capacities to reduce disaster risk, and mitigate damage. A necessary strategy requires the implementation of measures not only at the policy but also at the educational level. School curricula should include planetary defense in subjects of global concern, such as climate change, poverty, immigration and many others. Universities should offer career opportunities covering the necessary fields to build capacities including in astronomy, physics, space engineering and space law. In concert with this, a policy of promoting women and girls in STEM contributes to raise awareness in an inclusive manner in full compliance with General Assembly Resolution 70/212 [16].

It is important to know how to strike a balance between scientific knowledge and fake news in an interconnected world governed by social media and the Internet shaping public perceptions. It is of the utmost importance to disseminate necessary and timely scientific-based information in everyday language to avoid unnecessary alarm, and thus dissipate unrealistic fears and eradicate opportunist misinformation (false or inaccurate information) and disinformation (malicious information) [17]. This is a role that should be played by IAWN. Past disasters, like Hurricane Sandy and the recent Earthquake affecting Turkey and Syria, have demonstrated how easily, and quickly, fake news, dramatic footages and videos spread panic.

The role of religion is paramount for traditional reasons in many countries, and faith may play an important role downplaying catastrophism of those convinced that the Universe is at the brink of extinction. Furthermore, common values to most religions are solidarity, humanity, and cooperation, similar to what positive law imposes as a premise of the social contract in the domestic domain, and to what humanitarian principles mandate as part of the basic international coexistence, or *ius gentium*. On the other hand, there is the real danger that some sects or gurus will convince their followers that the threat is not real, that the scientists are not to be trusted, and that people should not collaborate, but rather incite others not to collaborate.

3.3. Preventive Law vs. Reactive Law

Most States have passed appropriate laws dealing with disaster management. If we consider that a disaster is defined as a calamitous event that causes widespread loss of life, great human suffering and distress, mass displacement, large-scale material or environmental damage and that seriously disrupts the functioning of the society [18], we can conclude that disasters may be local, transboundary and global. Yet, if we examine closely the number of States that have included asteroid/comets collisions in their strategies as a possible hazard, the outcome is of great concern. This begs the question as to whether any national emergency strategy is *mutatis mutandis,* i.e., applicable to an asteroid impact. If we take for granted that the answer is in the affirmative, then possible gaps and remedies to the inadequacy of the law will have to be addressed with a reactive approach when disaster occurs.

However, it is possible to conceive NEO hazards as essentially different compared to other disasters. In effect, although the full spectrum of consequences might range from local to global, the efforts for planetary defense action –surveillance and mitigation– can only be global, and that is the reason why planetary defense should be understood and addressed as a global challenge [19]. The need for telescopes and other assets to be distributed in different parts of the world is only one single part of the international strategy for prevention and mitigation. When options to implement defensive measures –deflection or destruction– are discussed, there is no acceptable alternative to the multilateral approach.

States should not sit idle and wait until IAWN alerts when a possible collision is imminent to discuss necessary legal frameworks, to undertake federal discussions or set up proper national committees. As long as the domestic situation is covered, the possibilities to allocate time and resources to develop an international strategy and to exchange good practices will be more productive. In this regard, capacity-building and technical assistance in drafting new legislation is a necessary tool that should be implemented with a preventive approach, i.e., before facts, and sometimes requiring a visionary approach. A reactive perspective of the law-making process probably leads to inefficient disaster management, and it might involve issues of State responsibility for the failure to comply with the due diligence principle [20]. In the context of planetary defense, this tenet imposes the obligation to adopt and implement legislative and administrative preventive regulations.

In this regard, pursuant to well-established international law governing human rights, States have a duty to adopt such laws or other measures as may be necessary to give effect to human rights [21]. In case of disasters, the vulnerability of the people affected is often the result of inadequate planning and insufficient disaster preparedness, as recognized by Walter Kälim in his report to the Human Rights Council [22]. Bearing in mind this human-centered approach, legislation should not only address the relief aspect of the emergency strategy, but also a mechanism to facilitate expeditious sharing of information on upcoming disasters (early warning).

3.4. Domestic Aid vs. External assistance

It is widely recognized that in case of a catastrophe, the affected State has the primary *role* [23] and the primary *responsibility* [24] to provide relief assistance to people within its territory. This means that it has the authority to direct, control, coordinate and supervise relief assistance. However, its response capacity may not be appropriate due to the magnitude of the catastrophe, internal indecision, improper action frameworks, inadequate backup infrastructure, and duration of the disaster. It thus may require either funding or human resources beyond its disposal. In that case, it is generally accepted that the affected State has a *duty* to seek external assistance [25].

However, it is possible to envisage a different scenario, where a State is not willing to fulfill its obligations, or is simply unable to do so. The responsibility to protect might provide assistance in such cases, i.e., to acknowledge that there is a residual responsibility of the international community to protect persons whose human rights are seriously threatened. In effect, so far the responsibility to protect has become an 'emerging norm' in the event of serious violations of human rights, such as genocide, ethnic cleansing, and other violations of humanitarian law [26]. In 2005, the responsibility to protect was supported by the UN Secretary-General in his report entitled "In larger freedom: towards development, security and human rights for all" [27].

However, its applicability to natural disasters is not straightforward and requires careful consideration [28]. The UN Secretary-General reiterated that the responsibility to protect applies –until States decide otherwise– only to genocide, war crimes, ethnic cleansing, and crimes against humanity [29]. He endorsed a narrow and deep approach, and warned against undermining the 2005 consensus at the World Summit [30]. It should be recalled that on that occasion, the UN General Assembly adopted a resolution with the outcome document that limited the responsibility to protect against those four international crimes [31]. This position was further embraced by the International Law Commission in its work on the protection of persons in the event of disasters [32].

While there is a domestic duty for the affected State to provide first aid and seek assistance, they likewise have a sovereign *right* to accept, consent to, monitor and coordinate external help. Taking into consideration an apparent hierarchy derived from acknowledging that the affected State to be the ultimate authority, there are other stakeholders that have an important role in the coordination task, although in an auxiliary manner.

At an internal level, the National Red Cross and Red Crescent Societies have a key supporting role in assisting States [33]. At the international level, it is the United Nations, the organization that has the central and unique leading role in coordinating international cooperation in disaster prevention, preparedness and relief [34]. Complementing the coordination table, the UN Emergency Relief Coordinator is the central focal point for States and humanitarian assistance [35]. In line with that, it is relevant to note Article 2 of the UN Charter that lays out the obligation of every Member to give the organization every assistance in any action it takes in accordance with that instrument [36].

International cooperation is a well-rooted obligation in international law, enshrined in several instruments [] [] [] [37] [] [] [], and likewise is a cornerstone of international space law [38]. COPUOS and its two Subcommittees —assisted by the Office of Outer Space Affairs (OOSA)– is the unique platform at the global level for international cooperation in space activities [39]. In addition, pursuant to the Space Benefits Declaration, States are free to determine the aspects of their participation in international cooperation on an equitable and mutually acceptable basis [40]. According to the conclusions drawn by the SMPAG Ad Hoc Working Group on Legal Issues, there is no obligation under international law to assist other States in any specific way or to any particular degree [41].

3.5. A right to take precautionary measures vs. a duty to take precautionary measures

The precautionary principle was embedded in the Rio Declaration on

Environment and Development (1992) in reference to environmental threats of serious or irreversible damage when there is a lack of full scientific certainty. According to the International Law Commission, the precautionary principle is a very general rule of conduct of prudence that imposes an obligation to keep abreast of the technological improvements in the field [42]. As Caroline Foster put it, a precautionary measure departs from the "primacy of scientific proof" [43]. This principle applies in cases where there is a potential, uncertain or hypothetical threat to cause *serious* or *irreversible* harm.

On the basis of this brief introduction to the precautionary principle, we wish to stress an interesting analysis made by Arie Trowborst. He distinguished between a *right* and a *duty* of States to take precautionary action. He argued that when there is a concern that *significant* harm may occur, States have a *right* to take precautionary action. However, when there is a concern that *serious* and/or *irreversible* harm may occur, States have a *duty* to act. In both cases there is a concern that harm may occur (this is the element of uncertainty), the difference is the degree of damage.

Although this approach seems interesting, it poses the challenge of clearly establishing a harm threshold. When undertaking early warning measures, the qualification of potential harm might determine the existence of a right or a duty to take precautionary measures. To further complicate things is the fact that scientific uncertainty might be interpreted and communicated in different, and even contradictory, ways depending on different stakeholders and conflicting interests.

If we examine the possible damage that a NEO impact might cause, it is clear that it might range from material damage, through loss of human life, to long-lasting intangible damage to the environment and ecosystems, even impacting future generations. Any human victim represents irreversible damage, and should be conceived as serious harm. In that sense, planetary defense missions might prefer to deflect an asteroid to move the impact target to an unpopulated area and, for instance, choose a desert or the ocean. However, human life should not be the only criteria to focus on because the possibilities of affecting the environment, and ecosystems causing irreversible damage for future generations are huge.

The previous reference to future generations deserves brief comment due to the special momentum that the concept has gained. In that regard, it should be recalled that since the 1972 Stockholm Conference on the Human Environment, the reference to 'future generations' became well-rooted in environmental law and sustainable development [44]. In 1997, UNESCO adopted the Declaration on the Responsibilities of the Present Generations towards Future Generations which expressly enshrines the responsibility of ensuring that the needs and interests of present and future generations are fully safeguarded [45]. The UN Secretary-General proposed in his report 'Our common Agenda' gathering efforts towards a Declaration on the Future Generations [46]. Upon receiving inputs from States and other relevant stakeholders, the co-facilitators collated some elements for such a future declaration. It is appropriate to make reference to one of the three elements that were identified as prerequisites for a safe and sustainable future: 'planetary well-being and preserving life on Earth' [47]. We have to promote planetary defense from NEOs as a cornerstone of that element.

In sum, a cautious approach is imperative in the context of planetary defense, where an "extremely rare yet enormously destructive risk" is at stake [48]. Events cataloged as "high impact, low probability" (HILP) represent an additional challenge: the implementation of the precautionary principle is not free from ambiguity, especially considering that the price of action vs. inaction is high [49]. This triggers the following question: what is the threshold for relinquishing a right to defend our planet?

3.6. Evacuation priorities: the most vulnerable vs. the productive sector

When an evacuation strategy is considered, States need to set priorities. Relocation shall comply with minimum standards of dignity and must be focused first and foremost on the most vulnerable groups. This means that persons with disabilities, older persons, pregnant women, and separated/unaccompanied children have to be prioritized [50].

Although the productive sector is undoubtedly a driver for development, its relocation is not prioritized, at least from a humanitarian perspective. The explanation for that may be found in well-established human rights jurisprudence and doctrine, whereby the right to life "constitutes a fundamental right, the effective protection of which is the prerequisite for the enjoyment of all other human rights, and the content of which can be informed by other human rights" [51].

Another group that is particularly vulnerable to disasters, and consequently to evacuation, are indigenous populations, peasants, pastoralists, and other persons attached to their lands in affected areas [52]. In the case of the first group, cultural aspects should be taken into account, and thus tailor-made contingency plans should observe the provision under human rights law not to forcibly remove indigenous populations from their lands without their free, prior, and informed consent [53].

3.7. Internal displacement vs. Cross-Border Displacement

As recognized by the UN Secretary-General, disasters are one of the drivers of displacement [54]. In every impact scenario, two possible forced movements of people are distinguishable: the first one is internal displacement, i.e., persons or groups of persons who have been forced or obliged to flee, or to leave their homes or places of habitual residence as a result of a natural disaster [55]. Since this type of human flow takes place within State borders, there are no migratory issues involved, and the affected State will have to guarantee the freedom of movement under human rights law. States have the primary responsibility to enable sustainable solutions to internal displacement [56]. Furthermore, one of the exceptions of forced internal displacement conducted by the State (evacuation) is when a disaster threatens life and health of the affected persons [57].

The other type of displacement relates to people that flee across borders in the context of sudden- or slow-onset disasters [58]. This group of displaced people does not fall under the concept of refugee under the 1951 Refugee Convention, as it does not include disasters as a legal reason to be considered a refugee under the treaty [59]. Moreover, cross-border disaster displacement is not regulated by international law, i.e., there is no obligation to admit displaced persons, there is no clarity as to what their rights should be in their new host country, under what conditions they might stay in the new place, and for how long. Beyond the protection that human rights law provides, displaced persons become subject to domestic migratory laws, and the specific practices that States may wish to implement in special circumstances.

One of the main rationales for such practices can be found in the principle of solidarity, which is not clearly defined in international law. In addition, humanitarian considerations and friendship bonds with neighboring countries help address displacement in two possible ways: admitting displaced persons (e.g., issuing visas, establishing migratory exceptions, waiving certain prerequisites, etc.) or refraining from returning foreigners to a country in a disaster environment (e.g., suspend a deportation, extend more considerate deadlines, etc.). It should be recalled that the discretion to admit or refuse aliens falls under the sovereign powers of States, thus they have the right to exercise this discretionary authority in a broad manner.

3.8. Own Space Capabilities vs. External Reliance

If we consider the disaster cycle in the context of planetary defense, this dilemma allows for a three-pronged analysis: first, the dilemma should be discussed regarding the early warning period. This includes State capabilities to observe, track and characterize NEOs, to determine their orbital position, and build impact models. It is not only necessary to find asteroids before they find us, but also to know more about their

composition [60]. There are very few States with sophisticated detection facilities, equipped with suitable ancillary instruments, robotic telescopes, or even spacecraft with telescopic capabilities. However, there is an important network of observatories around the world, coordinating through IAWN, that contribute to planetary defense. Most NEO detections are made by observing facilities belonging to the large space agencies. In addition, there are thousands of ambitious amateurs with relatively modest telescopes observing the skies in search of comets and asteroids. An example to be mentioned is the case of Gennady Borisov, who discovered the first interstellar comet in 2019 (called after him, 2I/Borisov).

Once hazardous objects have been identified, on the basis of information provided by IAWN and SMPAG, States should discuss and make a decision regarding possible planetary defense missions, either disruptive or destructive. For such an endeavor, States need the capacity of producing and launching a space object into orbit with the aim of deflecting or destroying an NEO. However, there are only some twelve States and international organizations around the world with launch capabilities, and some thirty States that master the whole spacecraft manufacturing process. This means that the technology, know-how and funds to conduct planetary defense missions are not an attainable goal in the years leading to the impact for most States not currently having that capability.

Finally, if the impact on Earth could not be avoided, this dilemma on the space capacities needs to be examined in the context of disaster risk response, recovery and rehabilitation through Earth observation. In this case, space data for monitoring disasters will depend on remote sensing capabilities. The Principles Relating to Remote Sensing of the Earth from Outer Space encourage States conducting space activities for the protection of the Earth's environment to cooperate in transmitting and making space data available to States concerned [61]. In addition, the International Charter 'Space and Major Disasters', which celebrates its 20th anniversary this year, is a worldwide collaboration that makes space data available to authorized users for disaster management in the pre- and immediate post-disaster phases [62]. For preparing for the disaster and for long-term rehabilitation periods, the Committee on Earth Observation Satellites provides access to data from a number of satellites in line with the work carried out by its Working Groups on "Capacity Building and Data Democracy" and "Disasters".

The analysis made above reveals that international cooperation is imperative when it comes to planetary defense during the whole collision event life cycle, which in other terms means that both developing and developed countries contributions can make a difference.

3.9. State of Emergency vs. business as usual

During the outbreak of COVID-19, States declared a state of emergency, implementing a series of restrictions on basic human rights [63]. Critical voices were raised even louder when the discussion moved away from limitations to civil rights to limitations of political rights, such as the right to cast a vote. There were several States that postponed their elections [64]. The question then was whether democracy and the rule of law were at risk due to the suspension of planned elections.

In some countries, the postponement of polls (usually up to three months) is enabled in their respective constitutions. In other cases, *ad hoc* solutions were established in agreement with all the political parties. Such contingent measures included postponement, early voting, postal voting, proxy voting and voting by mobile ballot box [65]. Not all solutions are applicable everywhere, and particular attention should be paid to the implementation of voting mechanisms that might deprive vulnerable groups –such as elderly people, people with disabilities and persons without Internet access– of the right to elect national or local authorities.

States of emergency are recognized under human rights law [66]. Public emergencies need to comply with certain conditions in order to be lawful: there must be a threat to the very existence of the nation, and it must be officially proclaimed. In addition, the measures should be exceptional and temporary. Finally, restrictions must meet the requirements of legality, necessity, proportionality, and being non-discriminatory.

According to well-established doctrine, a State may invoke the right to withdraw human rights obligations during a natural catastrophe. However, since not all such events qualify as a public emergency, the State should justify not only that such a situation constitutes a threat to the life of the nation, but also that the measures are strictly required by the exigencies of the situation [67]. The reason why the state of emergency is so restricted is because the suspension of the legal order often leads to systemic human rights violations [68].

The recent Covid pandemic teaches us an important lesson for future states of emergency: in order to preserve the turnout level of voters and to avoid diverting necessary State funds reserved to combat the exceptional state to fund extraordinary voting mechanisms, it is advisable to specify voting options in the relevant electoral codes beforehand, i.e., the necessary amendments need to be discussed and agreed upon during ordinary circumstances. In terms of planetary defense measures, this might be an additional preventive measure that risk mitigation plans might foresee to minimize undesirable effects.

3.10. Non-nuclear vs. nuclear deflection

There are different methods that may be used to prevent an asteroid from impacting with the Earth, including employing kinetic impactors, gravity tractors, space tugs and lasers. It is important to bear in mind that as is typical for every space technology, these techniques employed in planetary defense are likewise used for dual purposes and, as such, may be also misused as counter-space capabilities [69]. In that context, transparency and confidence-building measures provide a useful tool to avert misunderstandings.

In effect, kinetic impactors use the same technology of ascent anti-satellite (ASAT) weapons; however, the Double Asteroid Redirection Test (DART mission) proved to be a successful means to deflect an asteroid. Gravity tractors and space tugs remain immature techniques and their efficacy in planetary defense missions is yet to be determined. On the other hand, they present the same issues to space security as rendezvous and proximity operations (RPO) when used as co-orbital ASAT weapons. While RPO might be a plausible solution to space debris mitigation, the concerns regarding its possible misuse neutralize any incentive to develop this technique. Lasers can vaporize the surface of an asteroid and thus change its trajectory; however, such a technique needs extensive development in the implementation of space defense missions. Like other options, lasers are considered a capability that might be employed for malicious purposes in outer space, such as disrupting or blinding a satellite (dazzling).

Nuclear devices are the only currently available technology to deflect sizeable asteroids (>500 m) when the lead time is small (<10 years) [70]. A nuclear detonation might be carried out *on* or *nearby* an asteroid with the aim of changing its trajectory or destroying it. While the most effective technique would be nuclear deflection, for the time being it is the most contentious alternative. In effect, this option has a twofold disadvantage: the use of nuclear explosive devices (NED) has many barriers under current international law [][][] [71] [][][] and is politically sensitive. Its impact on non-proliferation and disarmament policies remains very controversial [72]. Furthermore, potential implications for the environment, and thus for future generations, cannot be disregarded, although the International Court of Justice has found that "the existing international law relating to the protection and safeguarding of the environment does not specifically prohibit the use of nuclear weapons" [73].

In addition to the dual-use nature, planetary defense missions could produce an asteroid fragmentation effect which is an extra concern for space traffic management and safety of space activities. All these aspects reveal that every effort in this field has a contact point with the agendas

of COPUOS, the Conference on Disarmament, the First and Fourth General Assembly Committees, and the IAEA and, therefore, coordination and joint work is necessary to enhance space global governance.

Finally, the possibility of characterizing and addressing an impending asteroid impact as a threat to peace in the terms of Article 39 of the United Nations Charter will definitely require the involvement of the Security Council [74]. In that scenario, it should be borne in mind that the permanent members of that Council are nuclear-weapon States and have veto power over resolutions, recognized as such in the Non-Proliferation Treaty. In other words, the nuclear deflection option is constrained by the Security Council.

4. Conclusions

As stated, an asteroid impact to Earth is a very low probability event. Yet, if it were to happen the consequences could be devastating. Although the 2023 PDC impact exercise is only a simulation, it provides the opportunity to examine some of the issues that need to be considered in case a large asteroid is found to have reasonable probability of impacting Earth within a warning time of five to ten years, in which time planning and carrying out a deflection or mitigation campaign may be considered. In this paper, we briefly discussed some of the topics that would need to be addressed in each of ten selected issues. There are other topics within these issues and indeed, other issues that should be covered.

For the size of 2023 PDC, and the warning time provided by the Planetary Defense Conference, we believe that the primary topic should focus on whether the United Nations Security Council would authorize the use of a nuclear explosive device (NED) to deflect or destroy the asteroid. Because the five permanent members of the Security Council, any one of whom can veto the use of an NED in space, are nuclear powers, it would be necessary to engage in geopolitical and economic, possibly even cultural and religious, discussions.

The 2023 PDC simulation will be carried out over a timespan of five days, during which time participants in the exercise will receive information on the determination of an impact date, the characterization of 2023 PDC, and the communications by IAWN through OOSA to SMPAG and COPUOS. Information will also be provided to governments in the risk corridor, as well as to the Security Council, and to various national and international organizations that would prepare and provide relief in case of an impact. In a real scenario, participants would have much more time to analyze and determine how the information received at one stage influences the decisions that are made later by each of the stakeholders. Nonetheless, participants will gain experience in those factors that drive the decisions that need to be made and how those decisions influence downstream decisions and actions. With the knowledge acquired during the PDC conference, participants will be able to reproduce the exercise in their home countries and institutions without the time limitations of the 2023 PDC exercise. From a simulated exercise, the first steps to prepare for an asteroid impact will have been taken.

Disclaimer

The scenario presented in this article is entirely fictitious. It should not be taken as a prediction, but it should be taken as a simulation of what an actual threat scenario may look like, and how in the span of a week, to take decisions to act that would take years in a real impact scenario.

The views expressed in the present article are those of the authors and do not necessarily represent the views of the institutions or entities they are affiliated to.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We would like to express our heartfelt gratitude to Dr. Robert Williams, esteemed astronomer and scholar, for his invaluable assistance in meticulously refining this manuscript. Dr. Williams' contributions have played a pivotal role in elevating the quality and clarity of this work. We also extend our sincere appreciation to Dr. Christian Koeberl for his constructive feedback as an insighful reviewer of this article.

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