Diplomatic, Geopolitical and Economic Consequences of an Impending Asteroid Threat

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Abstract

The exercise conducted during the PDC 2023 assumed a threat scenario with a large (around 500 m) asteroid; difficult or impossible to deflect, with a long (12.5 year) lead time. It is obvious that these years will be extremely challenging. Countries in the impact corridor will try to implement protective measures, both civilian and military, just as countries not directly affected will assess the effects of the event on the diplomatic, political and economic environment. We examine issues like the processes unfolding in the International Asteroid Warning Network, the Space Mission Planning Advisory Group, the UN-COPUOS, the United Nations Security Council and other international organizations, the possible reaction of the major stakeholders, and the likely response of their space agencies, in light of a possibly deteriorating global economy. We also examine possible legal actions and obligations of the parties involved. The possibility that major powers might exploit the situation in economic and military terms cannot be discounted.

Keywords

NEOs - Planetary Defense - COPUOS -International Space Law - Space Global Governance

Introduction: The Mitigation Event

An asteroid impact to Earth is a very low probability event. Yet, if it was 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 prevention or mitigation measures can be taken with the currently available organizational and technological resources. The crucial keys for a successful set of actions to prevent or mitigate the devastating consequence of an asteroid impact are its early detection and having a preplanned response.

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

A week later, the Minor Planet Center (MPC) announces it and gives it the designation “2023 PDC”, emphasizing that it is not a real asteroid. The MPC’s initial assessment reveals 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 imply that 2023 PDC is a Potentially Hazardous Asteroid (PHA). It also means that the international astronomical community will focus on observing it when in view of their telescopes. With additional reported observations, the orbit of 2023 PDC has become more certain, and the chance of impact in 2036 has grown. The NASA Center for Near Earth Object Studies (CNEOS) Sentry impact monitoring system determines that 2023 PDC has a 1-in-ten-thousand chance of impacting Earth in the year 2036. A similar conclusion is reached by ESA’s Near-Earth Objects Coordination Centre.

On 3 April 2023, as the tracking dataset has grown, the impact probability has increased and is estimated to be about 1%. An impact on Earth by 2023 PDC would have severe consequences for the countries in the immediate vicinity, and in the case of an impact in or near the water there might be a tsunami of a magnitude which would cause severe damage along coastlines. It will also influence the global climate, with consequences for agriculture and food production among many other consequences.

At present, on the Palermo Scale, 2023 PDC rates -0.88, high enough to place it at the top of the Sentry Risk list. On the Torino Scale, the asteroid is rated 1 (Green). This means that current calculations show the chance of collision is unlikely with no cause for immediate public attention or public concern, but sufficiently high for the planetary defense community to take action. With the information available, if the asteroid is on a collision course with Earth, the date of the impact can be predicted accurately to be 22 October 2036. Thus, the warning time is 12-and-a-half years.

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

The initial impact corridor spans the area between Mexico, the southern and eastern United States, the North Atlantic, the northwest coast of Africa, all the way down to South Africa. The impact corridor passes through several densely populated areas, including Washington, D.C.

There is also a disadvantage to the long lead time: the economy in the impact corridor will become severely affected, as investments cease, real estate values plummet, banks may become insolvent, as the population tries to leave the impact corridor. The long lead time will be a period of considerable political and economic uncertainty, during which events

might take unpredictable turns. Merchant shipping and other trade routes near to the risk corridor are likely to be discontinued around the time of a possible impact. Delivery chains will fragment. In Africa several areas where important raw materials are being produced are in danger. In fact, the economy might deteriorate to the point that the production of assets required for the mitigation effort will be in jeopardy.[**2**]

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

The event will 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 will most likely have to be evacuated. Europe will face a massive refugee problem, as large fractions of the population of the potentially affected African countries will be motivated to leave. As a consequence, a state of emergency will be imposed in many states. The military and other security forces could, in some countries, take charge.

The impact corridor of 2023 PDC does not pass through areas with major conflicts. If the impact corridor were several thousand kilometers to the east, it would pass through Eastern Europe, Belarus, Ukraine, the Black Sea, Türkiye, Syria, Lebanon, Israel and Egypt. It is impossible to guess the consequences, especially if the object were even larger.

1. Mitigation Planning

For several decades the scientific and technical astronomical communities have been observing and studying asteroids from the Main Belt, with orbits between Mars and Jupiter, as well as those known as near-Earth asteroids, with orbits 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 to 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 established by a group of space agencies, also 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 main 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 of different sizes and warning times before impact. Depending on the time available, SMPAG would examine possibilities of using a “gravity tractor” or a kinetic impact to the asteroid by one or more spacecraft, or possibly the use of 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 in view of existing space treaties and, in particular, of a failed deflection attempt. [**10**] Since 2015, both IAWN and SMPAG report to the STSC on the work carried out in the previous year.

As soon as 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. In particular, the governments of the space agencies of SMPAG would 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, which will monitor the events. The United Nations Office for Disaster Risk Reduction and other UN agencies, such as the International Atomic Energy Agency (IAEA), as the possibility of a nuclear deflection must be considered, and the UN High Commissioner for Refugees, as refugees and evacuees have to be expected, will get involved.

Both IAWN and SMPAG are strictly scientific and technical bodies. Their members are institutions under the jurisdiction of their respective governments or governing boards. This means that 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 which 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 right time for action? (Overreaction vs. Inaction)
2. Which is the role of schools, universities, social media, Internet and religion? (Awareness-Raising vs. Catastrophism)
3. How long do we need to wait until proper legal/policy and institutional mechanisms are in place? (Preventive Law vs. Reactive Law)
4. What we need – who can provide it first: Our neighbors? Our allies? An international fund? (Domestic Aid vs. External Assistance)
5. Which is the harm threshold for precautionary action? (A Right to Take Precautionary Measures vs. a Duty to Take Precautionary Measures)
6. Which are the evacuation priorities? (The Most Vulnerable vs. The Productive Sector)
7. Is there a duty 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 impact on 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)

2. Geopolitical and Legal Implications

In case of an impact scenario as the one presented during the PDC 2023, there are several issues that pose contradictory courses of action that –depending on certain factors- might be or not 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 with much time in advance. 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 does not intend to be exhaustive but rather illustrative:

1.1. Overreaction vs. Inaction

If we consider that in the current exercise, the estimated impact would be in 12.5 years, decision makers might consider it not necessary to act right away 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 allow for inaction. In that vein, 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 to what extent international space law applies to legal issues emerging from planetary defense, and what the limits that international nuclear law sets to a potential nuclear response are topics that deserve a continuous debate.

b) Another reason is the still existing myth that an asteroid collision with the Earth is pure science fiction in a Hollywood movie. 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 well in advance. The awareness raising campaign 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 in the extinction of species and 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". Since then, COPUOS has been an adequate forum for discussions at the intergovernmental and international level in an inclusive fashion on this topic as well. In fact, the call in the Vienna Declaration led to the establishment of IAWN and SMPAG.

c) A third reason that can be identified with inaction is a disassociation between policymakers' concerns and those of the general public. Once policymakers are aware of the need for a strategic plan, they have to make sure that society comprehends what these threats are and how they might change our lives. This is of course a difficult task, in

particular, when dissemination of related information is not as easy as reporting on more frequent and familiar events, such as tornadoes, floods, earthquakes and the like. This is an issue that will be further discussed in the next dilemma.

d) Another reason for inaction 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 that the asteroid threat will play a role in the election campaigns in many countries.

1.2. 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 advanced, 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, migration 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 that, 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**]

However, 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 layman 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 Türkiye and Syria, have demonstrated how easily 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 and incite others not to collaborate.

1.3. 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 worrying. This begs the question as to whether any national emergency strategy is *mutatis mutandis* 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 in case a disaster occurs.

However, it is possible to conceive NEOs 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 points 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 alternative to the multilateral approach.

States should not sit idle and wait until IAWN alerts about a possible collision to discuss necessary legal frameworks, to undertake federal discussions or set up proper national committees. As long as the domestic flank 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 that regard, pursuant to well-established international law on 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 part of the emergency strategy, but also a mechanism to facilitate expeditious sharing of information on upcoming disasters (early warning).

1.4. 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 first say in the direction, control, coordination and supervision of the 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 time duration of the disaster, and 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 simply it is unable to do so. The responsibility to protect might provide assistance in such cases -i. e. to acknowledge that there is a residual responsibility on 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 opportunity, the UN General Assembly adopted a resolution with the outcome document that limited the responsibility to protect to 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 is at the top of the pyramid, there are other stakeholders that have an important role in the coordination task, although in an auxiliary manner.

At the internal level, the National Red Cross and Red Crescent Societies have a key supporting role of 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 point at Article 2 of the UN Charter that lays out the obligation of every Member to give the United Nations 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 particular way or to any particular degree.[**41**]

1.5. 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 would like to point at 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, we will realize 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 is irreversible and should be conceived as serious harm. In that line, 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 the future generations deserves a 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) put forward an additional challenge: the implementation of the precautionary principle is not free from ambiguity, especially considering that the price of action and inaction is high.[**49**] This triggers the following question: which is the threshold for relinquishing a right to defend our planet?

1.6. 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 has to 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 at the top of the list. [**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 which is particularly vulnerable to disasters and consequently to evacuation is indigenous population, 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**]

1.7. 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 the 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, which 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 which 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 exceptional practices that States may wish to implement in specific 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.

1.8. 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 only very few States with sophisticated detection facilities, equipped with suitable ancillary instruments, robotic telescopes and even spacecraft with telescopic capabilities. However, there is an important network of observatories at different points of the globe, coordinating through IAWN, which contribute to planetary defense. Most NEO detections are done by the observation facilities of 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).

Second, once the hazardous object has 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 a NEO. However, there are only some twelve States and international organizations around the world with launching 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 any single State 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 phase of disaster risk response, recovery and rehabilitation through Earth observation. In this case, space data for monitoring disasters will depend on the 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 collaborative mechanism 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 life cycle, which in other terms means that both developing and developed countries' contribution can make a difference.

1.9. State of Emergency vs. Business as Usual

During the outbreak of COVID-19, States have declared a state of emergency, implementing a series of restrictions to 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 the periodicity of electoral processes.

In some countries, the postponement of polls (usually up to three months) is foreseen 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.

The state of emergency is recognized under human rights law. [**66**] Public emergency needs to comply with certain conditions in order to be lawful: there must be a threat to the life 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 be non-discriminatory.

According to well-established doctrine, a State may invoke the right to derogate from human rights obligations during a natural catastrophe. However, since not every one of such events qualifies as a public emergency, the State will have to 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 pandemic thus 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 include 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.

1.10. Non-Nuclear vs. Nuclear deflection

There are different possibilities 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 dual-use 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 are currently immature techniques and their efficacy in planetary defense missions is yet to be determined. On the other hand, they reproduce 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 further development in the implementation of space defense missions. Like the 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 is an aspect that divides waters.[**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 organ having veto power are nuclear-weapon States, recognized as such in the Non-Proliferation Treaty. In other words, the nuclear deflection option is mainly in their hands.

3. Conclusions

As stated, an asteroid impact to Earth is a very low probability event. Yet, if it was to happen the consequences could be devastating. Although the 2023 PDC impact exercise is a simulation only, it makes it possible to examine some of the issues that would need to be considered in case a large asteroid was found to have a probability of impacting Earth within a warning time of five to ten years in which to plan and carry out a deflection or mitigation campaign. 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 warning time provided by the Planetary Defense Conference, we believe that the main topic would be whether the United Nations Security Council would authorize the use of a nuclear explosive device (NED) to deflect or destroy the asteroid. As the five permanent members of the Security Council, anyone of which 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 in five days, during which time participants in the exercise will receive information on the determination of an impact date and characterization of 2023 PDC, on the communications by IAWN through OOSA to SMPAG and COPUOS and 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 an appreciation for 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.

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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 could look like, and how, in the span of a week take decisions to act that would take years in a simulated 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.

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