PREVENTION, MITIGATION AND PREPAREDNESS FOR DISASTERS: ROLE OF UN COPUOS IN DISASTER MITIGATION AND INDIAN PROGRESS

Akanksha Marwah, Assistant Professor (Law), Delhi Metropolitan Education, Noida
(Affiliated to GGSIPU, New Delhi)

Aditya Grover, Advocate, Delhi High Court

Abstract

Race in outer space has, since inception, been dedicated solely to the benefit of humankind, the purpose of which shall be to further the common interests of the world. Under the aegis of UN COPUOS, the world, as one international community, has been working on developing the technology for assisting governments to support their programmers throughout various stages of disaster management. Indian Space Research Organization (ISRO) has also been dedicating itself to capacity building for implementation of space technology in disaster management support. Geoportals like Bhuvan, National Database for Emergency Management and MOSDAC are used by ISRO for disseminating information in geo-spatial domain. It further collaborates with other technologically advanced nations for development of disaster management strategies based upon space technology. Besides the Outer Space Treaty of 1967, which acts as the *magna carta* of the space law, international instruments like International Charter 'Space & Major Disasters', Sentinel Asia, and UNESCAP have been guiding through the use of space technology for the benefit of *homo sapiens.* The objective of this research paper shall be to understand the mechanism through which the space technology has been used for disaster management. Further, the endeavour shall be to delve into the initiatives taken by the ISRO in this regard. Furthermore, the systems employed by other sufficiently equipped and scientifically advanced nations shall be analysed for suggesting similar technologies for India.

Contents

I. Introduction

Asteroid named 2021 AF8 has been identified to be reaching Earth at a speed of approximately 9 km per second and is predicted to close pass with Earth and cross its orbit. It has been classified by NASA JPL as a 'Potentially Hazardous Asteroid' (hereinafter PHO) since its diameter is about 328 meter which has been tinier than those which have earlier crossed Earth's orbit.[1] This has not been the first time when any threat from outer space has been approaching Earth. Irrespective of this, world community has not paid much heed to such kind of disasters, unfortunately.

Humankind constantly runs the threat of being devastated by the force majeure. With every step that is taken towards technological development that can supplant a safety cushion for humanity, it is met by some advanced nature of threat that challenges it. Not every nation, unfortunately, in the current technologically-advancing environment, is equipped with sufficient means to cope with the effects of disaster that they know of let alone those that are still to be discovered. While it keeps struggling to predict and prepare itself for the disasters like earthquakes, floods, cyclones, etc. and reduce the possibility of losses, it faces once in a million years threats of collision with outer space objects.

Near Earth Objects (hereinafter NEOs) have, today, been recognized as real threats from outer space. Their 'recognition' signifies that these threats have always existed, probably, since the formation of this universe. Because they are not frequent, there have been a few incidents in the past that mandated working on mechanisms to predict such incidences and develop approaches to reduce their effects as much as possible.

Hence, objectives of this paper shall be to understand 'disasters' in perspective of destruction caused by NEOs and the need to recognize this definition of disasters. The intention shall be to motivate countries to prepare them for NEO impact. Considering this, the paper shall focus

1 "Asteroid equal to the size of football field to fly past Earth on May 4, but here's the good news" April 6, 2021, *available at*: Asteroid equal to the size of football field to fly past Earth on May 4, but here's the good news (dnaindia.com) (Last visited on April 15, 2021).

on proposing how the disaster management approaches can be applied to management of cosmic hazards especially asteroids and comets. Furthermore, suggesting what else can be done in terms of policy making and planning to respond to such disasters.

II. Disasters: The Need of New Perspective

As stated by the United Nations Office for Disaster Risk Reduction (hereinafter UNDRR), a disaster can be defined as "a serious disruption of the functioning of a community or society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope with using its own resources." The World Health Organization (hereinafter WHO) defines disaster as "an occurrence disrupting the normal conditions of existence and causing a level of suffering that exceeds the capacity of adjustment of the affected community." The United Nations Office on Outer Space Affairs (hereinafter UNOOSA) also, within its work on disaster management, refers to disaster as any event which has the capacity to cause serious disruption to the functioning of the community and leads to human, material economic, and environmental losses.[2] The keywords that could be taken up as essential ingredients of any disaster can be pointed as:

a) serious disruption in the normal functioning of a community or society,

b) widespread human, material, economic or environmental losses and impacts, and

c) losses exceeding the ability of the community or society that has been affected to cope with the damages using its own resources.

These events could be natural or man-made. Further, natural disasters can be either Earth-oriented i.e., those arising due to changes in the surface of the Earth or in the atmosphere that surrounds the Earth or they can be outer-space oriented disasters arising due to outer-space objects hitting the surface of the Earth. Presently, the focus of disaster management authorities revolves only around the first kind of natural disasters like earthquakes, landslides, volcanic eruptions, tsunamis, etc. were only considered as disasters and policies and actions were only directed towards them. But with the development of space technology, the information regarding extra-terrestrial objects revolving around or in the parts of solar system has also been shared with the astronomers working on the exploration of universe. The news

2 *Available at*: Disaster management (unoosa.org) (Last visited on April 15, 2021).

of their coming across the Earth's orbit often finds the headlines. Even though the chances of them clashing the Earth are miniscule, they do pose a potential catastrophic threat to the Earthlings and peaceful enjoyment of their time on Earth.

In the current context, it would be better to read these definitions within the broader context so as to cover all the incidents that can cause disruptions on the surface of the Earth. Cosmic impacts are not very common. They may happen at a gap of even millions of years.[3] For instance, some 6.5 million years ago, extinction resulted due to an object that was not even one-billionth of the size of the Earth.[4] Until astronomers gathered enough evidence about the existence of celestial objects around the earth, there was not much attention given to the incidents of this nature. Global recognition was given to them only in 2010 by NASA. However, still it does not receive much attention since the probability is very low. The world got interested because even though their probability is very low, the impact they have is catastrophic.

NEOs are asteroids or comets that orbit the Sun with a closest approach distance to it (perihelion) of 1.3 AU or less. These objects are found generally in the region between Mars and Jupiter and also beyond Neptune's orbit in the outer region of Solar System. NEOs are found usually in four orbits: Atiras and Amors which may come close to Earth but never cross its orbit and in Atens and Apollos which have trajectories crossing to that of Earth. They do not include Long Period Comets (LPCs) which have periods greater than 200 years. However, they also pose an added challenge because they rarely enter the inner solar system and make their entry unpredictable. Also, their velocity is higher than that of Earth due to their highly elliptical trajectories, so they deliver more energy on impact.[5] Because of their great impact, it necessitates that people must know when and where the next hazard would take place. If NEOs are more than five km in diameter, they can lead to extinction of humankind. But it has been confirmed by astronomers that in the coming century no cosmic hazard is lined which could lead up to the extinction of humans from planet Earth like the way it happened for dinosaurs. But there are many other small objects than the larger ones and even the smallest ones can cause significant destruction which can be hundreds of times greater than what was done by Hiroshima atom bomb.

3 David Morrison, Impacts and Evolution: Protecting Earth from Asteroids, 154(4) Proceedings of the Americn Philosophical Society 439-540 (2010).
4 *Ibid.*
5 READI: Roadmap for Earth Defense Initiatives, International Space University, 2015.

Earth's atmosphere can deal with impacts from objects below 40 m diameter. In such cases, only dust or debris reaches the surface of the Earth which is unable to cause any big explosion.[6] But even in these cases, dust spread in the stratosphere can block sunlight and lead to planet-wide crop failure for months. Further, these NEOs are enough to destroy a large city or small country if their diameter is less than two km in diameter. If they are more than two km in diameter, they can lead to a global catastrophe. Besides these objects, there is also a danger from undiscovered objects hovering around Earth.

III. Planetary Defense

Protection of Earth from the potential destructions that could be caused by the NEOs is often studied under the conceptual framework designed for planetary defense. Planetary defense is used "to encompass capabilities and activities associated with detecting the possibility of potential asteroid or comet impacts with Earth, providing warning, and preventing such impacts or mitigating their consequences."[7] This involves finding and tracking NEOs that pose threat to Earth, characterizing these objects with reference to their orbit trajectory, size, shape, mass, composition, rotational dynamics, and other parameters. These features shall be helpful for understanding the impact of these objects and for adoption of efficient means to cope up with them i.e., their planning for their prevention, if possible, deflection, if possible, and reduction and mitigation of potential losses.

There are five elements of Planetary Defense *viz.* Detection, Deflection, Global Collaboration, Outreach and Education, and Evacuation and Recovery.[8] For detection and tracking the trajectories of the NEOs, it is important to be fully equipped with professional ground and space-based telescopes. Precision in this stage is fundamental for adopting any strategy for evading NEO attack. Deflection is the strategy adopted to deflect a comet or asteroid from its course and prevent it from hitting Earth. But it requires an early warning of at least two years. Global collaboration in such matters is required to promote a political environment where there can be development of new norms where there is consensus of all the countries. United Nations is the authority in such cases to act as a platform where the countries can initiate plans for defending Earth from NEOs.

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6 David Morrison, Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe, 364(1845) Philosophical Transactions: Mathematical, Physical and Engineering Sciences 2041-2054 (2006).
7 Report on the Near-Earth Object Impact Threat Emergency Protocols, Interagency Working Group on Near-Earth Object Impact Threat Emergency Protocols, January 2021, *available at*: REPORT ON NEAR-EARTH OBJECT IMPACT THREAT EMERGENCY PROTOCOLS (archives.gov) (Last visited on April 15, 2021).
8 *Supra* note 5.

Besides creation of technologies and policies, one significant essential is to create awareness as much as possible not only amongst the world community but also at the individual level. Outreach and Education, thus, aim at sensitizing the public through workshops, conferences, seminars, or other such events for disseminating information.

IV. Disaster Management approaches and Planning for NEO

a. Earth oriented Disasters

Any disaster management system approaches the problem within a similarly designed framework. Disaster management cycle assists the community in preventing, mitigating, preparing, responding, rehabilitating, reconstructing and recovering from disaster. Outer Space based activities have been applied throughout the world in frequent disasters like earthquakes, landslides, tsunamis, floods, cyclones, etc. Technologies like remote sensing, geographical information system, global positioning system, satellite meteorology, satellite communication, and global navigation satellite system, the impending disasters can be predicted and the population can be prepared for the same.

To address the same, the United Nations Office for Outer Space Affairs (hereinafter UNOOSA) established UN-SPIDER, the United Nations Platform for Space-based for Disaster Management and Emergency Response (hereinafter UN-SPIDER) in 2006. UN-SPIDER works for developing the solutions "to address the limited access developing countries have to specialized technologies that can be essential in the management of disasters and the reducing of disaster risks."[9] It helps in providing universal access to space-based information and services relevant to disaster management.

By promoting systems like remote sensing, satellite-based telecommunications, and global navigation satellite systems, UN-SPIDER mandates that developing countries should be enabled to prevent, prepare, send early warning signals, respond to disaster and reconstruct after it has hit through knowledge sharing and strengthening of institutions. Also, UNDRR was created in 1999 to ensure the efficient implementation of International Strategy for Disaster Risk Reduction.

India also has a well-developed system to support disaster management. The system constitutes of creation and understanding of risk knowledge, development of continuous

9 *Available at*: UN-SPIDER (unoosa.org).

monitoring and predicting systems, quick dissemination of information and framing of efficient response strategies.[10] In every nature of natural disaster, the technology works in a different manner to identify disaster-specific signals for sending warnings. For instance, before earthquakes, the deformations happening in the surfaces can be helpful for identification and sending warning signals. Space-borne synthetics aperture radar interferometry and Global Positioning System (hereinafter GSP) measurements can be placed at different locations to gather such information. To predict volcanic eruptions, the land surface has to be monitored. Any surface deformation and emission of gases can end up in providing seismic signal and thermal anomalies to detect impending volcanic eruptions.

Landslides are often triggered by earthquakes and heavy rainfalls. The systems can be deployed to continuously monitor changes in surfaces and cloud formation over mountainous terrains can help predicting landslides and reduce its effects. Floods are heavy often caused by heavy inundation, thus, they require forecast of precipitation. The quantum of precipitation, knowledge of topography, soil properties, dense network of river gauges, and high-resolution digital elevation models are analysed to predict occurrence of floods. Similarly, forest fires can be detected by identifying fire-prone areas.[11] With the help of spatial data providing geographical content like maps, aerial photography, satellite imagery, GPS data, rainfall data, borehole data, etc., such data can be provided. Satellites have been put in the orbits to continuously monitor the changes in the surface of the Earth like variabilities of terrain, vegetation and water level changes. India's Disaster Management Support Programme undertakes to monitor all the aspects to prevent and mitigate disasters. It also disseminates information through the portals like Bhuvan, National Database for Emergency Management and MOSDAC for better decision-making.[12]

Likewise, even though basic technology would differ, the approach that supports disaster management can be used even for dealing with NEOs impact. Hence, the framework which has been used across the world for preparing and mitigating Earth-oriented disasters can be used to guide to the states for tackling the NEO based disasters.

b. Application of Disaster Management Approaches to NEO and existing framework

10 Ranganath Navalgund, Need for Developing Effective Early Warning Systems for Natural Disasters using Space Technology, 107(6) Current Science 935-936 (2014).
11 *Ibid*.
12 *Available at*: Disaster Management Support - ISRO (Last visited on April 15, 2021).

Dealing with NEOs involves strategizing for the event, before, during and after it hits. Before the event of disaster, prevention, mitigation of losses and preparedness is focused upon. This followed by emergency response during and immediately after it hits and subsequently, recovery and reconstruction from the damage caused. Because NEO impacts are infrequent, the countries have limited experience in operational mechanisms and infrastructural capabilities needed to address them. In addition, the knowledge pertaining to the population of asteroids and comets which are potential threats to planetary defense is limited.

With the available technology, asteroids can be detected by their motion using small ground-based telescopes and with state of art imaging sensors their orbits can also be obtained.[13] For NEOs, with the use of advanced technology and high precision telescopes prediction now can be done with more accuracy. It becomes easier to map because the asteroids have stable orbits.[14] Astronomical surveys can, further, lead to determination of expected time when they could hit the Earth. This can help in relocating the population and key infrastructure from the vulnerable area to safer zones.

Besides preparing population for the disaster and translocating properties, after the prediction of the NEOs, with the available technology there is also a possibility of deflecting the asteroid to miss hitting the Earth in entirety. However, this solution is contentious because we might invite the increased danger as well by changing their natural course of movement. Since the 1990s, the United Nations (hereinafter UN) has been moving forward to advocate the policies and measures for avoiding risks of disasters, and hence reducing the losses caused by them to lives and properties. It advocates developing technologies that can further this purpose throughout all the stages of disaster management cycle, *viz.* prevention, mitigation, preparedness, response, rehabilitation, reconstruction and recovery.

The goal for planning disaster management techniques to answer NEO threat-impact is to ensure that all countries are aware of potential risks as well as to ensure effective emergency response and disaster management in the event of a NEO impact. This is more so in the case of developing nations which have limited capacity for predicting and mitigating a NEO impact. As this area is crucial for ensuring human security and entire community interest is at

13 *Supra* note 3.
14 *Ibid.*

stake, UN strives towards facilitation of international response to a NEO-impact threat, with UNOOSA playing an active role.[15]

The development in science and technology helps in four broad preparedness capabilities. They include, firstly, identifying the threats, secondly, supporting requirements for coordinating emergency response roles and responsibilities upon identification of potentially hazardous object impacts; thirdly, improving the understanding of the consequences of a NEO impact, including assessing vulnerability of terrestrial, sea-, and space-based assets, infrastructure, and populations; and lastly, researching into potential capabilities to deflect or disrupt NEOs that pose a threat.[16]

Further, for response and recovery, space-based technology can be used to assess the loss and begin the rescue and evacuation operation. Remote sensing and other similar geographic interface systems can provide information for assisting the rehabilitation and reconstruction of the impacted area. It can be validly said that asteroid mitigation is no different than any other natural disaster (flood, Earthquake, hurricane, etc).[17]

The hard-work comes after the impact. Prevention of natural disasters is a difficult task, especially when it comes from outer space. But with strategic planning its effects can be substantially reduced and the losses can be minimalized. On the other hand, poor handling of the disaster or having no recovery plans can lead to multiplication of the loss of lives and property by manifold. After a NEO impact, most of the damage occurs in the form of thermal radiation and ground shock, but the possibility of tsunami and atmospheric blasts remains for as much as 12 hours. During the recovery phases, strategies must be set in place to revive the essential infrastructure viz. communication, transportation, clean water, sanitation, electricity, and medical and food services. Hence the importance of recovery, rehabilitation and reconstruction is paramount even in the cases of NEO impact.

c. Technological Support and Projects undertaken for NEO

15 Near-Earth Objects and Planetary Defense, UNOOSA, *available at*: https://www.unoosa.org/documents/pdf/smpag/st_space_073E.pdf (Last visited on April 15, 2021).
16 Identifying Science and Technology Opportunities for National Preparedness, National Science and Technology Council, December 2016, *available at*: https://www.sdr.gov/docs/NPST%20S&T%20Opportunities%20Report%20FINAL.pdf (Last visited on April 15, 2021).
17 Near Earth Object Overview, Secure World Foundation, *available at*: https://www.un-spider.org/sites/default/files/Agnieszka%20Lukaszczyk_Near%20Earth%20Object%20Overview.pdf.pdf (Last visited on April 15, 2021).

UNOOSA emphasizes that all the countries, in particular developing nations with limited capacity, are have technology so as to make them aware of potential risks on the basis of which they predict and mitigate a NEO impact. In the absence of such technology, they are provided with timely knowledge by other countries which have such information with them. Further, it has to be ensured that they are able to develop effective emergency response and disaster management in the event of a NEO impact. Since planetary defense is a matter of security of entire humankind, UN continues to facilitate the processes for developing an international response to a NEO-impact threat, with an active role being played by UNOOSA.

Prevention, Early Warning and Awareness: Planning for NEO begins from gathering the knowledge about the existence of the threat that we are running. Thus, first objective is to find and track at least 90 percent of NEO existing in the Solar System, especially those are 140 meters and larger in size than a small football stadium and characterize them.[18]

The focus in this stage is on the mostly the detection and tracking of PHOs. Large telescopes are required for this purpose which have the capability of observing objects at great distances from Earth with greater accuracy. Near-Earth Object Wide-Field Infrared Survey Explorer (NEOWISE) is one such telescope which is controlled by NASA for this purpose. This Infrared Telescope Facility (IRTF) is located on the Big Island of Hawaii and helps in studying physical characteristics of NEOs and provide responses to newly developed close-approach NEOs.[19]

In 2018, the Near-Earth Object Impact Threat Emergency Protocols (NITEP) Interagency Working Group (IWG) was convened by the National Science and Technology Council's (NSTC) Subcommittee in Space Weather, Security and Hazards (SWSH). The committee completed the process of developing National Near-Earth Object Preparedness Strategy and Action Plan. The report was released in January 2021.[20] The action plans pertaining to threat assessment, validation of threat, communication of information to administrative offices, emergency procedures at the time of impact, and other provisions were deliberated upon. The objective put forth by this report is the global protection of the eco-system, of human beings

18 Near-Earth Object Observations Program, *available at*: https://www.nasa.gov/planetarydefense/neoo (Last visited on April 15, 2021).
19 *Ibid*.
20 *Supra* note 7.

and their property on Earth, and of the civilization of humankind from the effects of a devastating asteroid impact.

As per the report, in an event of a credible impact threat prediction, warnings will be issued by International Asteroid Warning Network (IAWN). If the size of object detected is found to be larger than about 50 metres and the impact probability is larger than one per cent within the next 50 years, the Space Missions Planning Advisory Group (SMPAG) will start assessing mitigation options and implementation plans for consideration by the Member States. White House Directive Action 5.4. in the report develop protocols for notifying the White House and Congress, State and local governments, the public, foreign governments, and other international organizations regarding NEO threats.[21]

Further, in collaboration with United States Air Force and MIT's Lincoln Laboratory, NASA initiated Lincoln Near-Earth Asteroid (LINEAR) project for systematic detection and detection of NEOs. It led to successful discoveries of majority of asteroids discovered since 1998. NASA has been in action since 1998 and conducts Spaceguard Survey. Furthermore, US Air Force is also funding the joint project of University of Hawaii, MIT Lincoln Laboratory, Maui High Performance computing Center and Science Applications International Corporation for developing multiple telescope system PAN STARRS (panoramic Survey Telescope and Rapid Response System). First prototype was launched in 2006 and full PAN STARRS began in 2010.[22]

European Space Agency is also working on certain projects to contribute to Planetary Defense. It has entered into collaboration with NASA on Asteroid Impact and Deflection Assessment (hereinafter AIDA). Under this project, NASA shall be working on Double Asteroid Redirection Test (hereinafter DART) which will be launched by 2022 and Hera will be Europe's part to be performed in the collaboration. It will be first ever investigation of a planetary defense technique for manipulating the orbit on an asteroid. The target in this operation shall be double asteroid system Didymos which will have a close approach to Earth in 2022. ESA shall also be installing Flyeye Telescope at the top of Monte Mufara in Sicily, island where first asteroid was discovered in 1801, by 2022.[23]

21 *Ibid*.
22 *Supra* note 6.
23 *Available at*: ESA - Planetary defence (Last visited on April 16, 2021).

Mitigation: Mitigation involves designing of strategies for reducing the impact of the disasters as much as possible by increasing awareness, educating the masses, providing infrastructure that can support and helping the sustain to survive the NEO impact. Designation of a nodal agency that would be endowed with the responsibility of coordinating with the specialized agencies and the government also helps in planning for NEO. Developing of plan of actions and schemes or projects for reducing and eliminating risks are to be pursued in this stage.

The White House Office of Science and Technology Policy released a report titled "National Near-Earth Object Preparedness Strategy and Action Plan". The report outlined the steps that NASA and the Federal Emergency Management Agency (hereinafter FEMA) will take in the next 10 years for preventing dangerous asteroids from striking Earth and preparing the country for the potential consequences of such an event.[24]

Preparedness: Governments of different nations are reacting at their own pace for preparing themselves for NEO impact. UNOOSA has also been heading the Department for NEOs. Strategies have been put in place so as to track the asteroids or comets and keep a check on their trajectory. Organisations such as European Space Agency and NASA have launched satellites, projects and programmes so as to prepare for the event of NEO impact.

For example, with the objective to discover and determine the orbits of NEOs that cannot be efficiently detected from the ground, Near-Earth Object Surveillance Satellite (hereinafter NEOSSat) has been placed by Canada for monitoring the trajectories of asteroids and/or comets.[25] Furthermore, Near Earth Object Modelling and Payloads for Protection (hereinafter NEO-MAPP) project has been launched by Europe and it addresses advanced research in NEOs and new payload technologies for planetary defence.[26]

Response: UN COPUOS endorsed recommendations for building an international response strategy to the NEO-impact threat. For designing a response and recovery procedure, establishment of national and international protocols for responding to NEO impact, whether

24 Hanneke Weitering, This is NASA's New Plan to Detect and Destroy Asteroids Before They Hit Earth, June 20, 2018, *available at*: https://www.space.com/40943-nasa-asteroid-defense-plan.html (Last visited on April 15, 2021).
25 NEOSSat (Near-Earth Object Surveillance Satellite), *available at*: https://directory.eoportal.org/web/eoportal/satellite-missions/n/neossat#foot10%29 (Last visited on April 15, 2021).
26 NEO-MAP, *available at*: https://neomapp.eu/ (Last visited on April 15, 2021).

in deep ocean, coastal regions, or on land, is pertinent. Different response strategies are required for different consequences coming out of a NEO impact.

Facilitating international cooperation and planning to promote recovery from a NEO impact in a timely manner with minimal disruption to the status quo are also inevitable. This includes assessments of critical infrastructure damage to effectively deliver foreign aid and recovery equipment to governments as needed.[27] The IWG report on January 2021 deals with response operation in terms of cost management incurred due to disasters.[28]

Recovery: In the event the strategies in place have failed, a system must be put in place for evacuation and post-impact recovery. Humanity has always survived other disasters, with the cost of loss of lives and damage to property, and would survive the NEO impact as well by way of evacuation and shelters.

Presently, the nations do not have evacuation strategies for disaster by NEOs. However, with already surviving other natural disasters such as floods, hurricane etc., the similar strategies can be used as they are, or with changes as are required. Protection of the citizens being the responsibility of the government, communications must be setup in place, so as to inform the population of the way of evacuation. The general public must be informed of the safe centres, shelters etc. With the approach of the NEO, the evacuation must be started in a given timeframe and arrangements must be made for amenities for the public in shelters.

IAWN and SMPAG has set a criteria and thresholds for responding to any NEO-impact information that it has received. The information is, firstly, with respect to the width of the object. The warning system is not overly alarmist so as to unnecessarily threaten the population neither is it ignored so as to result in delayed action by the appropriate authorities. Further, the warning system works also from the perspective of time period within which it is predicted to happen. The strategy helps in identifying and prioritizing the disaster management operation.

d. India and Near-Earth Objects

27 National Near-Earth Object Preparedness Strategy, National Science and Technology Council, December 2016, *available at*:
https://www.nasa.gov/sites/default/files/atoms/files/national_near-earth_object_preparedness_strategy_tagged.pdf (Last visited on April 15, 2021).
28 *Supra* note 7.

India's stand on responding to NEO is far from being satisfactory. But India is on its way to develop technologies and signing MOUs with organizations. The pace maybe in question, but with regard to NEOs, India has started to draw a roadmap. Project such as NETRA commands the area. Way back in 2012, ISRO had initiated studies on NEOs and deflection strategies for Near Earth Asteroids, as India actively participated in the efforts of the Space Debris Working Group of the United Nations Scientific and Technical Subcommittee in formulating the space debris mitigation measures leading to the adoption of the UNCOPOUS Space Debris Mitigation Guidelines. India is an active member of the Inter-Agency Space Debris Coordination Committee. However, no disaster management policy is set in place that would be followed in the unlikely event of asteroid impact. On Jan 3, 2020, A Memorandum of Understanding (MoU) was signed between Indian Space Research Organization (ISRO) and Indian Institute of Astrophysics (IIA). This MoU paved the way for future collaborations between ISRO and IIA in establishing optical telescope facilities under NETRA Project for space object tracking, studies related to space weather, Asteroids, and other NEOs. Furthermore, in a direction towards preparedness, India has setup Space Situational Awareness Control Centre, that will encompass, among other areas, NEO and planetary defence studies. The establishment of ISRO SSA Control Centre also marks an important milestone towards enhancement and augmentation of ISRO's SSA capabilities.

V. Legal and Policy Matters

The UN General Assembly recognizes the fact that disasters can have devastating impacts on world community and that coordinated global efforts are required to reduce their impacts. The coordination and mutual assistance on the global level without any discrimination on the grounds of scientific and economic developments in the country at risk can go a long distance for protecting the community interests.

Under a more holistic approach considering Earthlings to belong to one community, there lies an obligation on every state to share the technical know-how and timely information for mitigating as much losses as possible. This approach instead of dividing the world into different nations on this planet recognizes them as a part of common heritage of humankind and its protection a common goal of everyone.

The idea comes from the provisions contained in fundamental principles governing exploration of outer space and the *magna carta* of space law, i.e., the Outer Space Treaty,

1967[29] which states that the exploration of outer space and its use shall be for the benefit of the entire humankind and the conduct therein shall be in the interest of all countries.[30] The similar has been put forward by the principles of remote sensing which provide that the states indulging in remote sensing and the UN itself shall give technical assistance to other interested states on mutually agreed terms.[31] Furthermore, the use of remote sensing principles shall be ensured to protect Earth's natural environment and if any state has identified any information that is capable of averting any phenomenon harmful to earth's environment, then that information has to be mandatorily disclosed to the concerned state.[32] Lastly, there shall be promotion for protection of humankind from natural disasters by providing any information which could help in preventing and reducing the effects of natural disasters should be transmitted to the states concerned as promptly as possible.[33]

While remote sensing uses the technology placed in outer space to monitor the surface of the Earth and find out if here has been any change in the geographical character of any area and provide early warning signals for prevention of Earth-oriented disasters, the prediction of asteroids and comets revolving in their orbits around the Earth could be done with the telescopes placed on the Earth.

The question that comes up is whether or not this is a part of any state's responsibility to assist another country when the natural disaster apprehended is in the form of an asteroid or comet, notwithstanding how infrequent it is? If in planetary defense lies the interest of entire humankind, what are the duties and obligations of nations towards world community.

This gives rise to moral and legal duties of the technologically and economically advanced nations to share the benefits of their available resources and prevent such disasters. Within this duty, free dissemination and mutual exchange of information across the countries, assistance in development of technology, upgradation of technology and sensitization of general public can be included. Social and economic development transcending political and cultural barriers is mandatory for securing efficient means for planetary defense. Building of

29 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, *available at*: Outer Space Treaty (unoosa.org) (Last visited on April 15, 2021).
30 *Id*., art. 1.
31 Principles Relating to Remote Sensing of the Earth from Outer Space, *available at*: Remote Sensing Principles (unoosa.org) (Last visited on April 15, 2021), principle 7.
32 *Id*., principle 10.
33 *Id*., principle 11.

trust, cooperation and collaboration on projects shall be developed for developing a uniform framework.

VI. Conclusion and Suggestion

United Nations General Assembly, on December 6, 2016, declared that International Asteroid Day would be observed annually on June 30 to raise public awareness of the asteroid impact hazard. June 30 marks the anniversary of Tunguska impact over Siberia which took place in 1908. The loss of human lives was not significant in that event but the environmental impact was quite huge. Not every time human lives will be spared from being lost. Hence, planning for next NEO impact has become inevitable.

Communication, Cooperation, Coordination and Collaboration are the 4Cs which strengthen a disaster management system. With more knowledge and increasing threats from not only NEOs but also debris from outer space which enters the atmosphere of Earth quite often the technology for prevention losses occurring because of them becomes pertinent and inevitable. Communication of relevant knowledge mandates that there should be creation of knowledge portal where the information regarding their occurrence, well in advance can be put and management of the portal so that this knowledge can be timely disseminated. This shall make sure that knowledge is created as well as shared timely. With reference to the Disaster Management Courses, the syllabus must involve sensitization regarding the NEO impacts as well. Promotion of data collection, analysis, management and appropriate use and ensure its dissemination, after taking into account needs of different categories of users, becomes important.

There is also a need of formulating principles at international level for promoting continuous work on this field Each state has to bear a primary responsibility through international, regional, subregional, transboundary and bilateral cooperation. Enhancement of implementation capacity and capability of developing countries and facilitation by developed countries can help in actualization of community interest involved. On the technological grounds, there is a need to increase Technical Readiness Level and Operational Readiness Levels of existing technologies. Collaboration between developed and developing countries and their specialized agencies can help significantly in capacity building of the developing, undeveloped and underdeveloped nations. This has to be further supported by sharing of

knowledge amongst different stakeholders including government officials, at all levels, civil society, communities and volunteers, and the private sector.

Amongst different entities involved *viz.* educational centers, government, space agencies, etc., mock drills, periodically assess disaster risks, vulnerability, capacity, exposure, hazard characteristics and their sequential effects at the relevant social and spatial scale on ecosystems shall be continuously practiced. Arrangement of continuous dialogue between different entities and cooperation happens to be the key.

At the international level, a specialised committed under the aegis of UN COPUOS can be established for organizing events on this issue for effective dissemination of knowledge, advising on such matters, establishment of fund, designing a Framework of Action and annually reviewing the plans and policies. Private sector can also be involved in this for financially supporting the small countries.