

Initial Assessment of Recent NEO Response Strategies for the United Nations

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Abstract. In 2008, the Association of Space Explorers (ASE) and its international Panel on Asteroid Threat Mitigation has prepared a program for action for the United Nations in relation to the threat to the Earth from asteroids and comets. The program includes descriptions of three specific functions that the U.N. could develop. This includes specific groups dedicated to information gathering and mission planning that would report to an oversight group that would submit recommendations to the Security Council for appropriate action. These recommendations will be presented to the United Nations Committee on the Peaceful Uses of Outer Space (UN-COPUOS). This paper will examine these most recent recommendations and determine potential issues and improvements to ASE's recommendations. These specific recommendations given by the ASE are a positive first step in discussing specific ways the United Nations can be involved in coordinating a global response to the NEO threat.

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INTRODUCTION

Both recent observations of planetary bodies and geological records confirm the ever present threats from asteroids and comets that could be large enough to cause the widespread destruction of modern society. For instance, a massive impact occurred in the Tunguska region of Siberia around 30 June 1908, likely from an approximately several meter wide asteroid or comet, that devastated several hundred square kilometers with a destructive force equivalent to 3 to 5 megatons of TNT (several hundred times the energy unleashed by an atomic bomb over Hiroshima in 1945). Additionally, the Earth's surface still shows scars of previous larger-scale impacts. The more massive K-T (Cretaceous-Tertiary) impact (10 km diameter object), which took place approximately 65 million years ago, is believed to have led to the extinction of the dinosaurs. While K-T class impacts are very infrequent, objects with diameters of approximately 1 km can be expected to intercept the Earth every six to seven hundred thousand years.

Clearly, some thought and planning must take place in order to provide a reasonable level of protection against such disastrous events. Identification and cataloging of Near-Earth Objects (NEOs) and celestial bodies is an important first step. The question remains: "What should be done if a planetary impactor on a collision course with Earth is actually confirmed?" Effective planetary defense concepts must overcome a variety of challenges including the large variance in size, shape, composition, rotation rate, solid body/rubble pile characteristics, (gravitationally bound), and detection time of NEOs (Adams *et al.*, 2004; Rodgers and Izenberg, 2006; Colombo *et al.*, 2006; Scaffer *et al.*, 2007). Economics, reliability, technology constraints, and launch vehicle capacity may limit the size and scope of potential solutions (NASA Report to congress, 2007).

Given mankind's technological progress it is now conceivable to think the time has arrived where a serious examination of its response to the threat from asteroids and comets can be made. There is potentially a need to make plans in case of a threat (or a high probability of impact of one). How is this coordination done? What are the globally responsible parties? Is this an area where only those with the power (in terms of space projection) play?

These and other such questions introduce the debate of whether some type of global information, response, and strategy mechanism is needed in the area of planetary defense.

Some would argue that one a threat from an asteroid or comet arises (a high probability of Earth impact is confirmed); major space-faring national will either individually or in combination develop a response. Others would argue that there should be international mechanisms/protocols in place to coordinate such responses. These mechanisms would be in place to coordinate limited global resources as well as the fact that the impact point (for a non-global devastation impact threat) may not touch a country which does not have any space power projection capabilities.

BACKGROUND OF ASE GLOBAL RESPONSE STUDY

The paper here will discuss a recent initiative to develop a global oriented response process for planetary defense against asteroids and comets. The specific proposals have been set forward by the Near Earth Object (NEO) committee in the Association of Space Explorers (ASE), which have advocated for such a response and has done a credible on mobilizing others to discuss the issue. The ASE most recently, in September 2008, laid out a specific series of recommendations from their report called "Asteroid Threats: a Call for Global Response" (Schweickart, 2008; Schweickart *et al.*, 2008a and 2008b). This paper is a quick analysis of their findings and is based upon an executive summary that has been publicly released. All the details of the report will not be reiterated here. But in essence the report calls for a few specific actions. Specifically quoting the report calls for the following (Schweickart *et al.*, 2008b).

A global, coordinated response by the United Nations to the NEO impact hazard should ensure that three logical, necessary functions are performed as discussed in the following.

Information Gathering, Analysis, and Warning

An Information, Analysis, and Warning Network [IAWN] should be established. This network would operate a global system of ground- and/or space-based telescopes to detect and track potentially hazardous NEOs. The network, using existing or new research institutions, should analyze NEO orbits to identify potential impacts. The network should also establish criteria for issuing NEO impact warnings.

Mission Planning and Operations

A Mission Planning and Operations "Group," [MPOG] drawing on the expertise of the spacefaring nations, should be established and mandated to outline the most likely options for NEO deflection missions. This group should assess the current, global capacity to deflect a hazardous NEO by gathering necessary NEO information, identifying required technologies, and surveying the NEO-related capabilities of interested space agencies. In response to a specific warning, the group should use these mission plans to prepare for a deflection campaign to prevent the threatened impact.

Mission Authorization and Oversight Group [MAOG]

The United Nations should exercise oversight of the above functions through an intergovernmental Mission Authorization and Oversight "Group." This group would develop the policies and guidelines that represent the international will to respond to the global impact hazard. The Mission Authorization and Oversight Group should establish impact risk thresholds and criteria to determine when to execute a NEO deflection campaign. The Mission Authorization and Oversight Group would submit recommendations to the United Nations Security Council for appropriate action.

This paper will present several identified issues with this report. The comments made here are not meant to indicate that the actions proposed by the ASE are inappropriate. This paper is meant as a critique of some general and some

specific outcomes of the ASE discussion process that are described in their report. This author believes in general, the proposals by the ASE report are worthy of consideration in future bodies such as the United Nations Committee On the Peaceful Uses of Outer Space (UN-COPUOS).

OBSERVATIONS

The following section provides various comments (in no particular order) that are these author's initial perceptions of the ASE document. These are not meant to be conclusive but the result of an initial examination of the ASE NEO committee's outputs.

Issue of Funding

Many of the recommendations require staff and facilities to adequately perform the functions described. The Mission Authorization and Oversight Group (MAOG) is inherently a new organization that will require funding, yet the coordination functions of the two groups supporting the MAOG, namely the IAWN (Information, Analysis, and Warning Network) and the MPOG (Mission Planning and Operations Group), even if not needing a new United Nations (UN) institutional organization will require funding to correctly perform the duties needed. As we currently see international coordination is difficult to achieve given manpower and financial constraints. How much funding is assumed for such activities? Given this background, it is difficult to see how all three groups (IAWN, MPOG, and the MAOG) cannot be international bodies. Given the proposal for the IAWN, there is an issue of the status of the Minor Planet Center (MPC) which acts as a clearinghouse for data on many of these NEO observations. Does the MPC become involved in IAWN and does the IAWN focus take away of enhance the coordination role of the MPC?

Consensus on Earth Miss Distance

A fundamental issue of how good of an error ellipse for Earth impact will be. Many make the point that international coordination will be required because, in the case of a hypothetical impactor (non-Earth devastating), what incentive is there for a country with the capability for some type of mitigation but not being impacted to respond to the need of a country without such a capability but within the impact error ellipse (3-sigma position probability)? Another scenario would be what incentive the same space-power capable state has when it moves the impactor's error ellipse off of that state and onto another state (and presumably not away from the earth). However, to have such circumstances ne has to possess very good position estimate into the future where the 3-sigma position ellipse is, one in face smaller than the earth's diameter. This may be difficult if there are not enough observations from which to propagate the trajectory (ground, space, or in-site based). This circumstance may be achieved if there are many observations of the body. For instance, the asteroid Apophis (a recent asteroid of interest, currently 1 in 45,000 chance of hitting the Earth in 2036) during a close approach in 2029 will be about 6 Earth diameter away from the surface of the planet. At this point the uncertainty in its position (length of the 3-sigma error ellipse) is approximately 4500 km.

The point being made here is that with several observations of an asteroid (for instance there are 2 radar delay, 5 Doppler, and 731 optical observations of Apophis from 2004 until 2006), the exact impact point may not be known to within the geographic boundaries of any one country on the planet (<http://www.geog.le.ac.uk/bgrg/lab.htm>). In this case a transponder mission may be required. Thus a question arises of should we be concerned about actually moving the error ellipse just off one country. The reason is that the number of perturbations on an object's trajectory that are important when talking about such small miss distances are large (beyond the sun, planet, minor objects, thermal effects, Earth at close approaches, etc.). Thus one may not really want to just move an asteroid away from one country but be certain it does not hit the Earth given these uncertainties.

One specific area for one of the proposed groups, most likely the MPOG, would be a minimum consensus miss distance for any object that has a high probability of impact. Many mitigation studies in the past have used widely different miss distances; some using just one Earth diameter which to this author may be technically appropriate buy may be too close for even policy makers. This is if one is going to move an asteroid away from an Earth impact, it is

this author's contention that consensus opinion from multiple stake-holders would be that the miss distance should be several Earth radii.

Public Overreaction to the New, Higher Numbers of Potential Hazardous Objects (PHOs)

Within the confines of the report it is stated that there will be a coming wave of discovery with new observatories coming on-line (PanTARRS and LSST) (see; Schweickart, 2008). Within the next 15 years over 500,000 NEOs may be discovered (versus 5600 in the last 10 years). The ASE paper estimates that 3% may be potentially hazardous. There is concern that there will be many warnings with an associated over-reaction by the media and subsequently the public at large (the multiple Apophis scenario). Some people have speculated that this may not be a desirable situation and a coordinated "clearing house" may be needed to prevent such media excitement.

Paradoxically, it may be advantageous to actually have such a situation. As more and more potentially hazardous objects (PHOs) are found and are announced by the media, eventually the public, after a period of potential overexcitement will become more accustomed to the occasional announcement of a NEO threat. There may be a period of excitement but it may actually lead to a period of relative pragmatic interpretation of the data. One analogy could be the public's eventual acceptance of casualties within a long war, at the beginning there is a lot of attention, but as a conflict continues, the public eventually may become not as intensely focused on the same number of casualties per month in month 48 of a war versus month 4 (for good and/or bad). Another analogy would be the public's recent reaction to news accounts that the Large Hadron Collider (LHC), an international particle accelerator project, would create a mini-black hole that would devour the planet. Scientists had to confront this incorrect assumption on the part of the media and public by engaging with the media to explain the LHC's real purpose and effect. Without the public's initial incorrect assumptions driving the story, scientists may never been given the public platform to discuss the project. It may be interesting to consider the possibility of dealing with a period of media overreaction to the constant announcement of high probability impact events, and to use it as a chance to engage with the media. Such a situation would not negate the need of these proposed ASE groups within the U.N. but perhaps refocus their plans.

Responsibilities of the IAWN and MPOG

There are major policy responsibilities assigned to the IAWN. Specifically the following two (Schweickart, 2008):

- a. To serve as the official source of information on the NEO environment.
- b. To maintain (or where appropriate designate) the official clearinghouse for all NEO observations and impact analysis results.

These two activities may require a large amount of international coordination, offline and online. These are very broad mandates that are being given. These activities may require a larger than anticipated infrastructure to accomplish (in terms of resources).

There may be a need to rearrange some of the specific functions that have been divided up to the IAWN, MPOG, and MAOG. Within the ASE document, some of the responsibilities of the IAWN include the following two (Schweickart, 2008):

- a. To develop in cooperation with member states a comprehensive set of designated national disaster response entities [labeled as f. in the ASE report]
- b. To coordinate mitigation response planning with the designated national disaster response entities [labeled as g. in the ASE report]

It is recommended that these two areas be move to the MPOG. The fundamental purpose of the MPOG to this author appears to be mitigation and that encompassed ground mitigation. The inclusion of disaster response in the IAWN seems to dilute the very important mission of information and planning.

For the IAWN, there are two specific responsibilities dealing with the public and media that may need to be combined. The following two responsibilities are separately listed for the IAWN (Schweickart, 2008):

- a. To consider and recommend to the NEO Threat Oversight Group a public information policy on evolving NEO impact threats, and to explore threshold levels at which such information as the risk corridor, potential tsunami simulations, and other impact information for a potential NEO impact should be released to the public [labeled as e. in the ASE report].
- b. To develop and recommend to the NEO Threat Oversight Group a public information plan to include all parameters to be made available, update rate (or criteria), dissemination means, and enquiry handling policy [labeled as i. in the ASE report]

There may be a need to be more specific with regards to these two areas of responsibilities. Is the second responsibility listed above more general than the first? Perhaps a combined narrative into one area would bring together both broad and specific information dissemination responsibilities.

For the MPOG, one of the areas described deals with analysis of mitigation options and specifically cost (Schweickart, 2008):

- a. To develop costing models for each approved deflection campaign concept and for each planning and mission operations event [labeled e. in the ASE report].

The specific term used for “to develop costing models” may not be the most appropriate term for what may be desired. A more appropriate approach would be to use the phrase: “generate cost, operational, and schedule estimates.”

CONCLUSION

The development of the recommendations by the ASE, through the leadership of Rusty Schweickart, is to be commended. They are a very good first draft of the protocols and process that the international community may want to examine if they are serious in their response to this natural threat from asteroids and comets. The comments here are made to help develop the ASE recommendations further and to offer some preliminary thoughts on the output of the ASE process.

ACRONYMS

ASE = Association of Space Explorers	MPOG = Mission Planning and Operations Group
IAWN = Information, Analysis, and Warning Network	NEO = Near Earth Object
MAOG = Mission Authorization and Oversight Group	PHO = Potentially hazardous Object
MPC = Minor Planet Center	UN = United Nations

CONUOUS = Committee on the Peaceful Uses of Outer Space

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