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IAC-E.3.1B.4 RESPONDING TO THE THREAT OF POTENTIALLY-HAZARDOUS NEAR EARTH OBJECTS

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The record of history, as written in the many impact craters on Earth and the moon, demonstrate that it is just a matter of time before astronomers discover a near Earth object (NEO) headed toward a collision with Earth. As the 1908 Tunguska event, which leveled trees across an area of Siberia some 30 km in diameter demonstrated, even relatively small objects (30-50 m diameter) are capable of inflicting enormous damage. When such an event is imminent, how should we respond? Who should respond? What can the world do to prepare for this eventuality?

The uncertainties connected with predicting the impact point and amount of possible damage lead to the conclusion that any response would have to be an international one. The recent , Report of the Panel on Asteroid Threat Mitigation[1] by the Association of Space Explorers (ASE) makes the explicit recommendation that three functional groups be set up to respond to such an eventuality: An Information Analysis and Warning Network (IAWN) to issue a warning and characterization of the possible impact on Earth by an asteroid; A Mission Planning and Operations Group (MPOG) of agencies from space faring States that can carry out an asteroid deflection mission; and an Intergovernmental Mission Authorization and Oversight Group (MAOG) to authorize action if a potentially hazardous NEO is discovered (Fig. 1).

In 2001, following the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), the United Nations Committee on the Peaceful Use of Outer Space (COPUOS) set up an Action Team (AT-14) to examine scientific and technical matters related to NEOs. As a result of the work of AT-14, in 2009, the Scientific and Technical Subcommittee of COPUOS agreed to a three-year work plan to develop recommendations for international response to the near-Earth object impact threat and agreed that it would consider the recommendations contained in the Report of the Panel on Asteroid Threat Mitigation. The Subcommittee also agreed to establish a Working Group to carry out its work plan and that AT-14 would support the efforts of the Working

Group. This paper presents the results of a workshop that considered several issues associated with the functions of an IAWN. The Workshop was held in January 2010 in Mexico City.

The workshop was organized by the Association of Space Explorers, Secure World Foundation (SWF) and the Regional Center for Space Science and Technology Education in Latin America and the Caribbean (CRECTEALC). The workshop, which was hosted by the Ministry of Foreign Affairs of Mexico, included experts in the science of near Earth objects, disaster management and communications, and space policy.

INTRODUCTION

Although the evidence of prior asteroid strikes on the Moon and Earth have been studied for many years, only in the past two decades or so have astronomers made a concerted effort to catalogue the total population of Near Earth Asteroids (NEAs). At the present astronomers have discovered and catalogued some 7212 NEAs. Of these, some 819 are equal to or larger than one km.[2] Of all of the known asteroids, 1145 are considered Potentially Hazardous NEAs (PH-NEAs). "Specifically, all asteroids with an Earth Minimum Orbit Intersection Distance (MOID) of 0.05 AU or less and an absolute magnitude (H) of 22.0 or less are considered PHAs. In other words, asteroids that *can't* get any closer to the Earth (*i.e.* MOID) than 0.05 AU (roughly 7,480,000 km or 4,650,000 mi) or are smaller than about 150 m (500 ft) in diameter (*i.e.* H = 22.0 with assumed albedo of 13%) are *not* considered PHAs."[3]

The number of known asteroids greater than 150 m that are likely to threaten Earth for the next two decades is still small but expected to grow as more Earth- and space-based observations are carried out. Because international preparations to deflect or otherwise mitigate the effects of a PHA that is discovered to threaten Earth could take well over a decade, it is important to put the procedures in place to respond to one well before it is discovered. Further, the number of currently undiscovered smaller asteroids (less than 150 m in diameter) is estimated at around 25,000. As the 1908 Tunguska event illustrates, even small asteroids of 50 meters or less can threaten human welfare. Hence, it is wise to prepare ahead for the needed international response to a threatening asteroid.

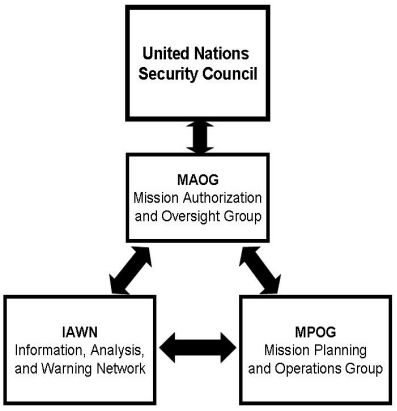

Figure 1. Concept for addressing the NEO threat from the ASE Report, which includes a Mission Authorization and Oversight Group (MAOG), an Information, Analysis and Warning Network (IAWN) and a Mission Planning and Operations Group (MPOG).[4]

THE REPORT

As noted above, Action Team 14 is developing draft international procedures for addressing the near-Earth object threat for consideration by the Working Group on Near-Earth Objects of the Scientific and Technical Subcommittee in accordance with the multi-year workplan agreed by the Committee for the agenda item on near-Earth objects. The Mexico City workshop began the process of clarifying the role, responsibilities, and composition of an Information, Analysis, and Warning network (IAWN) under the AT-14 Terms of Reference. This report was presented to the Working Group on Near Earth Objects at the February 2010 meeting of the COPUOS

Scientific and Technical Subcommittee. Many of its provisions have now been incorporated into the draft report of the working group.

A. IAWN Functions and Responsibilities

A.1.1. To perform these functions, workshop participants agreed that an IAWN should first continue the well-executed work of the institutions currently engaged in NEO detection, tracking, cataloging, and impact prediction. These include NASA's Jet Propulsion Laboratory "Spaceguard" and "Sentry" programs, the IAU Minor Planet Center and the University of Pisa's NEODyS group. Other aspects of IAWN functions and responsibilities follow.

Capability Review

A.2.1. These institutions and the agencies which support them should review the NEO data products currently distributed and suggest improvements or additional output needed for the astronomical community, policy makers, and the other NEO decision-making functions dealing with mission planning, operations, mission authorization, and oversight.

A.2.2. The workshop concluded that an effective IAWN will need additional capability to fulfill its mission. Among other things, its expertise should include analysis of the physical effects caused by a NEO impact, including study and modeling of tsunami effects. Such analysis and modeling will enable IAWN to be more effective in providing appropriate warning to potentially affected communities.

Communications

A.3.1. Workshop participants quickly recognized the need to develop a strong communications element. The current network institutions should study the existing communications methods used for distribution of NEO detection, orbit analysis, impact prediction, and notification protocols, and recommend improvements. The network should also examine protocols used by similar warning nets and institutions dealing with natural disasters , such as tsunami warning, to improve its communication to governments, policy-makers, international institutions, and the public and to mesh appropriately with existing disaster watch and warning protocols.

A.3.2. To be more effective, the IAWN should develop a communications strategy, using well-defined communication plans and protocols. NEO information should be distributed in "normalized" fashion (e.g. using words easily understood by the public and policy makers). News from the IAWN should be accurate, timely, and aimed at responding promptly and directly to misinformation, rumors, and media errors. This strategy should be grounded in the science of risk communications, psychology, sociology and other relevant social sciences.

A.3.3. The IAWN should investigate the communication channels and contacts used today by other disaster warning networks to communicate with the disaster management (DM) community. For example, a comprehensive list of designated DM contacts used by the International Strategy for Disaster Reduction (ISDR) or the World Meteorological Office (WMO) could serve IAWN purposes as well.

Education

A.4.1. The workshop recognized that education about the NEO threat is needed to give accurate and timely information to the public about the possible effects of a potentially hazardous NEO. It concluded that the NEO IAWN should develop an outreach and education plan, leveraging outlets maintained by existing scientific and disaster response institutions. The IAWN should also identify the major NEO risk

facts to communicate to the public, and coordinate a NEO outreach plan using entities such as the IAU, AGU, space agencies and amateur observer organizations. This program can begin with an understanding of what is already known in the social and behavioral sciences regarding how to reach, teach, and motivate the public for other natural hazards most effectively.

A.4.2. Three major elements that a NEO outreach plan might address include:

- What is the NEO risk to the public?
- What should the public expectations be of future impact events, warnings?
- What should the public do to prepare for and respond to an impact warning?

A.4.3. The workshop recognized that an effective education plan on the NEO hazard will cause a major shift in humanity's perception of the nature of the heavens, adding an element of "risk from above" to our long-held wonder of the heavens above. This change in perception will likely have cultural and psychological consequences. But, the long history of observing the heavens has always been marked by an understanding and memory of the skies being far from benign, comets are often seen in old skyscapes along with falling stars.

Risk Management

A.5.1. The IAWN can benefit from a large body of knowledge detailing the human response to other natural disasters. The NEO IAWN should include among its members expertise in risk analysis and decision making to address the behavioral and psychological elements of NEO disaster management.

Interfaces

A.6.1. To speed response, the IAWN should develop a schematic of its functions and organization, along with interfaces to other NEO decision-making functions. and bodies outlined in the 2008 ASE report..Such a functional diagram will serve as a useful coordination tool and in explaining IAWN operations to the public and coordinating entities.

Research

A.7.1 The IAWN should identify and call for necessary NEO–related research, addressing gaps in our knowledge of impact prediction or effects, or other areas necessary to the IAWN missions. A particular need the IAWN can address is the development of software-based impact response tools to aid decision-makers in assessing the human, infrastructure and financial consequences of a potential NEO impact.

A.7.2 The workshop revealed a large body of scientific literature of use to the IAWN in intelligently responding to and communicating about the risk and effects of an asteroid impact. The IAWN should perform a literature search, then compile and maintain a bibliography of relevant work on risk, communication, impact effects, NEO detection, etc. This NEO hazard bibliography should be accessible to the public, the NEO community, and the DM community.

Legal Counsel

A.8.1 Because an impact and the response to it may produce or fail to prevent property damage, mass casualties, and questions of authority and liability, the IAWN should have recourse to legal counsel, well-versed in space law, international law and NEO issues.

B. Establishment And Implementation Of IAWN

B.1.1. Proposals for establishing an Information, Analysis, and Warning network should incorporate the lessons learned from other institutions conducting similar functions in the

field of disaster management and response. Many of these lessons learned were captured in the report of the United Kingdom Hazards Working Group, which included experiences gained by the World Health Organization, the World Meteorological Organization, the Center for Disease Control, the Tsunami Warning System, and other risk management institutions. Broad experience in communications, analysis, and hazard warning already exists, and establishment of the IAWN should benefit from the experience and expertise of these related institutions.

Search for an Appropriate Institutional Model

B.2.1. In establishing the formal IAWN network, there should be a critical examination of existing institutions to formulate a model based on previous success. The NEO Action Team 14 could discuss applicable models for the IAWN structure during its intercessional work. Workshop attendees were unanimous in recommending against proposing any large bureaucracy or creating a United Nations entity to carry out IAWN functions.

IAWN Implementation

B.3.1. The AT14 should immediately create a steering group to propose and manage the long-term development of the IAWN. Such a group would then be in an ideal position to integrate the IAWN with the functions to be carried out by the Mission Authorization Working group and the Mission Planning and Operations group.

B.3.2. The steering group should not wait until all issues are resolved, but should take a phased approach to implementation, first describing the current flow of NEO information and analysis through existing network elements, then build added capability. When adding additional capability, the implementers should do nothing to encumber the current NEO information channels, or delay the flow of NEO discovery, orbit analysis, and impact prediction products.

B.3.3. Therefore, the IAWN members should first include current institutions like JPL's NEO Program and Sentry system, the University of Pisa's NEODyS system, and the Minor Planet Center. COPUOS and AT14 can then recommend and solicit additional participation to add functional capability, looking especially for broader geographic participation to enhance the network's utility.

B.3.4. AT14 should also study the question of what information from the IAWN would be needed by other NEO decision-making functions, such as those to be carried out by the Mission Planning and Operations Group (MPOG). The members should identify functional interfaces to the MPOG and Mission Authorization and Oversight Group (MAOG). Finally, the workshop attendees recommended that the IAWN establish a formal feedback and assessment process to assess the effectiveness of its information flow process and communications procedures.

C. Future Questions and Issues for AT14, COPUOS, and NEO Decision-Makers

The workshop discussion identified several questions that still require discussion and answers:

1. *Financing*: The attendees recommended that there be no exchange of funds between member states in implementing the IAWN. Given this, how can member states best support the IAWN and put it on a more permanent financial foundation?
2. *Structure*: Which IAWN elements should be in the standing "center," and which should be comprised of external resources at other institutions, connected virtually to the IAWN?

3. *Institutional model:* While keeping resourcing and central authority at a minimum, what model best enables an IAWN to assume effective responsibility for global NEO information release?
4. *Designating authority:* Which institution (COPUOS, General Assembly) can officially "designate" the IAWN as the authoritative body on NEO information issues? Is such formal designation appropriate? Could the IAWN be recognized as a credible authority simply through performing the mission, even without official blessing?
5. *Long term institutional footing:* How can the IAWN be placed on a long-term footing after establishment?
6. *Future workshops:* AT14 might consider proposing the timing and agenda for future workshops or discussions that identify the functions of the MPOG and MAOG (e.g. creating thresholds of impact probability requiring a decision to respond to a hazardous NEO).

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1 Report of the Panel on Asteroid Threat Mitigation, established by the Association of Space Explorers, www.space-explorers.org/ATACGR.pdf

[2] As of 24 September 2010. Jet Propulsion Laboratory, http://neo.jpl.nasa.gov/stats/. Accessed 25 September 2010.

[3] NASA Jet Propulsion Laboratory, http://neo.jpl.nasa.gov/neo/pha.html, Accessed, 25 September 2010.

[4] Association of Space Explorers, Asteroid Threats: A Call for a Global Response, 2008. Retrieved from http://www.space-explorers.org/ATACGR.pdf, accessed, 25 September 2010.