

Evolution of a (Fictional) Asteroid Threat: Preparing for Planetary Defense

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Conference

Representing

International Academy of Astronautics (IAA)

February 3, 2017



Headline (Daily Launch, AIAA January 10, 2017) Asteroid Passed Earth at Distance of 120,000 Miles on Monday [January 9, 2017]

The Daily Mail (1/9) reports that on Monday morning, an asteroid believed to be between 50 and 111 feet in diameter “passed by Earth at a distance half that of the Moon,” or about 120,000 thousand miles, according to researchers. The University of Arizona’s Catalina Sky Survey did not even detect the asteroid, named 2017 AG13, until Saturday [January 7, 2017].

NOTE: Asteroid that caused 2013 Chelyabinsk event was ~17 m (51 ft) in size



Introduction

- Asteroid Impact is inevitable
 - No known threats of large (>1km) asteroid impact this century
 - Most likely event is impact of smaller asteroid (<200m)
 - Impact of small asteroid (>50m) could destroy a city or devastate a local region
 - Likelihood of small asteroid impact this century ~1 in 5 (20%)
- Some countries conducting exercises to inform disaster responders and national leadership about such events
- This presentation
 - Describes exercise presented at 2015 IAA Planetary Defense Conference (PDC)
 - Invites your participation in exercise to be presented at 2017 IAA PDC



2015 Threat Exercise

- Developed for 2015 IAA Planetary Defense Conference by NASA-JPL and conference organizing team
- **NOT A REAL CASE**, timeline accurate only for this threat
- Four teams of conference participants considered threat
 - Team 1: Leaders of nations along threat corridor
 - Team 2: Leaders of nations not along threat corridor
 - Team 3: Members of the public along threat corridor
 - Team 4: Media
- Each team presented recommendations to panel of World Leaders
- Full description of scenario and results of discussions available at <http://pdc.iaaweb.org>



Evolution of a Threat: First Notice

June 9, 2015

- Asteroid discovered that will pass close to Earth on September 3, 2022
 - Object estimated to be 140 to 400 meters in size
 - 1 chance in 110 (0.9%) that will impact Earth
- Most likely that additional observations will reduce or eliminate impact probability
- If impacts, would be somewhere along line shown in next chart

EXERCISE **EXERCISE** **EXERCISE**
NOT A REAL WORLD EVENT This is part of an exercise that is conducted during the 2015 IAA Planetary Defense Conference.

DAY 1
PRESS RELEASE: JUNE 9, 2015

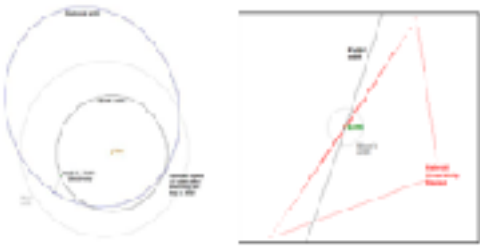
NEWLY DISCOVERED ASTEROID POSES SMALL THREAT OF EARTH IMPACT

A recently discovered near-Earth asteroid is predicted to pass very close to the Earth on September 3, 2022. The asteroid, designated 2015 EDC, was discovered on April 13, 2015, and has been tracked continuously over the last two months by observations around the world. Predictions for the asteroid's encounter in 2022 indicate that, while unlikely, an Earth impact cannot be ruled out. The current likelihood of impact is about 0.9% or 1 chance in 110, according to the International Asteroid Warning Network (IAWN), a worldwide partnership of agencies that detect, monitor and track potentially hazardous asteroids.

This asteroid's encounter should be no cause for public concern, since an actual collision is very unlikely: the chances are 109 out of 110 that the asteroid will safely pass by our planet. As 2015 EDC continues to be tracked by astronomers around the world through the rest of 2015 and into early 2016, its orbit will be better defined and final likelihood of impact will be eliminated.

The brightness of 2015 EDC suggests that it is between 140 and 400 meters (140 to 1340 feet) in diameter, but it is too distant for astronomers to make a more accurate estimate. The asteroid approached to within 0.2 AU (30 million kilometers or 18 million miles) of Earth on May 11, but it is now receding from the Earth and will not approach our planet again until the close approach in 2022. The image below on the left shows the orbit of 2015 EDC relative to the orbit of the Earth, along with the positions of the Earth and asteroid when the asteroid first discovered. The image on the right shows a zoomed-in view of the intersection point of the two orbits, along with the current uncertainty region of the asteroid when the Earth crosses the asteroid's orbit in 2022 (shown a red in scale).

Orbit of asteroid 2015 EDC



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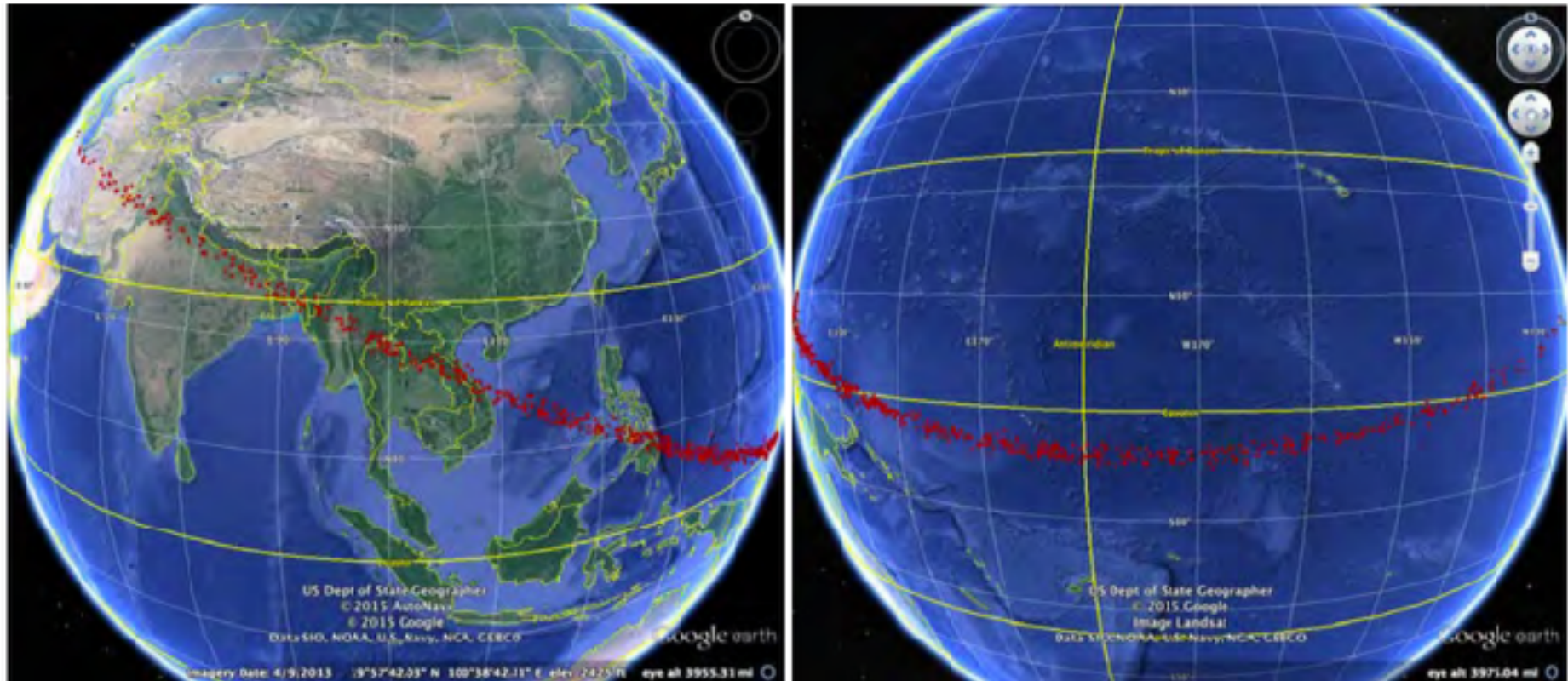
Credit: Scenario developed by NASA/JPL and team of experts



Threat Corridor for Fictitious Threat

If asteroid should impact, impact would occur at a point within threat corridor defined by red dots

(all images developed by Paul Chodas, JPL)



Possible Consequences

- Crater 5 to 7 km in diameter and up to 500 meters deep
- 6.8-magnitude earthquake
- Immediate damage over an area of approximately 70,000 square kilometers, about the size of the Republic of Ireland
- Ocean impact would create 10-meter tsunami that could inundate populated coastal areas with waves as high as 3 to 4 meters
- All nations with Pacific coastlines are vulnerable to tsunami damage

Questions

- What would your nation's actions be at this point?
 - For disaster management if nation is in or near threat corridor?
 - For public notification?
 - For asteroid deflection if a spacefaring nation?
- What should international community do?

Threat Corridor, 5.75 years to Impact

Impact probability 100%



Fourth Notice

August 1, 2019

- ~3 years to impact
- Six deflector missions being launched
 - Use kinetic impactors (nations veto use of nuclear explosives)
 - Four successful impacts required for sufficient deflection
 - Impact out of view from Earth; Observer spacecraft sent to assess effect

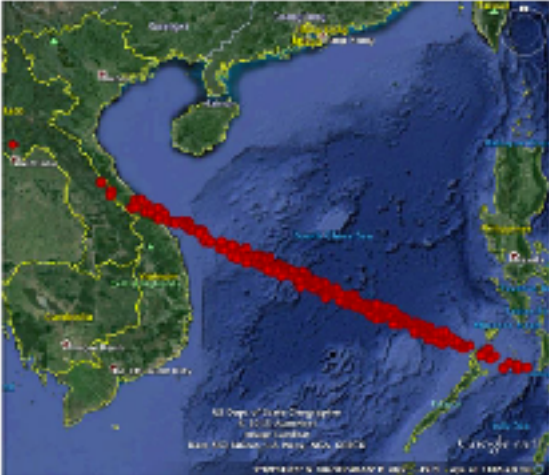
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NOT A REAL WORLD EVENT This is part of an asteroid deflection exercise conducted during the 2015 IAA Planetary Defense Conference.

DAY 4
PRESS RELEASE: AUGUST 1, 2019

NATIONS OF THE WORLD WILL SEND SIX SPACECRAFT TO DEFLECT ONCOMING ASTEROID 2015 PDC

Several nations with space launch capabilities have joined the effort to deflect oncoming asteroid 2015 PDC. A total of six Kinetic Impactor (KI) spacecraft are scheduled to be launched toward the object later this month. All six are designed to strike the asteroid at very high relative velocities over a seven-day period in early March 2020. Successful impact of at least four KI vehicles will move the object away from Earth impact.

Based on an extensive set of tracking observations taken over the last two years, ISRN has determined a much more accurate trajectory for asteroid 2015 PDC, and the potential impact location on September 5, 2022 has now been isolated to the South China Sea. The impact time would be 3:58 UTC on 11:53am local time. The red dots on the image below trace the extent of the possible impact locations, the so-called "impact footprint." Unless the asteroid is deflected, it will impact somewhere within this region.



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Sixth Update

- ~8 months to impact
- Deflection partially successful; 60-100m fragment remains
- Impact probability 100% in the region of Bangladesh, India or Myanmar
- More accurate impact location and size when object becomes visible to radar ~7 days before impact
- Impact energy up to 50 Megatons

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DAY 5: Update 2

PRESS RELEASE: FEBRUARY 4, 2022

SMALL FRAGMENT OF ASTEROID 2015 PDC WILL IMPACT IN THE REGION OF BANGLADESH, INDIA OR MYANMAR

Based on the most recent tracking observations of the fragment of 2015 PDC, IAWN announced that the smaller fragment will impact the Earth on September 3, 2022 at about 08:50 UTC. The predicted location of the impact is almost certainly in India, Bangladesh, Myanmar, or northern Thailand, as indicated by the image below. It is virtually certain that this will be a land impact or airburst.



Although the asteroid had not been observed for a year because it was on the other side of the Sun as viewed from the Earth, it just recently became observable again, and new observations confirm that the asteroid fragment is still on a collision course with Earth. Further observations over the next two months should dramatically shrink the size of the impact ellipse, and by May the impact location will be identified to within 100 km (60 miles) or so. Observations should continue until a month before impact, when the

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Final Update

August 27, 2022

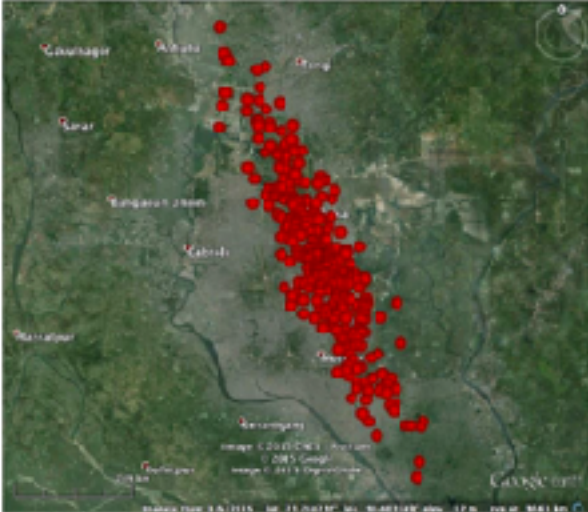
- 7 days to impact
- Radar data refines impact area to be in vicinity of Dhaka, Bangladesh
- 15 million people in impact zone

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DAY 5: Update 3

FRESS RELEASE: AUGUST 27, 2022
ASTERIOD 2015 PDC HEADED FOR IMPACT NEAR DHAKA, BANGLADESH

Based on radar measurements from NASA's Goldstone station, LAION predicts that the fragment of 2015 PDC will enter the atmosphere on September 3, 2022, and that the impact and/or airburst location will be in the vicinity of Dhaka, the capital city of Bangladesh at 9:50 am local time. Dhaka is the 10th largest city in the world and more than 15 million people are estimated to live in the greater Dhaka area. The image below shows possible impact locations.



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Planetary Defense a Worldwide Issue

Exercise illustrates that

- A serious threat would involve all nations, even those not in the immediate vicinity of the event
- Responding to an impact disaster could involve many or all nations
- Deflecting an oncoming object would likely involve all nations with capability to launch deep space missions

Recognizing these facts

- UN endorsed and member states established two groups
 - International Asteroid Warning Network (IAWN), which joins asteroid and comet discovery resources world-wide
 - Space Mission Planning Advisory Group (SMPAG), which attempts to organize the international response to such scenarios
- IAWN and SMPAG are now active and very involved with 2017 conference and threat exercise to be presented at the conference



2017 IAA Planetary Defense Conference

- May 15-19, 2017 in Tokyo, Japan
- Will include presentations from experts on
 - Discovery and characterization of asteroids and comets that might one day threaten Earth
 - Deflection and disruption of threatening object
 - Deflection mission and campaign designs
 - Impact consequences and disaster response
 - Decision to act (We have the technology; will we act in time?)
 - Public education & communication
- Includes tabletop exercise to develop response to fictional asteroid threat
- See <http://pdc.iaaweb.org> for more information



Invitation to Participate

- Realistic exercise will be part of 2017 conference
 - First update now available at conference website
 - Details available are sufficient for experts to begin consideration of deflection, disaster management options now
 - Focus group presentations (and full conference) available via live and recorded webcast
- Interested leaders may participate remotely



Who Should Participate?

- Exercise particularly valuable for leaders of
 - **Space agencies** that would be called upon to help deflect an asteroid in the event of an actual threat
 - **Disaster response agencies** that need to understand how an asteroid threat might emerge and whether they have appropriate response plans for such an emergency
 - **Government agencies and media** responsible for communicating to and dealing with the public
 - **Government leaders** who want to understand the types of decisions they would need to make and the resources they would be required to commit
- To participate remotely (**No cost to participate**, but must [register](#))
 - Send messages to the exercise's focus groups
 - More details provided when registered

PDC 2017 Threat Scenario: Initial Threat Corridor

**EXERCISE ONLY:
NOT A REAL-WORLD
EVENT**

- Possible impact on July 21, 2027
- Impact probability ~1% (1 chance in 100)
- Size estimated at 100 to 250 meters

Join us for an interesting exercise!

Thanks for your attention!



Summary

- Asteroid threat is real; no immediate threats known
- Must continue to build international cooperation on planetary defense and disaster response
- Tabletop exercises provide valuable learning opportunities
 - Help leaders understand how a threat might evolve and the decisions they will need to make
 - Inform disaster responders of nature of asteroid impact threat and disaster
- Participate in 2017 IAA Planetary Defense Conference exercise
 - Attend conference--see what the world is learning
 - Participate remotely--send questions/comments as exercise progresses

