IAA-PDC-23-0X-XX

HUMANS AND HAZARDOUS ASTEROIDS - 30 YEARS OF EXPERIENCE IN EDUCATION AND COMMUNICATION

Jana Tichá[1], Miloš Tichý[2], and Michaela Honková[3]
[1][2]*Klet Observatory, Zatkovo nabrezi 4, CZ-370 01 Ceske Budejovice, Czech Republic, phone +420 380 711 242, email: klet@klet.cz*
[3]*External collaborator, Ceske Budejovice, email: honkova84@gmail.com*

Keywords: *Near Earth Object, asteroid hazard, education, communication, public outreach*

ABSTRACT:

What to say to the public about asteroid hazards and how to tell them? Our institution represents a unique liaison of a small professional research institution devoted specifically to Near-Earth Objects (NEOs) (Klet Observatory, Czech Republic) and the educational branch (Ceske Budejovice Observatory and Planetarium, Czech Republic). Klet Observatory has been participating in a international NEO research effort since 1992 as a prolific astrometric NEO follow-up station. In 2002 we started the KLENOT Project using a new 1.06-m Telescope. Since 2014 Kleť serves as a cooperating sensor in the NEO segment of the European Space Agency Space Situational Awareness(ESA-SSA) programme (ESA-SSA). Klet Observatory obtained more than 50,000 astrometric measurements of NEOs including confirmatory observations, early follow-ups and recoveries since 1992. The latest major follow-up case was a small Earth impactor 2022 EB5 observed just before its impact.

In the beginning of the nineties we started some NEO presentations just as a public outreach of Klet Observatory work and an explanation to taxpayers what such research can be useful for. After thirty years of gaining experience we understand that education of the wider public, students, journalists, emergency services and decision makers on hazardous asteroids and planetary defense belongs to the most important tasks of NEOs scientists and research institutions. This paper presents a case study of NEO and asteroid hazard educational activities in South Bohemia implemented through the Observatory and Planetarium in Ceske Budejovice influenced by the long-term Klet NEO program. We will also mention locally specific connections to NEOs as well as our future NEO education plans.

KLET OBSERVATORY NEO RESEARCH

Klet Observatory has been participating in the international NEO research effort since 1992 as a prolific astrometric NEO follow-up station using the MPC code 046. We initially joined the effort with 0.85-m photographic telescope, later we continued with a 0.57-m reflector equipped with a small CCD detector. In 2002 we started the KLENOT Project using a new 1.06-m KLENOT Telescope, built at Klet specifically for NEO astrometry. KLENOT was assigned the new MPC code 246. Since 2014 Klet has served as a cooperating sensor in the NEO segment of the European Space Agency (ESA-SSA) program. More than 50,000 astrometric measurements of NEOs including confirmatory observations, early follow-ups and recoveries were obtained from 1992 hitherto. The latest important follow-up case was a small Earth impactor 2022 EB5 observed just 12 minutes before its entry to the Earth's atmosphere and subsequent disintegration over the Arctic Ocean. Klet's main objective is to provide astrometric measurements of NEOs to obtain deeper insights of the orbits of the NEO population. Although discoveries of asteroids are just our by-product, we still discovered three NEOs.

NEO EDUCATION AND PUBLIC OUTREACH

Almost simultaneously with the development of NEO research on Klet Observatory we began to be asked what such a thing is useful for and why should taxpayers fund it. We have started with public open days during holidays as well as we approached the media and experienced journalists. Klet's home is the Observatory and Planetarium situated in the city of Ceske Budejovice, which is the metropolis of South Bohemia, not far from Austrian and Bavarian borders. The Observatory was founded in 1928 and opened in 1937. The Planetarium was built in the seventies and rebuilt several years ago. It seems to be an excellent base for

NEO and asteroid hazard presentation and education. The total number of Ceske Budejovice Planetarium visitors exceeded 750,000 people over the last thirty years. It represents some 25,000 visitors per year. It has been giving us an excellent opportunity for bringing NEO information to a wider audience.

We have been incessantly seeking the best way to educate the public about NEOs, asteroid hazard and planetary defense. The NEO work includes NEO detections, physical studies, computing of close encounters, modeling of impact effects, options of mitigation, space missions to asteroids and so on. We started just with public lectures. Later we added specialized webpages, summer open days at Klet Observatory, social media, more contact with journalists, educational multimedia presentations for school excursions, activities for talented youth, community days, TEDx Budweis talk, Pecha Kucha Night talk and geocaching events. Ideas of Art & Science are also inspirational for these activities.The newest NEO and asteroid hazard activities includes outdoor exhibitions in a municipal park, Asteroid Days, public meetings and discussions with NEO researchers from different institutions, workshops for teachers as well as for students of Faculty of Education of the South Bohemian University. The latest fascinating and inspirational world event for NEO education activities was the DART mission to Dimorphos. In the near future we plan to start with a virtual reality technology in The Observatory and Planetarium Ceske Budejovice as well as increase use of STEM (Science, Technology, Engineering and Maths) system in public activities. Out-of-school education of all school levels represents more than sixty percent of visitors of the Observatory and Planetarium Ceske Budejovice.

All educational programmes are adapted to the age and knowledge level of pupils and students. We start with asteroids including NEOs for pupils of the fifth grade of elementary schools in the framework of a more detailed presentation of the Solar System - Sun, large planets, their moons, comets, asteroids including Near Earth asteroids and possible impact. Then children start to be interested in NEOs and NEO hazards, they care about, ask questions and discuss with lecturers. Educational programs for secondary schools are more comprehensive. NEO lectures for universities need more differentiation. Lectures for students of Education in Sciences of the University of South Bohemian include both facts about NEOs and asteroid hazards and didactics for various school grades. Students of Protection of Inhabitants both at the University of South Bohemia and the University of European and Regional Studies in Ceske Budejovice contain basic astronomical information about NEOs,about possible impact effects and options of mitigation. They thus recognize asteroid impacts as one of possible threats although a low probability one. We have had the opportunity to present NEOs and a thread of asteroid impact at the Conference of the Czech Integrated Rescue System in Southern Bohemia. The content was similar to that for crisis management students. It was mutually beneficial. We let them know about NEOs and asteroid hazards and rescue people understand an example of a low probability and high impact event. The conference committee appreciated both the topipresentation style. Asteroid impact is counted as one of 72 risks in an official National Risk Analysis of the Czech Republic yet. It is considered as high impact but low probability risk. We can be satisfied if our efforts contributed at least a little to this inclusion of asteroid impacts to Czech National Risk Analysis.

NEOs ON THE WEB:

On-line magazines (e-zins) are one of the most useful tools. There are many interesting and well designed websites maintained by NASA, JPL, ESA, the Planetary Society and others, but naturally the big majority of them are written in English. Therefore we decided to design and maintain a special website in Czech devoted to minor planets including NEOs. We based it on Klet long-term asteroid observing program, its international cooperation as well as our experience in education and public outreach programs. Czech public service on NEOs - www.planetky.cz - started in February 2001. Till 2023 March it published 389 original articles written for the general public by Klet team members. This number includes 152 articles directly about Near-Earth Objects. It has been indicated (March 19, 2023) that more than 1,800,000 visitors have viewed more than 5,500,000 pages on web www.planetky.cz so far. On the basis of language similarities this website has also been visited by many people from Central and East European countries like Slovakia, Poland, Ukraine and others. The first important topic we dealt with was a close approaches of well-known Near-Earth asteroid Toutatis, 1997 XF11 affair, future close approaches of Apophis, space missions to asteroids Eros and Itokawa, recovery of asteroid Hermes, a story of first detected Earth impactor 2008 TC3 including meteorites found in Sudan, new NEO surveys (CSS, Pan-STARRS) and NEOWISE mission results, several Klet Observatory NEO discoveries, Chelyabinsk superbolide. The latest important events to publish were the fifth small Earth impactor 2022 EB5 and especially the successful DART mission, which changed asteroid Dimorphos's motion in space. Taking into account a rapidly growing role of social media we created Facebook, Twitter and Instagram profiles of Klet Observatory. We run them on a topical basis. Nonetheless, as the knowledge and use of English language and/or use of automatic translators increases thus the possibility of reading original websites also increases, a public interest in the Czech NEO server stagnates or slowly decreases.

DECISION MAKERS

Asteroid impact is counted as one of 72 risks in an official National Risk Analysis of the Czech Republic yet. It is considered as high impact but low probability risk. We can be satisfied if our efforts contributed at least a little to this inclusion of asteroid impacts to Czech National Risk Analysis.

LOCAL SOUTH BOHEMIAN CONNECTIONS

Green semi-transparent tektites known as moldavites are found in many localities of South Bohemia. Their most likely source being the Ries Noerdlingen impact event 14.9 millions years ago. This fascinating natural impact glass is commonly known in our region, therefore it is one of nice opportunities for stories about asteroid impact, offering a strange almost mythical story combining disaster and beauty. Of course, other regions, states and countries have their own different connections to NEOs and asteroid hazards. It seems it is useful to use them.

Visitors usually ask about possible impact consequences: “What happens when the impactor…?” The hypothetical targets they choose are usually regional: southern bohemian metropolis Ceske Budejovice, nuclear power plant located in South Bohemia or some of dams at the Vltava river. These are difficult answers. However, educators can explain how many different factors have to be taken into account.

WHAT WE LEARNT FROM AUDIENCE DURING THIRTY YEARS OF ASTEROID HAZARD EDUCATION

To speak about an asteroid hazard, consequences of a possible Earth impact or different methods of deflection seems to be a somewhat sensitive matter.

- NEO and asteroid hazard information has to be clear, correct and up-to-date. Do not overemphasize risk.

- Use images, images and even more images, visualizations, videos. Better to see once than to hear a hundred times. Moreover, use analogy.

- Start with the basis: the Solar System as a humankind home. We cannot start directly with an asteroid hazard. It is necessary to introduce our Solar System as a foundation then to show the Sun, planets, moons, small Solar System bodies, to go to the NEO population and finally to focus on potentially hazardous asteroids.

- Speak also about social, economic and legal aspects of NEOs, asteroid hazard, planetary defense and mitigation of consequences. It is very interesting for the wider public

- Dialogue is necessary. Participatory communication is critical to building trust among NEO scientists and the wider public.

We need more than a simple two-way exchange. It could be a continuous process. The wide public is not a monolithic audience. What can we expect the public to know with respect to science and technology? The vast majority of the audience are not professional scientist, but some of them are experts in IT, machine industry, energetics, civil engineering, transportation, rescue management, higher education and so on. So to use knowledge and experience familiar to people from their civil life and profession is reasonable.

- Be aware that NEOs are subjects of sci-fi and action movies.

- Be apolitical. Our mission is longer than one election term. Moreover it is better for building trust with the audience.

- Be prepared in advance to deal with conspiracy theories and disinformation.

- The question is how to explain the probability of any event in general? Of course, it is very difficult. We should use language and scale that can be understood by the general public, not the language of scientists. Most people have little or no understanding of numerical probabilities and have only a binary reaction when learning about a threat or crisis: YES OR NO. We should use common language as: none/slight/moderate/severe. There is also a known psychological difference between “good” vs. “bad” probability for the same number (“I can win money in the lottery” vs. “I can be affected by an accident”). If we should use some numerical expression of probability, the question remains between percentage and once per some period. Hard to say.

- Speaking about various methods of deflection of an impactor, we also need to consider nuclear devices. It seems important to take into account some specific stigma attached to anything nuclear, although this stigma is about fear and has nothing to do with knowledge.

- Use familiar comparisons (as large as our region, as the main city, as Klet mountain, as distance from Ceske Budejovice to Prague)

- No false optimism. Take also into account that the public is not very interested in threats that are not immediate or appear abstract. This point is similar to other natural hazards.

- National and international collaboration, both institutional and personal, is essential both in NEO research, education and communication.

FUTURE PLANS:

We plan to broaden our educational activities and engage the audience more through a hypothetical impact scenario and a poll. It would be a special public event where interested visitors would become poll participants. We plan to re-play it with visitors having more interest in sciences, general public, students and so on. Both Klet Observatory and Planetarium Ceske Budejovice are ready to take active part in the International Year of Planetary Defense 2029.

RESUME:

The essential goal of all mentioned NEO educational and public outreach tools is to bring clear, correct, concise, comprehensive and current information to a wide spectrum of general public, students, educators, mass and social media as well as to decision makers and government officials. Lessons learnt from NEO educational and public outreach done by the Klet Observatory and Ceske Budejovice Planetarium until now help us to improve and increase these efforts. Finally, our role should be to inspire the next generation, children, pupils and students towards the natural sciences and smart technologies for a sustainable society with no discrimination.International collaboration is necessary for all mentioned tasks.

REFERENCES:

[1] Task Force on Potentially Hazardous Near Earth Objects, United Kingdom, (2000)
[2] International Astronomical Union, Resolution B3 on the establishment of an International NEO early warning systém (2012)
[3] White paper of 2011 IAA PLANETARY DEFENSE CONFERENCE (2011)
[4] http://www.planetky.cz (2023)
[5] Near Earth Objects Media/Risk Communication Working Group Report, Secure World Foundation (2012)
[6] Ticha, J.; Tichy, M.; Kocer, M. , NEO-related scientific and outreach activities at KLENOT in Near Earth Objects,our Celestial Neighbors: Opportunity and Risk, Proceedings of IAU Symposium 236. Edited by G.B. Valsecchi and D.Vokrouhlický. Cambridge: Cambridge University Press, pp.371-376, (2007)
[7] Sandberg, Anders (Future of Humanity Institute, Faculty of Philosophy + Oxford Martin School, Oxford University): The billion body problem: taking human (ir)racionality into account for planetary defence, PDC Bucharest, (2011)
[8] Billings, Linda (National Institute of Aerospace): Duck! Disaster! Destruction! Challenges in communicating about near-Earth objects, paper, PDC Flagstaff, (2013).
[9] Chapman, Clark, R. (Southwest research Institute, Boulder): NEO Disaster Response and Recovery in the Context of Other Natural Hazards, presentation, PDC Flagstaff (2013)
[10] http://www.esa.int/Our Activities/Operations/Space Situational Awareness/Near-Earth Objects-NEO Segment (2023)
[11]Ticha, J., Tichy, M.: Klet Observatory : 25 years of experience in NEO public education and communication, Journal of Space Safety Engineering, Vol.5, Issue 3-4,pp.209-210 (2018)

ACKNOWLEDGEMENT:

South Bohemian Region, Czech Republic
ESA project S2P-S1-PD-06.1 (CARMEN) contract No. 4000134667/21/D/MRP