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Whom should we call? Data policy for immediate impactors announcements

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1. Impact Monitoring

After the PR disaster of 1997 XF_{11} (March 1998), we started a crash research program on impact predictions. The difficulty was the chaotic motion of Earth-crossing asteroids (orbit uncertainty increases exponentially with time); it can be solved by replacing a real asteroid with a swarm of Virtual Asteroids. In 1999 we introduced Geometric Sampling to replace Monte-Carlo methods (see Milani, Chesley & Valsecchi, A&A 346, 1999). In November 1999 the first Impact Monitoring system CLOMON was operational. From 2002 the second generation systems CLOMON2 at Pisa and SENTRY at JPL are operational: critical cases are scanned for possible impacts in the next 90–100 years.

1.1. *The current Data Policy*

In collaboration with the IAU executive we established a data policy, (technical verification): all the reliable impact information must be posted on the web; however, no critical case (Palermo Scale > -2) is posted before verification. The current data policy does not prescribe exactly what to do about press releases, but we are very careful. NEODyS leaves to the media to select newsworthy cases, JPL has a PR person in charge of announcements, but uses this seldom. This data policy is motivated by the need of astronomical follow up (astrometric, physical observations). As observational information increases most virtual impactors become contradicted by data. The list of need-to-know people is very long, and they are not under the control of any single organization: thus secret is both detrimental and dangerous, especially because of conspiracy theories.

2. Immediate Impactors

The current setting of Impact Monitoring (NEODyS + JPL) has been operating for >10 years. There has been progress in understanding after cases with new features, e.g., (99942) Apophis, which initially had a very high Impact Probability for 2029. An algorithm upgrade was needed, but the policy for impact announcements did not need any change. The map of possible impact area was not made public.

In October 2008 the very small asteroid/meteoroid 2008 TC3 was discovered 21 hours before impact. The system (observers, MPC, Impact Monitoring) was found to work very efficiently: impact was announced by many astronomers, also by NEODyS, the impact location was predicted by JPL, the atmospheric explosion was observed by Meteosat and seen by an airplane pilot; meteorites were recovered.

The proposed Wide Survey for NEOs (as defined by ESA SSA studies) would cover the entire dark sky ($> 30,000$ sq. deg., 3 images each night). The goal is discovery of a large fraction of impactors large enough for ground damage in time for mitigation action (evacuation of target area). A simulation of 10 years of Wide Survey shows the capability of warning at IP>0.9 10 days before impact for most Tunguska-class impactors, 3 days for a majority of objects which could result in damage.

2.1. *Incomplete knowledge for the atmospheric segment*

As long as the orbit is in interplanetary space it is deterministic and can be predicted, with uncertainty depending only upon the amount, accuracy and time span of the available astrometry. Even over the much shorter time scale of an immediate impactor (few weeks to few days) the data policy has to be the same: given the need of collaboration by astronomers from all over the world, secrecy is impossible.

The situation changes when a small asteroid/meteoroid actually enters the Earth's atmosphere. Then the typically small uncertainty of the orbit(few km) grows significantly in the last minute of atmospheric flight. The most uncertain prediction is on where most of the kinetic energy of the impact is released, forming a fireball. This results, for low elevation entry, in a uncertainty of the ground zero location by tens of km.

The height of the energy main release can be such that strong thermal/pressure effect do not reach the ground. In the Tunguska event, with energy release in troposphere, a ~ 40 m diameter objects with $3 \sim 5$ MT energy generated a destruction zone of ~ 2000 sq. km. An impactor of the same composition but smaller diameter (like $20 \sim 30$ m) could result in no ground damage, or possibly a weak one. It is also possible for smaller impactors to cross the troposphere and impact in one piece. E.g., Barringer (Meteor) Crater was excavated by an iron meteorite about the same diameter of Tunguska.

2.2. *Evaluation of the risk*

When an immediate impactor is discovered, how much do we know about the object? If only photometry incidental to astrometry is available, the diameter may be uncertain by a factor 2.5. Estimates of mass include an additional uncertainty by a factor 1.5 in density, overall a range of about 20 for the uncertainty in mass. Thus a "damage prediction" could range from almost certainly not dangerous to 10 MT groundburst with very substantial damage: the evaluation of the risk is very poor.

The Wide Survey will need advanced follow up capabilities, also for physical observations, and these will have to be contributed by astronomers (as for 2008 TC3). This implies a significant list of need-to-know people and the impossibility of secrecy. The effect of these observations (spectra, polarimetry, infrared, radar) could decrease the uncertainty in the total energy to a much more limited range, such as $2 \div 3$. Thus the recommended data policy is to declare in public that we need more information in order to assess the damage, and thus ask for contributions.

2.3. *Data policy for the damage predictions*

The results of the modeling for the atmospheric reentry are far from certain, because they depend upon assumptions on composition and internal structure. This may result in uncertainties of tens of km on the location of ground zero, and several km in the altitude of the main energy release. Because of the poor information and of the nature of the problem, with no simple deterministic model, there is no guarantee that the information which would be needed by the emergency planning authorities would be available.

The only firm data policy rule applicable is that "thou shalt not lie". If it is not known what the ground effect of a given impactor would be, nobody should claim he/she knows. The danger is that someone could like to claim he knows what to do, when in fact this is not possible. This applies both to the communication with the public at large as well as to the briefing of a restricted group of authorities in charge of mitigation planning.