

# Deep Impact

Films about science or even pseudo-science can be powerful tools in the classroom. **Heinz Oberhammer** and **Markus Behacker** from the Cinema and Science project provide a toolkit for using the film *Deep Impact*.

In the classroom, a scene or clip from a popular film or documentary about science or even pseudo-science can be used to stimulate discussion and raise interest in scientific subjects. The Cinema and Science (CISCI) website<sup>w1</sup>, due to launch in December 2006, will describe a wide variety of film scenes, providing explanations and background information to help teachers prepare inspiring, film-based lessons.

This article on the film *Deep Impact* provides a sample of the content being developed by CISCI, including explanations for pupils and background information for teachers.

## Deep Impact

The young astronomer Leo Beiderman discovers a comet. In an attempt to destroy it, a shuttle is launched to place nuclear bombs on the comet; when these are detonated, they succeed in splitting the comet in two. The larger piece misses earth, but the smaller piece lands in the sea, creating a tsunami. In preparation for the impact, a limited number of citizens are sheltered in special bunkers, ready to rebuild society after the catastrophe has passed. The people are selected by lottery together with 200000 scientists, doctors, soldiers and other officials.

## Scene 1: Comet produces mega-tsunami

As the comet passes through the atmosphere, friction with the air causes it to become a giant fiery ball. When it hits the ocean, it produces a mega-tsunami, with waves around 400 metres high. The tsunami reaches and devastates New York City and Washington, DC, and floods vast coastal areas.

## Basic explanation

Comets consist of ice and dust and are therefore often called 'dirty snowballs'. They come from far out in the solar system. Asteroids, on the other hand, are rocks from a region between the planets Mars and Jupiter. Sometimes a comet or asteroid may hit earth. If it lands in the ocean, a series of gigantic waves are produced: a tsunami.

In this scene, a gigantic tsunami is produced when the comet hits the ocean. The tsunami, several hundred metres high, devastates New York City and other coastal areas. Given the size of the comet, several kilometres in diameter, the severity of the tsunami is realistic.

## Advanced explanation Comets

Comets consist of ice and dust and are therefore often called 'dirty



## BACKGROUND

## Cinema and Science (CISCI)

The CISCI project involves ten partners from Europe and the USA, and is part of the larger NUCLEUS project funded by the European Commission. The planned 160 content units will cover physics, biology, chemistry, mathematics, informatics and other science subjects and will be available on the CISCI website<sup>www1</sup> in English and the languages of the CISCI partners.

snowballs'. They originate from a far region of the solar system called the Oort cloud. When comets approach the sun, they heat up and emit particles from their surface (shown in the film as mini-eruptions). These particles are then dispersed by wind from the sun, forming the characteristic comet tail. Comets often have two distinct tails pointing in slightly different directions: one made of dust and the other of gas.

### Oort cloud

The Oort cloud was named after the Dutch astronomer Jan Hendrik Oort and is about 50 000 to 100 000 kilometres further from the sun than earth. The Oort cloud consists of trillions of comets, left over when our solar system was formed.

### Tsunami

The Japanese word 'tsunami' is written as two characters. The character 'tsu' means harbour, while the character 'nami' means 'wave'. The name comes from the experience of Japanese fisherman who returned to their harbour to find it totally devastated, although they had noticed nothing out at sea.

The height of a tsunami in open water is often less than one metre, although it may achieve a height of 30 metres or more as it approaches

the coast. A tsunami may be produced by earthquakes, landslides, volcanic eruptions and impacts from comets or asteroids. The most common cause is an undersea earthquake. Through the sheer weight of water, the waves can pulverise all objects in their path, reducing buildings to their foundations. Even large objects such as ships and boulders can be carried several kilometres inland. After all, one cubic metre of water has a mass of one ton. Water, travelling at the speed shown in the film, acts as a solid body on impact.

### Scientific description

Scientists have used computer simulations to describe an asteroid or comet, 1.4 kilometres in diameter, landing in the sea about 600 kilometres offshore. Such an event happens on average once every 1.8 million years. The simulation produced the following results:

- The released energy would correspond to about 275 000 megatons of TNT, or 27 500 hydrogen bombs.
- The asteroid or comet would completely evaporate upon impact.
- A crater about 12 kilometres wide and reaching 5000 metres below the water surface would be created.
- About 1 cubic kilometre of water vapour would evaporate together

with the debris of the comet or asteroid, creating a huge cloud.

- A gigantic tsunami would be produced, flooding coasts and reaching a height of about 120 metres, about 10 times higher than the Asian tsunami on 26 December 2004. In the film, the tsunami is about 400 metres high.

A comet moves with an average velocity of about 40 kilometres per second (14400 kilometres per hour). As the comet moves at a low angle across the sky, we can draw a comparison with the velocity of a passenger aeroplane, which has a speed of about 800 kilometres per hour.

The comet moves 180 times faster (14400/800) than the aeroplane. A passenger aeroplane can be observed moving across the sky for about 6 minutes, or 360 seconds. The comet would cross the sky in about  $360/180 = 2$  seconds. The time taken for the comet to move across the sky in the scene, therefore, is too slow.

To summarise, the *Deep Impact* scene showing the comet is not quite realistic. However, the tsunami and its devastating effects in the scene are essentially scientifically correct.

## Web references

w1 – The CISCI website can be found at [www.cisci.net](http://www.cisci.net)

## Resources

### Deep Impact sites

The Internet Movie Database:

[www.imdb.com/title/tt0120647/](http://www.imdb.com/title/tt0120647/)

Wikipedia:[http://en.wikipedia.org/wiki/Deep\\_Impact\\_%28film%29](http://en.wikipedia.org/wiki/Deep_Impact_%28film%29)

Amazon (DVD: *Deep Impact*, Special Edition, Dream Works Home Entertainment): [www.amazon.co.uk](http://www.amazon.co.uk)

Amazon (DVD: *Deep Impact*, Paramount): [www.amazon.com](http://www.amazon.com)

### Comet sites

Wikipedia: Scientific description of comets:

<http://en.wikipedia.org/wiki/Comet>

Views of the Solar System: introduction to comets, including images:

[www.solarviews.com/eng/comet.htm](http://www.solarviews.com/eng/comet.htm)

Views of the Solar System: film about the history of comets: [www.solarviews.com/cap/comet/vcomet.htm](http://www.solarviews.com/cap/comet/vcomet.htm)

Windows to the Universe: educational site about comets: [www.windows.ucar.edu/tour/link=/comets/comets.html](http://www.windows.ucar.edu/tour/link=/comets/comets.html)

NASA/ESA Hubble Space Telescope site: video clips about comets:

[www.spacetelescope.org/bin/videos.pl?searchtype=free\\_search&string=Comet](http://www.spacetelescope.org/bin/videos.pl?searchtype=free_search&string=Comet)

## Oort cloud sites

Wikipedia: scientific description of the Oort cloud:

[http://en.wikipedia.org/wiki/Oort\\_cloud](http://en.wikipedia.org/wiki/Oort_cloud)

Views of the Solar System: introduction to the Oort cloud:

[www.solarviews.com/eng/oort.htm](http://www.solarviews.com/eng/oort.htm)

## Sites about comet or asteroid impacts

Wikipedia: scientific description of an impact:

[http://en.wikipedia.org/wiki/Impact\\_event](http://en.wikipedia.org/wiki/Impact_event)

Earth Impact Effects Program: an interactive website to estimate the environmental consequences of impacts on earth: [www.lpl.arizona.edu/impac effects/](http://www.lpl.arizona.edu/impac effects/)

Solar System Collision: an interactive website to estimate the effects of impacts on different planets:

<http://janus.astro.umd.edu/astro/impact/>

## Tsunami sites

Wikipedia: scientific description of tsunamis:

<http://de.wikipedia.org/wiki/Tsunami>

Tsunami!: questions and answers about tsunamis:

[www.ess.washington.edu/tsunami/](http://www.ess.washington.edu/tsunami/)

Asian Tsunami Videos.com: amateur videos of the 2004 Asian tsunami: [www.asiantsunamivideos.com](http://www.asiantsunamivideos.com)

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Table 1: *Deep Impact* details

<i>Title</i>	<i>Deep Impact</i>
<i>Release year</i>	1998
<i>Film producer</i>	DreamWorks SKG, Paramount Pictures, Zanuck/Brown Productions
<i>Director</i>	Mimi Leder
<i>Scientific subject and topic</i>	Physics and astrophysics

Table 2: Scene 1 details

<i>DVD</i>	<i>Deep Impact</i> , Special Edition, DreamWorks Home Entertainment
<i>Time interval</i>	Track 27, 01:39:05 - 01:41:55
<i>Scientific keywords</i>	Comet, asteroid, planet