

Hazard Risk Analysis

Astronomical

Asteroid, Comets, and Meteor Crashes
Geomagnetic and Ionospheric Storms
Space Object Crashes

Astronomical Hazards

This section introduces three types of astronomical or space-based hazards: asteroids, comets and meteors; space weather storms (such as geomagnetic and ionospheric storms), and space-object crashes. As you will see when completing the risk analysis, the first two are caused by nature and the other is caused by people (human-caused). When developing resilience strategies for these hazards it is important to understand where the primary cause for the hazard lies. These hazards originate from outer space and the Earth's upper atmosphere. In some cases, scientists would be able to offer some warnings to communities if they are likely to be affected. However, there are certain times of the year, or certain specific years, that would make it more likely for your community to experience some of these hazards.

Resources are available to assist you in completing this analysis in the [Risk Analysis Resources section](#).

Asteroid, Comets & Meteor Crashes

Definition

Asteroid, comets and meteor crashes are a result of an asteroid or meteor from space entering earth's atmosphere and crashing on earth, causing damage. These crashes can cause damage if they happen on land or over water.

Discussion

Asteroids are a type of small and rocky mass that orbits the Sun. Asteroids can be many different sizes, for example they could be as large as a small planet (roughly 965 km across) or smaller than 1 m across. Some of the smaller asteroid chunks frequently break apart and burn up in Earth's atmosphere, which cause meteors.

Astronomers have discovered many "Near Earth Asteroids" that cross the Earth's orbit and some that come close to the Sun, but the majority of asteroids orbit between the planets of Mars and Jupiter in an area that has become known as the asteroid belt.

Meteoroids are also chunks of rock and metal that orbit the Sun and can sometimes enter the Earth's atmosphere. This process creates meteors. If meteors reach the ground, they become meteorites. Although meteors can be any size, we would call them asteroids if they were more than a few meters across., However, most meteors and meteorites are smaller, and can even be microscopic in size.

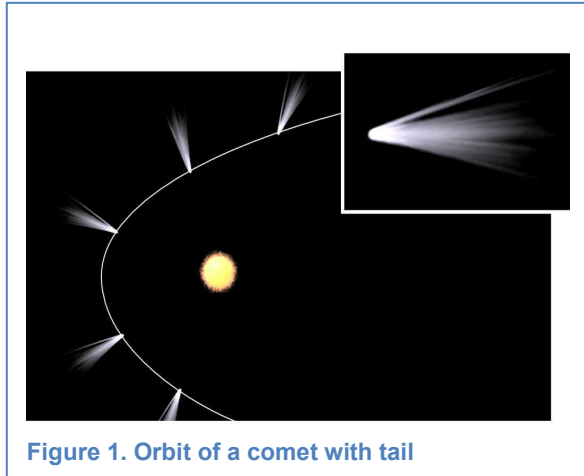


Figure 1. Orbit of a comet with tail

A comet is a small chunk of ice, dust, and rocky material that orbits the sun and is usually only a few kilometers wide. When a comet comes close enough to the Sun, it can develop a "tail." The tails of comets are made of gas and dust that have been driven off the comet's surface by the Sun's energy. A comet's tail always point away from the Sun, no matter what direction the comet is moving. Comets spend most of their time very far away from the Sun, and they are active only for a short period (a few months at most every few years) because they move quickly around the Sun on their elongated orbits.

There are several times throughout the year when more meteors are seen than normal.

These are called meteor showers. They can happen when the Earth crosses the orbit of a comet, and the meteors are thought to be small pieces of the comet. Some of the most visible meteor showers happen in August (called the Persids meteor shower) and in December (called the Geminids meteor shower). Meteor showers are named for the constellation that they are closest to,, such as the Perseus and Gemini constellations. Sometimes, meteoroids from space survive the trip through the atmosphere and land on the Earth. If they do, they are called meteorites. They can be stony or metallic, and are mostly made of iron and nickel.

It Happened Here...

On February 27, 2021 a meteor with a blue tail streaking across Alberta prompted hundreds of reports. The blast was so huge it could be seen from the tip of the US border all the way up into the Arctic circle.

On November 20, 2008 in Marsden, Saskatchewan (population 234) the meteorite nicknamed the "Buzzard Coulee Fireball" shot through the sky at 5:30pm. There were no injuries reported. Following the incident debris from the meteorite was found scattered throughout the area.

To the Cree, "pahpamiyhaw asiniy" is a sacred rock containing the face of the creator. It is a 150-kilogram meteorite that fell to earth centuries ago and the First Nations people are looking to repatriate the meteorite from the Royal Alberta Museum.

Hazard Rating				High Risk	<input type="checkbox"/> Low Risk	<input type="checkbox"/> Need More Info	<input type="checkbox"/> Not Applicable
Yes	No	Need More	Not Applicable	FACTORS			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Asteroids, meteors, and comets are more likely to strike when their paths cross close to the Earth's orbit. Areas are at higher risk when these events have been predicted to happen by astronomers. Have any asteroid, meteor, or comet events been predicted for the near future?			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	An asteroid or comet impact in water can cause a tsunami or large inland waves. Coastal areas are at risk for asteroid induced tsunamis. Areas near large lakes are also at risk for large waves produced by asteroids and comets. Is your community on the coast or near a large body of water?			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Meteor showers often happen when small chunks from a passing comet enter the Earth's atmosphere. This risk increases when comets pass close to the Earth's orbit. Are any comets scheduled to pass close to the Earth's orbit?			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Many meteor showers happen at the same time every year, such as the Perseids in August and the Leonids in November. Areas are at a greater risk during these times. Is an annual meteor shower scheduled to occur soon?			

Space Weather Storms: Geomagnetic and Ionospheric Storms

Definition

Geomagnetic storms are caused by major disruptions in the sun's activity, which then affects the geomagnetic field of the earth. Ionospheric storms happen when the sun gives off a sudden burst of radiation. These types of storms can also produce larger aurora borealis (the northern lights) in more southern regions around the world.

Discussion

Canada is one of the countries that is most affected by geomagnetic and ionospheric storms as these space weather storms occur primarily around the earth's North Magnetic Pole. Space weather storms are natural hazards that may cause communications disruptions and alter the orbits of spacecraft and satellites. The storms may also cause surges in electric power lines and equipment failures in the power grid that can result in electric power blackouts over a wide area. Geomagnetic storms can last several hours or even days, and storms can surge several times a day as the solar wind "gusts" around the Earth.

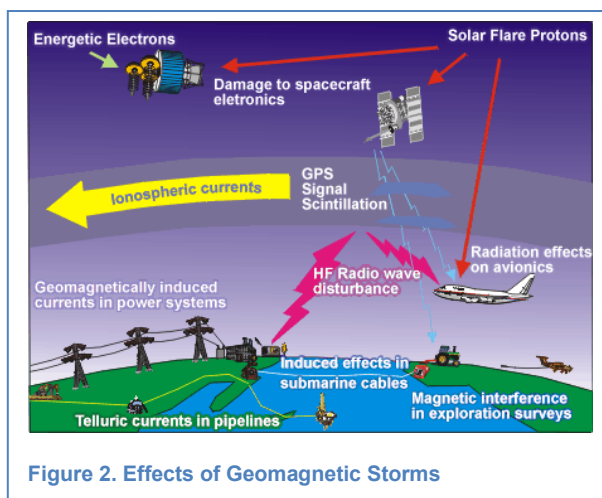


Figure 2. Effects of Geomagnetic Storms

Severe consequences of geomagnetic storms are:

- Power systems: transformers can overheat and power systems can malfunction. This can cause individual power lines to “tripping-out” and a collapse of whole power grid, leaving communities without power.
- Airplanes and Spacecraft operations may experience navigation and tracking problems.
- Cable systems can be affected by changes in electrical voltage.
- Pipelines: steel pipelines are covered with special electric coatings to prevent them from corrosion and wear and tear, and this protection can be disrupted during geomagnetic storms, long enough to result in increased corrosion and potential spills.
- Radio communication: ionospheric storms can cause radio signals to fade out. Storms that can last for weeks will cause serious communication failures with aircraft and northern communities.

For additional information check [Risk Analysis Resources \(Geomagnetic Storms\)](#).

It Happened Here...

On March 13, 1989 in Trecesson, Quebec (population 1000) at 2:44am a geomagnetic storm reached Earth causing the Hydro-Quebec power grid to collapse. The storm was linked to ejections from the Sun on March 9, 1989. 6 million people were left without power for 9 hours and estimates of lost revenue were in the hundreds of millions.

Hazard Rating				High Risk	<input type="checkbox"/>	Low Risk	<input type="checkbox"/>	Need More Info	<input type="checkbox"/>	Not Applicable	<input type="checkbox"/>
Yes	No	Need More	Not Applicable	FACTORS							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Areas located on rock with a high concentration of sulfur and graphite are at greater risk because these rocks are known conductors during geomagnetic events. Is your community located on and/or near sulphides and graphite?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	These types of space storms are more common around the northern or polar areas where you can experience Northern Lights. Areas where the Northern Lights are visible are at risk. Does your community frequently see the Northern Lights? (Check Risk Analysis Resources: Auroral Oval).							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is your community located in an area has experienced frequent numbers of geomagnetic storms in the past? (Check Risk Analysis Resources: Geomagnetic Storms).							

Space Object Crashes

Definition

Space objects are satellites, rockets, space shuttles, or other objects sent out into space by humans.

Discussion

Since 1957 some 2,500 satellites, space stations and other objects have been sent out into space. These objects circle the earth as close as 240 km from the earth’s surface to over 800 km away. These objects move very fast, at over 27,000 km per hour. Other objects (usually satellites) are sent out even further away from the earth, and are made to synch with the Earth’s rotation. This is called a geosynchronous orbit, and it allows satellites to match the Earth’s rotation and "hover" over the same spot at all times. Weather and television satellites are generally in this category.

“Space Junk” is made up of a variety of objects including abandoned satellites and broken parts of space objects. Just like other objects, this debris whizzes around at 27,400 km an hour, so even tiny pieces of space junk can be a serious hazard for satellites and other functioning space objects. Anything that goes up must come down, so sooner or later all of this space junk will come back to earth. Although no one has been killed by falling space junk so far, NASA estimates that on average one piece of space junk falls to earth each day.

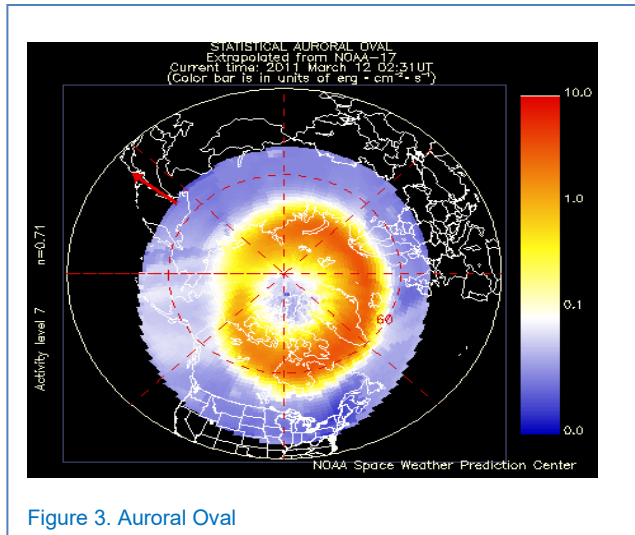
It Happened Here...

On Jan. 24, 1978, Cosmos 954, a Soviet satellite, crashed near Great Slave Lake, scattering radioactive waste across a 124,000 sq km swath of the Northwest Territories, Alberta and Saskatchewan. The radioactive waste affected Dene (Chipewyan) and Inuit communities around the Great Slave Lake region in the Northwest Territories.

Hazard Rating				High Risk	<input type="checkbox"/>	Low Risk	<input type="checkbox"/>	Need More Info	<input type="checkbox"/>	Not Applicable	<input type="checkbox"/>
Yes	No	Need More	Not Applicable	FACTORS							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	In some cases, there will be no warning, but in other cases, depending upon the reason for the crash, scientists may be able to provide information as to when and where the crash will occur. If they have the ability to direct the fall of the space object, scientists would try to make it fall into the ocean. The second option would be to bring the space object down in unpopulated areas. There is a small, increased chance that a space object crash would occur in a rural, non-populated area. Is your community small, rural and located in a remote part of Canada?							

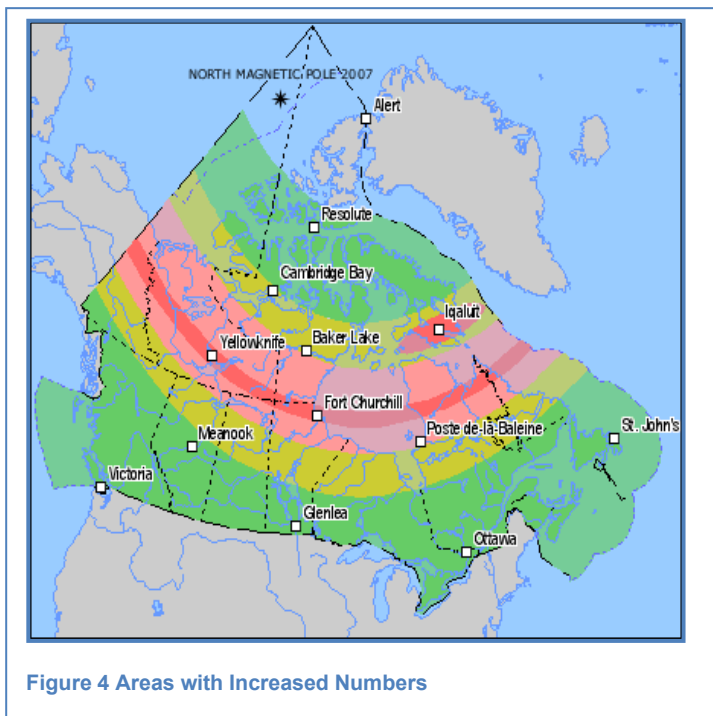
Risk Analysis Resources

Auroral Oval (Northern Lights)



The Auroral Oval, or the Northern Lights as it is commonly known, can shift on a day-to-day basis. Here is a map of the Northern lights over the North Pole on March 12, 2011. As you can see, the Northwest Territories and Nunavut are completely within the Northern Lights zone. Additional parts of British Columbia, Alberta, Saskatchewan, Ontario and Quebec also fall within the zone.

Geometric Storms/ Space Weather Storms



The following map indicates areas most likely to experience geomagnetic/space weather storms.

GeoMagnetic Storms and Space Weather

Natural Resources Canada's "The Atlas of Canada" provides a lot of information about geomagnetic storms, including the affects of a space weather storm and maps of the active regions where space weather storms occur. The Atlas also contains information about the location of gas pipelines and transmission lines in comparison to the regions where space weather storms occur.

<https://www.spaceweather.gc.ca/index-en.php>

<https://www.nrcan.gc.ca/maps-tools-and-publications/maps/atlas-canada/10784>

Keywords: space weather maps Canada

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