



Finding Impact Craters and Water Systems

LESSON DESCRIPTION

Remote satellite images of the earth are used to distinguish impact craters from other landforms. Water systems may also be studied. By constructing a model of a catchment basin, students can see how remote satellite images are used to learn about drainage systems and catchment basins on Earth as well as their possible existence on other planets.

OBJECTIVES

Students will:

- Describe the effects of extraterrestrial objects upon the Earth's topography, atmosphere, and living organisms
- Describe the role of satellite technology in helping scientists to identify evidence of impact events
- Define the concept of a catchment basin and a watershed
- Give examples of how their model relates to the real world
- Give examples of basic concepts of catchment basins and watersheds, such as, water runs downhill, hills make divides, low-lying areas create pooling, water quality is affected by what is upstream
- Draw conclusions as to how their model may be used to study images of Mars
- Compare and contrast drainage systems and catchment basins with features on Mars
- Describe why and how science is an ongoing process of discovery

NASA SUMMER OF INNOVATION

UNIT

Earth and Space Science - Remote Sensing

GRADE LEVELS

7th -9th

CONNECTION TO CURRICULUM

Science, technology and mathematics

TEACHER PREPARATION TIME

1 hour, This time will vary dependent upon the familiarity of the instructor with landforms and the availability of student internet access.

LESSON TIME NEEDED

Estimated 3 hours Complexity: Basic

NATIONAL STANDARDS

National Science Education Standards (NSTA)

Physical Science

- Properties and changes of properties in matter
- Motion and forces
- Transfer of energy

Earth and Space Science

- Structure of the earth system
- Earth's history
- Earth in the solar system

National Geography Standards (NCGE)

- The World in Spatial Terms
- The Uses of Geography

MANAGEMENT

Finding Impact Craters

<http://craters.gsfc.nasa.gov/lesson.html>

Each activity within this unit has material which will need to be downloaded and printed in advance of the lessons.

If students do not have access to the images online, the Landsat images of the land forms will need to be reproduced in color. For the identification and discussion portion of the activity, the teacher may need to rename Mount St Helens images since this feature is more well known in the U.S. as a volcano. Depending upon location, other features may need to also be renamed with their abbreviation.

Students should work in pairs in scrutinizing their images as we see and interpret images differently. This is also helpful with materials management.

Hydrology Investigation: Model a Catchment Basin

http://classic.globe.gov/tctg/hydro_la_modelcatchment.pdf?sectionId=160&lang=EN

The catchment basin model may be outdoors or inside. The area will need to be 1 meter square: a table top if inside; plywood if outside. Covering the floor with plastic is recommended. Decide if the model is temporary or permanent before gathering the materials.

It would be helpful to print out the images of some of Earth's drainage basins and stream networks prior to the lesson. Images with similar features may be printed for Mars.

CONTENT RESEARCH

Many people know that craters cover the surface of the moon. In fact, impact craters appear on all rocky (terrestrial) planets and many of their moons. The Earth has been shaped by these dramatic impact events no less than other planetary bodies have been, and one can see evidence on the Earth in terms of its geology, biology, and chemistry.

NASA scientists currently study satellite images for evidence of impact events. Finding the evidence requires careful interpretation of satellite images. Wind and water have eroded away most of the evidence; various other geologic processes have concealed it; oceans and vegetation now cover much of the rest. Satellite observation technology enables us to see landforms that we can't see with our eyes alone. When impact craters are found in satellite images, interdisciplinary teams of scientists can go to the sites on the ground to learn more about them and how they have changed their surroundings.

Water responds to the pull of gravity and is channeled by the materials it must pass through. Most students, when asked what direction a river flows, will respond with a cardinal direction – south or east, for instance. The catchment basin (also called drainage basin) is the place where water converges at a common point – where water hits and flows. The watershed is the basin boundary.

The drainage systems on Earth can also be studied by using satellite

MATERIALS

Finding Impact Craters

Student Worksheet for Step 1:
[When an Extraterrestrial Object Hits the Earth](#)

Student Worksheet for Step 2:
[Known Effects of Impact Events](#)

Student Worksheet for Step 4:
[Describing Satellite Images of Possible Impact Craters](#)

Student Worksheet for Step 6:
[Questions You Would Ask on a Field Expedition to a Possible Impact Crater](#)

Satellite images of landforms with pseudonyms for student use

(Students may recognize some names and know already whether or not they're impact craters.)

[Aorounga \(Aor\)](#)

[Elgygytgyn \(Elg\)](#)

[Haughton \(Hgh\)](#)

[Manicougan \(Man\)](#)

[Mount St. Helens \(Msh\)](#)

[Richat \(Rch\)](#)

[Schooner \(Sch\)](#)

Teacher Reference Sheet:

http://craters.gsfc.nasa.gov/teacher_ref.html

Model of a Catchment Basin

Miscellaneous objects used to create the model infrastructure

Outdoor models may use: sand, wood, rocks, etc.

Indoor models may use classroom items such as buckets, bowls, rolls or paper towels, etc.

Plastic sheet (2 x 2 meters)

Spray bottle with water

Sponges

Red food coloring

Permanent marker

Ruler

Topographic map

Satellite images of Earth and

Mars (listed in Lesson Activities)

images. Both the drainage systems and the stream networks images of Earth may be compared to similar features observed in the satellite images of Mars.

Vocabulary:

Impact Craters: Craters formed when objects or impactors smashed into the surface.

Ejecta is the material thrown out of the area that becomes the crater during impact. This does not account for all material since much is vaporized or melted.

Rays: The bright streaks starting from a crater and extending away for great distances.

Raised Rim: Rock thrown out of the crater and deposited in a ring-shaped pile at the crater's edge during an impact.

Crater Floor: The bowl shaped or flat area of a crater, usually below the surrounding ground level unless filled in with lava

Erosion: The movement or grinding away of surface materials by wind, water, ice or gravity.

Watershed: the catchment basin boundary; where all of the water that is under it or drains off of it goes to the same place

Catchment basin (drainage basin): an area of land where surface water from rain and melting snow or ice converges to a single point, usually the exit of the basin, where the waters join another waterbody, such as a river or lake. In closed drainage basins the water converges to a single point inside the basin, known as a sink, which may be a permanent lake, a dry lake, or a point where surface water is lost underground. The drainage basin includes both the streams and rivers that carry the water as well as the land surfaces from which water drains into those channels, and is separated by a drainage divide.

LESSON ACTIVITIES

Finding Impact Craters

<http://craters.gsfc.nasa.gov/lesson.html>

This activity will guide students through discussions regarding known impacts that have occurred on the Earth and the possible outcomes that have resulted.

Working in teams of three to five, students will then evaluate satellite images of the earth to determine the traits associated with impact craters in different regions of the world.

The activity description contains six steps with the first three steps providing background which may or may not be required for every group in the upper grade levels.

Hydrology Investigation: Model a Catchment Basin

http://classic.globe.gov/tctg/hydro_la_modelcatchment.pdf?sectionId=160&lang=EN

This activity introduces what a catchment basin is and how it works. The students construct a 3-dimensional model of a catchment basin and use the model to investigate basins and water pathways.

Use NASA satellite images to explore further the basins and water pathways. Challenge the students to compare and contrast the known features of Earth with what is evidenced in the satellite images of Mars.

Pennsylvania

http://gcmd.nasa.gov/records/GCMD_USGS_PA_DIGIT.html

China

http://daac.gsfc.nasa.gov/geomorphology/GEO_5/GEO_PLATE_D-5.shtml

Mars

<http://www.nasa.gov/centers/ames/news/releases/2003/03images/marslake/marslakes.html>

<http://mars.jpl.nasa.gov/mro/newsroom/pressreleases/20030212b.html>

ADDITIONAL RESOURCES

Graphics for Simple and Complex Impact Craters:

http://craters.gsfc.nasa.gov/crater_diagram.html

Aerial Image of Barringer Crater in the U.S.:

http://craters.gsfc.nasa.gov/assests/images/Barringer.best_aerial.gif

Video of Iturralde Impact Crater (also called Araona Crater) in Bolivia:

http://craters.gsfc.nasa.gov/assests/movies/Iturralde_movie.mpg

Solar System Exploration

http://solarsystem.nasa.gov/scitech/display.cfm?ST_ID=345

Geology.com utilizes many NASA Resources in discussing related topics. Near-Earth asteroids

<http://geology.com/articles/near-earth-asteroids.shtml>

Maps and image gallery for Mars

<http://www.lpi.usra.edu/resources/>

DISCUSSION QUESTIONS

- How often do impacts occur? Does the rate of impacts vary over time? If so, does it vary regularly or randomly? *Impacts take place every day! The size and speed of the impactor is significant.*
- Are asteroids or comets the more frequent impacting bodies? *Both have been observed impacting on different planets in our solar system, but there appear to be more asteroids closer to the Earth.*
- Have impact events caused more than one major biological extinction event?
- http://rst.gsfc.nasa.gov/Sect18/Sect18_4.html approximately half way through this site you will see two graphics that help to support discussions in this area
- When will the next impact event take place? How big will it be, and how will it affect life?
- Answers will vary. 2012 discussion: <http://www.nasa.gov/topics/earth/features/2012-quest.html>
- What would happen to the hydrology site if there was a change such as a dam, a forest added, a forest removed, pollution? *Students should be able to show the impact of these changes through manipulating the model.*
- Explain something that might happen in a basin that would affect its water temperature. *Answers will vary.*
- Select a satellite image of Earth and trace out the catchment basin and water pathways. *Tracing should show understanding of the model as transferred to an image*
- Select a satellite image of Mars and speculate what features observed might be basins and water pathways. *Students discuss and come to conclusions.*

ASSESSMENT ACTIVITIES

Crater Rubrics

<http://craters.gsfc.nasa.gov/rubric.html>

<http://craters.gsfc.nasa.gov/assests/pdf/rubric.pdf> (Downloadable pdf)

Student assessment is divided into five levels with 0 = no understanding of how impact events have shaped the land, atmosphere, and living things. To Level 4 = There is evidence in this response that the student, using analysis, has a full and complete understanding of how impact events have shaped the land, atmosphere, and living things.

On the web site, each Level has further details for the characteristics associated with the level.

Catchment Basin

- Give each student a situation and have him/her demonstrate it on the model.
- Ask students to draw an image of a catchment basin and a drainage system labeling the basin and watershed areas accurately.
- Ask students to point out features on Mars that scientists are now studying which could be evidence of a water system on the planet.

ENRICHMENT

NASA Earth Observatory provides current and archived articles and images on a variety of topics related to remote sensing of the Earth:

<http://earthobservatory.nasa.gov/>

Geology.com and Google Maps identify many of the larger known “asteroid impacts”:

<http://geology.com/meteor-impact-craters.shtml>

USGS Study of the Chesapeake Bay Impact Crater:

http://meteor.pwnet.org/impact_event/impact_crater.htm

GSFC BASIC SCIENCE STUDIES II: IMPACT CRATERING This is an instructive article by scientists at NASA’s Goddard Space Flight Center with deep background in the study of impact craters:

http://rst.gsfc.nasa.gov/Sect18/Sect18_1.html

Students may build a stream table to demonstrate geologic actions on Mars

<http://passporttoknowledge.com/lfm/teachers/tq/program1/Act1.3.html>

This guide is entitled, “Mars Exploration: Is There Water on Mars?” There are numerous activities that can be used to enrich the lesson activities of this unit.

http://mars.jpl.nasa.gov/education/modules/water_preface.pdf