An Introduction to Land Cover Changes over Time

This lesson plan builds on the lesson plan on **'Understanding Land Use and Land Cover Using Google Earth'**. Please refer to it in terms of definitions on land use and land cover. The terms land use and land cover is not synonymous. Land use is defined as human use of land. In other words it refers to the economic use to which land is put. Examples include parks, medium density residential areas, and industrial areas. Land cover is different. Land cover refers to the material in contact with the Earth's surface. An area designated as a park on a land use map, for example, may include several land covers such as areas of deciduous or evergreen forest, or fields of grass (herbaceous vegetation). Another example is your school. On a land use map, your school may be shown as an "institutional use" or "educational use." Within the boundaries of your school's property, you may be able to identify several land covers including forest areas, grassed fields, and impervious surface (your school building(s), parking lot, sidewalks, etc.).

Many land use, land cover, and land use/land cover classifications have been developed by federal, state, and local government agencies. For example, the U.S. Geological Survey used a modified version of what is referred to as the Anderson classification system for the 2001, 2006 and 2011 National Land Cover Data (NLCD) classification scheme. The image below shows the Anderson classification system.

11 Open Water	NLCD 2001 Land Cover Classification Legend
12 Perennial Ice/Snow	11 Open Water
21 Developed, Open Space	12 Perennial Ice/Snow
22 Developed, Low Intensity	21 Developed, Open Space
23 Developed, Medium Intensity	22 Developed, Low Intensity
24 Developed High Intensity	23 Developed, Medium Intensity
31 Barren Land	24 Developed, High Intensity
41 Deciduous Forest	31 Barren Land
42 Evergreen Forest	32 Deciduous Forest
43 Mixed Forest	41 Evergreen Forest
51 Dwarf Scrub[1]	43 Mixed Forest
52 Scrub/Shrub	51 Dwarf Scrub*
71 Grassland/Herbaceous	52 Shrub/ Scrub
72 Sedge Herbaceous[1]	72 Grassland/ Herbaceous
73 Lichens[1]	72 Sedge/ Herbaceous *
74 Moss[1]	74 Moss *
	81 Pasture Hay
[1]Alaska only.	82 Cultivated Crops
	90 Woody Wetlands
	95 Emergent Herbaceous Wetlands
	* Alaska Only

The NLCD 2001, 2006 and 2011 will be displayed using the above legend. The image below shows the **NLCD Land Cover map** for the 48 continuous states:
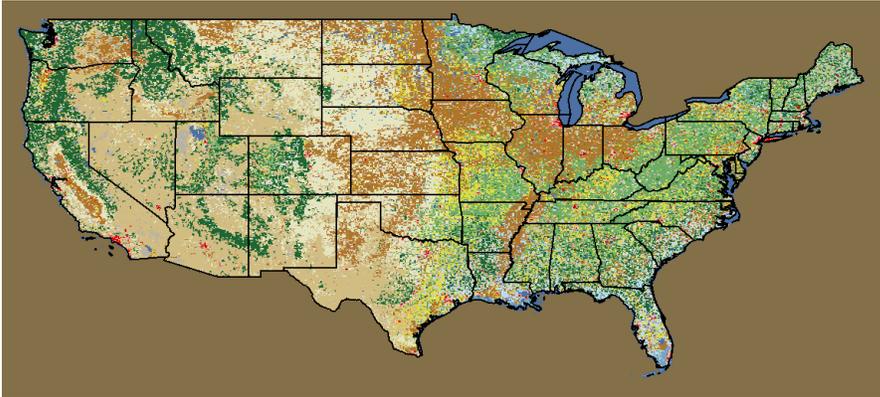

In addition to the NLCD 2001 land cover map, the lesson plan will also demonstrate how to display the **impervious surface** and **tree canopy** data for your school in Google Earth as well as ArcGIS online. *Impervious surfaces* are mainly artificial structures, such as pavements (roads, sidewalks) that are covered by impenetrable materials such as rook tops, asphalt. Below is shown the map where impervious surface areas are shown in red.

NLCD Impervious Surface Map.
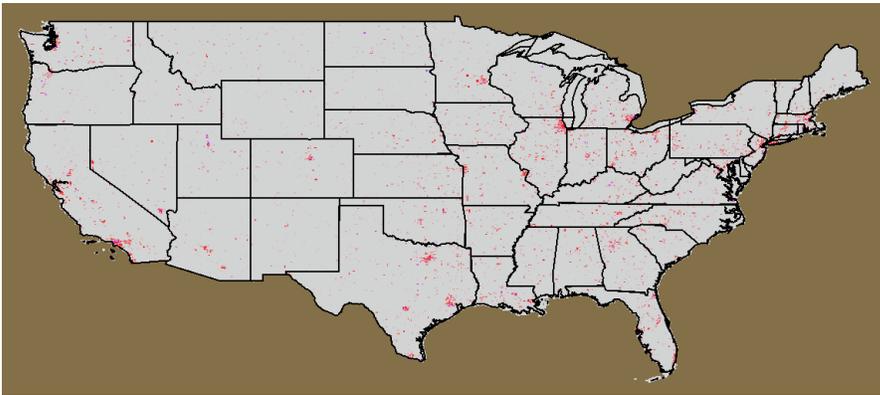
The map below shows **the NLCD Canopy Layer.** Green areas show tree cover for the whole US.
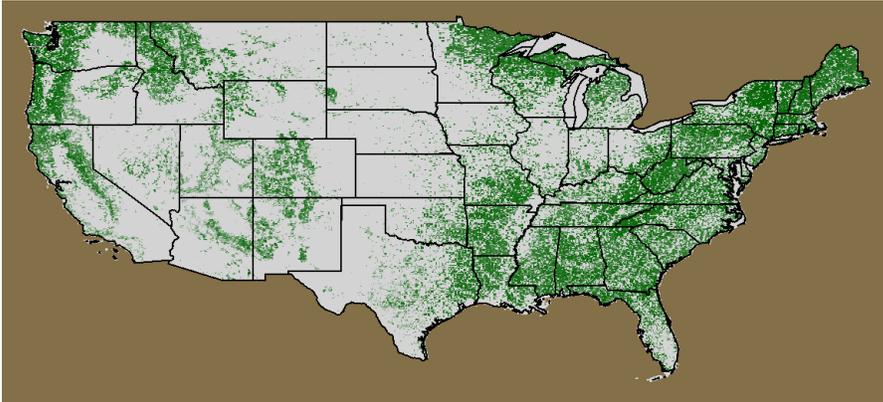
Encyclopedia of the Earth Article

Land use and land cover, discusses the differences between how natural and social scientists define land use, describes the causes and consequences of land use and land cover change (loss of biodiversity, climate change, pollution, other impacts), identifies the different methods used by scientists and land managers to study land use and land cover (remote sensing, geospatial analysis, driving forces, modeling), and explains the concept of sustainable land management. In addition to this article, a list of other teacher resources is included below.

Lesson: An Introduction to Land Cover Changes over Time

Learning Objectives:

The overarching goal of the US Land Cover Data Set is to promote the awareness of the trends and use of spatial information about the impact of changes occurring to the land cover and its influence on human health and the environment. Understanding perspectives of space-based observations will help students to monitor changes on our planet to develop strategies to manage natural resources, and sustain human wellbeing.

Displaying an extensive collection of historical and current satellite imagery is enabling students to observe and document the significance and consequences of changes in the environment, many of them caused by human activity, over time. Students can better understand the long-term changes to our planet by seeing and understanding how humans (and climate) are modifying the land's resources.

Students will begin this lesson with locating land cover change data sets over different time periods online, import these data sets into Arc GIS online to observe environmental and human-made changes to the Earth land cover. Analyzing these changes will guide students to better manage environmental resources at all geographical scales, from local to global level.

Lesson Plan 3 – Land Cover Changes Over Time

Students will learn to:

- Distinguish between different land cover types.
- Identify areas on a map, which do not allow water to flow through and which surface areas are penetrable by water.
- Discover the locations of tree cover in the US.
- Consider effects of environmental changes.
- Develop strategies to positively influence these changes.

Teacher Prep time: Depends on the teacher's experience with the software. One hour is required for those who are new to ArcGIS. Fifteen minutes is required, to review the lesson, for those with an already set-up account and working knowledge of the software and an understanding of land cover classes.

Prerequisite: **EOD_Lesson Plan 1_ Introduction to Land Use and Land Cover Using ArcGIS Online**

Class Time Requirement: 50 minutes

Materials needed: Windows or Mac computer with Internet connection and access to ArcGIS online

Teacher Prep Instruction: Create an account for ArcGIS online by following the instructions on the following website: https://www.arcgis.com/features/index.html

Classroom Instructions:

Access the following website to familiarize yourself with the concepts of Land Use and Land Cover - ***http://landcover.usgs.gov/usgslandcover.php***

National Land Cover Data Base (NLCD) – is a 16-classes land cover classification scheme. It is comprised of three different elements: Land cover, percent tree canopy density and percent-developed impervious surface.
Impervious Surface – are mainly artificial surface covered by impenetrable materials (asphalt, concrete, etc.)
Canopy- is the layer of stems of trees, leaves, branches that cover the ground when viewed from above.
KLM – stands for 'keyhole markup language' and is a file format used to display geographic data in an Earth browser such as Google Earth. Those files are often distributed in zipped format as .kmz files.

Now you will learn the procedure to view the NLCD data sets (land cover, impervious surface, and tree canopy layers) in ArcGIS online:

Lesson Plan 3 – Land Cover Changes Over Time

1.) Sign in to your ArcGIS online account. For instructions on how to create an account see **"EOD_Lesson Plan 1_ Introduction to Land Use and Land Cover Using ArcGIS Online".**

2.) Visit" https://raster.nationalmap.gov/arcgis/rest/services/LandCover

3.) Select "LandCover/USGS_EROS_LandCover_NLCD (MapServer)" to access the NLCD data sets.

4.) Select in the **"View In"** section the **"ArcGIS Online map viewer"**, shown in the picture below. The selected hyperlink will take you automatically to the ArcGIS online website where the NLCD data sets will be displayed.

5.) The following window appears:
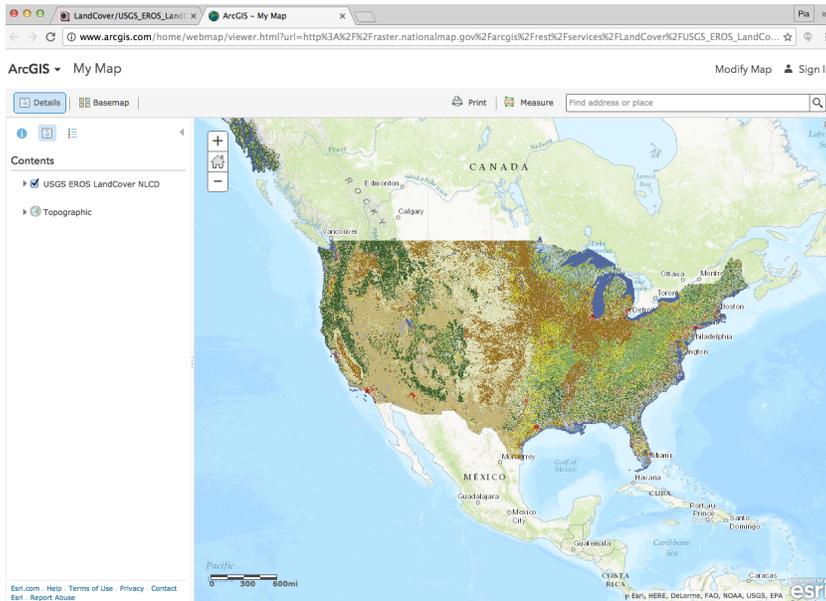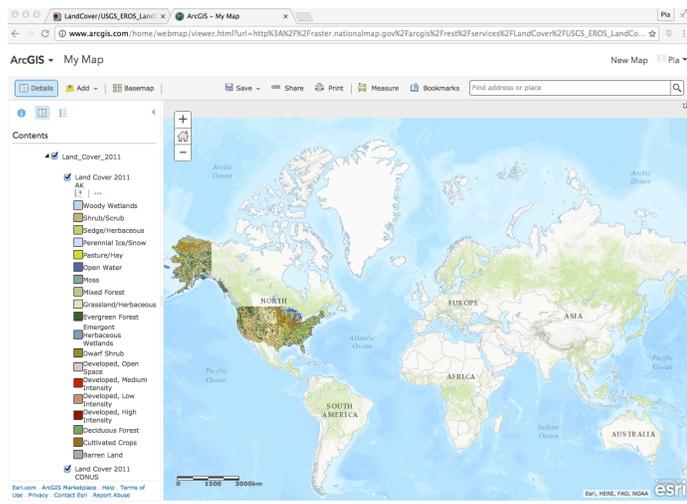

6.) In the **"Details"**, **"Contents"** section mouse over the arrow to expand the **"USGS EROS LandCover NLCD"** folder. Now you are able to select the data sets you would like to display (see screenshot below).
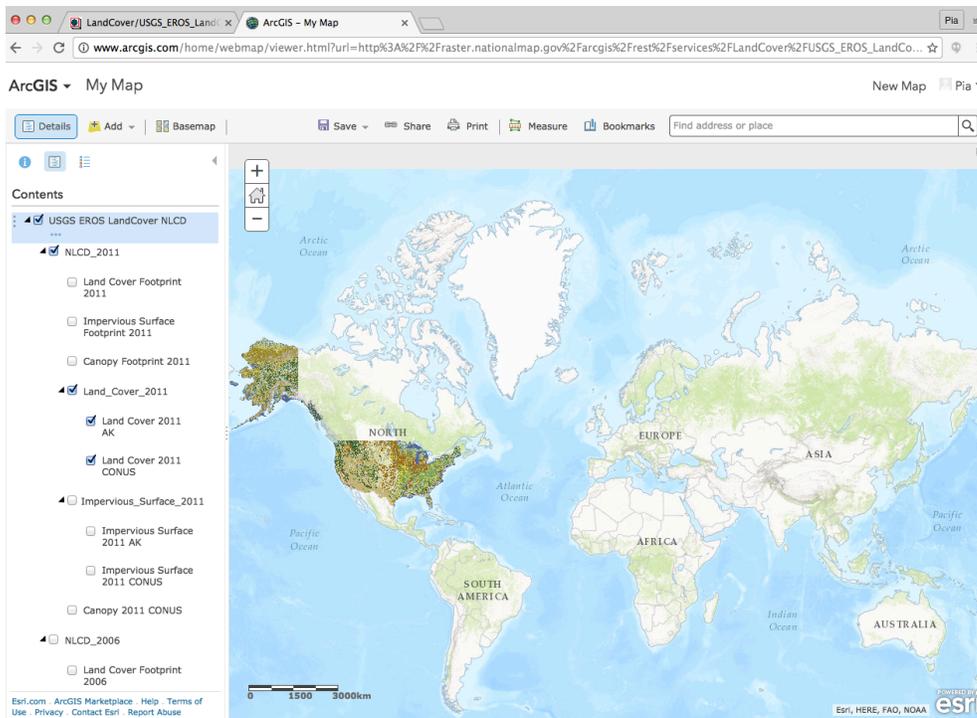
7.) You can turn on the modified Anderson classification system from the dropdown menu in the selected data set folder.

Note: In the **"Basemap"** menu bar are different kinds of maps the selected NLCD data sets can be displayed on, e.g. Imagery, National Geographic.

Classroom Questions:

- What land cover types are around your school in 2016? And what land cover types are visible in historical data sets?
- What is the definition of impervious surfaces and the canopy data?
- Is there a correlation between the impervious data layers location and the canopy data layer location?
- Has the area covered with tree canopy/impervious surfaces changed over time?
- What are reasons influencing this change?
- What are the impacts of the changes to human health and to the environment?
- What are ways to influence these changes?

Congratulations now you have learned how to import the NLCD data sets and how to display these in ArcGIS Online!

Lesson Plan 3 – Land Cover Changes Over Time

Resources

Get Land Cover Data:
http://landcover.usgs.gov/landcoverdata.php

2001 National Land Cover (US EPA Multi-Resolution Land Characteristics Consortium)
http://www.epa.gov/mrlc/nlcd-2001.html

Anderson Classification System
http://landcover.usgs.gov/pdf/anderson.pdf

Land Cover Trends (U.S. Geological Survey)
http://landcovertrends.usgs.gov/main/classification.html

The USGS Land Cover Institute
http://landcover.usgs.gov/uslandcover.php

Import NLCD data sets:
*http://raster.nationalmap.gov/arcgis/rest/services/LandCover/USGS_EROS_LandCover_*
NLCD/MapServer