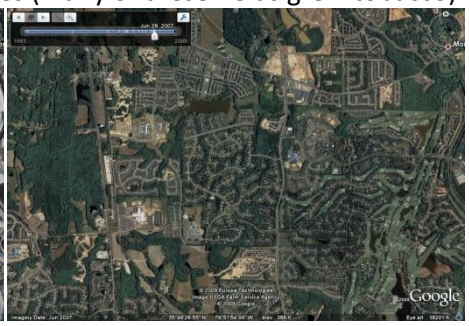
Lab Objective:	Explore landscapes using online tools and learn some of the information needed to manage an ecosystem from a soils perspective. *Goal 1: be able to discern differences in a landscape and its components through an aerial photograph* *Goal 2: be able to locate a specific geographic location using online mapping software* *Goal 3: be able to calculate slope for a landscape*
Content Overview:	Landscapes are four dimensional systems, varying in the horizontal (*x* and *y*), and vertical (*z*) dimensions and especially in the fourth dimension of time (*t*). Over time natural processes, such as erosion, geologic activity, or plant community changes can alter the shape and appearance of the landscape. For example, below are images of Mt. Saint Helens in Washington State from pre-May 18, 1980 and shortly after its eruption.   The eruption was a catastrophic event and changes are obvious; however, most natural changes are more subtle and require long-term observation to notice. Besides natural changes, humans can influence landscapes in many ways, not the least of which is urban expansion. Below are images of Cary, North Carolina, in 1998 and 2007 (from Google Earth). Note the conversion of both agricultural land (upper left) and forested land (lower left) to suburban housing. This type of conversion can alter migratory patterns of animals and birds, change storm and seasonal hydrology, and facilitate the introduction of non-native animals and plants that will affect the regional ecology. This is to say nothing of how such changes impact soils. And, what's more, the agricultural land of 1998 represents a previous conversion from native forests that, in the Eastern United States often dates back to colonial times (many of these fields grew tobacco).   With this lab you will explore the topography and landuse changes for a given site and also for your local area. This will be done with web-based mapping software. Several mapping tool websites exist for your pleasure. Some mapping software webpages are linked below, although we will not be using all of them (verified 1/12/12)(some sites may require additional software or drivers):

	The National Map Google Maps Oregon Explorer ArcGIS Explorer
Definitions:	None this Unit
Exercise:	We will utilize two mapping software systems to explore landscapes abroad and in our back yard. Supplies: • Windows-based computer (unsure if Linux will work, up to you to find out) • Google Earth (download at Google Earth, if you already have it installed, make sure you have the most recent version) • Google Maps at http://maps.google.com 1) Before starting the exercise, you should explore each of the above products so they are familiar to you; in a sense, play around. For some of you, this may include reading the instructions, for others it may just mean typing in places and searching. 2) You will be doing some math and working with measurement units. If you are unfamiliar with measurement units and converting units, see the Extra Background Info at the end of the lab. 3) Locating a place and taking measurements – Google Earth a. In the search bar for Google Earth (GE) type Butte, Montana and hit enter. GE will zoom you in to an eye level of around 41 miles (displayed in lower right of the image). Zoom in to 30,000 ft using the scroll wheel on the mouse (keep your mouse in the center of the image) or the zoom bar on GE. You will notice a large lake on the north east side of town. -Place your mouse over the center of the lake and record the elevation of the lake (located bottom center of the image). Always Include units (e.g. feet). _____ Lake elevation b. Under the view menu, click on "Historical Imagery" so that it is checked. A timeline shows up in the upper right of the image. The vertical grey bars represent the time the image was taken. This section of the US has multiple images available. Drag the timeline bar all the way over to the left and the GE image is from 1995 (grayscale picture). Drag the timeline bar all the way to the right and the image is actually a composite of a 2009 image on the top and a 2010 image on the bottom. Use the fast-forward or reverse arrows on the side of the timeline to select the image that represents only 2009. c. Center (click and drag) the image on the lake and zoom in to around 12,000 feet eye elevation so the lake fills the image. In the top GE toolbar is an icon of a

ruler. Click on this and a box pops up for measuring length. Chose to measure PATH instead of LINE and measure the length of the shoreline of the lake (click along the lake with the mouse, trying to capture the little coves and peninsulas). You will see a yellow border around the lake where you have clicked
-Record the total shoreline length (include units) and leave the path window open for the next part. Note the image date in the lower left corner.

_____ Shoreline Length _____ Image date

d. Make sure your path on the 2009 image is still visible and explore the different images, answering the questions below.

_____ in what year was the lake the smallest?

_____in what year was the lake the largest?

_____in what year was the image geographically offset (pay attention to shoreline shape and location with respect to your measured path – the position of the lake changes in one of the images – the photo has a geographic calculation error in it that makes the lake seem to move)

e. Report on the reason the lake is there, easy to find out with an internet search. Include what the lake is called.

f. In the GE search bar, type Ft. McMurray and hit enter. GE will zoom to Ft. McMurray. Use the zoom to back out to an eye altitude around 64 miles

_____ Where (country-wise) are you?

g. In the lower left of the Google page is a box called Layers. In there are optional information layers to add to your map. Make sure the "Global Awareness" box is checked. Pull the image down a little and you will see a UNEP icon on the right side of the image. Click on the icon and a window pops up. Click on the link that says "Overlay Images". A new image pops up in the window and in the "Places" menu to the left, an item for the Oil Sands is now there. One image is checked (2004). Check the other image (1974). The change between 1974 and 2004 is obvious; the loss of green area is due to mining of the oil sands. Using the ruler tool, select line and on the 1974 image measure a vertical line from the north part of the disturbance to south part and record the distance (don't forget units). Do the same for the horizontal distance. Use this to calculate the rough area of the disturbance (A=L x W) (area is a rough estimate because we are using a square to measure a multi-sided polygonal area). (Having difficulty? See the Athabasca Example in the lab folder)

h. Click on the left menu to remove the 1974 image and so the 2004 image shows. Calculate the same rough values as in 2f.

i. Determine the change in land area disturbed between 1974 and 2004. If we assume that land use conversion over that period was even from year to year, what is the approximate annual rate of change (land area disturbed per year) between 2004 and 1974 (units!)? Learn more about the Athabasca Oil Sands here: Oil Sands Discovery Center.

4) Topography and terrain in Google Maps (GM).
   a. In a web browser, open Google Maps. Type Mt Vesuvius Italy into the search bar and hit enter. A brilliant color image of the volcano's crater appears (Earth view – the default may be Map view, click earth in the upper right corner to see the satellite images). Open another browser window and open this terrain-based Google Maps. Type in Mt Vesuvius Italy into this search bar and hit enter. You will see Vesuvius as a topographic map. Zoom out two clicks on the zoom bar (left side) and then drag the mountain to the upper left corner. You should now see the city of Pompeii. Pompeii is at an elevation of 10 meters. (Click here to read about Pompeii).
   -What is the elevation of the summit of Mt Vesuvius (you will have to zoom in to see the topolines)?
   -What is the slope (rate of change, rise over run) between the city and the summit, 10.1 kilometers distant (multiply by 100 to get %)? ***(read Extra Background Info at the end of the lab if this all sounds Italian to you)***
   -If a lahar (heated viscous ash flow) flowed down the flanks of Mt. Vesuvius at a rate of 80 km/h, how long would it take to reach Pompeii?
   b. While still in terrain mode, type Mt. St. Helens in GM. Click the zoom bar till the scale bar (lower left) shows 1 mi. Notice the puffy rounded flows on the south east flank of the mountain? Go to your other web browser that has the non-terrain version of google maps running and also type in Mt St Helens. Click to "satellite" and see what those puffy flows are. Those flows are lava and mud flows from the volcano. Because they are recent (1981) and treeless you can still see the terrain. Is that true in all cases?
   c. In both google map pages, type in Mt. Adams Washington and hit enter. You will see Mt. Adams in the center. On the satellite version, drag the mountain to the south and to the north. You will see a brown lava flow on both sides of the mountain, one heading north and one heading south. Can you see any lava flows where the trees are? Not likely. Drag the center of the mountain to the upper left and then zoom in one more click. See any yet? None that are obvious. Now switch back to the terrain map. A lot more topographic detail shows up when you remove vegetation, including that inverted V shape that is just south of the mountain. So, as you are driving around, try to imagine the landscape without the vegetation. Maybe you don't know your area like you think you do….

5) Exploring home.
   a. In GM and GE type in the name of your home town and state. Play with the zoom in GM until the images cover about the same area. In GM, at the top right of the image is a "link" button. Click it and copy the link and paste in the Report Items slot on the Turn In sheet. Make sure the timeline in GE is set to 2012 (the historical imagery line – 2012 will give you the most recent imagery).

	b. Compare the images. Do they contain the same information (i.e. are they the same photo?)? You may have to look carefully. If they are not the same, which is more recent? c. In GE, under the file menu, save a JPG of the image (file/save/save image). In the timeline determine and record the date of this image (might not be 2009). Move the slider to the oldest photo date and save a copy of that image. Record the date. d. Use these two images and describe the changes you see. These should be landscape changes, not changes due to the seasons the images were taken. Observations may include new development, new roads, clear-cut forests, conversion of farm land to forest, etc. Write this in paragraph form. Include the images and the paragraph in your report items.
Report Items:	Answers to questions in (Use the Turn In Sheet): 2.a. Elevation of Lake _____ 2.b. Length of shoreline _____ 2.c. Smallest year _____; Largest year _____; Offset year _____ 2.d. Why is the lake there and what is it called? 2.e. Where are you? _____ 2.f. 1974 Vertical distance _____; Horizontal distance _____; Area _____ 2.g. 2004 Vertical distance _____; Horizontal distance _____; Area _____ 2.h. Disturbed area changed _____; Rate of change _____ 3.a. Elevation of Vesuvius_____; Slope _____%; Time for lahar _____minutes 4.a. Link for GM _____ 4.b. Are images same? Y / N; If no, which is more recent GM / GE? 4.c. Date of most recent GE image_____. Date of oldest GE image _____. 4.d. describe.
Study Questions:	None
Extra Background Information	*<u>Calculations and conversions</u>* This lab requires you to do some conversions of units, such as miles to kilometers, or inches to feet. These are actually fairly simple to do, as long as you keep track of your work. For exampleThere are 12 inches per foot. When you perform division, you know any number divided by itself is 1. When 12 inches is the same thing as 1 foot, so we can set these up as a ratio (see left) . When the fraction is written this way, we can use it to convert feet to inches. For example, if I have 2 feet and I want to determine how many inches there are, I set the equation up this way: $2\text{ ft} \times \frac{12\text{ in}}{1\text{ ft}}$. The units "ft" cancel and just the "in" units remain to go with your answer. 2 X 12 inches is 24 inches, so there are 24 inches in two feet. It helps to have a list of common conversions, so those are included in this lab at the end. You will need some of these throughout the term.

$\frac{12\text{ in}}{1\text{ ft}}$

Feet and inches are English units of measure. Most of the world uses the metric system, which is based on units of 10. The meter is the base unit, 1000 meters is a kilometer and one thousandth of a meter (0.001) is a millimeter. Base 10 is easier to work with. The inch is base 16 and the foot is base 12, and the yard is base 3, so really English measurement are hard deal with. But we Americans use them. Sometimes you need to convert between metric and English. If you follow the rule of including the units when you set up your problem, like in the inches-feet example above, the work is really easy division and multiplication. Common conversion factors are also located in the conversion chart at the end of the lab. Let's work one through.

Example Problem: The plans for the dog house you are building were downloaded from a design website in England, where they use metric. Your ruler in the shop only has inches and feet, so you have to do some conversions. The base of the doghouse is 0.5 meters wide…how many feet is that?

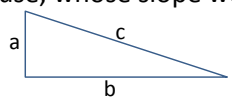
The conversion chart says there are 3.28 ft per meter. I have meters and I want to get feet, so I set my ratio up with meters on the bottom, feet on the top. Whatever unit you want in the long run needs to be on top. Set up the equation like this:

$0.5\text{ m} \times \frac{3.28\text{ ft}}{1\text{ m}}$. The meters cancel out and just feet units remain. Multiple 0.5 times 3.28 and you get 1.64 ft. Of course, since feet are base twelve, not base ten, you have to then determine how many inches 0.64 equals. Maybe it would be better to directly go from meters to inches. Using the conversion relationships in the chart, you can set the equation up this way (there are three steps total, one to go from meters to centimeters and then from centimeters to inches).

$0.5\text{ m} \times \frac{100\text{ cm}}{1\text{ m}} \times \frac{1\text{ in}}{2.54\text{ cm}}$. Meters cancel, then centimeters cancel and the only unit left is inches. Do the math, 0.5*100 is 50 and then 50/2.54 is 19.685 in. Is that the same as 1.64 feet? Well, each foot has 12 inches so 1.64ft * 12in/ft = 19.68 in. So both methods give the same result.

<u>Calculation of Slope</u>

Slope pretty much describes how steep something is. In soils we are usually talking about a hillside. You also use slope when you talk about how steep a grade a road has, or how much energy a stream has as it flows down hill. Slope is simply a unitless ratio of the amount of elevation change to the horizontal distance over which that elevation changes. You are really looking at the steepness of the hypotenuse of a triangle, like the one below where *a* is the elevation, or rise, *b* is the horizontal distance, or run, and *c* is the hypotenuse, whose slope we are concerned about (slope = rise/run).



We can consider that a mountain that is cut in half will look a lot like this triangle, although not likely as smooth. Our mountain has a peak at 100 feet above sea level. The side of the mountain goes all the way to the ocean, so its base is a 0 feet. The total elevation (*a*) is 100 ft. The top of the mountain, as the crow flies, is 15 miles from the ocean, so the run (*b*) is 15 miles. We need to calculate slope, Slope = Rise/Run (or *a/b*).

To make the slope unitless, the units on the numbers have to be the same. If we used 100 ft and 5 miles, we would end up with ft/miles, which makes no sense. So we either have to convert feet to miles, or miles to feet. Either way will work, but here we will convert miles to feet, then calculate slope.

$$1.5\text{mi} = \frac{5280\text{ ft}}{1\text{ mi}} = 7920\text{ ft} \; ; \quad \text{Slope} = \frac{\text{Rise}}{\text{Run}} = \frac{1000\text{ ft}}{7920\text{ ft}} = 0.126$$

So the slope is 0.126. Since it is unitless, we can multiply it by 100 to get the percent. So our mountain has a 12.6 percent slope. You can do the same calculations if you are using the metric system, you would just want rise and run both in either kilometers (km) or meters (m).

Rates

When you are looking at your speedometer, you are looking at a rate (velocity) – distance per unit of time. In the US we use mi/h. In Canada they use km/h. So the equation is: $\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$. Using the rules of multiplication and division, we can rearrange the equation to isolate either time or distance and solve for that variable. Those equations look like this: $\text{Time} = \frac{\text{Distance}}{\text{Velocity}}$; $\text{Distance} = \text{Velocity X Time}$. You will need to do this during the term

1 meter (m)	=	3.28 feet (ft or ‘)
1 mile (mi)	=	1.6 kilometer (km)
1 mi	=	5280 ft
1 inch (in or “)	=	2.54 centimeters (cm)
1 mi	=	80 chains
1 yd	=	3 ft

1 hectare (ha)	=	10,000 m^2
1 acre (ac)	=	43,560 ft^2
1 section (sec)	=	640 ac
1 sec	=	1 mi^2
1 township	=	36 mi^2
1 ha	=	2.47 ac

1 ac-ft	=	1233 m^3
1 gallon (gal)	=	3.79 Liters (L)
1 ft^3	=	7.5 gal
1 gal	=	128 ounces (oz)

1 pound (lb)*	=	0.45 kilogram (kg)
1 ton (US)	=	2000 lb
1 lb	=	16 oz
1 oz	=	31.1 gram (g)

°C	=	(°F-32)*5/9
K	=	°C+273.15

Area

Rectangle A= B*H

Triangle A = 0.5 B*H

Circle A = π * $radius^2$

Volume

Box V = B*H*W

Pyramid V = 1/3* B*H*W

Cone V = 1/3* π *r^2*H

Cylinder V = π * r^2*H