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Imaging Technology Using *Google Earth* and *NASA World Wind*

Northwest Center for Sustainable Resources (NCSR)
Chemeketa Community College, Salem, Oregon
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Northwest Center for Sustainable Resources
Chemeketa Community College
P.O. Box 14007
Salem, OR 97309
E-mail: ncsradm@chemeketa.edu
Phone: 503-399-5270

Imaging Technology Using *Google Earth* and *NASA World Wind*

Introduction

Until recently, access to and manipulation of high resolution remote sensing imagery was limited to those with specialized training in geographical information systems (GIS). New sources such as *Google Earth* and *NASA World Wind* have now become available that make this ability accessible to the casual user with the click of a mouse. These sources are not meant to replace the more sophisticated GIS since they lack sophisticated analysis tools. However, they open the world of remote sensing to a much broader audience and will probably generate further interest in the remote analysis of the Earth.

Google Earth and *NASA World Wind* provide a digital model of the Earth that is comprised of hundreds of thousands of individual satellite and aerial images that are stitched together. The result is a searchable, high-resolution image of the planet.

Both *Google Earth* and *NASA World Wind* are excellent visualization tools. Three-dimensional viewing of topographic maps, aerial photographs and satellite imagery will bring to life earth features such as landforms, cities and forests. More importantly however, they provide instructors with a palatable method for introducing students to scientific inquiry. Students are placed in an environment where they can ask interesting questions, develop reasonable hypotheses and use the imagery to test these hypotheses.

Student access is best obtained by downloading the software to a computer laboratory outfitted with computers that meet the minimum specifications and then teaching the laboratory at that location. Alternatively, computers may be brought into the science laboratory or students could work on the activity outside the classroom on their own computers. These programs could also be used as a presentation tool in either lecture or laboratory settings.

The technology has broad application in the education of students in natural resources and environmental science. One atmospheric scientist at NASA's Goddard Space Flight Center stated that, "...it's just a short matter of time before systems like *Google Earth* are an essential requirement for people in our field. As soon as one group shows that this is useful, everyone will adopt it." The same could probably be stated for those who teach in this area.

Google Earth and *NASA World Wind* are used in several NCSR modules. Additionally, the tools can be used to augment lecture material, introduce a field experience, or develop a stand alone activity. The possibilities are limited only by the imagination of the instructor. In this module we introduce the technology and describe how to access the software.

Google Earth

Site Description

Google Earth is a source of high resolution aerial and satellite imagery that is available for free download (<http://earth.google.com>). Imagery is available for the entire earth's surface and layers may be applied for elevation, terrain, roads and a number of other features. Users can easily navigate from one location to another using a mouse, keyboard or navigation controls provided with the software. Although the resolution varies from site to site, at many locations users can zoom in to the level of individual trees and buildings. Users can search for rivers, towns, business addresses and latitude and longitudinal coordinates. The user interface is intuitive and should be easily learned by faculty and students.

Other features include the ability to mark separate study sites and "fly" to them for more detailed study. Elevation data is provided and can be manipulated to exaggerate the elevation effect. A "tilt" function allows users to change their perspective while viewing hilly terrain. Distance between features and the dimensions of features can be measured with a measuring tool. The user defines the endpoints for the line as well as units of measure.

For all of its strengths (cost, ease of use, availability, etc.), *Google Earth* does have some drawbacks. The resolution of images is uneven. In some areas individual trees can be resolved while in others, high elevation images can be seen clearly but zooming in results in images that are unclear. USGS topographic maps are not available with this software. Advanced (GIS-like) features such as measuring distance along a user-defined path and determining area within polygons are available, but these come only with *Google Earth Plus* and *Google Earth Pro* versions which must be purchased.

Minimum System Requirements

Windows 2000 or XP
Pentium 3, 500Mhz
128M RAM
400MB disk space
3D-capable video card with 16Mbytes of VRAM
Internet connection

NASA World Wind

Site Description

World Wind is open source software that provides access to high resolution aerial and satellite imagery. Imagery is available for the entire Earth's surface and layers may be applied for elevation, terrain, roads and a number of other features. *World Wind* can be downloaded for free at <http://worldwind.arc.nasa.gov>.

NASA World Wind will require downloading a number of files to the hard drive of laboratory computers and will direct you to some *Microsoft* web sites for additional software. The user interface for *NASA World Wind* is less intuitive than *Google Earth* and instructors will benefit from the quick tutorial offered under the HELP menu. Select “Walkthrough” and then, “Launch Flash Walkthrough of World Wind’s Basic Functions”. Instructors may also want to direct students to this tutorial prior to completing the exercise. Further information on the various types of imagery available with *NASA World Wind* may be obtained by selecting, “Launch Flash Walkthrough of World Wind’s Default Image Layers”.

The user interface features the ability to "search", "navigate", "zoom", "tilt" and "rotate" and to run some canned simulations. Vertical exaggeration can be manipulated to improve visualization of hilly terrain. Several "layers" of satellite and aerial imagery are available that allow you to image any place on Earth. Three dimensional views of terrain are based on various sources of Landsat satellite data. Coverage for these images is excellent (worldwide) but resolution is significantly less (30 m/pixel) than other layers described below. Unlike *Google Earth*, *World Wind* features U.S. Geological Survey (USGS) topographical maps for the most areas in the United States.

Some high resolution images are also available. For example, USGS Ortho Imagery is particularly useful and available for most areas in the United States. This layer allows for high resolution (1 m/pixel) viewing of 3-D aerial photography. *World Wind* also features USGS Urban Area imagery for selected cities which provides images of very high resolution (0.25 m/pixel). This allows the user to view urban landscapes in dramatic detail to the level of seeing individual buildings and cars.

The recency of the images depends on the data source for each layer and varies from about 1990 to 2004. USGS topographical maps may be somewhat older. It is unlikely that you will be able to see the world in real-time using these tools anytime soon. Images are public domain, thus educational use of these images does not require copyright permission.

Minimum System Requirements

Windows 2000 or XP
700Mhz CPU
128M RAM
1GB disk space
3-D graphics card
Internet connection

Examples of Imagery Use

The examples below are provided to allow instructors and students to acquaint themselves with some of the features and capabilities of *Google Earth* and *World Wind*. The examples reference examination of watersheds but can be easily adapted to examining other geographic features.

Applications of *World Wind*

Examination of USGS Topographic Maps

1. Open the *NASA World Wind* program and follow the coordinates provided by the instructor (or alternatively, enter a river or nearby town name location into the search function) to locate the watershed under study. Move your location by dragging the *left* mouse click. Zoom in for a closer look by rolling the scroll wheel on your mouse or, alternatively, holding both mouse buttons down and pushing *forward* to zoom in and pulling *back* to zoom out.
2. Click on the "USGS Topographic Maps" icon to activate that layer.
3. Become familiar with the entire watershed study site by following the river from its entry into a major river, bay or the ocean to its source in the uplands. Use the "zoom" function to view in greater detail. On most rivers, distance along the river is indicated with the symbol "X" every mile. These so-called "river miles" can be used as benchmarks to locate features in the watershed.
4. The three-dimensional aspects of a watershed can be viewed by "tilting" and "rotating" the image. Drag the *right* mouse click to control these features. "Travel" through the study watershed to familiarize yourself with these controls.
5. Turn your attention to the lands immediately adjacent to the entire river. Land *ownership* plays a significant role in how that land is managed and broad categories of ownership can be determined from the USGS maps. Public lands and their boundaries such as national and state forests, county parks, wildlife refuges, etc. are clearly indicated on these maps. Lands without any designation can be assumed to be owned by private landowners.
6. Note the distribution of forests (green areas) and non-forested areas (white) on the maps.

Examination of USGS Digital Ortho Photos

USGS Digital Ortho Photos provide a high resolution (1m/pixel) images that can be used to visualize the watershed in great detail in three dimensions. Images are in black and white and are particularly useful to obtain detail on land use in the watershed. Features such as agricultural land, clearcuts, and forests of different ages can be easily distinguished from one another based on tonal and textural differences.

Examination of Landsat Imagery

The following information presents an opportunity for an optional activity or a classroom demonstration.

Since 1972, NASA has launched a series of earth observation Landsat satellites. Seven such satellites have been launched providing a 33-year old record of the Earth's continental and nearby ocean surfaces. The resulting imagery provides unprecedented access to data critical to land surface monitoring and global change research. Landsat 7, the latest in this series, was launched on April 15, 1999 and continues to provide high quality data.

NASA World Wind provides various layers of Landsat 7 imagery that are useful in watershed evaluation. This imagery presents some advantages and disadvantages over the USGS imagery. The primary advantage is that the coverage is worldwide as opposed to only U.S. for USGS imagery. Also, since both 1990 and 2000 imagery is provided, comparisons can be made between them to view land use *change* over time. The primary disadvantage is that resolution is lower (30 m/pixel) and thus, less detail can be seen. Landsat layers available include Community Landsat 7 (pseudo-color), Landsat 7 Geocover (1990 and 2000) and NLT Landsat 7 (pseudo-color). This imagery is best suited to viewing broad-scale patterns such as landforms, forest harvest patterns, urban and rural development patterns and agricultural land use.

As an example of the capabilities of Landsat imagery, investigators have used Landsat images to examine crop diversity in California's Imperial Valley. More than 25 separate crops were identified in nearly 9000 fields covering 458,000 acres. The entire study which used only Landsat imagery required only 45 person-hours to complete. Such inventories are a critical tool used in crop forecasting which in turn is used to plan for future labor, fuel and transportation needs over a wide region.

For more information on Landsat see <http://landsat.gsfc.nasa.gov>

Application of *Google Earth*

1. Follow the coordinates provided by the instructor (or alternatively, enter a river or nearby town name location) to "fly" to the watershed under study.

2. To become familiar with the study site, follow the river from its source to its entry into a major river, bay or the ocean.
3. Use the "rotation" feature and the "tilt" feature to get various 3-dimensional views of the study watershed. Try changing the **elevation exaggeration** ("Tools", then "Options") from the default setting of "1" to "2" or "3". This feature will exaggerate the appearance of elevation changes and should assist you to visualize the watershed. Try navigating through the watershed moving upstream. With careful observation you should be able to determine its approximate boundaries. The boundaries will appear as ridge tops.