

Web Serving Landsat 7 Satellite Imagery for the Preservation of Wisconsin's Lakes

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Abstract- Through the application of carefully developed algorithms, Landsat 7 imagery is being developed as a reference tool capable of lake monitoring. The imagery acquired by Landsat 7 can be used to analyze, manage, and enhance water quality and characteristics in the lakes. Given the interest of other scientists, government agencies, non-profit organizations, and growing demand from the public who are also lake stakeholders, web serving this information for these purposes is ideal.

A. Introduction

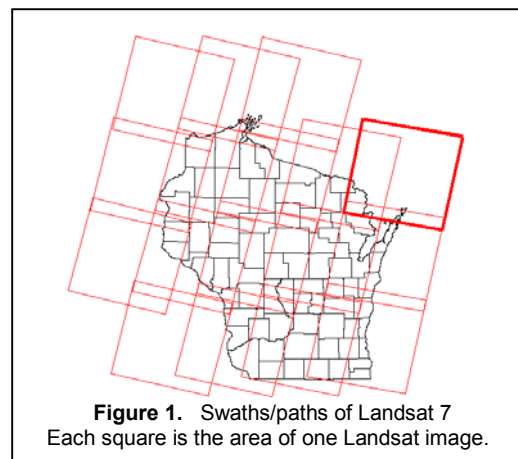
The potential benefit for using Landsat 7 data and imagery to analyze, manage, and enhance water quality and characteristics in Wisconsin's 15,000 lakes is largely untapped. The study of these lakes is important because of their economic and biological roles. Maintaining and improving the quality of the lakes is a goal of researchers as well as a benefit for the public. A key to attaining this goal is the communication of current satellite imagery and data to research colleagues and the public. Making data available through the Internet will improve communication, foster interactive relationships among volunteers collecting lake water quality measurements and samples, and allow correlations to improve scientific accuracy. This also provides a way of communicating between the public and the lake researchers to keep a positive flow line of information for the benefit of both parties.

The Internet is a major medium for information sharing and retrieval and is an efficient tool for scientific research and development. My goal was to investigate the most efficient means to serve Landsat 7 data and imagery through the Internet. The challenge for web serving is to develop fast algorithms for processing and transferring data from very large image data sets. The prototype web application developed returns requested satellite imagery from data stored at the Environmental Remote Sensing Center (ERSC), at the University of Wisconsin in Madison. The images include different spectral band

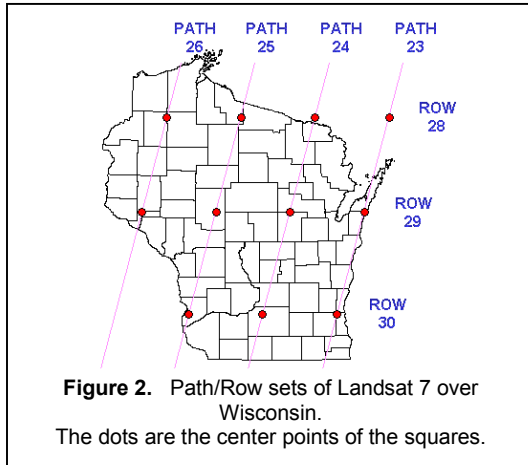
views that are very helpful in analyzing lake quality and clarity. This is important because the data can be used to promote the preservation and continued study of water clarity in the lakes. Developing new algorithms for web serving geospatial images and data will contribute to the rapid evolution of innovative research and commercial applications in a field that is growing exponentially.

B. Methods

Due to the large size of Landsat images, it was discovered that the best way to serve the images and data on Wisconsin counties was to take subsets of the larger image swaths taken by the Landsat 7 satellite at different sections of Wisconsin. To accomplish these subsets a program



entitled "Subset" developed by Peter Weiler (staff member of ERSC) was used. Each path-row section image (see Figure 1 and Figure 2) taken by Landsat 7 was used to make subsets of the counties covered in the swaths. These county-sized images are meaningful to the public,



researchers, and government officials who collaborate in managing the lakes. However, images were not in a format that could be displayed on the Internet. Peter Weiler then modified his program so that the subsets could be saved in the widely accessible compressed jpeg (.jpg) format.¹ After this modification the images were then ready to be served over the Internet. The subset software and a Wisconsin state map were used to complete the subsets of the counties.

Create Perl based CGI (Common Gateway Interface) Scripts

CGI² programming involves designing and writing programs that receive their starting commands from a Web page—usually, a Web page that uses an HTML form to initiate the CGI program. CGI scripts are used to take and receive messages for the benefit of the user and the progression of the web application. CGI scripts in the programming language Perl were also going to be used to call software on the server to extract images and data and return the images and data to the web page for viewing by the user. This would be the dynamic aspect of the website. Instead, we chose to statically serve the information to the users. Dynamically presenting the data involves allowing the user to access and subset unique areas from the data sets desired when they choose. Statically presenting the data involves already having constant subsets of data sets that the user can choose from.

Using subsets is a very important feature because the satellite images that will be used will be very large and would otherwise take too much time to download.

¹ “JPEG short for the ‘Joint Photographic Experts Group’. This is a group of experts nominated by national standards bodies and major companies to work to produce standards for continuous tone image coding.”

² The Common Gateway Interface (CGI) is a standard for interfacing external applications with information servers, such as HTTP or Web servers. A plain HTML document that the Web daemon **retrieves** is **static**, which means it exists in a constant state: a text file that doesn’t change. A CGI program, on the other hand, is **executed** in real-time, so that it can output **dynamic** information.

Also Perl based CGI scripts were used to allow the user to submit comments and suggestions relevant to the lakes in their counties, the site, current research, or anything that they would like. The information submitted will be used to continue to enhance the web application and to keep up with and meet the concerns of the public and research partners.

Creating the Website hosting the Application

The website was developed using Macromedia Dreamweaver 3. This software was very helpful in developing the website features. The preferred language to send data across the Internet is HTML, which stands for Hypertext Mark-up Language. Dreamweaver aids in this production because it provides Graphical User Interface that allowed me to create the web application minus the tediousness of writing the source code for the 70+ pages on the site. Dreamweaver creates the source code while the user uses its commands to create the page. One of the most helpful features of Dreamweaver was the template. The functionality enabled creation of a template that provided a set design to follow while creating the pages to the website. A consistent template supports faster interactivity and enhances usability. After this template was created it was used to develop all the pages of the site. Consistent color schemes, fonts, images, and other features were easier to implement throughout the site this way. The site needed to be consistent respect to color schemes and image schemes. The site features include a brief introductions of Landsat 7 imagery, an image of Landsat 7 swaths, individual pages for each of Wisconsin’s counties that include a list of each of the lakes in the county, a Comments and Suggestions page for users, mainly Wisconsin residents, to give feedback about the lakes in their county and research taken place by the Environmental Remote Sensing Center, and other links to other sites giving more in depth information about Landsat 7 and other research that is being completed surrounding the lakes of Wisconsin.

C. Testing and Refining

The site was tested to see if the web application meets the standards that I wanted to accomplish. Some standards were not achieved, mainly the dynamic aspect of accessing the data sets. This will be discussed in later sections. The site is easy to use, thus is very much user friendly. Also the information content is not final. Other information providing a more in-depth amount of information will be added later when the web site will be launched. This is a prototype, a standard that will be used as an example for a more innovative web application that will follow. The testing focused on the image display and download time. This is very critical because it has to be fast enough that the user does not leave the sight disgruntled. After going through each of the individual pages created for each

of the counties, I observed the down load time for each of the pages. Of course the download time will vary with different computers due to variances in connection speeds (56K modems, DSL, Cable, T1) and other factors. Also the CGI scripts were tested. This was done to make sure that scripts worked properly without errors. They must retrieve the correct data in the desired format, and must do it effectively. After testing, the web application was enhanced to make sure the site, along with the subroutines that support the site, works effectively when accessed by users. Links were checked to make sure that they were not dead or links that retrieved sites that were not intended to be accessed. Also alt tags, an HTML tag, were placed on certain images so that when the user moves their mouse over the image, a small title or description will appear.

D. Results

The result of this research is a web application product that serves Landsat 7 images to the public. The URL of the application is as follows: <http://geo.ersc.wisc.edu/ERSC-SAT/index.html> (also see Figure 3 and 4). The application allows users to access satellite images of each of the counties of Wisconsin. Along with the images of the counties, names of the lakes that are in the county are on that county's page. Adding this was done to provide a reference tool to users.

A page was created to give a small introduction about some of the features of Landsat 7. Along with this introduction I included a link to a page used by the Institute for Environmental Studies and Environmental Remote Sensing Center that focuses on Landsat 7 data and other pertaining subjects. Also include on the web application is a page that shows how Landsat 7 takes images over Wisconsin. It displays the paths that Landsat 7 follows while passing over Wisconsin. Also it displays a graphic of the image-swaths that Landsat 7 takes of Wisconsin. The last feature that will be discussed, probably one of the most important of the site, is the Feedback page. This page will be used to allow researchers, the general public, and others to submit comments about possible future enhancements. They can also submit some helpful information about their lakes or what ever research they may be in the process of doing. This will help keep a positive flow line of communication. The feedback application asks the visitor to enter their name, e-mail address, their website if they have one, how they came across the site and some comments and suggestions that they may have. Further enhancements and studying this feature will truly follow to gain the best way for the users to interact with the web application's comments and suggestions portion.

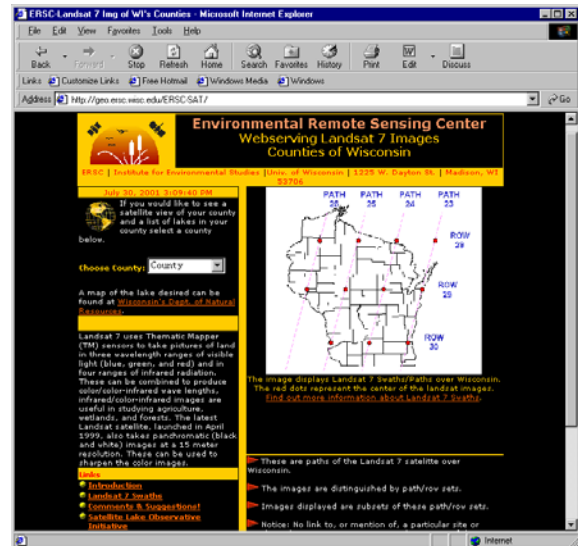


Figure 3. Image of the Web application.
URL: <http://geo.ersc.wisc.edu/ERSCSAT/index.html>

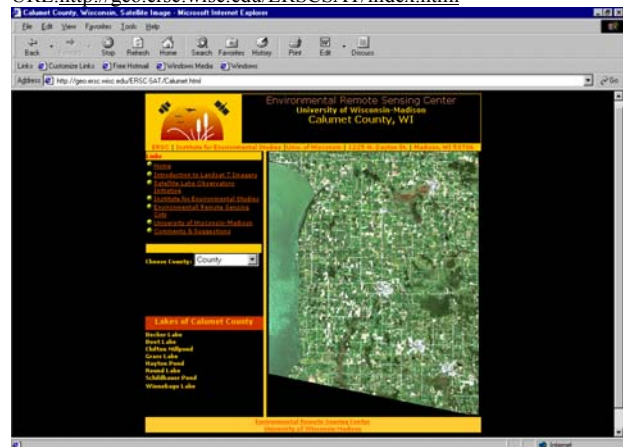


Figure 4 Image of a county page displays Landsat 7 image of the county and a lake list.

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