

Development of a Web-based Vegetation Spectral Library (VSL) for Remote Sensing Research and Applications

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Abstract

All objects on the Earth's surface absorb and reflect portions of the electromagnetic spectrum. Depending on the composition of the material, every material has its characteristic spectral profile. The characteristic spectral profile for vegetation is often used to study how vegetation patterns at large spatial scales affect ecosystem structure and function. Analysis of spectroscopic data from the laboratory, and from various other platforms like aircraft or spacecraft, requires a knowledge base that consists of different characteristic spectral profiles for known different materials. This study reports on establishment of an online and searchable spectral library for a range of plant species and landcover types in the Arctic, Anatarctic and Chihuahuan desert ecosystems. Field data were collected from Arctic Alaska, the Antarctic Peninsula and the Chihuahuan desert in the visible to near infrared (IR) range using a handheld portable spectrometer. The data have been archived in a database created using postgre sql with have been made publicly available on a plone web-interface.

Remote Sensing and Spectral Libraries

Spectral characteristics of vegetation and other land surfaces are often used to study ecosystem structure and function at large spatial scales. Spectra can be used to 'train' classifications of satellite imagery or model land-atmosphere carbon flux for example. These types of analysis, as well as other remote sensing using data derived from spacecraft, manned or unmanned aircraft, requires access to a knowledge base of spectral profiles for known land and vegetation surfaces. The Vegetation Spectral Library (VSL) (Goswami, 2011) is an example of a web based cyberinfrastructure tool intended to make such a knowledge base freely available to international scientific research communities and anyone who takes an interest in the spectral signature data of vegetation. There are only a few comparable web based initiatives. The only two web-based spectral libraries are the U.S. Geological Survey (USGS) Spectral Library for minerals, and the ASTER Spectral Library available at the NASA Jet Propulsion Lab (JPL) for a collection of spectra from a range of materials including data from the USGS Spectral Library and the Johns Hopkins University (JHU) Spectral Library that specializes in minerals and meteorites with some snow and vegetation spectra. Only the ASTER spectral library offers search capabilities over their data sets. Therefore, the VSL is an important contribution to the remote sensing community with its web-based platform and enhanced data browsing/search capabilities.

Description of the library

The VSL was created using a PostgreSQL database interfaced to a Plone web interface. The application was hosted on a server in the Systems Ecology Laboratory at the University of Texas at El Paso. Currently, the library includes 235 datasets collected from around the world, data from several arctic locations, the Antarctic Peninsula and offshore islands, and several locations in the Chihuahuan Desert.

The data in the library is freely available to web based users who can download the data directly from the web-based library. Users can either browse or search for data according to location, site name, landcover type, and other parameters such as sky conditions, time of day, and sampling instrument. Data are coupled to metadata and digital images of vegetation or land surfaces from which spectral signatures have been derived. The users can also view and plot the data online.

There are two levels of users for the library, administrator and general users. The administrator has the ability for higher level data management and can manage user profiles and access (add, remove, restrict user privileges), manage data (upload, modify, delete), and manage written content on the site. General users can browse and search for data and download this data in ASCII format. If the general user wants to contribute data to the library, s/he can request permission by sending an email to the site administrator. Once approved, s/he can upload data and metadata to the library. Metadata requires that a prescribed format is met. The metadata form and the upload data form are explained in detail in the online help menu

User statistics

Google analytics was added to the site in December 13, 2008 to track web traffic. This facilitates monitoring of visitors use the library and from they have accessed the site. The latter is providing important information for the potential geographic needs of the user community (Fig. 5.18). Statistics from Google analytics shows that during the period 12/01/2008 – 16/03/2015, a total of 7,229 users visited the site from 120 countries around the world. The top ten countries visiting the VSL were United States, Russia, India, Germany, Colombia, Canada, Brazil, United Kingdom, Iran and Italy (Table 1). Germany had the highest percent new visits at 82.94 closely followed by India (78.05) and United Kingdom (77.27%).

Discussion

With newer and existing initiatives focused on environmental data collection and increasingly higher spatial and temporal resolutions and for larger areas of coverage (e.g. National Ecological Observatory Network (NEON), Flux Network (FluxNet), Spectral Network (SpecNet), AsiaFlux, EuroFlux, the volume and complexity of environmental data is likely to grow exponentially given the range of advancements in sensor and communication technologies. While the instrumentation and hardware performance has produced large volumes of complex data, it is becoming increasingly clear that such development needs to be coupled to the development of new cyberinfrastructure to ensure that scientific needs are being met (US NSF Cyberinfrastructure vision for the 21st century, 2007). In this study, a specific cyberinfrastructure tool have been developed for application in remote sensing science and application. As evidenced by the constant use of the library from worldwide audience, it is evident that this sort of applications are in need for the research

community and hence should be supported by the funding agencies. Our experience of developing the library was invaluable and provided first hand experiences and insights into how modern cyberinfrastructure can help remote sensing research. The work described is by no means a complete cyberinfrastructure for application in a large scale community and was in no way intended to serve the community. Rather it was a small part of the PhD research work of the lead author which apparently served a worldwide community.

Table 1. The following table shows the top ten countries by number of visitors and percent new visits during the period 12/01/2008 – 16/03/2015.

Country	Visits	% New Visits
United States	2,178	70.62
Russia	883	32.84
India	442	78.05
Germany	252	82.94
Colombia	241	69.71
Canada	204	79.90
Brazil	200	36.50
United Kingdom	154	77.27
Iran	143	71.33
Italy	138	65.22

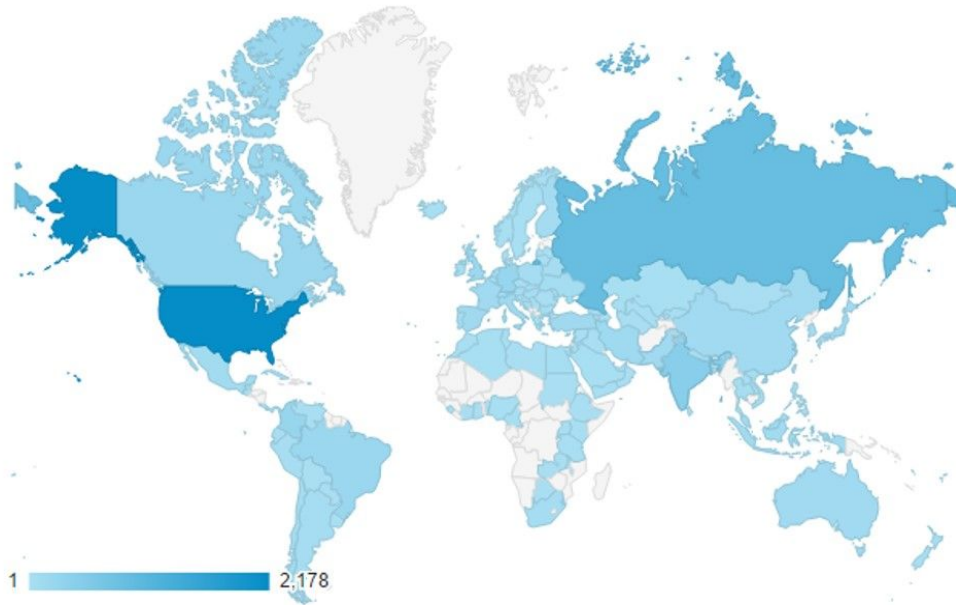


Figure 1. The above figure shows the countries from which VSL was accessed during the period 12/13/2008 – 13/03/2015. The website had a total of 10,919 page views from 7,229 visitors spread over 1,460 cities located in 120 countries across six continents.

Acknowledgements:

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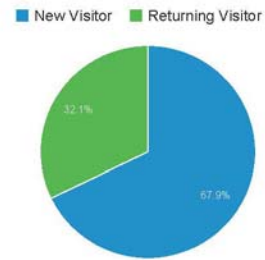
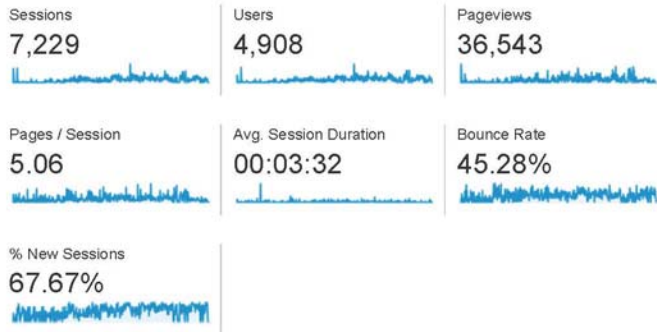
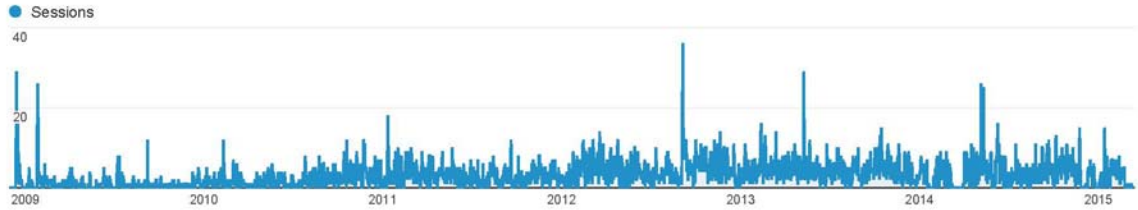
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Audience Overview

Dec 1, 2008 - Mar 15, 2015

All Sessions
100.00%

Overview



Country	Sessions	% Sessions
1. United States	2,178	30.13%
2. Russia	883	12.21%
3. India	442	6.11%
4. Germany	252	3.49%
5. Colombia	241	3.33%
6. Canada	204	2.82%
7. Brazil	200	2.77%
8. United Kingdom	154	2.13%
9. Iran	143	1.98%
10. Italy	138	1.91%

Supplementary Figure 1. Google analytics data for browsing records of the library accessed on March 16, 2015.