EXPANDING UNDERGRADUTE REMOTE SENSING RESEARCH OPPORTUNITIES THROUGH WYOMINGVIEW

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ABSTRACT

WyomingView, a university-led consortium in Wyoming, is part of the AmericaView (www.americaview.org) program funded by the USGS. One of the goals of WyomingView is to identify and provide learning opportunities in remote sensing for undergraduate students. Remote sensing research projects provide a way for students to apply the concepts and methods introduced in the classroom for addressing issues pertaining to land cover mapping, change assessment, and wildlife habitat monitoring. However, identifying appropriate research topics, collecting images and field reference data, and analyzing imagery can be challenging for many undergraduate students. WyomingView, working in cooperation with its federal and state government agency consortium members in Wyoming, identified several potential natural resource management topics. In many instances these agencies were active partners in the research projects. They provided either the field data that students could use with the images or expert knowledge associated with a specific problem. Using the satellite data obtained from WyomingView data archive, students were able to address natural resource management and agricultural issues of local or state-wide importance. WyomingView also provided partial financial support to these students in the form of internships and scholarships. This paper describes the process and challenges in establishing such research programs that can enhance student learning experiences.

INTRODUCTION

Remote sensing research projects allow undergraduate students to apply the concepts and methods learned in the classroom to solve real world problems. Most undergraduate students complete a class project as part of their course requirements; however, these projects are of limited scope and are often completed during the final few weeks of the semester. Working with real world problems enables students to gain valuable experience and increase their employment potential (Sivanpillai and Driese, 2008). However, identifying suitable research topics, collecting images and field or reference data, and analyzing those images can be challenging for many undergraduate students (Sivanpillai, 2008). When the class size is large it is not reasonable to expect the instructors to identify topics and help collect and analyze images.

WyomingView, working in cooperation with its consortium members, identified several research projects and acquired the related images and field data. Federal and state government agency members of the WyomingView consortium are tasked with addressing many natural resource management issues. Some management issues are well suited for remote sensing applications, but these agencies may not have specialized remote sensing software or trained remote sensing personnel. For example, agencies are interested in monitoring vegetation reestablishment in shrublands following prescribed fire treatments but they do not have resources for establishing a short- or long-term monitoring program. By working with these agencies WyomingView has identified a list of research topics that can be completed by students within a semester. These agencies do not fund the students but are willing to provide existing field data or provide expert knowledge about these problems. This is a win-win situation for students and the agencies involved. From a student perspective, these projects provide opportunities for addressing real-world problems and their findings will be used by the agency personnel. By committing some resources, existing field data and expert knowledge, agencies can find solutions to some of their natural resource management issues. This paper describes the rewards in establishing such research programs for students.

IDENTIFYING RESEARCH PROJECTS

Identifying remote sensing research projects that are challenging and can be completed within a reasonable time frame (often a semester) can be difficult. Agencies have numerous tasks competing for limited resources and availability of a student intern to work on some of those tasks is very attractive. The agencies must recognize, however, that students working on these projects may not have the necessary background information or all the technical skills for completing the research.

Second, the level of remote sensing or image processing skills must be appropriate for undergraduate students. Problems that require complex image processing skills or integration of other geospatial data might be not be suitable for all students. Instructors have to examine the requirements before assigning these projects to students.

Third, it is important to select projects that can be associated with someone in the agency. In other words, there is a supervisor or person-in-charge for each project. If students (or the instructor) have questions during the course of the work they can contact appropriate person in an agency and obtain answers or clarifications. Careful consideration of these factors along with few general ones (student's interest and skills) will ensure successful completion of these projects and provide valuable experience for the students involved. To date, students have completed approximately 10 such projects. Some of these were supported with in-kind contributions from other grants. Two projects that were supported entirely by WyomingView are described the next sections.

EXAMPLE 1: MAPPING CONIFER ENCROACHMENT

The Wyoming Department of Agriculture (WDA) wanted to map the extent of pastures lost to conifer encroachment between 1994 and 2001 in the Medicine Bow National Forest. Exclusion of livestock grazing in these pastures led to conifer encroachment and information about the spatial extent of these encroachments is essential for future planning and management activities. WDA contacted WyomingView about completing this project through our student internship program. Further, WDA was willing to provide information about past land management practices and their influence on conifer encroachment. WyomingView identified an undergraduate student majoring in Biology to work on this research project. Land cover status for the study area in 1994 was derived from 1m, B&W digital ortho quarter quad (DOQQ) while the 2001 status was derived from a 1m color infrared (CIR) DOQQ. Initially we decided to digitally classify these images; however, it became evident that there were numerous small features (patches) and also shadows cast by trees that introduced spectral overlap between various classes. Also, the limited spectral information in the 1994 B&W image resulted in the misclassification of shadows cast by forest stands as water. It became evident that advanced image processing skills which were beyond the student's skill set were required for mapping this land cover. As an alternative, we decided to generate these land cover maps using manual photo-interpretation (or heads-up digitizing) techniques in ArcGIS (ESRI, Redlands, CA) which required considerably more time than originally envisioned (Figure 1). These developments resulted in the extension of this project to two semesters instead of one.

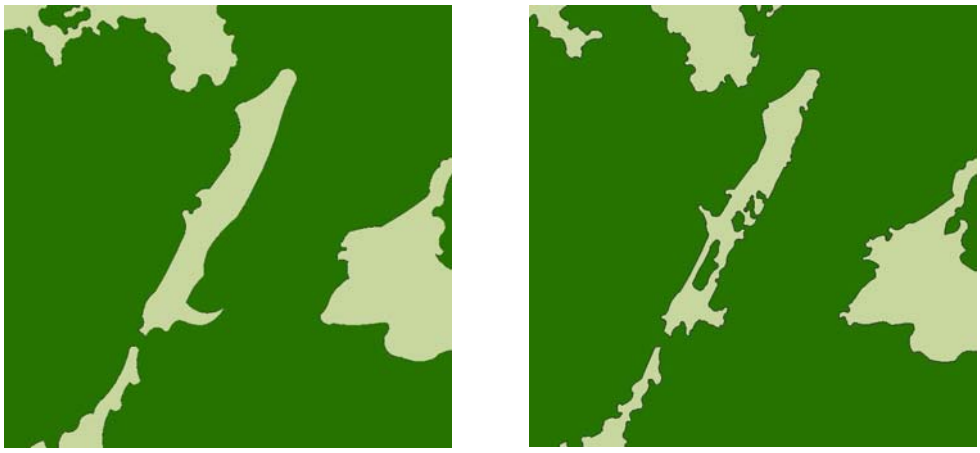

Figure 1. Screenshot of the 1994 (left) and 2001 (right) land cover for a portion of the Medicine Bow National Forest. Woodlands (dark green) are encroaching meadows (light green) in the study area.

The final maps had the following land cover classes: forest, pastures, water, clear-cuts, and bare ground. Shapes

were useful for determining clear-cuts, and size and texture were useful for distinguishing pastures from forest stands. Pastures had relatively smooth texture (fewer trees) in comparison to forest stands. Identifying water bodies posed a considerable challenge in the 1994 B&W image and the student had to rely on the knowledge of WDA personnel for identifying water bodies. However, interpreting cover types was relatively easier in the 2001 CIR DOQQ. Delineation of bare ground forest/stand boundary was easier in the 2001 images than in the 1994 images.

This project provided valuable experience in terms of the challenges involved in defining and implementing the goals and objectives of a real-world natural resource management issue. This project also provided an opportunity for the student to work with land management agency personnel to understand how tasks are defined and modified as needed. At the completion of the project, WDA obtained the 1994 and 2001 land cover maps and a change map highlighting the areas of lost to conifer encroachment.

EXAMPLE 2: MONITORING OCEAN LAKE SURFACE AREA

The Wind River Environmental Quality Commission (WREQC), a tribal agency located in Ft. Washakie, Wyoming identified several projects associated with tribal land management some of which were suitable for remote sensing applications. One of those projects was to map the areal extent of Ocean Lake, located within the reservation. Water from this lake is used for activities such as irrigation and recreation. Given the environmental, ecological and economic importance of this lake, the Commission wanted to map changes to its shape and area once every 5 years since 1985. Mapping water surface area is a widely used application of Landsat and other remotely sensed data. A Native American UW student expressed interest in working on this project. This student was interested in serving "the Indian communities in helping to assess water, forest, grasslands and other natural resources, farming and ranching production, and in conservation efforts." He saw this as an excellent opportunity for gaining experience in natural resource management issues relevant to Indian tribes.

With the availability of free Landsat data he was able to obtain two images per year starting from 1986. In each year, one image corresponded to the spring snow-melt and the other to mid-fall. Each image was digitally classified to generate water and non-water classes. These raster images were converted to vector files and area of the lake was computed for each time step. Additionally the student obtained data from 3 weather stations near Ocean Lake for comparing the surface area values to snow/rainfall and temperature patterns. These maps will provide valuable information for WREQC about past changes in Ocean Lake area and its relationship to environmental factors.

CONCLUSIONS

By working with its members, WyomingView has identified numerous research projects for students. These projects provide an opportunity for the students to work with government agency personnel on real-world problems. Most of this research can be completed within a semester. It is important that the instructor correctly identify the skills required for completing the tasks and ensures that the student can complete those tasks with minimum supervision. It is also necessary to have a contact person in these agencies for answering any questions that the student might encounter during the course of the research work.

Agencies receive finished products such as maps and reports in exchange for their time and field data. With the availability of no-cost Landsat data we expect the number of projects to increase since purchasing Landsat images ($640 - $800/scene) was previously a limiting factor.

REFERENCES

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