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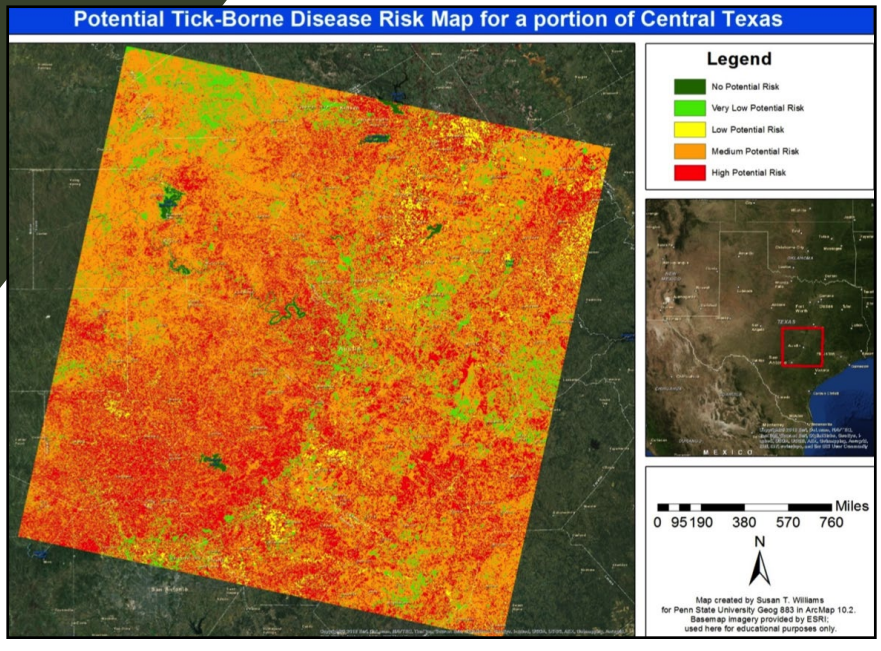
UNEARTHING LANDSLIDES

Remote Sensing Online Education at Penn State University



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The field of remote sensing is arguably going through the most disruptive period of change in its history. The explosion in the number of satellites, both commercial and civil, has occurred alongside the rise in new sensing technologies, such as lidar, and the emergence of Unmanned Aerial Systems (UAS). The way in which we extract information from remotely sensed data has also changed dramatically with the developments in Object-Based Image Analysis (OBIA) and processing in the cloud.

Today's remote sensing and GIS practitioners are being challenged to keep pace with this rapidly evolving professional landscape while maintaining their current projects and workload. Continuing education involving travel to workshops and conferences is often prohibitively expensive and time-consuming. Webinars are becoming more common, but they do not offer comprehensive training or individual feedback. Penn State, an established leader in geospatial education, continues to add to its online curriculum in order to meet this demand, offering certificate and graduate programs in GIS, Homeland Security, and Geospatial Intelligence.

In particular, our graduate-level remote sensing course, "Remote Sensing Image Analysis and Applications" (GEOG 883) has been redesigned to focus on OBIA, using medium and high-resolution optical imagery in combination with lidar for more robust feature extraction and image analysis. The course redesign has not changed the long-held overall objective of the

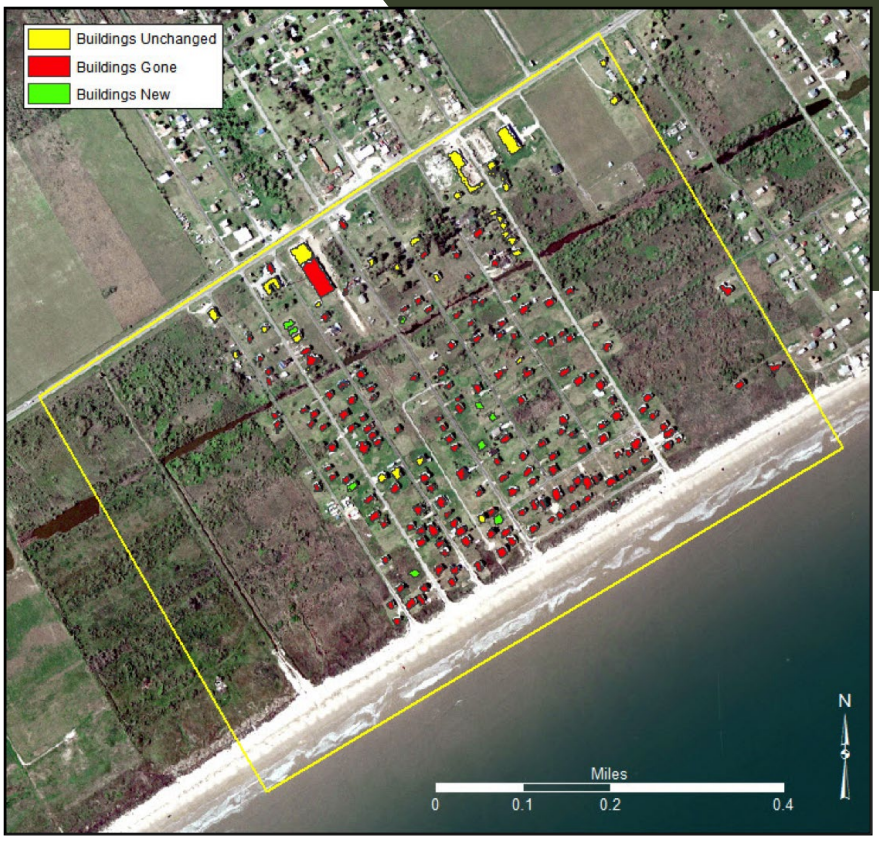
BY JARLATH **O'NEIL-DUNNE** & KAREN **SHUCKMAN**

course, which is to develop students who are capable of solving problems using remote sensing technologies.

The redesign process did, however, offer us an opportunity to update our content and our instructional format. The first objective was to incorporate cutting-edge remote sensing technologies, so that our students would have marketable skills, while at the same time insuring that they were lifelong learners able to adapt to an emerging field. The second was the chance to integrate new learning technologies into the course that would enhance the student experience.

To meet our overarching objective of creating students capable of solving problems using remote sensing technologies, we decided that developing remote sensing workflows would serve as the theme of the course. We wanted our students to leave the course with the confidence that they could obtain remotely sensed data, preprocess that data, extract useful information from it, and finally draw conclusions.

This didn't mean that we needed to reinvent remote sensing education; the course is still rooted in remote sensing fundamentals established over the past several decades. Students receive in-depth instruction in the electromagnetic spectrum, and we stress an understanding of Olson's elements of image interpretation that were first introduced in 1960. The preprocessing techniques we cover are also fairly standard, from basics such as reprojecting raster imagery, to more advanced topics such as atmospherically correcting satellite data. However, one of the biggest changes that emerged from the course redesign, and a change that distinguishes Penn State's remote sensing curriculum from practically every other remote sensing course, is the emphasis of object-based approaches to feature extraction over pixel-based approaches.



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In the vast majority of remote sensing courses we surveyed, and even in the remote sensing textbooks, object-based approaches are treated as an afterthought—an emerging technology that is covered as a special topic towards the end of the course. This is despite the fact that a decade of peer-reviewed research has shown that object-based approaches to feature extraction outperform pixel-based ones. In addition, object-based approaches, which take into account both the spatial and spectral properties of the image, are far more analogous to traditional manual image interpretation than pixel-based approaches. Thus, object-based approaches are a natural extension of the elements of image interpretation. Furthermore, object-based approaches greatly facilitate data fusion, particularly of optical imagery and lidar, which is undoubtedly the future of remote sensing analysis.

Early on in the redesign process, we realized that we had to narrow down the number of software packages used in the course. While many remote sensing professionals run upwards of ten geospatial software packages to get their work done, this number would be unmanageable in a distance education

environment in which each student is using his or her own computer.

For the introductory, preprocessing and image interpretation sections of our course we were largely able to stick with ArcGIS as the software platform. Given our student's experience with ArcGIS, in prior coursework at Penn State and in their professional careers, the choice of ArcGIS was an easy one. We also coupled ArcGIS with ENVI, which has some more advanced remote sensing capabilities and integrates seamlessly with ArcGIS.

For the OBIA portion of the class the students move on to using eCognition, which is arguably the most robust commercially-available software for object-based analysis. The majority of our students have no background in OBIA and thus the subject matter and the software is entirely new to them. The first lesson on feature extraction using OBIA is clearly a challenge for our students, but we have continually been impressed with how they rise to the challenge. Within two weeks our students are capable of integrating active and passive remote sensing datasets into an object-based framework where they extract features using a rule-based expert system.

Our approach to teaching has largely moved away from reading lessons and step-by-step labs to multimedia instruction and problem solving. Numerous video tutorials demonstrate remote sensing tools, tasks, and techniques. Because these videos help the students understand both the theoretical and technical aspects of remote sensing analysis, the lab activities consist of remote sensing challenges that the students have to solve. Students are presented with a problem statement and guidelines, and are given the freedom to apply their knowledge to develop solutions.

Students who complete Geog 883 are able to:

- process remotely sensed data to make it useful in geographic information systems;
- perform image enhancement on remotely sensed imagery;
- extract information from remotely sensed data using a variety of manual and automated techniques;
- critically assess the strengths and weaknesses of remote sensing instruments and platforms for a variety of application scenarios;
- develop multi-step remote sensing workflows to solve problems in a variety of application areas;
- apply acquired knowledge and critical thinking skills to solve a real-world problem with appropriate remote sensing data and processing methods

Geog 883 is appropriate for the student who has some prior knowledge of remote sensing and GIS and desires to take their skills to the next level. For those with less experience, or those desiring a more comprehensive educational experience, Penn State now offers a multi-course curriculum in remote sensing that we hope will soon become its own certificate program. This curriculum currently consists of:

- Geog 482: The Nature of Geographic Information Systems
- Geog 480: Exploring Imagery and Elevation Data in GIS Applications
- Geog 481: Topographic Mapping with Lidar
- Geog 883: Remote Sensing Image Analysis and Applications
- Geog 597G: Geospatial Applications for Unmanned Aerial Systems (UAS)

These courses are made publicly available for educational purposes through a Creative Commons license, and as such, prospective students can peruse weekly lesson materials at length. Enrolling in courses as a registered student allows access to lab materials, performance assessment, and individualized attention from a dedicated instructor, in addition to earning graduate level credits from a globally recognized university.

We see the proof of the success of our class in the quality of the work that our students produce in their final projects. Despite having little to no prior remote sensing training our students continually impress us with the complex problems they tackle using remote sensing technology, from mapping hurricane damage using multi-temporal lidar to estimating forest loss stemming from wildfires. In subsequent articles we hope to profile some of these student projects. If you are interested in exploring the courses, including the Geog 883 multimedia tutorials for object-based image analysis, we encourage you to follow the links provided above.

Jarlath O'Neil-Dunne is Lecturer in the John A. Dutton e-Education Institute at Penn State University and the Director of the University of Vermont's Spatial Analysis Laboratory.

Karen Schuckman is a Senior Lecturer in the John A. Dutton e-Education Institute at Penn State University and a Past-President of the American Society for Photogrammetry and Remote Sensing.