

## **INTEGRATING GEOSPATIAL TECHNOLOGIES AND SECONDARY STUDENT PROJECTS: THE GEOSPATIAL SEMESTER**

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### **RESUMEN:**

El Semestre Geoespacial es una actividad de educación geográfica centrada en que los estudiantes del último curso de secundaria en los institutos norteamericanos, adquieran competencias y habilidades específicas en sistemas de información geográfica, GPS y teledetección. A través de una metodología de aprendizaje basado en proyectos, los alumnos se motivan e implican en la realización de trabajos de investigación en los que analizan, e incluso proponen soluciones, diferentes procesos, problemas o cuestiones de naturaleza espacial. El proyecto está coordinado por la Universidad James Madison y lleva siete años implantándose en diferentes institutos del Estado de Virginia, implicando a más de 20 centros educativos y 1.500 alumnos. Los alumnos que superan esta asignatura de la enseñanza secundaria obtienen la convalidación de determinados créditos académicos de la Universidad de referencia.

### **PALABRAS CLAVE:**

Sistemas de información geográfica, enseñanza, didáctica de la geografía, semestre geoespacial.

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**ABSTRACT:**

The Geospatial Semester is a geographical education activity focused on students in their final year of secondary schools in the U.S., acquiring specific skills in GIS, GPS and remote sensing. Through a methodology for project-based learning, students are motivated and involved in conducting research using geographic information systems and analyze, and even propose solutions, different processes, problems or issues spatial in nature. The Geospatial Semester university management not only ensures proper coaching, guidance and GIS training for teachers of colleges, but has established a system whereby students who pass this course of secondary education gain the recognition of certain credits from the University.

**KEY WORDS:**

Geographic information system, teaching, geographic education, geospatial semester.

**RÉSUMÉ:**

Le semestre géospatial est une activité axée sur l'éducation géographique des étudiants en dernière année des écoles secondaires aux États-Unis, pour l'acquisition de compétences spécifiques en matière de SIG, GPS et télédétection. Grâce à une méthodologie pour l'apprentissage par projet, les élèves sont motivés et impliqués dans la conduite de recherche utilisant des systèmes d'information géographique et analysent, et même ils proposent des solutions, des processus différents, des problèmes ou des questions spatiales. La gestion de Semestre géospatial par l'Université assure non seulement un bon encadrement, d'orientation et de formation sur le SIG pour les enseignants des collèges, mais a mis en place un système dans lequel les étudiants qui passent ce cours d'enseignement secondaire gagnent la reconnaissance de certains crédits de l'université.

**MOTS-CLÉS:**

Systèmes d'information géographique, enseignement, didactique de la géographie, semestre géospatial.

## **1. BACKGROUND**

In United States secondary schools, students in their final year, and especially in their final term, are often not engaged and focused on their schoolwork. They have completed college admission applications and tests and have little at stake in their academic performance. They are beset by a curriculum that focuses on high-stakes testing at the expense of more inquiry-based learning, which could lead to more engaging higher-order thinking and problem-solving. Teachers report challenges in motivating these students and they often come to university unready to engage with more challenging content.

Additionally, Geography has scant presence in high school curricula in the United States, and even less attention is given to geospatial technologies such as geographic information systems (GIS), GPS, and remote sensing, despite the fact that these technologies are predicted by the US Department of Labor (2007) to provide the fastest growing career prospects over the next decade.

While some emphasis has been given to providing professional development in geospatial technologies to teachers in the use of geospatial technologies, the implementation into the curriculum has been very limited (Kerski, 2001 and Baker *et al.* 2009). The reasons given are often related to lack of time, lack of expertise and technical issues. Whatever the reasons, despite a broad array of projects, few students have any detailed exposure to these cutting-edge tools.

In 2004, then Governor of the Commonwealth of Virginia, Mark Warner, recognized some of the challenges mentioned above, and suggested some possible solutions, focusing attention on the problem. While he placed a focus on Advanced Placement (AP) coursework, this attention provided an opening for us to propose a very different sort of opportunity, the Geospatial Semester.

## **2. CONCEPT**

The concept of the Geospatial Semester is simple. We work with secondary schools to provide a term- or year-long class in which students learn about and develop skills with different geospatial technologies, including GIS, GPS and remote sensing, and in which they engage in an extended locally-based project to apply those skills in answering spatial questions of interest. The class is taught by the secondary school teacher, with regular technical support and mentoring from university faculty. Students both earn high school credit and have the option (upon payment of a tuition fee) to earn university credit. The tuition is considerably discounted (70% reduction) from the standard rate.

## **3. OPERATION**

While the concept is simple, the execution and operation of the Geospatial Semester has its complexities. Interestingly, much of the complexity comes on the part of the secondary schools. We start by working with interested teachers and school district administrators. Once a school decides to participate, they must decide on how to offer the class (science, social studies, or technical education) and identify the teacher. Often, they must officially add the class to their Course of Studies and then recruit students to make sure there are enough participants for the class to be offered.

At the university, once we created courses and had them approved, we simply offer sections via our Office of Outreach. We visit each class and enroll students that wish to pursue the dual enrollment credit (this is not required for participation in the

Geospatial Semester) and then we continue to work with the teachers and the students through regular visits (every 2-3 weeks) and even more regular contact via telephone and e-mail. This kind of extended interaction between university faculty and high school instructor is very unusual, even in dual enrollment classes.

Once we've identified a new school/teacher, we work with them to provide professional development and curricular materials as the teacher starts to plan his/her course. A number of the teachers have prior GIS experience through university classes or work experience. We have developed a complete set of materials that teachers can use to master the technologies themselves as well as use with their students to introduce them to different facets of the technologies. We've also recently written a book "Making Spatial Decisions Using GIS" (1<sup>st</sup> and 2<sup>nd</sup> edition), published by ESRI Press, that is used by most classes as more advanced material.

We are currently in the 8<sup>th</sup> year of offering the Geospatial Semester. In the inaugural year, we offered it at just four schools and we have grown the program to approximately 20 schools and more than 500 students annually. A map of participating schools can be found at <http://www.isat.jmu.edu/geospatialsemester/map.html>

#### **4. EXAMPLES OF STUDENT WORK**

The quality of student work has been very high. While not all of the projects have been locally-based, a great number of them demonstrate both substantial GIS and cartography skills as well as interesting spatial analysis and scientific problem-solving. The students build their geospatial skills through a variety of exercises and small-scale projects early in the class and then they move to the project phase. For many students, this extended (many week) project is often the first time they have worked on any assignment requiring more than a few days. The teachers and the JMU mentors work with the students to help them explore project ideas and then shape them into GIS projects for which data are available and that can be done in the time allotted. The student project ideas are generally very innovative, but as veteran GIS users know, identifying appropriate and relevant data is the key to a good GIS project. It is here that the university mentors make a big difference. As the secondary teachers gain more experience offering the Geospatial Semester, they are much more able to provide more guidance to students regarding projects.

The figures below show a number of examples of the final project presentations of different students from urban, suburban and rural settings. Many more student project examples can be found on the project website: <http://www.isat.jmu.edu/geospatialsemester>.

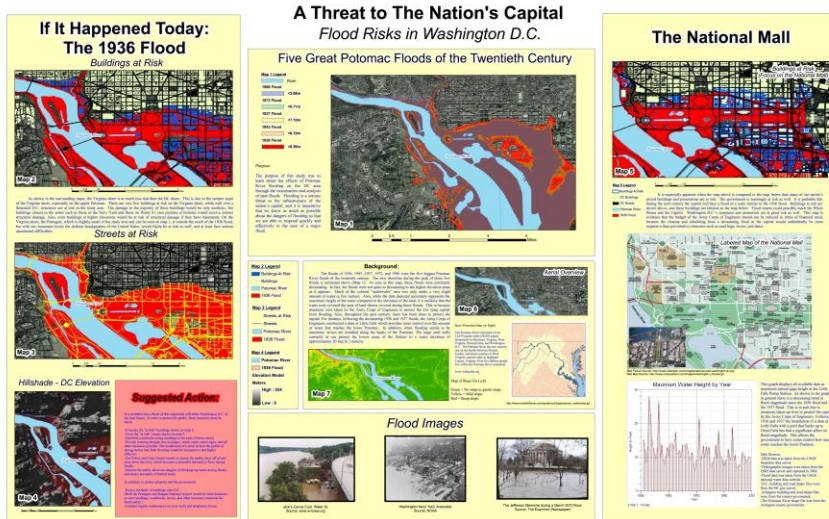


FIGURE nº1: This project from Washington-Lee High School in Arlington, VA explores how a flood of the same magnitude of the 1931 flood of Washington, DC would impact present day Washington. This project combines historical data with modeling and uses a very attractive visual display to convey the results. This project was a multiple-award winner at the 2010 National Conference for Geographic Education map competition.

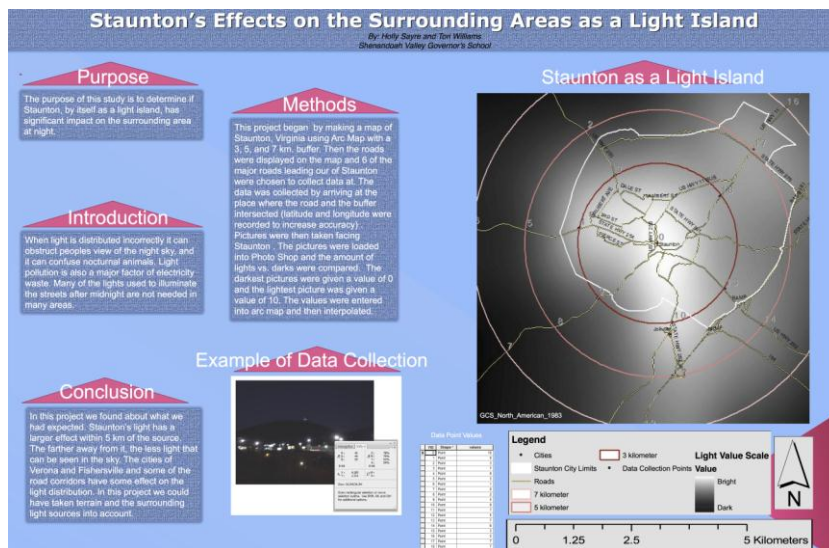


FIGURE nº 2: This project from the Shenandoah Valley Governor's School investigates the impact of ambient light from a small Virginia City. The students designed the investigation and took the data shown. One of the most intriguing aspects of this project was the ingenuity the two young women showed in determining how to take pixel brightness from a digital camera and turn it into a compelling spatial display. It also shows the value of raster interpolation to estimate the brightness between the measured values.





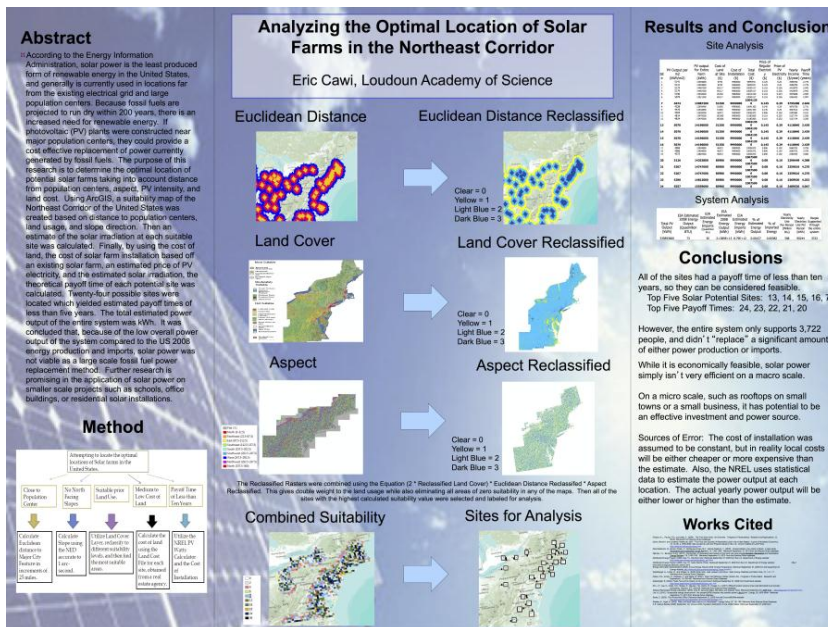


FIGURE n°5: This project from Loudoun Academy of Science in the suburban Washington, DC area investigates the optimal locations of solar farms in the northeastern part of the United States using multiple selection criteria. This project shows the power of GIS in site selection. In this case, the student was interested in alternative energy sources and how they might support large urban populations. The combination of multiple criteria into a single decision is a good analog to real-world decision making.

This array of projects demonstrates some of the possibilities that secondary students chose to explore. They are clearly interested in projects that tie to their communities and that are socially relevant. Other projects have included assessing the traffic flow around secondary schools, evaluating school bus routes, testing the efficacy of local hazardous weather warning devices (e.g. tornado sirens). Tying the projects to issues about which students care or that provoke their curiosity has proven to be key to the success of the Geospatial Semester.

## 5. SUCCESSES

From the examples of the student work shown in the previous section, students are clearly mastering the use of different geospatial technologies and the analysis techniques. As with any class, there is a range of quality of effort and output, but there is no question, in interacting with the students, that they have mastered the software. The more interesting challenge is helping them build the ability to pose and answer spatial questions that are amenable to analysis with GIS. We have been engaged in a

multi-year study exploring the quality of student projects using a rubric developed based on the 21<sup>st</sup> Century Skills thinking skills (Partnership for 21<sup>st</sup> Century Skills, 2004). Our results to date (Charles and Kolvoord, 2011) show that students demonstrate considerable ability in gathering data and creating maps, but struggle to reach higher levels of competence in spatial analysis. This will come as no surprise to anyone who has worked with secondary students. Their concrete skills can be excellent, but they can struggle as they move to more abstract thinking (note that this problem is also a challenge at university level).

The students are also engaged and actively participating. The quotes below are indicative of students' feeling about the experience.

*“Geospatial Analysis is unlike any other topic I’ve studied before, it’s applicable to almost everything inside and outside of school. It gives you experience with cutting edge technology. It’s great!”*  
Female Student, Fairfax County

*“When I signed up for this class, I thought I would be just another science class that our school would try to put a “fun” spin on, but this class is one of the most exciting classes I’ve ever taken. It makes you think, it challenges you to be innovative, but it’s something you can use. It makes the work more meaningful when you know you’re doing something that affects your life.”*

Female Student, Fairfax County

The quality of student work has also been externally validated as students have won recognition in state and national contests (for example, the project shown in Figure 1 won multiple awards at the 2010 National Council for Geographic Education Map Competition).

Another benefit of the Geospatial Semester is that students are introduced to central ideas in Geography to a much greater extent than the current United States curriculum generally permits. While the Geospatial Semester is not a Geography class, it engages students in geographic thinking and problem-solving and has resulted in many students considering Geography as a potential college major or GIS as a possible career path. The Geographic Science program at JMU has grown in parallel with the growth of the Geospatial Semester.

An unanticipated benefit of the Geospatial Semester has been the engagement of the participating teachers (Kolvoord, Charles and Purcell, in press). The current focus on high-stakes testing has led to a great deal of formula-based teaching (i.e. pacing guides, rigid curriculum structure, little opportunity to adapt to current events and student interest). The opportunity to teach a course like the Geospatial Semester has reenergized some experienced instructors and given them the opportunity to be creative and draw their students into open-ended inquiry. This has resulted in considerable satisfaction on the part of participating teachers, despite the effort



required. In fact, one teacher has delayed his retirement because he's enjoying teaching the class so much. The opportunity to learn and use a technology that is constantly changing is a welcome stimulus to many Geospatial Semester instructors.

## **6. CHALLENGES**

While it would be most gratifying if every student in every classroom were able to produce the quality work on display in the maps shown above, it must be noted that not every student remains engaged throughout the class. While the overall level of motivation is very high, some students don't perform as well as they might. In some cases, they've joined the class due to parental pressure or a mistaken idea of what the class entails. Some also lose motivation for personal reasons that have little to do with the class.

Teachers can also struggle with the class. Interestingly, we've found that it isn't prior GIS skill or knowledge that determines which teachers are most successful, but rather their experience with, or willingness to embrace, project-based learning. We've discovered that we can help shore up any GIS skill deficiencies much more easily than we can help teachers model and support project-based learning. As a consequence, we've had some teachers and schools drop out of the Geospatial Semester. We've also faced the challenge of teacher mobility. In the U.S., it is not unusual for teachers to either change schools or school districts, or to move into administrative posts. These changes can move a school from a successful Geospatial Semester offering to no offering at all. We're continuing to work with these districts to identify and support potential instructors.

We also continue to struggle with how much guidance and mentoring to offer both teachers and students. An important component of the Geospatial Semester is helping to build competence on the part of both the secondary teacher and the students. We are sensitive to not wanting them to be dependent on our consultation and help, but also wanting to make sure that we give them sufficient support to allow them to explore projects that have both challenge and depth. The support personnel at JMU are in regular conversation about the depth of mentoring offered in different classrooms. We also spend considerable time debriefing at the end of the year to consolidate successful practice and learn from our mistakes.

A final challenge has been following students after the completion of secondary school to determine what impact, if any, the Geospatial Semester has had on their choice of university program or career. We don't have any way to maintain contact with these students and as soon as they change an e-mail address, they are lost to us. In the future, we are anticipating a tracking system that will allow us to follow students from secondary to tertiary education in Virginia, but it doesn't yet exist.

## 7. CONCLUSION

The Geospatial Semester is finishing its 8<sup>th</sup> year. More than 2,000 students in schools around Virginia have participated in the project and the large majority of them have earned university credit for the experience. Students have demonstrated that they can master professional-grade GIS software and use it to explore locally-based projects of interest. Students remain engaged throughout their final year of secondary school and are introduced to content and career paths not ordinarily available to them. Participating teachers report being energized by the experience and are able to bring project-based learning opportunities to students in the midst of a mania for high-stakes testing.

We look forward to continuing to build the Geospatial Semester into more schools and mentoring student projects in GIS. If you would like more information about our efforts, please go to our website (<http://www.isat.jmu.edu/geospatialsemester>) or contact us.

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