How to set up a GIS program at a tribal college

Sylvio Mannel
Mathematics and Science Department, Oglala Lakota College, 3 Mile Creek Road, Kyle, SD, 57752. Phone: (605)455-6137, sylvio@mannel.com

Kim Winkelman
President, Comanche Nation College, 1608 SW 9th St., Lawton, OK 73501.
Phone: (580) 591-0203, lakota71@direcway.com

Abstract

This paper provides detailed ideas on how to set up a college GIS program and how to develop it for maximum benefits in education, research, and community. We draw our experience from setting up the GIS program at Oglala Lakota College, Pine Ridge Reservation in South Dakota. GIS can be useful in many fields and is relatively inexpensive to set up. Native Americans applied science in the past and now embrace GIS technology for everyday decision making, such as housing and as a tool for preserving cultural identity. The wide range of GIS is visible in research collaborations, which include sustainable bison ranching, geospatial pattern analysis of diabetes and mapping of cultural and historical Lakota sites. General issues related to establishing a GIS program are outlined in this report. This report is presented to provide a first overview of GIS and promote this technology to other colleges, especially tribal institutions.

1. Introduction

Geographic Information Systems (GIS) and Global Positioning Systems (GPS) have become buzz words for progress and technology. Often the work associated with GIS/GPS is either highly underestimated or overestimated by the general public. The following paper gives a practical overview on how to set up and maintain a GIS program. It is aimed towards GIS coordinators and anyone interested in initiating or collaborating with a GIS program. This paper requires little or no prior GIS knowledge.

Although there are many definitions for GIS, it generally refers to making maps with a computer and exploring spatial relationships, for example between vegetation, precipitation, and terrain factors to predict areas with higher risks of wildfire. This technology often goes hand in hand with GPS. A GPS can be used to mark and find locations which can be added to a GIS along with other layers such as roads, or aerial photos.

The main advantage of a GIS program is its seemingly endless applications. OLC's GIS program has supported ranchers, firefighters, parks and recreation, forest service, human services, health service, water resources, and assisted in areas of Lakota studies, tourism, and environmental science. Maps can be used in such applications to identify animal/plant relationships, to map hotspots of diabetes, and to preserve and protect historical sites.

The Pine Ridge Indian Reservation is located in southwestern South Dakota. The history of the Pine Ridge reservation is rich with outstanding Native Americans, such as Sitting Bull, Crazy Horse, Red Cloud, and many more having lived within the area (Freedman 1987, Brown 1993). Important Native American events include the historic massacre of Native Americans at Wounded Knee in 1890 and the recent history of the AIM stand off in 1973. Protests still happen, for example, about the stronghold area northeast of the reservation, where negotiations are under way to return parts of the Badlands National Park to tribal management. Living conditions can be challenging; former President

Clinton acknowledged an unemployment rate of nearly 75% (Clinton, 1999) which is likely to be even higher at the present time.

Oglala Lakota College (OLC) was chartered in 1971 by the Oglala Sioux Tribe to coordinate higher education on the Pine Ridge Indian Reservation. This college provides educated human resources for the tribe and other reservation entities. OLC is currently in the process of establishing the Oglala Lakota University through outstanding teaching, research, community services and assessment (OLC Mission statement). OLC caters to 1500 students who take classes in nine college centers across the Pine Ridge Reservation in South Dakota and one additional college center in Rapid City, South Dakota. Some of theses centers are more than 100 miles from the main college center. One major challenge is the relatively low number of students which are distributed over a large area. Ways are consistently being explored to recruit students not only for participation in established classes, but also as research assistants.

OLC's GIS lab was built and established as part of a grant by the National Science Foundation (NSF). The initial set up was complete in 2003 and subsequently it has found a place in education, research and community services. The GIS/Remote Sensing Lab at OLC also deals with Remote Sensing which broadly means classification of satellite data. This paper is presented to concentrate on GIS and how the lab was set up, how the classes were prepared, the start of research, and how the lab incorporated outreach to the community and K-12 institutions. The goal of the authors is to provide details of what worked (and what didn't) to support other efforts in promoting this technology, especially to tribal institutions and smaller colleges/universities.

2. GIS

The popularity of GIS has grown for several reasons. These include the increased use of spatial data analysis in decision making, the public's increase in computer literacy, the widespread use of online maps, and the growing private and commercial implementation of GPS. GIS supports a variety of applications, such as land use planning, environmental

management, sociological analysis, and business marketing (Price 2004). Information technology (IT) continues to advance in everyday applications. Recent developments in this technology include self check-outs in supermarkets, I-pods, online tax filing, and cell phones that allow for Internet access and photography. Geographic Information Systems (GIS) are by definition a part of IT and along with the trend of using this technology in everyday life the general public also embraces GIS and GPS applications. In 2001, the Department of Defense (DOD) gave up the practice of 'selected availability' by allowing undistorted GPS signals. From this time on GPS operation and related mapping applications have seen a dramatic rise, for example for navigation during hunting, hiking or geocaching (a type of treasure hunt using GPS coordinates). The easiness of utilizing many online map services is another contributing factor to the popularity of GIS. Many online map services, such as mapquest.com, mapblast.com, and Google provide online maps that allow basic GIS services, such as zooming and querying.

3. Native Americans and GIS technology

While this primer discusses the development and utility of geospatial technology today, we would be remiss not to mention the important conceptual framework of Indian heritage in the science discipline. Ancient creation and origin stories as well as star maps strongly indicate the importance American Indians placed on scientific observation and study of the laws of the universe. We know, for example, that the Lakota peoples' sacred Black Hills (Paha Sapa) in South Dakota are one of the oldest natural geographic features on the face of Mother Earth. Early scientific investigators would not hear the voices of the Lakota who told scientists what they would find in their investigation. Today, we know that the Black Hills are indeed one of the oldest natural features on the planet. Lakota creation stories, Star Knowledge and modern science can be combined by looking at a satellite image of the Black Hills. They make the shape of the human heart – and, the ancient Lakota name of the Black Hills is – "The Heart of Everything That Is."

We should also remember that much of the foods we eat throughout the world originated with American Indians and were then exported to Europe and Africa. Indian farming

techniques of hybridization and their understanding of practical genetics further validates their preoccupation with science in their day-to-day life-ways. Forensic science is also validating many aspects of American Indian creation stories. DNA research and modern archeological dating techniques seem to substantiate their origin stories as to their evolution in the Americas.

In short, science and scientific observation is nothing new to the American Indian – and that trend continues even today. For example, Native American land issues are of national importance; and reservations are now being created on National Park land (Deverse 2001). NativeView, a native geoscience organization, works closely with governmental agencies to address Native GIS and remote sensing issues. In an executive memorandum on tribal Sovereignty and Consultation, in 2004, President Bush reiterated the commitment of the United States to Native American issues (Bush 2004). Relationships between National and Native American governments however, remain sensitive (Clogg 1999, Cook-Lynn 2001, Igoe 2004).

Native Americans are taking advantage of geospatial technology in a variety of fields to map health issues (Bond 2001, Menke 2001), natural resources (Koschak 2001, Walker 2001) and to preserve and assert their heritage (Clogg 1999, Hartman 2001, Burroughs 2003). In 2003, ESRI granted the “Special Achievements in GIS” award to the “Names Places” project of the Coeur d'Alene Tribe in Idaho. Although this tribe has only a small number of tribal elders that speak the Coeur d'Alene language, tribal GIS professionals are using geoscience as a means for teaching the language and the stories that go along with the geography (Hartman 2001). James Rattling Leaf and John Goes in Center, two Native Americans working at the neighboring Rosebud Indian Reservation, produced a cultural resource-management tool CDROM, called RezMapper (Rattling Leaf 2002). This application presents cultural aspects of the Rosebud reservation in a range of maps, imagery, GIS layers and multimedia data in a dynamic interface.

Digital mapping as it is possible though GIS can assist in many general areas. GIS is currently used in different Oglala Sioux Tribe (OST) offices, such as the land office. OLC's GIS program plays a role in:

- Preserving historical, cultural and recreational areas
- Promoting traditional Lakota way of life
- Improving health conditions that are pressing in current Lakota society, such as diabetes
- Involving Middle and High Schools in mapping Lakota traditional areas
- Researching ecological issues on the reservation.

4. Establishing a GIS lab

In comparison to other labs, such as chemical or biology labs, a GIS lab is relatively inexpensive and easy to set up. One could start a GIS program by purchasing GIS software and installing it on existing computers. That is how the first GIS classes were offered at OLC. **The four main components of a GIS system are:**

- Hardware
- Software
- Qualified personnel
- Data

4.1. Minimal Setup

Depending on the size, scope and goal of the program, the set up of a GIS lab can cost from just a few thousand dollars to open ended. As a minimum, a GIS lab requires new or existing computers and software. There are several GIS software packages. We present ESRI's ArcGIS software because the majority of the world utilizes it. The scope of ESRI's software ranges from free simple GIS programs, such as the ArcExplorer to professional ArcInfo. ArcView has intermediate functionality and is often sufficient for beginning GIS classes and intermediate GIS analysis. In addition, ESRI offers special extensions, such as 3D, or geospatial analyst. The following is an overview of basic setup costs associated with a GIS lab. The prices presented here for ESRI products include the

educational discount for colleges and universities and are based on ESRI information as of June 1st 2005.

- Computer: about $1,500
- ArcView 9.x license: $250 each, or lab license for up to 25 computers: $1,000
  - **or** ArcInfo: $1,500 each, or $6,000 for lab license:
- Basic WAAS enabled GPS units: $200 (e.g. Garmin GPS 72)
- Data: mostly **ZERO**

Although, not necessary, one may want to consider the following expenses:

- Annual fee for updates and technical support for ArcView: $250/yr, and for ArcInfo: $1,500/yr (prices are the same for single or lab licenses)
- ArcGIS extensions, such as 3D: $150 each, or $500 for lab license

ESRI offers substantial educational discounts, for example, for regular customers ArcView costs $1,500 versus $250 for educational institutions. Contact ESRI for details and additional information.

4.2. Data

A large amount of free data is in public domain and available through the federal government (Hartley 2005, Redman 2005). Popular data are road layers and Digital Orthophoto Quads (DOQ) which are digital georeferenced aerial photographs. Some data can be very costly, for example, specific research projects may require the sampling of detailed data. However, many GIS Internet sites offer data for **free** download and only require an initial sign up, for example:

- http://datagateway.nrcs.usda.gov – great first stop (provides DOQs, landcover type and many other data categories)
- http://www.geodata.gov
- http://nationalmap.gov
- http://seamless.usgs.gov
- http://ned.usgs.gov – national elevation data set
- http://soildatamart.nrcs.usda.gov - soil survey

- http://www.sdgs.usd.edu/register/index.html - State Geological Surveys like South Dakota Geological Survey (SDGS) provide layers of DOQs, topo maps, and Digital Line Graphs, such as roads and water.

4.3. Additional components

Grants can ensure a continued state of the art GIS facility and may specifically be directed towards Native Americans (e.g. through NSF or DOD). These grants can be used to purchase additional instrumentation. However, for two reasons one should restrain the temptation of purchasing components too lightly: a) instrumentation may require maintenance costs and b) employing the new instrumentation may be time consuming, especially, if it is only tangent to the actual work. As an example it may not be necessary to purchase a digitizing table or a map scanner if most required data is already in digital form. Some additional components could include:

- ArcInfo license and/or additional GIS extensions
- Additional computers
- GPS units with sub-meter accuracy, e.g. Trimble GeoXT
- Plotter (to print poster size maps)
- Network server
- Salary for students and computer administration

4.4. GIS coordinator

A GIS coordinator should have expert knowledge of GIS. Higher degrees are of advantage for conducting research and applying for research grants. Because of the encompassing nature of GIS a coordinator works with a variety of people. The role of a GIS coordinator could be to advise on GIS techniques and assess the feasibility of suggested GIS projects. Sometimes, clients hear about potential GIS applications and largely underestimate the labor associated with it. The scope of some projects may lie outside the limits of time, technology, and experience available to the GIS coordinator.

4.5. Support

Many organizations are interested in expanding their outreach to tribal colleges. Our program is embedded in a framework of partners who helped in different aspects of the GIS program. The authors are willing to provide specific contact information. The following organizations may be a good source for expertise in running a successful tribal GIS program:

- NativeView
- AmericaView and State groups (e.g. SDView)
- USGS EROS Data Center
- Local GIS organizations (e.g. in SD: Black Hills Mapping group, SDView)
- State GIS organizations, in SD: GIS departments in DoT, SDGS, First District Association of Local Governments, etc.
- Neighboring tribal, private or state colleges/universities

4.6. Maintenance

After the initial setup, yearly maintenance costs are associated with a GIS lab. Most GIS labs are networked, so that students can work with any computer through an account on the network. Network and computer maintenance support is critical and time consuming and should be planned for. Maintenance items include:

- Automatic updates and technical support for ArcView and/or ArcInfo
- Salary for GIS coordinator, research assistants and possibly consultants
- Update of computers and other software
- Network and computer administration

A functioning GIS lab is only the beginning and much dedicated effort and expertise are necessary to actually establish and maintain a program that brings GIS into education, research and outreach.

5. Establishing a GIS program through education, research and community outreach

Education, research and community outreach can already be initiated while the GIS lab is being set up. Most successful college programs include education and to some extent research. In addition, community outreach is important, especially on tribal lands. OLC's GIS/Remote Sensing lab reaches out to OLC affiliates, community, K-12 schools, and tribal entities. Often, education, research and community outreach go hand in hand. For example, community members take GIS classes to advance their work skills and local schools collaborate to promote Lakota culture and history. The college GIS program profits from this outreach through the exchange of data and expertise. For example the OST Land Office demonstrated their GPS technology and assisted in the purchase of GPS units.

Outreach activities can take up significant time. With a growing GIS program careful planning is necessary to accommodate educational, research and community commitments. Often, the GIS coordinator will find him/herself in the position of not only explaining the potentials but also the limits of GIS.

5.1. Education

There is a strong desire in the Pine Ridge community to apply geoscience tools, resulting in nontraditional students signing up for GIS classes. Employees from the OST land office, water resources, BIA and community members participated in GIS classes to expand their work expertise. GIS is not only used at a professional level but also to preserve the local environment, promote business or claim ownership of land. These non-traditional students play a major role in increasing the number of students.

There are excellent textbooks for teaching introductory GIS courses, e.g. "Mastering ArcGIS" by Price (2004) or "Getting to know ArcGIS" by Ormsby et al. (2004). In addition, ESRI offers courses that can be purchased through grants for individual students. One frequent comment is that students wish to learn applications within the

local area. Our GIS/Remote Sensing classes utilize local data and require a final project based on the student's choice. OLC's GIS program offers the following classes: "Applications of GPS/GIS", "Introduction to GIS", and "Remote Sensing – Viewing our land from space". These classes are partly or fully accessible through the internet.

Workshops are offered in addition to regular classes. One or two-day workshops are popular with tribal and rural organizations on the Pine Ridge Reservation. Workshops can be a powerful tool to inform about GIS, recruit students and can be a source of revenue. So far, tribal fire fighters, ranchers, teachers, non-profit organizations and OST Parks and Recreation participated in workshops.

Two fun activities for a basic workshop or the beginning of a course are the "GPS treasure hunt" (figure 1) which introduces basic GPS navigation and "Download and Display of geospatial data" which introduces GIS and demonstrates the interaction of different programs.

Activity 'GPS treasure hunt'

The actual activity is preceded by a presentation about GPS principles, including number of satellites, concept of accuracy, and basic navigation skills. Students then go outside and navigate with a GPS to a hidden item, such as a flag. Students learn basic GPS operation, such as navigating to a previously saved location and marking a new location. They also recognize possibilities and limits of GPS technology. The activity is concluded by visiting the geocaching.com website to inspire GPS applications for recreational activities. This website promotes hiking and education by publishing locations of geocaches (pronounced geocaSHes). Geocaches may be an educational location or a hidden box on public land where a finder can exchange "treasure" items, such as postcards and add his/her name to a log book.

Figure 1. Middle school students looking for the red flag during a GPS treasure hunt.

Activity 'Download and display of geospatial data'

This activity introduces and demonstrates the interconnectedness of Internet, GIS and other IT applications. Students download local data, such as an aerial photograph, from the internet and use ArcGIS or the free ArcExplorer to display it as a base layer underneath GPS coordinates. See section 4.2 for data sources. Students get comfortable interacting with different software applications such as the internet to download data, WinZip to unzip the data, Window Explorer to organize data and finally GIS to display and explore it. Students learn basic GIS techniques, such as zooming, panning and layering while identifying features of an area well-known to them. This activity could stand by itself or as a follow up after the "GPS treasure hunt".

These two activities are intended to awaken the student's interest in GIS or as an inspiration for project ideas. We offer these activities in workshops or outreach presentations and found them a good recruitment tool for the actual classes. Visit www.olc.edu/~smannel/gis for more information.

5.2. Research

Research offers a number of benefits to a tribal college and the community. For example, our research work on diabetes and sustainable buffalo ranching (figure 2) has direct impact on issues important to the Lakota people. The "Lakota Land" project, for example, intends to help preserve sites of Lakota cultural and historical importance.

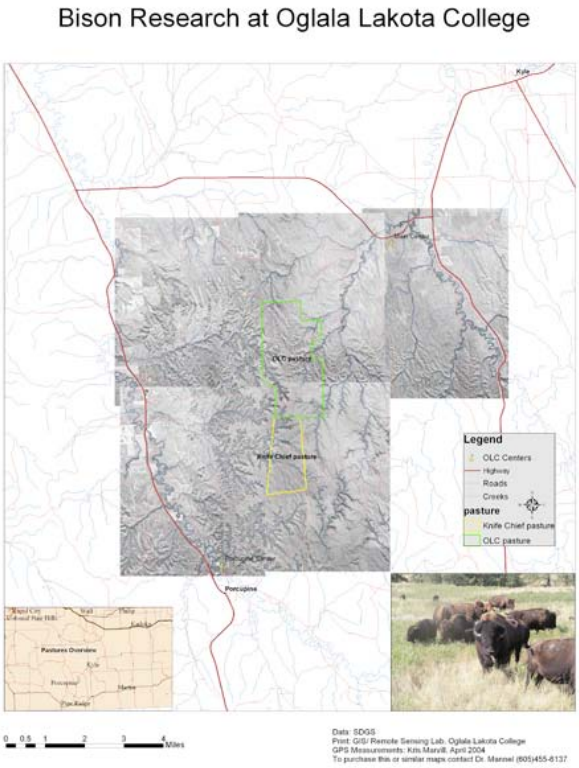

Figure 2. *Maps of two bison pastures that are included in USDA-funded research.*

Research grants help maintaining a GIS program by contributing to salaries, instrumentation and indirect costs of a college. Research can advance a university's reputation as a quality scientific and educational institution through:

- Personnel that is specialized and keeps up-to-date in their professional field through research
- Publications
- Presentations in conferences and meetings
- Participation in tribal or non-tribal organizations (e.g. Native View)

Research grants may also create job-opportunities for students. In a reservation where the unemployment rate is over 75% this is an important issue. Yet, we found it sometimes difficult to recruit research assistants due to the reservation wide distribution of students. Several institutions exist where a researcher can apply for funding, e.g. ESRI, NASA, or NSF. Some of these organizations allocate grants specific to tribal colleges.

5.3. Community and K-12 outreach

Community outreach includes collaboration with individuals, organizations, agencies and tribal schools. This outreach is an opportunity to bring Native Americans and Americans of European or other descent together. For example, OLC as a Native American College supports white ranchers in implementing GIS/GPS technology. Tribal and non-tribal persons alike have already attended classes and workshops. The following services are provided to OLC affiliates, collaborators and community:

- Advise about GIS potential and limits
- GIS/GPS Workshops
- GIS/GPS user support
- Research opportunities for students
- Equipment, such as GPS units or spectrometer
- Geospatial data over Pine Ridge reservation
- Lab can be scheduled for classes, meetings, or training
- Maps and poster prints with plotter

Within the last year at least ten middle and high school classes visited OLC and participated in GIS/GPS activities (figure 1). As a result, some schools on the reservation started implementing GIS/GPS into their curriculum. OLC supports those efforts with expertise and equipment. Some of these school children now participate in OLC's Lakota Land project, where they will research and map their own heritage.

6. Conclusion

Native Americans embrace the opportunities of GIS in day-to-day decision making and in preserving culture and history. Once a qualified GIS coordinator is found it is relatively easy to get a GIS program started. Data is often free, and equipment inexpensive in comparison to other labs. Education, research, and community outreach are important factors in measuring the success of a GIS lab. Working with the community helps recruiting additional students and enriches research projects. The success of a GIS program depends on partners and collaboration. For any questions or suggestions, please contact us or visit www.olc.edu/~smannel/gis .

Acknowledgement

We would like to thank Oglala Lakota College and its president Tom Shortbull for providing vision and framework for this program. Specifically, we thank Mike Fredenberg, Stacy Phelps and Albrecht Schwalm for administering the initial grants that allowed the establishment of the GIS/Remote Sensing lab. Native View, SDSM&T, USGS EROS Data Center, OST agencies and many more provided support in issues concerning education, research, community outreach and technology. We also thank Maribeth Price, Peter Iwen, and Rebecca Manel for reviewing this paper and Charles Comes Killing for his dedicated work in the GIS lab and on the Pine Ridge Reservation.

References

Bond, C. (2001). Cherokee use GIS for Demographic Analysis. Native Geography**:** 17.

Brown, D. (1993). Wounded Knee - An Indian History of the American West. New York, Henry Holt and Company.

Burroughs, B. S. (2003). Mississippi Choctaw's Use GIS and Mapping to Manage Tribal Lands. International GIS User Conference, San Diego, CA, ESRI.

Bush, G. W. (2004). Memorandum for the Heads of Executive Departments and Agencies - Government-to-Government Relationship with Tribal Governments. Washington, D.C.

Clinton, W. J. (1999). Clinton addresses Pine Ridge Indian Reservation.

Clogg, J. (1999). "Maintaining Cultural And Ecological Diversity On The Central Coast: Co-Management Options." Sierra Club of British Columbia (25:02).

Cook-Lynn, E. (2001). Anti-Indianism in Modern America. Urbana and Chicago, University of Illinois Press.

Deverse, B. E. (2001). Utilizing GIS to Develop Partnerships between Tribes and U.S. Government Agencies. International GIS User Conference, San Diego, CA, ESRI.

Freedman, R. (1987). Indian Chiefs. New York, Holiday House.

Hartman, J. (2001). GIS and Preservation of Tribal Culture. Native Geography**:** 20-21.

Igoe, J. (2004). "Good Land, Historical Initiatives and Present Opportunities for the Future of the South Unit.".

Koschak, M. (2001). South Rainier Elk Herd Study: Puyallup Tribe of Indians Wildfire and GIS Departments. Native Geography**:** 24-27.

Menke, K. A. (2001). "Interactive Atlas of American Indian Elders' Health." Native Geography: 18-19.

Price, M. (2004). Mastering ArcGIS. New York, McGraw-Hill.

Rattling Leaf, J. (2002). Rez Mapper, GeoPresenter.

Walker, J. (2001). Shoshone-Paiute Tribes, Natural Resources Department. Native Geography**:** 22-23.

Authors

Sylvio Mannel, PhD

Sylvio Mannel received his Masters in Germany and his PhD at South Dakota School of Mines and Technology. He worked in several private and public institutions prior to managing the GIS/Remote Sensing program at Oglala Lakota College. When starting the GIS program he was faced with many questions, such as how to set it up, how to keep it running, and where to find good data and teaching material.

Kim Winkelman, PhD (Oglala Lakota/Comanche)

Kim Winkelman is now the President of Comanche Nation College in Oklahoma. He is the former Vice President of Instruction, Oglala Lakota College. He teaches courses in

Native American Studies, including American Indian creation stories, teachings, and prophecies as they relate to ancient and modern science.