Using Geospatial Technologies to Enhance and Sustain Resource Planning on Native Lands

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The quality of life of Native Peoples will be unavoidably altered as a result of long-term climate change and increased interannual climate variability, especially as it relates to air quality, water resources, forests, agriculture, and wetlands. Native Peoples have had centuries of experience on the land; they have responded to many changes and have found ways to live sustainably. Nevertheless, in addition to facing uncertain environmental changes as a result of climate change, today Native Peoples face diverse internal and external challenges to their ability to manage their natural and cultural resources. These include logging, mining, tourism, and urban encroachment.

Sophisticated geographic information tools, including geographic information systems (GIS), the Global Positioning System (GPS), and remote sensing systems, can assist in meeting these challenges by empowering Native Peoples in the development and execution of their own resource strategies. Yet, because of cultural differences between Native communities and the dominant, European-influenced culture, these powerful geospatial technologies cannot be simply incorporated into a Native management framework without recognizing and bridging these cultural differences.

Different Viewpoints, Different Ways of Knowing

It is difficult to generalize about the beliefs and worldviews of Native Peoples of North America because the over 565 recognized tribal and Alaska Native groups are highly diverse in language, religion, and cultural practices. Nevertheless, most Native Peoples who subscribe to traditional ways approach the world and their place in it differently than do people of Western European background. For most Native Peoples, a sense of place and connection to the land is vitally important to their conception of self (Swentzel, 1990; Momaday, 1976; Tuwaletstiwa, unpublished data, 1998). In general, Native Peoples consider themselves inextricably tied to the natural world, all components of which are sacred (Capps, 1976). Living in such a world requires reciprocity of behavior, in which other components of nature, whether rocks, streams, animals, or birds, must be treated with respect (Johnson, 1983). As Native Peoples generally see it, to do otherwise could lead to negative consequences for humans because the sustainability of human life depends on the continued bounty of nature. Likewise, sustainability of non-human life depends on the wise use of these natural resources. It is a point of view that values experience and long term direct observations of the air, land, sea, and water. This point of view also values collective over individual values. Land ownership and management among Native Peoples tend to be collective, rather than individual.

European philosophy, in contrast, imparts a separate status to human beings, setting them apart from the natural world. According to this view, which is supported by the *Book of Genesis* and by a philosophic tradition extending back to the ancient Mediterranean civilizations, humans have a duty to command nature, molding it and exploiting it to meet their needs and wishes. In the United States, especially, individual values and ownership are highly valued, sometimes to the detriment of broader societal needs. The two points of view often come in conflict on and near Native lands.

Today, Native communities are caught between two forces—that of the need to manage their resources in the context of numerous external pressures, laws, and regulations, while still adhering to their fundamental belief in a world of reciprocity and collective values. Sometimes these forces are in direct opposition, as when culturally or ecologically sensitive areas are threatened by environmental alterations occasioned by nearby development or intensive land use.

Climate Change Research, Geospatial Technologies, and Resource Management

Recent research on climate change demonstrates the dramatic effects climate change and climate variability can have on local environments and on people (Liverman *et al.*, 1998). For example, the patterns of drought and flooding brought on by the effects of El Niño and La Niña during 1997 and 1998 severely affected people's lives in several regions of North America. Scientists are now beginning to understand the mechanisms that cause these massive changes of climate and will in time be able to predict their occurrence and estimate their probable effects with considerable confidence. Related research also demonstrates how humans have altered their local environments, even during pre-industrial periods when land altering technologies were limited in capability and scope (Sever, 1998). This research is helping practitioners learn how to respond more effectively to future environmental challenges. The results of this research, managed on the federal level by the U.S. Global Change Research Program (URL: http://www.usgcrp.gov), are also available to Native Peoples for managing their lands

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through the Center for International Earth Science Information Network (URL: http://www.ciesin.org).

Geospatial technologies, which are used intensively in environmental change research, can help bridge the substantial gap between Native ways of knowing and European inspired viewpoints. These technologies provide the basis for capturing detailed information about land characteristics and resources and displaying different kinds of knowledge (Ecotrust, 1995). For example, GIS can assist in capturing and displaying graphically the knowledge of elders about a geographic area (Goes In Center, 2000). It can also display viewsheds as seen from sacred sites, enabling planners to protect these viewsheds both for appropriate worship and for the secular visual enjoyment of visitors. Furthermore, GIS can be used to catalogue and categorize areas of critical biodiversity or tribal resources that Native Peoples might want to safeguard for future generations.

GPS can be used to catalogue the locations of sensitive sites (Tuwaletstiwa, unpublished data, 1998) and to locate accurately boundaries of Native lands, and to map routes of historic and/or ceremonial importance. GPS is also a principle tool for georeferencing GIS maps and remotely sensed images of the land.

Remotely sensed data, which may be acquired by sensors on aircraft or spacecraft over large land areas, are often incorporated into a GIS framework. These data can be used to reveal subtle changes in the health of timber stands or to analyze the effects of clear cutting on the local environment. Such data can also be applied to the analysis of urban growth and to the status of water resources. Generally, remotely sensed data are extremely valuable in analyzing changes in the land. When combined with local knowledge provided by tribal members, such data can yield information beneficial for long term resource management. Because the vantage point of space readily extends beyond arbitrary political boundaries, satellite data are advantageous for examining the results of activities throughout entire watersheds or other natural boundaries beyond current Native Reservation boundaries that may nevertheless affect the ability of Native Peoples to manage their own lands.

In general, these tools can incorporate both Native and non-Native observations and research for Native Peoples' benefit. They especially provide the opportunity for Native Peoples to employ their own vision of the management of tribal resources. Furthermore, because Native Peoples do not force a sharp distinction between the sacred and secular aspects of the world, decisions about tribal resources have a spiritual component that is seldom appreciated by non-Native peoples. These technologies allow aspects of the spiritual to be incorporated into planning.

Overcoming Barriers to the Use of Geospatial Technologies

In order for these tools to reach a high level of utility on Native lands, tribal governments and Native corporations will need to overcome a number of hurdles. These include relatively high costs of data, software, and hardware; lack of adequate training in the technologies; and inadequate basic preparation in K through 12 education. Furthermore, the cultural differences between Native Peoples and the dominant U.S. culture require an approach that explicitly recognizes such differences and attempts to bridge them. Yet, perhaps the biggest hurdle is the lack of awareness among the Native decision-makers of the benefits and hurdles of using these technologies. The following paragraphs expand on these hurdles.

Costs

Native organizations, like many educational institutions and non-profit organizations, face a sometimes daunting financial hurdle in establishing their own land information capabilities. Fortunately, the costs of software and computer hardware have been falling rapidly, while capabilities have increased. In addition, NASA's Terra and Landsat 7 satellites are now in orbit, creating new sources of moderately priced data. These data are available from the USGS EROS Data Center Distributed Active Archive Center (URL: http://edcdaac.usgs. gov). On the other hand, the costs of training and retaining qualified personnel to operate geospatial systems can be high. Proponents of the use of geospatial technologies within Native organizations are under great pressure to demonstrate the cost effectiveness of these technologies to their superiors. These individuals would benefit from thoughtful cost analyses prepared for their context.

Training

Several federal agencies, including NASA Earth Sciences Education (URL: http://www.earth.nasa.gov/), and the USGS EROS Data Center Distributed Active Archive Center (URL: http://edcdaac.usgs.gov), offer considerable on-line information and training materials for geospatial technologies. Over the years, the Bureau of Indian Affairs, through its Geographic Data Service Center (URL: http://www.gdsc.bia.gov) has operated a training program in geospatial technologies (recently vastly reduced in scope) specifically for Native Peoples. In addition, there are many geospatial service companies, some of which also provide information on the Internet and training for a fee. The American Society for Photogrammetry and Remote Sensing has sponsored internet-based training (URL: http://research.umbc.edu/~tbenjal). Finally, geospatial software companies offer training (often for a fee) on their software packages. Despite the available resources, training requires considerable investment. Nevertheless, because Native lands are often adjacent to lands managed by federal agencies, it is in the federal agencies' interest to assist the development of land resource management strategies by providing adequate training to Native Organizations. In doing so, they could work through the Indian colleges, some of which have developed their own geospatial capabilities. The Shiprock, New Mexico campus of Diné College, for example, is providing GIS training to Native Peoples under a NASA grant.

K-12 Education

More thorough environmental education would provide a much-needed foundation for training in geospatial technologies. The GLOBE program (Global Learning and Observations to Benefit the Environment)—a worldwide network of students, teachers, and scientists working together to study and understand the global environment (URL: http://www.globe.gov)—can be an extremely useful resource for supporting environmental programs in tribal schools. Indian colleges could also assist such efforts by developing culturally sensitive teaching modules and materials for use in tribal schools.

Cultural Differences

Native Peoples have always struggled with the difficulties of defining their approaches in a setting dominated by funding and other resources controlled by individuals with a different cultural background (Morishima, 1997). The Native Peoples, Native Homelands Climate Workshop (see below) aired some of the differences between the views of Native Peoples and non-Native peoples that affect the stewardship of Native lands. However, fully realizing the capabilities of geospatial technologies on Native lands will require reaching a broad community of Native peoples, ranging from government leaders to the ultimate beneficiaries—the peoples of the tribes. This will require the development of ways to interpret geospatial technologies in the Native context, through the use of storytelling and appropriate analogies and metaphors.

Lack of Awareness

A variety of outreach activities, including training, demonstrations on Native lands, and the development of educational activities, will help educate managers and other decision makers about the value of geospatial technologies for Native lands. These include explicit efforts to demonstrate with real world cases the cost effectiveness of these technologies.

The Native Peoples, Native Homelands Climate Workshop

To address the issues of climate change on Native lands, in October 1998 NASA organized a workshop in Albuquerque, New Mexico (URL: http://www.earth.nasa.gov/native/). This workshop was one of 20 regional workshops held in support of the U.S. Global Change Research Program (URL: http://www.usgcrp.gov). The workshop discussion (URL: http://www.nacc.usgcrp.gov) illustrated the need for a four-pronged approach to GIS and remote sensing—research, outreach, education, and training. The workshop sparked several initiatives, led by NASA's Earth Science Enterprise, to support Tribal Colleges and other Native organizations in the development of GIS and remote sensing programs.

One important outcome of the workshop was the creation of the Southwest Native Peoples Native Homelands Initiative (URL: http://www.nacc.usgcrp.gov), centered in the Earth Data Analysis Center (EDAC) of the University of New Mexico, and working with partners from other universities and southwest tribal organizations. The Initiative is addressing all four approaches, described in the following paragraphs.

Research

Over the centuries, Native Peoples have developed many techniques to cope with the effects of climate change. In the dry southwest, especially where small annual differences in the amount of precipitation or in its seasonal distribution strongly affect the size and quality of the harvest, capturing and retaining moisture is crucial to survival (Anschuetz, in press; Norton and Sandor, 1997). Understanding better how southwest Native Peoples have coped over the centuries with interannual and long term climate change will help federal, state, and local officials, and also individual citizens learn how to meet the challenges of future changes in climate. Hence, during 1999 and 2000, Native and non-Native researchers from the University of New Mexico have worked in partnership with several Pueblo villages and Navajo chapters in central and western New Mexico to study traditional Native methods of water harvesting, retention, and control, using GIS and remote sensing methods.

Outreach

One of the critical needs is to illustrate the utility of GIS and remote sensing in meeting the needs of Native Peoples. Hence, Initiative participants organized a symposium in October 1999, focused on the use of geospatial technologies on Native lands. Entitled Eagle's View of Mother Earth, the gathering of tribal representatives and GIS/remote sensing experts explored the use of these technologies on Native lands. Because these technologies raise a number of sensitive issues for Native Peoples, the organizing team invited southwest Native participants from several tribes, including elders, to describe their approaches, both traditional and contemporary, to geospatial knowledge. The presentations were enormously illuminating to participants and attendees alike, as they illustrated, among other things, how traditional knowledge can inform geospatial studies, and, in turn, how geospatial technologies can support and extend the utility of traditional knowledge.

Training

Because of the importance of remote sensing imagery to resource management, EDAC has held several training sessions in GIS and remote sensing, in cooperation with tribal groups, including Intertribal GIS.

Education

As part of the initiative, EDAC is working with the Southwest Indian Polytechnic Institute (SIPI) to develop educational modules in GIS and remote sensing specifically designed to be used in tribal schools.

Conclusion

Encouraging the use of GIS, GPS, and remote sensing on Native lands will require a variety of continuing activities such as we have discussed above. In order to be effective, these must be sustained over several years, until they are well integrated into resource planning and management. The fruits of these efforts will be known by the improvements they make in the ability of Native Peoples to sustain their own lands in response to their own needs and funding resources.

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