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Cartographic Encounters at the Bureau of Indian Affairs Geographic Information System Center of Calculation

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The processes of geographic information system (GIS) development at the US Bureau of Indian Affairs (BIA) represented an extension of past cartographic encounters with American Indians through the central control of geospatial technologies, uneven development of geographic information resources, and extension of technically dependent clientele. To support this thesis, I will first introduce the concept of cartographic encounters, as it relates to the historical exchanges of geographic information between indigenous people and non-Indians in North America. Although many studies of cartographic encounters exist within the history of cartography and anthropology literature, no study has specifically described the constructive processes of geographic information development within the agencies that acquired information from American Indians, historically. Second, in an effort to fill this void, I will introduce the concept of centers of calculation from the sociology of scientific knowledge. Bruno Latour developed this concept while following scientists and technicians through their laboratories as they constructed technologies and scientific facts. Centers of calculation as a concept blends very well with ideas of cartographic encounters, highlighting the colonial legacy of going out into the world and accumulating geographic information used

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in the construction of scientific maps, models, and simulations. Third, I will present a case study on GIS development at the BIA, demonstrating these very processes.

Cartographic Encounters

One of the primary concepts associated with research on indigenous map making and GIS in North America is cartographic encounters.[1] Developed by a historian of cartography, G. Malcolm Lewis, cartographic encounters addressed issues associated with the process of geographic information exchanges among Europeans, Euro-Americans, and American Indians throughout the past five hundred years. Lewis writes that "map content was used by whites in developing strategies and in adding systematically to geographic knowledge."[2] One example includes the solicitation and construction of indigenous maps by the Hudson's Bay Company in 1770.[3] Another cartographic encounter involved the creation of maps by Inuit people for the Sir John Franklin expedition and others.[4] Scientists, like geologists, also acquired geographic information from North American Indians.[5]

The tension between scientific and indigenous cartographies was evident in North American cartographic encounters. Much of the early work on American Indian cartographies focused on the manifestation of colonialism through process and representation, and presented the impacts of the encounters as often-contradictory and dualistic: direct or indirect, intentional or consequential, immediate or delayed, and unique or universal.[6] For instance, the Iglulik people conceptualized Wager Bay as a whale. Lewis remarks that "this is a late example of what was quite common in earlier encounter maps: the coexistence of real and mythically endowed features."[7] However, it was unclear whether the scholars undertook research in order to determine the basis of geographic reality among the Iglulik people. In other instances, explorers like Lewis and Clark were utterly confused by the indigenous use of natural materials to convey geographic knowledge.[8] These geographic processes—going out to the periphery and bringing information back to the center—resulted from the need of government bureaus to map and archive the lands inhabited by indigenous peoples.

Cartographic encounters occurred among American Indians, government bureaus, and archives. Maps created in government bureaus and archives involved direct and indirect contact among explorers, indigenous people, and bureaucrats. Explorers often received geographic information from indigenous informants, who were out in the field, and used the information to create scientific maps. Usually, the maps did not acknowledge indigenous people as the source of the geographic information used to create maps.[9] The act of not acknowledging the information source was a form of cultural assimilation that incorporated the people, land, and information into the fabric of scientific cartographic representations.[10] Lewis writes, "Most incorporating and assimilating was by mapmakers working in the central bureaus of colonial offices of European governments or, from the late eighteenth century onward, by those with access to official records."[11] Colonial aspects of cartography included the acquisition of geographic information from indigenous people and the creation of cartographic representations without acknowledging them as sources. These encounters have continued in North America more recently through land use and occupancy mapping.

Recent encounters involving the mapping of geographic information among many American Indians began in Alaska and Canada during the 1950s, 1960s, and 1970s.[12] Numerous mapping projects emerged as cartographic encounters between outside researchers and indigenous communities, integrating stories and experiences told by local hunters, gatherers, fishermen, and trapping groups onto maps in places like Quebec, the Northwest Territories, and the Inupiat region of North Slope Barrows, Alaska.[13] North American Indians supplied the geographic information and knowledge for land-claims, land-use, and occupancy mapping projects.[14] Lewis argues that these maps "were in no way indigenous in form, content, or style" because they emerged through standardized procedures and incorporated the use of scientific base maps as their foundations.[15] Among North American Indians in Alaska and Canada, modern mapping and GIS originated as cartographic encounters between researchers and indigenous communities. This was a different model from the one recently adopted by American Indian tribal governments located in the lower forty-eight states.

Most American Indian tribal governments located in the lower forty-eight states adopted GIS through top-down, federal government processes.[16] The primary federal government institution that shaped GIS and the flow of data to American Indian tribal governments was the BIA Geographic Data Service Center (GDSC), presently known as the National Geospatial Resource Center.[17] GIS at the BIA evolved as a centralized, top-down network and acted as the primary repository of geographic information for Indian country. The BIA center was a high-tech operation equipped with state-of-the-art computer hardware, software, and technical expertise.[18] Among its many projects, the bureau created a nationwide map of Indian land during the 1990s, which has been described as difficult to interpret accurately and not representative of the true state of Indian land in the United States.[19] As a form of incorporation and assimilation, the BIA map did not show American Indian land allotments, people, or names.[20] By conforming and adopting the BIA vision for GIS, while ignoring community-based models, lower forty-eight tribal governments "have not produced a distinctive set of terms [or body of work] that sets them apart from the mapping work of nonindigenous people."[21]

A recent cartographic encounter between Indian country and the BIA involved the construction of a GIS nationwide database. The first BIA digital system was called the Indian Integrated Resource Information Program (IIRIP) and was developed to support resource management on tribal land areas.[22] Even the very name of the system implied integrating, incorporating, and assimilating Indians into the fabric of natural resource management.[23] The BIA claimed that "more than two-thirds of reservation acreage [was] represented" in its database.[24] Information used to construct the database included aerial photographs, topographic maps, satellite images, resource inventories, various state maps, and BIA field notes.[25] However, according to one BIA GIS specialist, few tribes utilized their GIS database.[26] Some tribal governments were suspicious of the BIA and its efforts to map Indian land.[27] Yet the contradictory nature of past cartographic encounters rang true at the BIA.

Contradictory evidence exists that shows the BIA both inhibited and stimulated GIS development within tribal governments. Issues that stifled early implementation efforts included the difficulty of using GIS, funding issues, accuracy and access to data, lack of training opportunities, and communication problems between the BIA and tribal governments.[28] In addition to technical complexities, perhaps the most stifling attribute of the BIA was its control of natural resource applications in the timber-rich Pacific Northwest.[29] For instance, the BIA controlled the GIS applications and vast storage of data on the Colville Confederated, Warm Springs, and Flathead reservations. All three tribal governments made requests to control their own applications and data, but the BIA denied their requests.[30] Governments like the Cherokee Nation of Oklahoma successfully used the BIA to implement and develop tribally controlled geospatial systems.[31] Other tribal GIS applications involved water-rights litigation, land-claims issues, tribal land-use planning, and the documentation and protection of culturally sensitive sites.[32]

Tribal governments and organizations used commercial GIS for numerous resource management applications. The Environmental Systems Research Institute (ESRI) developed a standard GIS used by several tribal governments and organizations throughout the past twenty-five years. An early collaboration between ESRI and American Indians included the creation of an overlay map of Zuni land used in a land-claims issue.[33] Plaintiffs in the case of *Cobell v. Norton* used ESRI GIS software and BIA data sets to examine trust land assets.[34] Outside of litigation, tribal governments used GIS for numerous natural and culture resource management applications. One recent publication featured very brief summaries of GIS usage in Indian country including land-use planning, natural resource management, and cultural revitalization efforts.[35]

In summary, cartographic encounters between American Indians and non-Indians represent an exchange of geographic information that has continued to evolve throughout the last five hundred years. Some scholars frame these encounters as dichotomous. Of interest to this research were encounters among explorers, technicians, scientists, and American Indians within North America. Often non-Indians solicited geographic information from indigenous people who knew the landscape. Indigenous informants were not given credit as being sources of vital geographic information. The result of not acknowledging the sources of such information was that American Indian geographic information, such as place names, sacred sites, storyscapes, and locations of people, became assimilated into resource maps and translated as standardized or homogenous mountain, river, and town site cartographic objects and symbols.

Recent cartographic encounters involved outside researchers and North American Indians in Alaska and Canada. This form of mapping information in fact incorporated the stories and experiences of community members such as hunters, fishermen, and trappers. However, the majority of North American Indian tribal governments located within the lower forty-eight states adopted GIS as a top-down, federal government model, one that emanated from the BIA. Bureau efforts hindered and aided tribal governments in the development of GIS during the 1980s and 1990s. Yet tribal governments and organizations used commercial, standardized products in the development of resource management applications.

A need exists to reveal the processes of cartographic encounters emerging in the age of the information society. Careful attention must be given here because information technology processes, like GIS, can have a profound impact on the economies, cultures, and institutions in Indian country. The social processes of GIS are more complex than simple binary encounters between people and their maps. Rather, GIS processes emerge within the messy and often partially developed domains of scientific and technical centers of calculation.

Center of Calculation

The term *center of calculation* describes the reach of scientific institutions that go out into the peripheral regions of the world to collect geographic information or physical materials. Sociologist of science Bruno Latour introduced the concept to describe early European inventories and subsequent mapping of distant lands on the periphery. Upon initial contact, indigenous people had a distinct advantage over explorers, military scouts, natural historians, anthropologists, and geographers. American Indians possessed a wealth of local knowledge about their homeland, including the location of natural resources, river systems, climatic conditions, ocean tides, medicinal recipes, and the local topography. Early explorers did not. To overcome the disparity between indigenous knowledge and scientific knowledge, information had to be gathered from informants and sketched on paper in a form familiar to scientists. One goal of science was to bring knowledge of the periphery back to the center.[36] Once back at the laboratory or museum, scientists made more precise and stable maps, manuscripts, models, and simulations.

Contemporary scientists constructed maps, models, and facts within their laboratories, allowing officials and managers to exert a degree of control over the physical environment. The development and implementation of maps, models, and simulations worked as important components of the control process. By collecting and processing data about the world, scientists and technicians created virtual maps, models, and simulations, which allowed them to experience the physical environment from within the controlled confines of their own laboratories, map rooms, and museums. Centers of calculation connect with economic and political systems, giving those in the center control over people, places, and things on the periphery. State- and corporate-sponsored science contributed to the power of the center of calculation. These conditions converted seemingly insignificant places into a center of calculation that acted on the periphery from a distance.[37]

Centers of calculation hold and organize information, data, maps, numbers, and digital data. Empires accomplished this by sending naturalists, cartographers, geographers, anthropologists, and technicians out into the world to collect and make initial inscriptions of people, places, and things located in faraway places. This process is known as a *cycle of accumulation*. Each time an expedition went out and returned, explorers brought back more information that the center used to make better maps. The creation of scientific maps allowed explorers to return to the periphery and claim additional natural resources or other materials. The accumulation of information about distant places gave the centers of calculation advantages over the periphery, allowing the centers to perform action from afar through the use of maps.[38] North American Indians and their land have been subjected to multiple cycles of accumulation, which began at the time of first contact with Europeans and continued into the late twentieth century.

Cartographers and their maps shaped colonial practices.[39] Many American and Canadian federal government agencies like the BIA, the Canadian Department of Indian Affairs, and the US Geological Survey (USGS) succeeded in carrying out multiple cycles of accumulation and mobilization of geographic information about American Indian people and their lands throughout the past couple of centuries. A few examples include western expeditions, military mapping surveys, the four Great Surveys of the West, ethnographic studies of North American Indian tribes, and the mapping of reservation and individual allotment land.

Centers of calculation describes how the US federal government collected, classified, and used geographic information for controlling and confining American Indians to reservations during the late nineteenth century. Matthew Hannah argues that the nineteenth-century American Indian allotment and ration system, managed from the center of Indian agencies, was a partial regulatory instrument implemented for individual surveillance and individual punishment. The ration system forced Lakotas to register their camp locations at official distribution calculation centers. Beyond this, the federal government used the ration registration system as a way of determining good and bad Indians.[40] In another example, John Wesley Powell led one of the "Great Surveys of the West" in which he counted, collected, and conducted ethnographic-language studies on several tribes in the western United States and Great Plains.[41] Scott Kirsch writes, "There was more than a geographical character to the observations and measurements, photographs, paintings, and ethnographic objects routed from the arid lands [periphery] to Washington [core], where they could be reconstructed and often made available for public consumption in maps, and only through this traffic of knowledge between Washington and the West, between science and government, between natural and social sciences, and across the threshold of the public sphere did the West take shape in Washington."[42]

Cole Harris refers to the North American Indian reserve as a spatial system used to manage land resources and people. In Canada, the British government sent out surveyors to measure the land that was to become British Columbia. The surveyors relied heavily upon their own scientific and technological methods of reproducing a cadastral map of the landscape. Local indigenous informants provided "far more information than the commissioners had time for or wanted. . . . They wanted to know how many cultivable acres a band possessed and how many were actually being cultivated . . . [they wanted] firm quantitative information."[43] This kind of standardization process made the geographic information stable and combinable, so that it could be shared across space. Canadian reserve agencies constructed maps so that British Columbia could be located within colonial space, and numbers were used to keep track of populations, allocate land, and "enable a bureaucracy, essentially without local knowledge, to make decisions about localities" from afar by using technologies of distance.[44] Kirsch and Harris reflect Latour's view that "those who sit inside [bureaucratic or scientific centers] may combine, shuffle around, superimpose and recalculate figures and end up with a 'gross national product'. . . or [the layout of an island], 'the taxonomy of mammals', 'proven oil reserves' or a new planetary system."[45]

Centers of calculation maintained the stability of the materials collected and inscriptions created "so that they [could] be moved back and forth [between the center and periphery] without additional distortion, corruption or decay."[46] Specimens such as plants, animals, bones, North American Indian medicine bundles, shields, weapons, housing, clothing, maps, and GIS data needed to be stabilized so that the centers of calculation could produce more maps, digital geographic information, and knowledge about the periphery. Thus the movement and stability of newly acquired information required central control in order to standardize and send data where it was needed.

In order to extend networks, maps and geographic information had to be standardized so that they could combine. Centers combined past and present materials and made maps, database layers, tables, and charts. Once the scientists and technicians standardized their materials through the use of scientific map projections, coordinate systems, recognizable cartographic symbols, attribute tables, and computer software packages, the information and knowledge produced by anthropologists, geographers, geologists, or biologists could be combined with seemingly distant entities such as economic institutions, missionary organizations, academic institutions, and corporations.[47]

Technologies such as GIS do not merely diffuse from one location to another. Rather, technologies are translated through a series of negotiations and agreements such as making technical assistance, training, and software available to dependent users. When extending networks, actors must be enlisted and convinced that their goals and interests aligned with those of scientists and their laboratories.[48] Translations are the goals, objectives, and interests that pass between actors and make data, software, hardware, and ideas flow. To succeed in making networks strong and durable, actors select only the people, places, and materials that help them reach their goals. For example, a scientist attempting to perform a translation might say, "You have a problem that I can solve, but you have to follow my instructions and guidelines precisely." Technical specialists, scientists, engineers, and others "speak in the name of new allies that they have shaped and enrolled; representatives among other representatives, they add these unexpected resources to tip the balance of the force in their favor."[49] Statements such as these exist in texts, technical manuals, training modules, project guidelines, roundtable discussions, conference proceedings, newsletters, embodied skills, and countless other materials.[50] Translation is the process of making two different actors equivalent in an actor-network.[51]

In summary, the Latourian concept of centers of calculation includes cycles of accumulation, mobility, stability, combinability, and further extension of networks. The BIA represented a cartographic and GIS center of calculation within Indian country. Because the bureau has such an impact on tribal government GIS, a study of the agency's archives was in order.

Data Sources

Primary and secondary sources for this research exist at the GDSC in Lakewood, Colorado, the National Archives, and university libraries. Primary sources include the BIA quarterly technical reports (1986–2005), the database organization guidelines, BIA enterprise software distribution records, and help-desk database records collected between May 2004 and September 2005. These primary sources provided summaries of GIS development activities including many of the people, organizations, technical artifacts, and maps involved in the construction of GIS and the geography of GIS implementation throughout Indian country. Unfortunately, BIA technical reports did not exist outside of the agency and could only be obtained directly from the bureau. The software distribution records and help-desk information have not been released to the public. Outside of the bureau, secondary source documents reside at the National Archives Southwest Division in Fort Worth, Texas (Record Group 75) and the Government Documents Department at the University of Oklahoma library.

This was the first time an outside researcher examined archival documents at the BIA GIS center, revealing details on the implementation of GIS and the flow of materials and information out of the agency. However, it must be noted that several quarterly technical reports were missing at the time of research. The most complete set of quarterly technical reports exists for the years 1988 through 1994. An incomplete set of quarterly technical reports exists for the years 1995 through 2005. However, other textual documents, such as the help-desk database records for the years 1998 and 2005 and the enterprise licensing agreement database for the years from 2002 to 2005, are included in the analysis on the flow of commercial GIS to tribal governments offices. Although the agency holds an incomplete archive, the documents reveal much about the technical aspects of the center. The database documents represent the most concrete evidence for actual cartographic encounters between the BIA and individual tribal governments. Missing from the quarterly technical reports were correspondence letters, negotiation workshops, and dialogues between individual tribal governments and the BIA. Because of historical events, many American Indians remained deeply suspicious of the BIA, and likewise the agency was often suspicious of American Indians.[52] In the paragraphs to follow, I will detail one cartographic encounter between the BIA and Indian country.

Encountering the Bureau of Indian Affairs Center of Calculation

The BIA was one of the early adopters of GIS within the US Department of the Interior (DOI). According to one BIA source, in 1975 at the Portland, Oregon area office, development began to address forest management projects.[53] Bureau officials had a high interest in the development and production of timber resources on American Indian reservations.[54] As with past cartographic encounters, the BIA archived materials by incorporating and assimilating American Indian land and resources into its technical processes, without acknowledging any exchanges with indigenous people in BIA documents. The BIA conducted a pilot study on GIS and began implementing what was called the Indian Integrated Resource Information Program (IIRIP) in 1983. A collaboration among the Department of the Interior agencies, private consulting firms, and an interagency network, this program involved the installation of computer hardware and software infrastructure, establishment of GIS expertise within the BIA, and creation of a geospatial database.[55]

For the BIA, stability meant being able to move geographic information, computer hardware, GIS software, and technical information throughout the network without fear of distortion or corruption.[56] One of the first tasks included connecting the BIA with several BIA field offices through a network of computer hardware and software (see fig. 1). Expert, command-driven machines made up the early computer hardware, which created data access difficulties for some tribal governments.[57] Diligent bureau technicians toiled with the hardware to create a functional network that could successfully mobilize digital data. During the early implementation phase, computer hardware changed rapidly and was often difficult to maintain. Equally daunting was the use and maintenance of early GIS software.

Archival documents revealed that the Map Overlay and Statistical System (MOSS) was the first GIS software that the BIA used. Implementation of the noncommercial GIS software occurred during the late 1980s at the BIA and its field offices in Albuquerque, New Mexico; Billings, Montana; Portland, Oregon; Fort Apache, Arizona; San Carlos, Arizona; and Mescalero, New Mexico.[58] Even though the BIA extended far out into Indian country, there was no archival evidence denoting that tribal governments or their personnel aided in the construction and development of GIS at the BIA center. Rather,

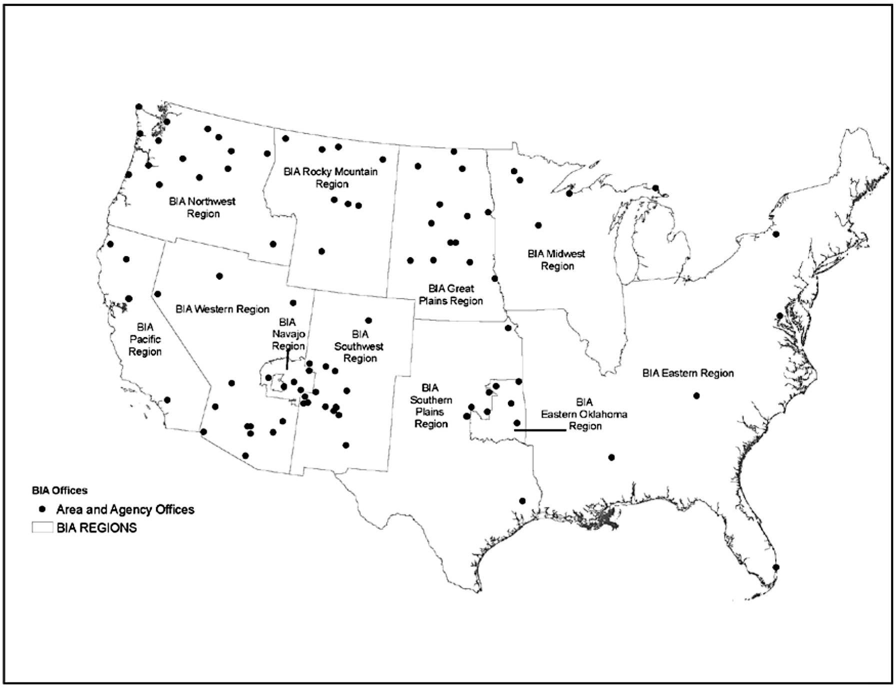

Figure 1. *Map showing the location of each BIA field office and jurisdictional region.* Data Source: *BIA Geographic Data Service Center Quarterly Reports (Lakewood, CO, 1992).*

the BIA collaborated with the US Fish and Wildlife Service (USFWS), the USGS, the Bureau of Land Management (BLM), and a private technical consulting firm called Technicolor Government Services (TGS). These natural resource management agencies assisted the bureau in developing its initial GIS capabilities. Mobilization of these institutions into a network consisting of computer hardware and software gave the digital center an advantage over the manual periphery. Big plans existed for the centralization of a standard GIS software package within the DOI. The BLM and the USFWS had the ambition of implementing MOSS across the DOI.[59] Although the BIA and other DOI agencies initially invested in MOSS, its stability came under question.

The real or perceived instability of MOSS concerned the BIA. By 1988 and 1989, the BIA began to take full control of what it referred to as an in-house GIS, while the other DOI agencies only provided data.[60] But MOSS was not a part of its plans: "The policies of this office [Geographic Data Service Center] regarding these activities are driven by the fact that there are limited resources available for support to GIS users in the BIA [driven by the need for a technical support network that was inadequately unstable in relation to

MOSS]. Consequently, extensive effort in the area of MOSS support is not planned."[61] MOSS software and supporting computer hardware had limited functionality. For instance, "Because MOSS was designed with a specific application in mind, enhancements to the overall package [were] limited."[62] Another limitation was MOSS reliance upon specific computer hardware, meaning that "transportability of this software to more modern computer hardware technology [proved] to be a substantial task."[63] The BIA perceived MOSS to be unstable and immobile. This perception of MOSS's limitations extended out to BIA field office personnel, who also found it difficult to contend with the software.

Lack of technical assistance presented major issues pertaining to connectivity with other agencies in Indian country. For example, one BIA manager described the BIA GIS programs as extremely sophisticated but lacking in analytical power. Furthermore, the manager felt his expertise at using Mylar overlays (a manual spatial analysis technique) was sufficient for addressing the region's natural resource applications. Added to this concern was the fact that MOSS was difficult to operate. It was GIS software very specific to the DOI and was programmed by using complex computer language. This prevented wide usage of the software among BIA field offices. Lastly, the BIA manager was told that his skills were not good enough to run the program at his agency office, and so all the office's applications remained on computers at the BIA GIS center.[64] Beyond the issue of interagency connectivity, control was also an issue among federal agencies using MOSS.

The BIA's reliance upon outsourced technicians disrupted the DOI division of cartographic labor. This was evident in memos regarding the job performance of BIA commercial technical assistants. In the following passages, a reverse form of paternalism was directed at the BIA by the BLM.

> BLM: I personally feel [the commercial technical firm] has been seriously over-estimating, and over-charging as well . . . [BIA Manager] reviewed all work going to [the commercial technical firm] and resulting estimates. I don't know [BIA Manager] or his background, but I hope he has the digitizing experience to evaluate these estimates to make sure they are in line. I personally feel [the commercial technical firm] has taken advantage of this contract to legally bill for items not necessary and charge excessive hours. Part of the problem has been inexperienced state coordinators and attitude priorities that concern getting work done rather that cost-effectiveness.[65]

The BIA GIS center responded to this memo:

> BIA: [The BIA Manager] has almost three years experience in management of database construction projects with three data entry vendors. . . . BIA considers him to be totally qualified to manage data entry projects. . . . This situation is quite

disconcerting and raises questions about accounting procedures being utilized. . . . BIA does not track BLM account codes. In fact, we are not provided the accounting codes which have been assigned by BLM to BIA projects.[66]

BIA: Considering that BIA has funded BLM to manage this function under the BLM data entry contract, it is incumbent on BLM to correct their records to accurately reflect project tasks as discussed in your memo . . . it is unfair to [the commercial technical firm] to withhold payment for the submitted invoices reflecting a balance of approximately $50,000 due from BIA accounts. It is not their fault that BLM failed to maintain proper accounting records.[67]

BIA: You make several serious allegations against [the commercial technical firm]. Your implication being that [the commercial technical firm] is dealing with the government in a fraudulent manner. This is a serious accusation, indeed, and BIA assumes that you have the documented evidence to defend this libelous statement. BIA's experience with [the commercial technical firm] in no way supports your allegations. In addition, BIA disassociates itself from past and former charges with respect to any such accusations.[68]

BLM restated its position as the cartographic center for the DOI and the nation: "Besides accountability of the contract billings, I'm also responsible for monitoring and advising on the digitizing work of the contract. I don't pretend to be an expert, but as [a new manager] for the . . . [BLM] . . . I feel I can offer some assistance on some of the digital projects you encounter."[69]

The BIA did not accept the BLM as the only geographic information center of calculation for the DOI. Rather, it saw the attention of the BLM as a direct attack upon its emerging network and the bureaucratic structure of the agency. The implementation of GIS "upset well-defined task relationships and lines of responsibilities."[70] TGS technical specialists held the network together through the construction of an elaborate network of hardware and software that connected one remote site to another. Without TGS, no work would have been accomplished. The allegations leveled by the BLM and the rebuttals by the BIA further weakened the MOSS network, but they strengthened the BIA GIS network; the bureau achieved some level of independence by implementing a stable, commercially available software package.

By the late 1980s, the BIA enrolled in a newly emerging corporate GIS network emanating from the Environmental Systems Research Institute (ESRI). As a small nonprofit company, ESRI focused on developing business relationships with government organizations, mainly through natural resource management applications. Because many government organizations lacked expertise in the areas of computer technology and GIS, ESRI filled the void. Its software package, ARC/INFO, was extremely successful because of its ability to run on a variety of computer platforms.[71] The success of the company was also attributed to "the forging of close links with users in education and other sectors."[72] ESRI's early strategy for selling its products "was a matter of pressing GIS solutions on unaware and unwilling potential users, involving constant selling and subsequent support."[73] ESRI's ARC/INFO software was compatible with the BIA hardware network, and, most importantly, ESRI provided the BIA with much-needed technical assistance to implement the software and develop GIS applications that would affect Indian country. ESRI worked closely with the agency and promised to support the development of GIS to be compatible with the BIA hardware network in 1988.[74]

To summarize, the BIA practiced self-determination through the outsourcing of technical assistance and the acquisition of commercial software. American Indian tribal governments and personnel did not contribute to early development efforts. Implementation of GIS transformed the BIA into a creator of geographic information similar to the BLM and USGS. Its new role as a mapmaker upset the division of labor within the DOI but empowered the BIA. Armed with a cadre of outsourced technicians, the BIA joined forces with a stronger commercial GIS network and developed a partial nationwide geospatial database.

Cycle of Accumulation

The quarterly technical reports (1988–92) revealed that development of the BIA Nationwide Database (BND) represented another cycle of accumulating geographic information on American Indian land. Unlike past cartographic encounters and cycles of accumulation, the BIA did not have to invest heavily in fieldwork. During this recent cartographic encounter with Indian country, computerization offered other solutions such as accessing data by using existing paper maps and geographic information. Thousands of topographic maps served as base maps for the massive database project and reflected the modern scientific values of precision, completeness, and cost-effectiveness.[75] At the BIA, thousands of topographic maps hung in a stable, centralized, secured computer storage room. The room also held several computer server towers, long desks, and map cabinets. Outside of the air-conditioned storage room, dozens of technicians digitized features off the maps and digitally stitched their work together using high-powered computers and GIS software, thus making GIS more stable and durable.[76] Hidden under the rationalized exterior of scientific management practices was the reality of having to digitize Indian country seamlessly into a database in order to service agency field offices and, later, tribal governments.

However, the BND was geographically uneven, pointing to regions of greatest interest. Documents revealed that the BIA accumulated significant

Figure 2. *GIS data development per BIA region from 1988 through 1992.* Data Source: *BIA Geographic Data Service Center Quarterly Reports (Lakewood, CO).*

amounts of data for some regions and less for others. The number of tribal governments located within each region had an impact on the amount of data produced, but this was not always the case. Technicians at the BIA accumulated the most geographic information on the Southwest, Northwest, and the Western regions. They accumulated a moderate amount of geographic information on the Midwest, Rocky Mountain, Great Plains, and Pacific regions. But very little geographic information existed in the database for the BIA Eastern, Southern Plains, and Eastern Oklahoma regions (see fig. 2).[77] James C. Scott argued that modernization projects "did not successfully represent the actual activity of the society they depicted, nor were they intended to; they represented only that slice of it that interested the official observer."[78] National partiality extended to the database content as well.

The BIA accumulated only a partial natural resource inventory of Indian country. As mentioned before, most of the geographic information accumulated by the BIA consisted of features digitized from existing topographic maps. Bureau technicians classified topographic features as base themes that included buildings, camp grounds, streams, lakes, ponds, and reservoirs, springs, tanks, and wells, pipelines and transmission lines, land status, other agency management, public land survey, reservation boundaries, county boundaries, state boundaries, roads, and transportation (see fig. 3). Timber management and range management layers also made up a good amount of geographic information in the database. The BIA focused development of timber data on the Southwest, Rocky Mountain, and Northwest regions (fig. 4). However, one assessment of forest management found deficiencies: "the level and sophistication of resource information management [at the BIA] appears to be trailing substantially behind that of other governmental organizations. Databases, including GIS layers, that would typically be available to stakeholders on-line, are generally not available for Indian forestlands."[79]

The BIA forest and timber data were uneven in that peripheral regions had only minor forest and timber data development. Because of the importance of agriculture and grazing leases on Indian land, range management data existed for the majority of regions, with the exception of California, Oklahoma, and the eastern United States (see fig. 5). Other GIS data included digitized maps featuring buildings and settlements, geology, energy, water resources, infrastructure, transportation, and fish and wildlife.[80] Finally, the BIA did not accumulate sensitive or proprietary tribal information such as sacred sites, vegetation gathering sites, traditional medicine sites, hunting trails, or ancient ruins. Mark Monmonier wrote that "the national mapping organization willingly sacrifices political, ethnic, and physical boundaries . . . [making] complete coverage seem both doable and essential."[81]

Considering that the BND was a nationwide project, it was assumed that all American Indian reservations received complete GIS coverage. This was not the case. Instead, the accumulation of information was geographically uneven, consisting primarily of basic topographic map features. A decrease in funding eliminated many data-entry personnel positions. Over time, the BIA extended its networks farther out to tribal government offices by providing free technical assistance, training, and commercial GIS software; these were methods for tying all allies together and extending GIS networks further into Indian country. Tribal governments depended upon the technical expertise of the BIA to stabilize their own systems. Others connected with the network for the first time by accepting free GIS software from the bureau.

Extending Geographic Information System Networks

During the 1990s, tribal governments had limited access to the bureau's centralized resources while needing cartographic assistance and encountering problems with GIS software. BIA technicians often translated the underdevelopment of GIS as an access problem on the periphery. For example,

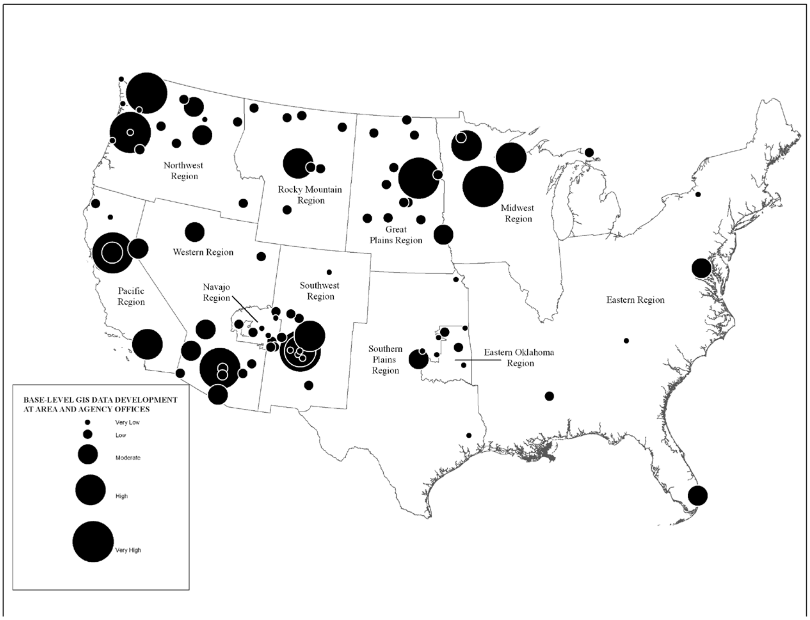

Figure 3. *Map showing the geography of base-level geographic information development per BIA region.* Data Source: *BIA Geographic Data Service Center Quarterly Reports (Lakewood, CO, 1992).*

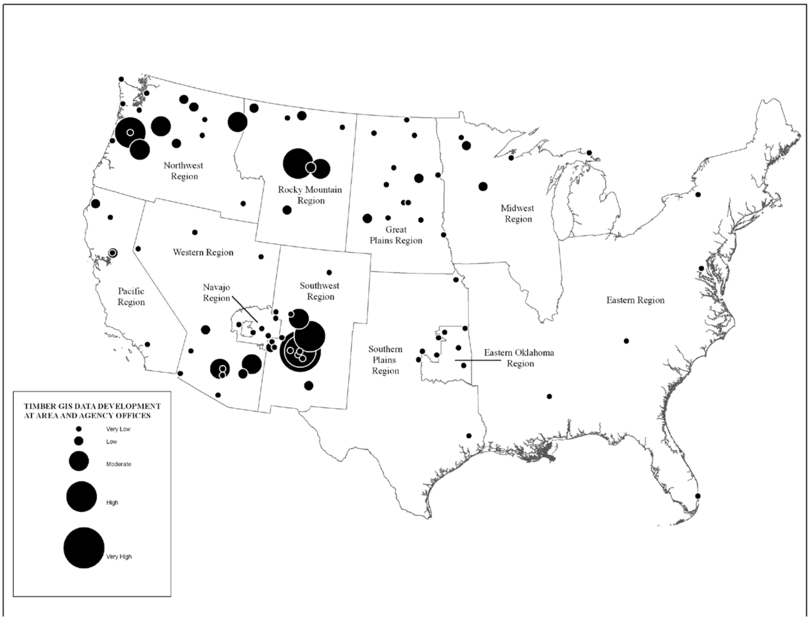

Figure 4. *Map showing the geography of timber management data development per BIA region.* Data Source: *BIA Geographic Data Service Center Quarterly Reports (Lakewood, CO, 1992).*

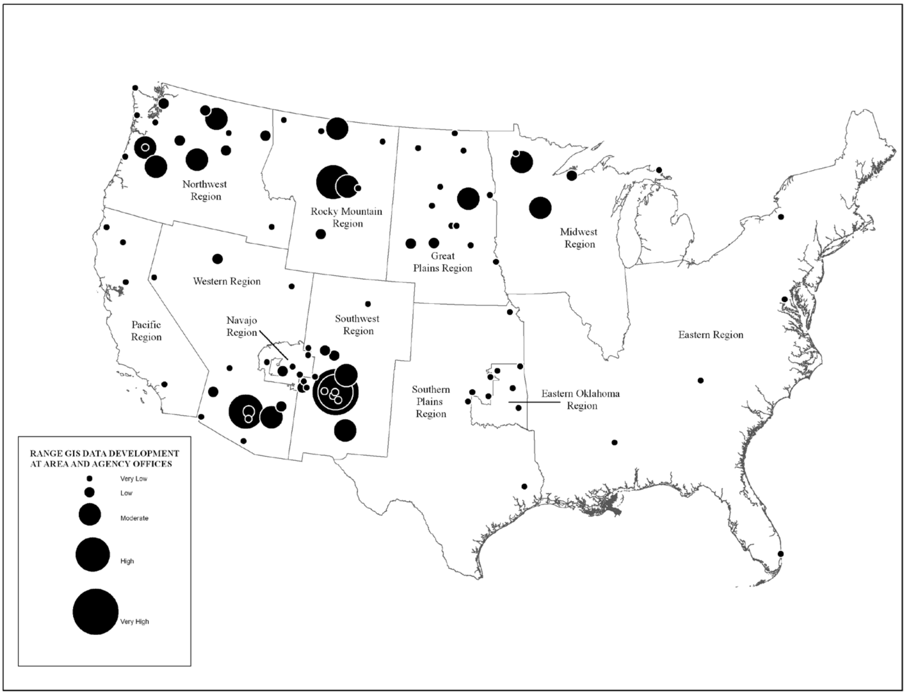

Figure 5. *Map showing the geography of range management data development per BIA region.* Data Source: *BIA Geographic Data Service Center Quarterly Reports (Lakewood, CO, 1992).*

access to the database was extremely difficult for some tribal government offices because they had poor telephone services and their access to powerful personal computers was limited.[82] The Hoopa Valley tribal government had a difficult time downloading data from the BIA geospatial database and ended up using sixty-four floppy discs that took sixteen hours to download. The agency saw this method of retrieving data as inefficient and time-consuming.[83] In a related issue, the Red Lake tribal office apparently had very poor telecommunications facilities and no method of downloading geospatial data for its own reservation.[84] BIA technicians recognized the poor technical conditions on reservations. However, the BIA was not willing to shape its own system to meet the needs of tribal governments because the cost of developing individual tribal systems was too expensive.[85]

Between 1991 and 1995, several tribal governments and organizations sought cartographic assistance from BIA technicians. For example, the BIA assisted in the design and production of land-status maps, timber maps, base maps, national Indian land maps, land cover and landownership maps, and soil maps.[86] Tribal governments needed good maps and data for their land bases but lacked the data and tools necessary to develop them. This translated to BIA managers who agreed that tribes needed to digitize their own land allotments, environmental data, land-use maps, and cultural sites.[87] Mapmaking was potentially the highest priority among tribal governments in the United States. This made sense considering that tribal offices first needed data and maps before they could develop their own applications and analytical models. Over time, more and more tribal governments sought assistance on how to use GIS software. This represented a major step in harnessing the analytical power of the technology and the ability to create stable data.

Many tribal governments requested technical assistance regarding the use of GIS software. Seven years of data (1997–2004) revealed that the majority of technical assistance requests came from the Navajo, Coeur d'Alene, Cheyenne River Sioux, Nez Perce, and Cherokee Tribe of Oklahoma.[88] Active engagement with technical personnel at the BIA indicated that these tribes took advantage of the free technical services and conducted GIS activities associated with federal agency grants. For example, the Coeur d'Alene government worked on a nationwide American Indian place-name project funded by the USGS.[89] In Fort Defiance, Arizona a vibrant GIS utility program operated at the Navajo tribal offices. The Cherokees developed a very active GIS program that included an environmental agency that mapped Indian land allotments for the Environmental Protection Agency (EPA) during the late 1990s.[90]

GIS training also attracted a significant number of tribal governments during the 1990s and early 2000s. The BIA reported that "course manuals, documentation, and classroom presentation materials have been developed [by the BIA] for BIA and tribal GIS applications."[91] Several basic GIS training courses attracted BIA field personnel as well as personnel from tribal governments. However, by the mid-1990s, the bureau shifted from specialized GIS training modules to "canned" ESRI courses. The diffusion of canned training modules required authorization and endorsement of instructors by the ESRI: "one [BIA] staff member is an authorized ESRI instructor for both Introduction to ArcView GIS and Working with ArcView Spatial Analyst training classes. Consequently, the GDSC provides authorized ESRI course manuals, documentation and classroom presentation materials to students attending these classes."[92] Nancy Obermeyer and Jeffery Pinto write that "an important source of the bureaucracy's power [was] professionalism," and the establishment of a certification process.[93] This allowed the BIA to leverage with the ESRI in order to improve its professional standing among tribal governments. By 2004, the BIA spoke for all of its allies when the agency announced it was responsible for the establishment and promulgation of policies, procedures, standards, and goals for all spatial data technologies and applications throughout Indian country.[94] This position could be interpreted as the total incorporation and assimilation of Indian country into the BIA technical system. Not only was the center an obligatory component of tribal GIS, but also further commercialization of GIS at the BIA—through corporate technical assistance, training materials, and, markedly, the distribution of free software products to tribal governments—strengthened the position of the ESRI in Indian country.

The BIA extended its network farthest through the distribution of free commercial GIS software to tribal governments. During the 1990s, a total of thirty-seven tribes worked directly with the BIA in order to develop GIS applications; only thirteen developed applications on their own.[95] By 2005, the ESRI GIS software network included more than 230 tribal governments and organizations located within all of the BIA regions. Primary tribal government offices using GIS included natural resource management, environmental protection, government administration, planning, and cultural programs.[96] The data in table 1 show that natural resource management was a priority among tribal governments in Indian country. Many of these departments included natural resource management, forestry, range management, water resources, mineral resources, and irrigation, to name only a few. Tribal environmental programs actively engaged with GIS. Tribal administration departments also made up a good portion of the tribal offices participating in the GIS network. Tribal administration departments in the Alaska, Eastern, Midwest, Northwest, Pacific, Southern Plains, and Western regions acquired GIS software from the BIA. The category administration referred to the fact that an Enterprise GIS is the method by which managers and users of geospatial data can share that information to enable effective intra-organization collaboration. An Enterprise GIS will enable both BIA and Tribal offices to have access to high quality geospatial data pertaining to Indian country.[97]

It was unclear how much the EPA aided in the development of GIS, but it was known that the agency did distribute software to the tribes like the BIA. This evidence suggests that GIS was being used as a tool to supplement larger and stronger tribal government networks and was not a standalone technology. Employees within tribal governments performed duties in different departments simultaneously.[98] In many cases, environmental managers were also GIS specialists, surveyors, and cartographers. The technology that was supposed to help tribal governments integrate into the nation's natural resource management program created more work for employees.

The quarterly technical reports indicated that tribal governments depended upon the BIA for accessibility, cartographic production, and help with ESRI software. The GIS networks that passed through the BIA not only shaped the agency but also initiated the enrollment of many tribal governments. Furthermore, the number of tribal governments that received standardized

TABLE 1
DISTRIBUTION OF GIS TO TRIBAL GOVERNMENT OFFICES

BIA REGION	GIS Dept.	Natural Resources	Environmental	Admin.	Planning	Cultural Programs
Alaska	.08	.22	.11	.43	.16	0
Eastern	0	.38	.10	.28	.24	0
Eastern OK	.06	.10	.38	.22	.12	.12
Great Plains	0	.27	.21	.11	.30	.03
Midwest	.04	.28	.10	.30	.24	.04
Northwest	.08	.40	.09	.27	.11	.05
Pacific	.02	.14	.37	.30	.17	0
Rocky Mt.	.08	.45	.17	.04	.22	.04
So. Plains	0	0	.43	.33	.18	.06
Southwest	.04	.39	.09	.17	.29	.02
Western	0	.10	.44	.20	.24	.02
MEAN	**.04**	**.25**	**.23**	**.24**	**.21**	**.03**

Source: United States Bureau of Indian Affairs, *Blanket Purchase Orders by Region* (Unpublished Database Document, Lakewood, CO), 2005.

technical assistance, training, and GIS software increased dramatically from 1998 to 2005. Technical assistance and training aided tribal governments in becoming more familiar with geospatial technologies. However, many tribal government managers in Oklahoma viewed ESRI canned training modules as being too general, with too much information to digest during workshops.[99]

CONCLUSION

Technicians at the BIA did build a successful network and geospatial database for many of the bureau's field offices, employing independent operations, creating quality data, and assimilating commercially available geospatial technologies. BIA technicians maintained a functional federal government system for approximately thirty years. Yet USGS topographic maps served as the foundation for much of the BIA geospatial database. Perhaps more effort should have been put into creating unique natural resource data instead of replicating in the form of digital line graphics what the USGS already had constructed. Technical assistance, training, and GIS software distribution effectively reached many tribal government personnel interested in adopting geospatial technologies. However, one of the obligations of the BIA was the promotion of self-determination among American Indian tribal governments. Within the context of self-determination, centralized development of technological capabilities and control of natural resource applications was problematic. Furthermore, top-down GIS and the hidden technocracies within bureaucratic organizations was a major obstacle to be overcome, not only among American Indian tribal governments but also in many organizations that implemented the technology during the 1980s and 1990s.[100]

The lack of participation by American Indians in BIA development projects was a continuation of past paternalistic processes. During the era of Indian self-determination, progress should have been measured by how much American Indians participated in government decision-making policies, such as an Indian integrated system or nationwide database. Federal policies such as the National Environmental Policy Act called for public participation in terms of environmental planning and decision-making activities. Furthermore, the DOI's Integrated Resource Management Plan required that American Indian tribal governments and communities participate in plan development. The BIA could have focused solely on the development of GIS within tribal governments. Yet the trajectory of GIS development was almost entirely controlled by the bureau. Furthermore, the geospatial database development was not for American Indian people, tribal governments, or community organizations. Rather, the database met the interagency geospatial needs of the BIA. Outsourced technical specialists, data-entry technicians, and BIA personnel constructed GIS content for Indian country. None of the evidence suggests that tribal governments, elder groups, or community organizations actively participated in the technical construction of GIS at the bureau. Paternalistic development deviated from public participation models and the Indian Self-Determination and Education Act.

The BIA constructed geographic data and classification procedures that again limited the diversity of the landscape throughout Indian country. The collection of materials and people networked inside the centers allowed other people and places on the periphery to be shaped. Bureau technicians accumulated what Latour refers to as "traces" to make Indian country "familiar, finite, nearby, and handy."[101] As with past cartographic encounters, the localized particulars of indigenous knowledge and language were omitted from the BIA maps. The agency used only what was perceived as standardized, scientific geographic information.

The uneven development of GIS at the BIA represents a colonial cartographic encounter, supporting some of the arguments put forward by Lewis and other historians of cartography. The BIA maintained a binary between the federal government and among American Indian tribal areas, through uneven representation of Indian country by the BIA Nationwide Database. Uneven development of GIS was not an inevitable or natural process. It was constructed by the hegemonic federal government system through regulations, funding, and technology distribution. Allotment areas continued to be marginalized in relation to GIS development. The impacts and legacy of federal allotment policy continued to haunt many areas of Indian country. Furthermore, the one-way flow of technology, expertise, education, and data from the technological center to the underdeveloped periphery was not progressive. Rather, one-way flow from the center was paternalistic and a reflection of previous cartographic encounters in Indian country.

The free distribution of GIS software products was not progressive. These freely available products kept tribal governments dependent upon external groups for assistance, training, and education. The free distribution of software maintained the networks of dependency. Maintaining GIS networks at the BIA was expensive and technically difficult to operate as more tribal governments requested software, leading to more requests for technical assistance and training. Other federal government agencies encouraged the implementation of commercial GIS software within American Indian tribal governments for gathering environmental data in the ever-increasing environment of privatization in the United States. As Obermeyer argues, "The decentralization of GIS [hardware and software] masks the centralization of geographic modeling programming and the potential problems that may arise. . . . [O]rganizations implementing GIS readily may get the impression that they have greater control over their work than they actually have."[102]

These findings identified regions within Indian country that had significant contact with GIS, ESRI, and the federal government throughout the past twenty years. Many tribal governments on the so-called GIS periphery have only recently begun acquiring and incorporating GIS into their governmental functions. What factors accelerated or inhibited the adoption of GIS by American Indian tribal governments? A future study might begin by comparing and contrasting development within tribal governments that reside in the core GIS regions. Who owns American Indian geographic knowledge? When a tribal government successfully receives a grant from a federal agency, data is recorded, stored, and manipulated within GIS. Who within the tribe is consulted? Who owns the so-called cultural intellectual property, who are the spokespersons, and how might incorporating such knowledge into GIS lead to patenting, piracy, and loss of control outside the tribe? Such a study must include not only tribal government officials but also members of American Indian communities. In the end, studies of tribal GIS should yield much information on the cultural production of GIS in Indian country.

Notes

1. G. Malcolm Lewis, *Cartographic Encounters: Perspectives on Native American Mapmaking and Map Use* (Chicago: University of Chicago Press, 1998).

2. Ibid., 23.

3. Richard I. Ruggles, *A Country So Interesting: The Hudson's Bay Company and Two Centuries of Mapping, 1670–1870* (Montreal: McGill-Queen's University Press, 1991).

4. Gary E. Moulton, *The Journals of the Lewis and Clark Expedition*, vol. 1, *Atlas of the Lewis and Clark Expedition* (Lincoln: University of Nebraska Press, 1983).

5. Lewis, *Cartographic Encounters*, 24.

6. Ibid.

7. Ibid., 26.

8. James F. Ronda, "'A Chart in His Way': Indian Cartography and the Lewis and Clark Expedition," in *Mapping the North American Plains*, ed. Frederick C. Luebke, Frances W. Kaye, and Gary E. Moulton (Norman: University of Oklahoma Press with the Center for Great Plains Studies, University of Nebraska–Lincoln, 1987), 81–91.

9. Ibid.

10. Ibid.; Mark Palmer, "Cut From the Same Cloth: The United States Bureau of Indian Affairs, Geographic Information Systems, and Cultural Assimilation," in *Information Technology and Indigenous People*, ed. L. E. Dyson, M. Hendriks, and S. Grant (Hershey, PA: Information Science Publishing, 2007), 220–31.

11. Lewis, *Cartographic Encounters*, 34.

12. Melinda Laituri, "Indigenous Peoples' Issues and Indigenous Uses of GIS," in *The SAGE Handbook of GIS and Society*, ed. T. L. Nyerges, H. Couclelis, and R. McMaster (Los Angeles: Sage Publications, 2011), 202–21; Mac Chapin, Zachary Lamb, and Bill Threlkeld, "Mapping Indigenous Lands," *The Annual Review of Anthropology* 34 (2005): 619–38.

13. Chapin, Lamb, and Threlkeld, "Mapping Indigenous Lands"; Martin Weinstein, *What the Land Provides: An Examination of the Fort George Subsistence Economy and the Possible Consequences on It of the James Bay Hydroelectric Project: Report of the Fort George Resource Use and Subsistence Economy Study* (Montreal: Grand Council of the Crees [of Quebec], 1976); Peter J. Usher, "Northern Development, Impact Assessment, and Social Change," in *Anthropology, Public Policy, and Native Peoples in Canada*, ed. N. Dyck, and J. B. Waldram (Montreal: McGill-Queen's University Press, 1993), 98–130; J. Sonnenfeld, "Changes in Subsistence among Barrow Eskimo," *Project No. ONR-140* (Calgary, AB: Arctic Institute of North America, 1956).

14. F. Berkes, A. Hughes, P. J. George, R. J. Preston, B. D. Cummins, and J. Turner, "The Persistence of Aboriginal Land Use: Fish and Wildlife Harvest Areas in the Hudson and James Bay Lowland, Ontario," *Arctic* 48 (1995): 81–95; Peter J. Usher, Frank Tough, and Robert Galois, "Reclaiming the Land: Aboriginal Title, Treaty Rights and Land Claims in Canada," *Applied Geography* 12 (1992): 109–32; Martin Weinstein, *Aboriginal Land Use and Occupancy Studies in Canada: A Paper Prepared for the Workshop on Spatial Aspects of Social Forestry Systems* (Honolulu and Chiang Mai, Thailand: East-West Center, Chiang Mai University, and Ford Foundation, 1993).

15. Lewis, *Cartographic Encounters*, 97.

16. Chapin, Lamb, and Threlkeld, "Mapping Indigenous Lands."

17. Mark Palmer, "Engaging with Indigital Geographic Information Networks," *Futures* 41, no.1 (2009): 33–40; Chapin, Lamb, and Threlkeld, "Mapping Indigenous Lands"; Robert Rundstrom, Douglas Deur, Kate Berry, and Richard Winchell, "Recent Geographical Research on Indians and Inuit in the United States and Canada," *American Indian Culture and Research Journal* 24, no. 2 (2000): 85–110; M. Marchand and Richard Winchell, "Tribal Implementation of GIS: A Case

Study of Planning Applications with the Colville Confederated Tribes," *American Indian Culture and Research Journal* 16, no. 4 (1992): 175–83.

18. Palmer, "Engaging with Indigital." "Indian country" means (a) all land within the limits of any Indian reservation under the jurisdiction of the US government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation; (b) all dependent Indian communities within the borders of the US whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state; and (c) all Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same.

19. Dan Cole, "One Cartographic View of American Indian Land Areas," *Cartographica* 30, no. 1 (1993): 47–54.

20. Lewis, *Cartographic Encounters*, 33–34.

21. Chapin, Lamb, and Threlkeld, "Mapping Indigenous Lands," 622.

22. David D. Greenlee and Stephen C. Guptill, "GIS Development in the Department of Interior," in *The History of Geographic Information Systems: Perspectives from the Pioneers*, ed. T. W. Foresman (Upper Saddle River, NJ: Prentice Hall, 1998), 181–98.

23. Palmer, "Cut from the Same Cloth," 225–26.

24. Robert Rundstrom, "GIS, Indigenous Peoples, and Epistemological Diversity," *Cartography and Geographic Information Systems* 22 (1995): 45–57.

25. Palmer, "Engaging with Indigital," 35.

26. Bryan A. Marozas, "A Culturally Relevant Solution for the Implementation of Geographic Information Systems in Indian Country," *Geography Organizing Our World: Proceedings of the Thirteenth Annual ESRI User Conference*, vol. 1 (1993): 365–81.

27. Rundstrom, Deur, and Berry, "Recent Research," 97.

28. Marozas, "A Culturally Relevant Solution," 368–69.

29. Marchand and Winchell, "Tribal Implementation of GIS," 177–80.

30. S. I. Adams, "GIS on the Rez: A Case Study of GIS Implementation on the Colville Indian Reservation" (master's thesis, University of Washington, 1999).

31. Crystal Bond, "The Cherokee Nation and Tribal Uses of GIS," in *Community Participation and Geographic Information Systems*, ed. C. Will, T. Harris, and D. Weiner (London: Taylor and Francis, 2002), 283–94.

32. Bryan A. Marozas, "The Role of Geographic Information Systems in American Indian Land and Water Rights Litigation," *American Indian Culture and Research Journal* 15, no. 3 (1991): 77–93; Frank Duerden, "GIS and Land Selection for Native Claims," *The Operational Geographer* 10, no. 4 (1992): 11–14; Laura Smith, "Indigenous Geography, GIS, and Land-Use Planning on the Bois Forte Reservation," *American Indian Culture and Research Journal* 32, no. 3 (2008): 139–52.

33. Mark Warhus, *Another America: Native American Maps and the History of our Land* (New York: St. Martin's Press, 1997).

34. W. P. Dizzard, "Border Analyses by GIS Could Untangle Indian Trust Fund Assets," *Government Computer News* 22, no. 7 (2003): 1.

35. Nancy Sappington, David Gadsden, Anne Taylor, and Christopher Thomas, eds., *Tribal GIS: Supporting Native American Policies with GIS* (Redlands, CA: ESRI, 2008).

36. Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987).

37. Ibid.

38. Ibid.

39. Anne Godlewska and Neil Smith, *Geography and Empire* (Oxford: Blackwell Publishing, 1994).

40. Matthew Hannah, "Space and Social Control in the Administration of Oglala Lakota," *Journal of Historical Geography* 19, no. 4 (1993): 412–32.

41. James Mooney, *The Calendar History of the Kiowa Indians* (Washington, DC: Smithsonian Press, 1979).

42. Scott Kirsch, "John Wesley Powell and the Mapping of the Colorado Plateau, 1869–1879: Survey Science, Geographic Solutions, and the Economy of Environmental Values," *Annals of the Association of American Geographers* 93, no. 4 (2002): 645–61.

43. Cole Harris, "How Did Colonialism Dispossess? Comments from an Edge of Empire," *Annals of the Association of American Geographers* 94, no. 1 (2004): 165–82.

44. Ibid., 176.

45. Latour, *Science in Action*, 227.

46. Ibid., 223.

47. Ibid.

48. Jonathan Murdoch, "Inhuman/Non-Human: Actor-Network Theory and the Prospects for a Non-Dualistic and Symmetrical Perspective on Nature and Society," *Environment and Planning D: Society and Space* 15 (1997): 731–56.

49. Latour, *Science in Action*, 259.

50. Michel Callon, "Techno-Economic Networks and Irreversibility," in *A Sociology of Monsters*, ed. J. Law (New York: Routledge Press, 1991), 135–38.

51. Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford; New York: Oxford University Press, 2005), 108.

52. Lilias Jones Jarding, "The Department of the Interior's Appeals Process and Native American Natural Resource Policy, 1970–94," *Policy Studies Journal* 27, no. 2 (1999): 217–41.

53. Marchand and Winchell, "Tribal Implementation of GIS;" Chris English, BIA Natural Resource Manager, Phoenix Agency Office, personal conversation with the author, Intertribal GIS Conference in Tulsa, Oklahoma, March 10, 2005.

54. Mark Palmer and Robert Rundstrom, "Recycling the Past: GIS, the BIA, and the Digitization of Indian Country," unpublished manuscript.

55. US Bureau of Indian Affairs (hereinafter referred to as BIA), *Issue Paper: Indian Integrated Resource Information Program* (Lakewood, CO: Geographic Data Service Center [hereinafter referred to as GDSC], 1988).

56. Latour, *Science in Action*, 223.

57. Palmer, "Engaging with Indigital," 36.

58. Mark Palmer, "Creating Indigital Peripheries: Geographic Information Systems, the Bureau of Indian Affairs, and the Digitization of Indian Country" (PhD diss., University of Oklahoma, 2006).

59. Greenlee and Guptill, "GIS Development," 194.

60. US BIA, Indian Integrated Resource Information Program Interagency Memorandum Issue Paper (Lakewood, CO: Office of Trust and Economic Development, GDSC, 1988). A copy is in author's possession.

61. US BIA, *GIS Program Target Dates* (Lakewood, CO: Office of Trust and Economic Development, GDSC, 13 April 1988), 1.

62. Battelle Corporation, *Final Report on Cost and Benefit Analysis of Geographic Information System Implementation to Bureau of Indian Affairs* (Lakewood, CO: Battelle Corporation, GDSC, 1988), 13.

63. Ibid.

64. I conducted an informal interview with a BIA natural resource manager during the fall of 2005. He revealed some of the difficulties associated with the GDSC geographic information system (hereinafter referred to as GIS) network and technology transfer.

65. US Bureau of Land Management–Contracting Officer Representative (hereinafter referred to as BLM-COR), memorandum regarding data-entry charges, April 7, 1987, from BLM-COR to BIA GDSC (Denver, CO, 1987).

66. US BIA, Invoice Approval for Data Entry Funds, April 20, 1987, Program Coordination and Information Systems (Lakewood, CO, 1987).

67. Ibid.

68. Ibid.

69. This dialogue is found in a memo from the BLM-COR to the BIA GDSC, and a response; BLM-COR, memorandum regarding data entry charges, April 7, 1987.

70. Nancy J. Obermeyer and Jeffrey K. Pinto, *Managing Geographic Information Systems* (New York: Guilford Press, 1994), 71.

71. J. T. Coppock and D. W. Rhind, "The History of GIS," in *Geographic Information Systems: Principles and Applications*, ed. D. J. Maguire, M. F. Goodchild, and D. W. Rhind (London: Longman Publishers, 1991), 32–33.

72. Ibid., 33.

73. Ibid., 32.

74. BIA GDSC director, personal conversation with the author, October 2005.

75. Mark Monmonier, *How to Lie with Maps* (Chicago: University of Chicago Press, 1996), 123.

76. Personal observations by author while conducting research at the BIA GDSC.

77. Explanations for the uneven development and geography of BIA data go beyond the scope of this article but will appear in a future publication.

78. James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998), 3.

79. Indian Forest Management Assessment Team, *An Assessment of Indian Forests and Forest Management in the United States* (Portland, OR: Clear Water Printing, 2003), 13.

80. US BIA, *Fourth Quarter Report* (Lakewood, CO: Office of Trust and Economic Development, GDSC, 1992).

81. Monmonier, *How to Lie with Maps*, 124.

82. J. Guerra, "Data from Indian Affairs GIS helps 200 Tribes Manager Their Land," Government Computer News (Washington, DC: Post-Newsweek Media, 1998) http://gcn.com/articles/1998/07/27/data-from-indian-affairs-gis-helps-200-tribes-manage-their-land.aspx, last accessed 29 December 2011.

83. US BIA, *Fourth Quarter Report* (Lakewood, CO: Office of Trust and Economic Development, GDSC, 1990), 3.

84. US BIA, *Proceedings: 1993 Winter Users Forum* (Lakewood, CO: Office of Trust and Economic Development, GDSC, 1993), 32.

85. Battelle Corporation, "Final Report," 12–72.

86. US BIA, *Fourth Quarter Report* (Lakewood, CO: Office of Trust and Economic Development, GDSC, 1991), 8; US BIA, *Fourth Quarter Report* (Lakewood, CO: Office of Trust Responsibilities, GDSC, 1993), 19, 38; US BIA, *First Quarter Report* (Lakewood, CO: Office of Trust Responsibilities, GDSC, 1994), 13, 17 ; US BIA, *First Quarter Report* (Lakewood, CO: Office of Trust Responsibilities, GDSC, 1995), 19. The BIA created maps for the following groups: Standing Rock Sioux Tribe, Pine Ridge Tribe, Round Valley and Quileute Tribes, and Agua Caliente Band of Cahuilla Indians.

87. Notes from a conversation with BIA personnel at the Southern Plains office.

88. US BIA, *Fourth Quarter Report* (Lakewood, CO: Computer Data Systems, GDSC, 1997); US BIA, *Second Quarter Report* (Lakewood, CO: Affiliated Computer Services, GDSC, 2001); US BIA, *Third Quarter Report* (Lakewood, CO: Affiliated Computer Services, GDSC, 2002); US BIA,

Fourth Quarter Report (Lakewood, CO: Affiliated Computer Services, GDSC, 2003); US BIA, *First Quarter Report* (Lakewood, CO: Lockheed-Martin Technology, GDSC, 2005).

89. The Coeur d'Alene GIS department announced this program through mass e-mails to the indigenous mapping group in 2005 and 2006.

90. A Cherokee environmental officer told me that his office secured funding from the Environmental Protection Agency Region 6 to map Indian land in Oklahoma (2000).

91. US BIA, *Second Quarter Report* (Lakewood, CO: Computer Data Systems, GDSC, 1997), 5.

92. US BIA, *Second Quarter Report*, 2001, 6.

93. Obermeyer and Pinto, *Managing Geographic Information Systems*, 77.

94. US BIA, *GIS User Conference Enterprise GIS*, Dennis Marenger, Technical Program Manager (Lakewood, CO: GDSC, 2004) CD-ROM, Slide 2.

95. Marozas, "A Culturally Relevant Solution," 366.

96. US BIA, *Unpublished Blanket Purchase Orders by Region* (Lakewood, CO: GDSC, 2005): n.p.

97. US BIA, *Fourth Quarter Report* (Lakewood, CO: Affiliated Computer Services, GDSC, 2004), 12.

98. Visits to tribal government offices in Oklahoma; informal discussions with tribal GIS managers at the Indigenous Mapping Network meeting in Tulsa, OK (2005).

99. Personal observations at Oklahoma tribal government offices.

100. Nancy J. Obermeyer, "The Hidden GIS Technocracy," *Cartography and Geographic Information Systems*, 22, no. 1 (1995): 78–83.

101. Latour, *Science in Action*, 230.

102. Obermeyer, "The Hidden GIS Technocracy," 81.