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CREATING *INDIGITAL* PERIPHERIES: THE BUREAU OF INDIAN AFFAIRS, GEOGRAPHIC INFORMATION SYSTEMS, AND THE DIGITIZATION OF INDIAN COUNTRY

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CREATING *INDIGITAL* PERIPHERIES: THE BUREAU OF INDIAN AFFAIRS, GEOGRAPHIC INFORMATION SYSTEMS, AND THE DIGITIZATION OF INDIAN COUNTRY

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF GEOGRAPHY

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For Kristen, Patrick, and Nicolas

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ABSTRACT

The uneven development of GIS as the BIA represents a core-periphery geography. Since the nineteenth century, North American Indians have encountered the implementation of new technologies used to meet the goals and objectives of United States federal Indian policies. The latest technology transfer project involves the implementation of geographic information systems (GIS). The BIA initiated the development of GIS networks at the Geographic Data Service Center in Lakewood, Colorado. Early development focused primarily upon the implementation of GIS within BIA Area and Agency offices and not tribal government departments. Centralized GIS development involved the mobilization, stability, and combinability of geographic information resources; which led to yet another cycle of accumulating information on American Indians and their land resources. Next, the agency developed and implemented the BIA Nationwide Database (BND). The BND represented a digital version of Indian Country. Evidence shows that the BND contained very little sensitive or proprietary tribal information. Rather, the vast majority of the BND consisted of topographic map features, timber management, and range management coverages. Development of the BND was uneven, covering some reservations while neglecting others. Mapping the geographic information networks reveals a core - periphery geography. Those reservations containing timberland resources and participating in integrated resource management received the most GIS development, American Indian land allotment areas received less development. Fluctuations in funding during the mid-1990s led to the demise of the BND as an updated GIS resource. This led to the implementation of the BIA GIS ration network. As with past networks, the BIA collaborated with external groups to implement the latest federal policy, automation of government functions. The BIA worked closely with the Environmental Systems Research Institute (ESRI) in the implementation of GIS into comprador tribal governments. Maintenance of the GIS networks included technical assistance, training, and the distribution of GIS software rations. Thus, GIS at the BIA does not represent a linear march to progress, but rather represents a recycling of past colonial practices.

CHAPTER ONE

INTRODUCTION

Developing technological solutions for addressing crises and risks is deeply engrained in American society. Often such solutions emerge during social, cultural, economic, or environmental transition periods, such as the transition from military to environmental security. One historical example is the transfer of federal responsibility for American Indians from the Department of War to a natural resource and conservation agency, the Department of the Interior (DOI) in 1849. Throughout this transitional period and beyond, the United States federal government continued a ruthless military campaign against various tribes as they were rapidly dispossessed of land resources. One consequence was the transformation of indigenous social and economic systems. The DOI, through its Bureau of Indian Affairs (BIA), simultaneously attempted to integrate American Indian people, their land, and natural resources into their bureaucratic inventories and maps in Washington D.C., while supported by a network of Indian agencies, forts, and Christian missionaries throughout what is now referred to as Indian Country.[1]

The New Risk

The BIA implemented a new technological solution to combat environmental and economic risks in Indian Country. In 1990, the United States Congress declared that “the forest lands of Indians are among the most valuable resources…encompassing more than 15,990,000 acres of land, including more than 5,700,000 acres of commercial forest land and 8,700,000 acres of woodland.” Furthermore, the document goes on to reveal that “there is a serious *threat* to Indian forest lands arising from trespass and unauthorized harvesting of Indian forest land resources” (U.S. Congress 1990) [emphasis added]. To address natural resource management on American Indian reservations, the Bureau of Indian Affairs developed a geographic information system (GIS) known as the Indian Integrated Resource Information Program (IIRIP), which is housed at the BIA’s GIS Department, the Geographic Data Service Center (GDSC) in Lakewood, Colorado.

Computer-based GIS are information technologies that are used in the gathering, inscription, storage, manipulation, visualization, and production of spatial information output. GIS revolutionized the way that institutions like the BIA and American Indian tribal governments conceptualize and use geographic and environmental information. Some scholars argue that information technologies like GIS are “transforming basic cultural concepts and experiences such as those of time, space, reality, privacy, and community and [are] also affecting fundamental shifts in cultural practices” (Brey 2003, 55). Thus, institutions using the technology are shaped by GIS (Sheppard 1995). Such impacts have prompted advocates of American Indian self-determination[2] to raise concerns about the development of GIS in Indian Country and some of the controversies surrounding its implementation within tribal governments (Rundstrom et. al 2000).

The main thesis is that the uneven development of GIS, at the BIA GDSC, creates core-periphery geographies.[3] One of the early controversies associated with the BIA's GIS implementation strategies included the Colville Confederated Tribe's concern about the central control of their forest management applications at the BIA GDSC and BIA area offices in the early 1990s (Marchand and Winchell 1992). The Warm Springs and the Flathead tribes both expressed the desire to develop and control their own in-house GIS. However, the BIA GDSC denied their request and moved forward with their own centralized development (Adams 1999). One BIA GIS coordinator puzzled over the apparent lack of interest in GIS by tribal governments, and called for a culturally-relevant solution to the implementation problem (Marozas 1993). It was unclear whether tribes had rejected GIS or were simply disinterested in the BIA's GIS implementation strategy of central control.

My purpose in this dissertation is to explain the initiation, representation, and maintenance of GIS networks emanating from the BIA GDSC and extending throughout Indian Country. Components of the BIA GIS network include geographic information databases, technical assistance, training, and the distribution of GIS software products. As in other federal government agencies, the BIA toiled with the independent development of GIS for the past two decades. BIA proponents of GIS portrayed the technology as an inevitable "march of progress" and the only solution to the real and perceived environmental problems in Indian Country (Bureau of Indian Affair 1988a; Battelle 1988). I claim that GIS development involved building upon past efforts to control, represent, inventory, and manage American Indians and their land. The historical continuity with the colonial past goes against the linear trajectory model and triumphalist claims of technological development advocated by GIS proponents. From a social standpoint, GIS development at the BIA is not a linear march to progress, but rather a recycling of traditional colonial practices.

At the core, the GDSC completely centralized the development of geographic information resources at their center in Lakewood, Colorado. Early development included an uneasy transition from industrial to post-industrial methods of mapping natural resources and data inventories through the construction of the BIA Nationwide Database (BND). Although the BIA presented early GIS efforts as nationwide in scale, the development of geographic information was spatially uneven and aligned with BIA regions holding vast timberland resources and those tribes participating in integrated resource management practices. These activities perpetuated the process of uneven development between the core and periphery. Later, fluctuations in congressional funding stalled development of the centralized database and nearly eliminated the GDSC.

Following major reductions in funding, the agency focused on providing technical assistance, training, and GIS software rations to BIA field offices and tribal government personnel. This business-oriented implementation strategy incorporated several departments of tribal governments into an evolving network that was given further momentum by a GIS software licensing agreement between the Environmental Systems Research Institute (ESRI) and the Department of the Interior (DOI) in 2002. The result was a network of dependency, driven by the Office of the President, the U.S. Congress, neo-liberal economics, transnational corporations, and federal government agencies. As GIS networks continue to expand, new hubs and nodes are being established within American Indian tribal governments throughout Indian Country.

Structure of the Dissertation

This dissertation consists of seven chapters. The second chapter provides an overview of the data, methods, and conceptual framework used in this study. Archival research is usually employed by historical geographers in their research of past processes and places. Archival materials found at the BIA GDSC reveal information about the development of GIS and its diffusion throughout Indian Country. The conceptual framework for this study incorporates a modified actor-network theory approach based on the concepts of centers of calculation and rations.

The third chapter provides some insights on the standardization of institutional GIS. These insights are found within a body of literature that Michael Curry refers to as conventional histories of GIS development (Curry 1998). More specifically, this chapter presents information on the independent development, nationwide applications, and standardization associated with GIS implementation within North American institutions, including some tribal governments.

What initiated the BIA GIS networks? The main argument in chapter four is that GIS development at the GDSC is yet another cycle of accumulation and inventory of American Indian land resources by the BIA. It is here that the centers of calculation framework is incorporated, including cycles of accumulation and theoretical insights on the conditions needed for a laboratory to become a center of calculation and perform action at a distance. Conditions for centering at the BIA involved the mobilization, stabilization, and combinability of information through natural resource management policies, central control of resources, and implementation of GIS technology.

How did the BIA represent Indian Country in their GIS? Chapter five focuses on centralized development of the BIA Nationwide Database (BND). I argue that the BND is yet another core-periphery representation of Indian Country. This argument is supported by five main points. First, the BND is nationwide in name only. It represents a partial inventory of natural resource information, based primarily on USGS topographic map features. Thus, the BND replicates pre-existing map systems. Second, the BND is unevenly developed in terms of geographic information data and BIA regional coverage. Third, this arrangement creates a core-periphery geography of underdevelopment. Fourth, the core-periphery geography is not based on American Indian demography. Instead, it is shaped by the presence of timberland resources and the development of integrated resource management practices on reservations residing in select BIA regions. Finally, fluctuations in funding and changes in federal Indian policy led to the demise of the BND program.

How does the BIA maintain GIS networks in Indian Country? The GDSC maintains GIS networks by establishing itself as an obligatory point of passage for a dependent and underdeveloped periphery of tribal governments. I will argue that the GDSC maintains GIS networks by facilitating the transfer of GIS technology to dependent tribal governments through technical assistance, top-down GIS training, and the distribution of GIS software rations. Tribal government dependency increases the irreversibility of the networks.

Chapter seven presents a summary, conclusion, and suggests some avenues of future research regarding the American Indian tribal governments. I also discuss counter-mapping and GIS, by tribal communities, as alternatives to federal government control. Findings from this dissertation will help determine future research directions in relation to GIS use in tribal governments.

Scope

This dissertation focuses on institutional GIS at the BIA GDSC between 1988 and 2005. Originally, my intention was to conduct research on GIS at the American Indian tribal government level. However, two important issues arose while considering venturing down this research path. First, I was concerned about jumping through bureaucratic hoops to conduct research on American Indian tribal governments and their employees, and having my worked shaped by the Human Subjects research board at the University of Oklahoma. Time was more of an issue than the bureaucratic process, however. Second and most important, I had to consider the politics of being a member of the Kiowa Tribe of Oklahoma and conducting research on any number of tribal GIS operations in Oklahoma, not to mention tribal governments on a nationwide-scale. The eastern and western Oklahoma political divide among tribes is still vibrant. I did, however, consider doing a research project on the Kiowa's efforts at GIS. After a preliminary visit I decided that their development and implementation efforts were immature and a single case study might not yield enough empirical data.

The next option was the study of GIS at the federal government level and its diffusion throughout Indian Country. For my master's degree, I conducted field research at the Anadarko Agency Office in Anadarko, Oklahoma. Although the BIA is highly bureaucratic, I felt comfortable navigating through their map and land record archives. Considering that some of the early literature on GIS and American Indians dealt with the BIA's control of GIS applications (Marchand and Winchell 1992), I decided that a study of the BIA was in order. The BIA is divided into regions throughout the United States, containing BIA field offices (Figure 1.1 and 1.2). Tribal reservations and land allotment areas reside within the regions as well. I selected the center of BIA GIS activity, the GDSC, as the focal point of my research.

The GDSC and its accompanying archives are located in Lakewood, Colorado as part of a larger Department of the Interior complex. Core–periphery regional geographies emerged from the pages of technical documents found at the GDSC.

The BIA is a mediator between the United States federal government and American Indian people, positioned in the center, yet maintaining strong connections with the periphery of Indian Country. As a scholar and member of the Kiowa community in southwestern Oklahoma, I too claim a middle ground. As a scholar, I am squarely within the center. As a Kiowa, I am a member of a unique community made up of a whole spectrum of people and segmented by tribal factions. As with the BIA or any academic scholar, my contact with the community can have transformative effects. This condition also weighed into my decision to study federal government archives instead of American Indian people.

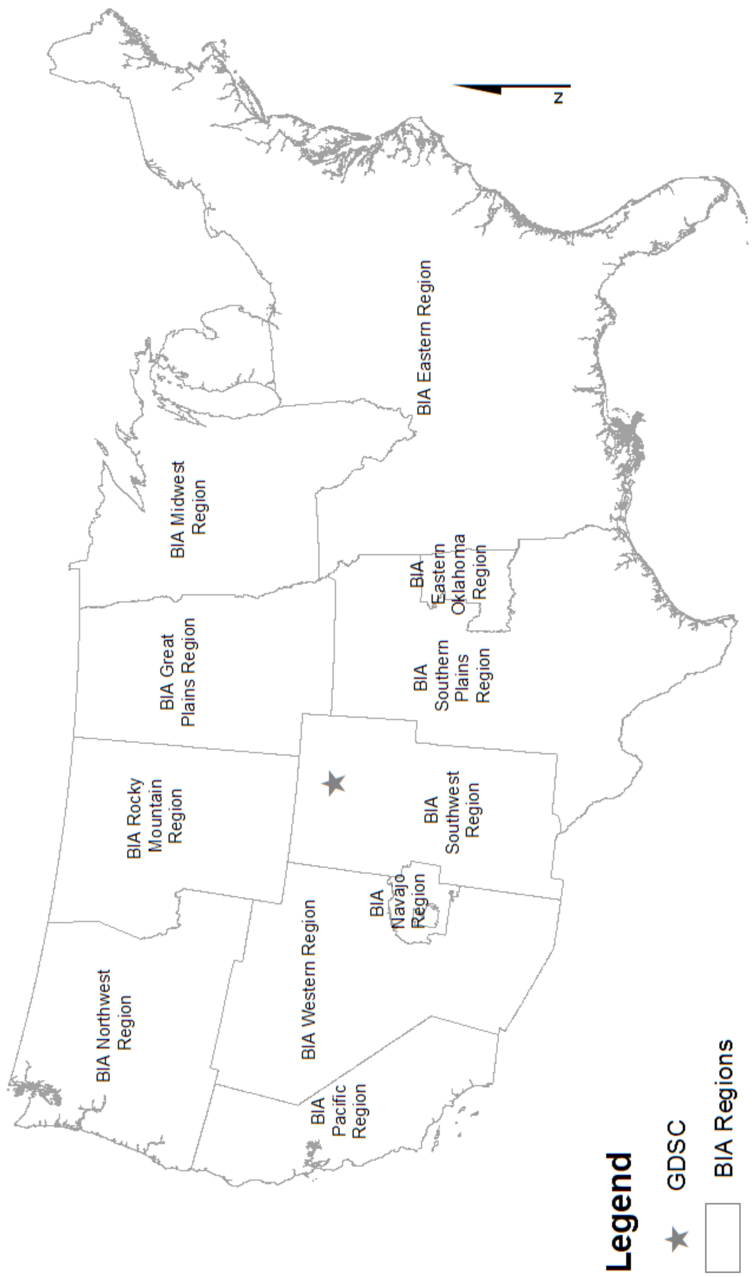


Figure 1.1. Bureau of Indian Affairs Regions.

Figure 1.2. Bureau of Indian Affairs Area and Agency Offices (Field Offices).

CHAPTER TWO

DATA, METHODS, AND CONCEPTUAL FRAMEWORK

For decades, American academic scholars and federal agency researchers have gone into North American Indian communities to study people, languages, and landscapes among other things. Scores of anthropologies, ethnographies, sociologies, and geographies have been constructed for American Indians. However, very few American Indian academic scholars have re-constructed the geographies of institutions such as the BIA. This kind of counter-research process requires scholars to go to institutions and engage either with individuals through ethnographic methods, or in the case of this study, engage with the colonial archives (Harris 2004). I am the first academic researcher that I am aware of to have unlimited access to the centralized archives housed at the BIA GDSC in Lakewood, Colorado. I used these materials to trace the development of two GIS implementation strategies at the GDSC and their geographic expression throughout Indian Country.

ARCHIVAL RESEARCH

Archival research can involve investigating primary and secondary sources of information and documents held at national repositories such as the National Archives, government documents housed at university libraries, and by exploration of files at government agencies. Documentary sources are in the form of annual reports, plans, cost-benefit analyses, photographs, maps, personal letters, dairies, log books, and computer databases (Roche 2005). Textual documents are representations of how actors as authors view the world. For this study, information pertaining to the origins, development, and implementation of GIS at the BIA led me to the Geographic Data Service Center (GDSC) in Lakewood, Colorado. Other BIA documents used in the study are housed at the National Archives Southwest Division in Fort Worth, Texas and the Government Documents Department at the University of Oklahoma library. The internet is now a good source of previously published documents including U.S. Congressional records and other legislative acts. Search engines such as *Google* are useful tools for networking and connecting multiple documents. As a result, archival research for the late-twentieth century is both a manual and digital process.

Readings from the literature on GIS and society (Pickles 1995) provided initial ideas and inspiration for this dissertation. More specifically, I focused on the literature pertaining to American Indians and GIS, including the impact of the BIA on some tribal government GIS programs (Marchand and Winchell 1992). Other studies of interest included the impacts of GIS on the geographic epistemologies of indigenous peoples and the mapping relations between the federal government and American Indians (Rundstrom 1993; Rundstrom 1995). Each of the papers mentioned the BIA in relation to GIS development in Indian Country. However, none of the studies actually focused specifically on the agency, its data and the implementation of GIS in Indian Country. I decided that a more thorough study of GIS at the BIA was in order.

I made four trips to the BIA GDSC: May 2004, August 2004, April 2005, and September 2005. During these trips, I made photo copies of all available technical reports and received digital and analogue copies of the software distribution and Help-Desk records from the GDSC staff. I also made trips to the National Archives Southwestern Division in Fort Worth, Texas during the summer and fall of 2005 to collect additional historical and policy information on the BIA. These BIA archival materials are cataloged under Group Record 75.

Archival Materials

Texts are the most important material for this dissertation. The ultimate goal here was to work primarily with texts and the wording within the texts to find out in what kinds of geographies emerge. The main bodies of archival materials that inform this study are the GDSC Quarterly Technical Reports, the Database Organization Guidelines, GDSC enterprise software distribution records, and Help-Desk database records. These primary sources provide detailed summaries of GIS development activities including many of the people, technical artifacts, and inscriptions involved in the construction of GIS and the geography of GIS implementation throughout Indian Country. The content within these documents connected with other documents regarding national polices and technical programs. The technical reports are not distributed outside of the agency and can only be obtained directly from the GDSC. The software distribution records and Help-Desk information have not been released to the public. During my trips to the GDSC I collected primary textual materials including: GDSC Quarterly Technical Reports (1986-2005), BIA GIS Database Organization Guidelines, several correspondence letters (1987-1988), GDSC Users Forum Proceedings for the years 1993 and 2004, technical GIS software manuals, public brochures, a BIA GIS cost-benefit analysis (1988), Integrated Resource Management Guides (1998 and 2001), GDSC newsletters (1994 – 1999), Indian Lands in the United States map (2003), the general GDSC budget (1981-2005), BIA – ESRI Enterprise Licensing GIS software distribution records (2002 – 2005), and Help Desk technical assistance database records (1998 – 2005). Secondary sources on the BIA are accessible at the University of Oklahoma library. These materials help explain the origins, development, and implementation of GIS implementation strategies at the BIA GDSC between 1987 and 2005. More specifically, I identify relevant human and non-human actors, the materials that they circulate, and analyze the changing dynamics of GIS at the GDSC over two decades.

This is the first-time a large portion of the BIA GDSC documents have been analyzed to reveal details on the implementation of GIS and the flow of materials and information out of the agency. Although the GDSC holds an incomplete archive, the documents reveal much about the technical aspects of BIA GIS. Studying archival materials at the agency allows for the reconstruction of past stages of GIS development at the GDSC. However, it must be noted that several quarterly technical reports are missing. The most complete set of quarterly technical reports were acquired for the years 1988 through 1994. An incomplete set of quarterly technical reports was found for the years 1995 - 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 2002 to 2005 are included in the analysis of GIS diffusion to tribal governments in chapter six. These documents are instrumental in showing the flow of technical assistance and the geography of software products from the GDSC to tribal governments. The database documents represented the most concrete evidence for actual contact between the BIA and individual tribal governments.

Missing from the quarterly technical reports are correspondence, negotiations, and dialogues between individual tribal governments and the BIA. These reports are written from the perspective of the BIA, a federal government agency with deep roots in Indian Country. Often American Indians are deeply suspicious of the agency, and likewise the agency is sometimes suspicious of Indians. This is also true of academic researchers who want access to public documents. At least one masters-level researcher who made a reconnaissance visit to the GDSD described the staff at the agency as friendly, yet intimidating. Furthermore, some GDSC staff members took any criticism of the BIA as a personal attack.[4] Intimidation was not a factor in my research. However, there was a very long delay between the time I requested the GDSC budget and the time it was received as an incomplete outline.

Approach

There is no single, all-encompassing method of analysis used in archival research. Scholars often go into the archives with a general idea, approach questions inductively, or have theoretical positions in mind. After reviewing archival documents it becomes clear that the complexity of the texts often shapes the method of analysis, causing the researcher to go back and forth, dazed and indecisive. Part of the strategy to control the confusion associated with multiple document sources is to focus on specific themes within the records. In this study, two GIS implementation strategies emerged as the topics of inquiry. The conceptual framework used to understand these strategies is a modified version of actor-network theory (ANT). ANT also provides a method for tracing material objects from the BIA GDSC to other points throughout Indian Country.

The approach of this dissertation research falls under the category of critical GIS, which is a sub-topic of critical human geography.[5] I chose to use analytical approaches from Science and Technology Studies (STS). Philip Brey provides some important insights on STS in the book *Modernity and Technology* (2003). Those interested in STS should consult this excellent book. A few highlights from Brey's chapter will assist in explaining some of the STS approaches considered for this dissertation research.

STS is a relatively young (1970s) field of inquiry "that is based on studies of science and technology and their relation to society that are both empirically informed and on sound theoretical footing" (Brey 2003, 46). Connected with STS is the history of technology, which contains a large breadth of insights that although extremely important for understanding the development of technology in society, goes beyond the scope of this study. The STS approaches considered for this dissertation research included: the social construction of technology, the social-shaping thesis, the technological-shaping thesis, and ANT.

One of the first STS approaches I considered for this dissertation was the social construction of technology (SCOT), and especially the work of Trevor Pinch and Wiebe Bijker (1987). One of the primary premises of social constructivism is the "claim that technological change can be entirely analyzed as a result of processes of social negotiation and interpretation, and that the properties of technologies are not objective, but are effectively read into the technologies by social groups" (Brey 2003, 51). Pinch and Bijker theorize that relevant social groups interpret technologies in different ways, and ultimately shape an artifact's development (Bijker et. al 1987). If I had chosen to find out why one variety of GIS failed and another succeeded, the social construction of technology approach would have served a great purpose. Even the *idea* of GIS is a social construction[6] (Hacking 1999) [emphasis added]. SCOT has been criticized for giving too much explanatory power to social groups and social processes in the development of technology, while neglecting the influence of nature or other forms of technology on development.

The social-shaping thesis is closely related to SCOT. While the social-shaping thesis acknowledges that social groups and social process strongly shape the development of technology, it is not as socially deterministic as SCOT. According to Brey, "the social-shaping thesis denies the technological determinist idea that technological change follows a fixed, linear path, which can be explained by reference to some inner technological 'logic' or perhaps through economic laws[7]" (Brey 2003, 50). Rather, technological development is multidirectional, meaning that there are multiple paths of development; some emerge and grow, others wither away. The social-shaping thesis is a weak form of constructivism in that technology is strongly "conditioned by social factors" (Brey 2003, 51).

Technology may not determine the direction of society, but technology does transform society. Next to ANT, the technological-shaping thesis has the greatest influence on this dissertation research. The technological-shaping thesis claims that society is strongly shaped by technology. This means that there are multiple "functions, meanings, and effects" that always accompany the development and implementation of technology (Brey 2003, 52). Technology has political consequences (Winner 1980), can contain gender biases (Bray 1997), and shapes the behavior of users (Latour 1991). This type of position is a soft or weak form of technological determinism.

Where is the geography in these approaches? STS does not emphasize place or space. However, one of the first things that attracted me to STS was the use of schematics to represent and describe relationships between social groups and technical artifacts. Graphic representations and co-word analysis maps are found in some SCOT and ANT articles (Bijker et. al 1987; Callon et. al 1986). In this dissertation, ANT is used to map places, material flows, and relational spaces of alignment. It was the possibility that connections and relationships, organized through ANT, could be cartographically represented that pushed me in the direction of Bruno Latour and Michel Callon's work.

CONCEPTUAL FRAMEWORK

Many ANT concepts can be found in two influential studies: *Techno-Economic Networks and Irreversibility* by Michel Callon (1991) and *Science in Action* by Bruno Latour (1987). The concept of *centers of calculation*[8] addresses the initiation, representation, and justification for GIS networks emanating from the GDSC. Theoretical insights regarding action at a distance and centers of calculation are geographic in nature and are important in my analysis. How have geographers approached ANT?

Economic geographer Nigel Thrift (2000) wrote that “geographers have become very interested in actor-network theory” (5). ANT, as a component of the larger body of research conducted under the banner of Science and Technology Studies (STS), has caught the attention of geographers because the research framework can be used to better understand the construction of technology and nature, and is another means of understanding space and place (Thrift 1996; 2000). The journals *Environment and Planning A* and *Environment and Planning D* are at the forefront of ANT – geography research. Two studies focused specifically on ANT, technology, and the geographies of relations (Bingham 1996; Hichliffe 1996). Other articles have proposed ANT as a framework for understanding economic shifts, arguing that networks are “a dominant organizational form in the post-Fordist era” (Murdoch 1995, 731). As a method of analysis, ANT attempts to breaks-up dualities and allows for theories of heterogeneous associations (Murdoch 1997a; 1997b). Geographers have also applied insights from ANT to the study of plant – human interactions and to the study of world cities and their connections (Hitchings 2003; Smith 2003).

Very few geographers incorporated STS insights into the GIS and society debate (Schuurman 2000). The ones who did, however, proved to be very influential to this dissertation research. Eugene Martin (2000) used ANT as a framework to understand the interactions between GIS and society. Martin’s paper was influential to this dissertation in terms of methods and its strong connection with Michel Callon’s (1991) classic article on techno-economic networks. The research showed the interactions between texts, people, money, technology, and control in the implementation of GIS in Ecuador. Martin (2000) used schematics to show relationships between four different actor networks. The paper concludes by suggesting that "the best use of ANT for investigating GIS may be to continue exposing the social interactions behind GIS operations so practitioners, managers, theorists and researchers will be more sensitive to building stable GIS actor-networks" (Martin 2000, 735).

Other geographic information scientists like Nicolas Chrisman and Francis Harvey incorporated theoretical insights from STS into their work. These studies include the social construction of GIS boundary objects and the social construction of GIS (Harvey and Chrisman 1998; Harvey 2000). Harvey and Chrisman have also drawn inspiration and conceptual frameworks from Deleuze and Guattari's (1987) work on rhizomatics in the book *A Thousand Plateaus*. Chrisman and Harvey noted the difficulty of interpreting Deleuze and Guattari, but also insisted that ecological concepts such as rhizome and strata are useful metaphors for research on GIS and society. Burno Latour sees similarities between the rhizome concept and ANT. He proposed that Actant-Rhizome is a more organic and better name for his project than ANT (Thrift 2000).

ANT is not without controversy in geography. Scott Kirsch and Don Mitchell (2004) are concerned that strong versions of ANT present humans and non-humans only as autonomous objects connected within networks. Humans have very little agency and are not subjected to either oppressive or liberating societal structures. However, the authors do agree that weak versions of ANT can contribute to Marxist insights and theories that have informed materialist social theory and geography for the past 150 years. They also argue that actor networks are often presented in terms of cause and effect relationships. However, Kirsch and Mitchell argue that the agency issue should not be a fatal flaw. Instead, they point to Noel Castree's suggestion that Marxist insights could "accommodate a weaker version of ANT" and retain critical viewpoints. Their own view point is that power is situated in centers, individuals and social relations, and "in some ways, actor network studies have indeed been quite effective at showing how such centering processes occur" (Kirsch and Mitchell 2004). In the sections to follow, I will lay out some of the ANT concepts and methods associate with intermediaries, actors, and networks.

Intermediaries and Actor-Networks

Michel Callon states that, "an *intermediary* is anything passing between actors which define the relationship between them…examples of intermediaries includes scientific articles, computer software, disciplined human bodies, technical artifacts, instruments, contracts and money" (Callon 1991, 134). Trying to identify and study intermediaries can be an overwhelming task, which can be overcome by limiting intermediaries to text inscriptions (reports, books, articles, notes), technical artifacts (machines, hardware, software), human beings (skills), and all forms of money –

funding (Callon 1991). For this dissertation, textual documents are the intermediaries of interest. Texts and technical artifacts, such as those associated with GIS help define the roles of human and non-human actors in the network (Murdoch 1995). The technical reports connect with other objects, texts, people, and places. In fact, "Words, ideas, concepts and the phrases that organize them thus describe the whole population of human and non-human entities…intermediaries describe their networks…and they compose them by giving them form" (Callon 1991, 135). Intermediaries such as the GDSC quarterly technical reports, the Database Organization Guidelines, Help Desk records, software distribution records, correspondence letters, integrated resource management guidelines, and other archival materials found at the BIA describe the agency's networks and their geographic expression in Indian County. Government documents are the foundation of this dissertation.

Conceptualizing networks requires decoding the wording within intermediaries. Meaning is inscribed within intermediaries such as maps, GIS layers, technical reports, natural resource assessments, and digital databases. Words within documents can be traced to other documents (network). For instance, the GDSC quarterly technical reports refer to the BIA Integrated Resource Management Plan (IRMP); the IRMP refers to the National Indian Forest Resources management and Integrated Resources Management Act; these documents led to two assessments of Indian forests and forest management in the United States, which identified American Indian reservation areas with significant timberland resources. Tracing the policies in this manner led to explanations of why the GDSC developed GIS layers for some BIA regions while neglecting others. The meanings associated with timber and forests are also regionalized in the layers. Various discourses are also found in the archival materials at the agency including discourse ideas associated with globalization including neo-liberal economics and environmental policies implemented in North America, but ultimately meant for the world. Other discourses emerged, including social transitions such as post-industrial society, privatization and the aggressive plans for imperial expansion of global networks, and GIS being the glue that will bond the IT empire to the world. Those who author such meanings within intermediaries are actors.

The actor as author is what differentiates them from intermediaries. They combine, mix, degrade, compute, and predict intermediaries to create the next inscription (Callon 1991). For example, the United States Congress is an actor that authors laws and regulations that are then passed on to government agencies and the general public. The flow of laws to agencies and people influences behavior and conditions. It is the connections and flow of laws, documents, and ideas that create action. Actors are not preordained with characteristics. One must trace and read the intermediaries and associated networks to gain more knowledge about actors. Callon states that, “It is precisely because human action is not only human but also unfolds, is delegated and is formatted in networks with multiple configurations, that the diversity of the action and of the actors is possible" (Callon 1999, 194). Actors put intermediaries into motion. The combination of actors and intermediaries creates networks.

Networks are groups of interconnected actors and intermediaries. By following the networks it is possible to locate and describe additional groups, identify other significant actors, and trace interconnected intermediaries (Callon 1991: 142). Callon's techno-economic network is "a coordinated set of heterogeneous actors which interact more or less successfully to develop, produce, distribute and diffuse methods for generating goods and services" (Callon 1991, 133). This is important here because material goods initiate relationships between actors and allow them to define one another through interactions (Murdoch 1995). Actors can actually define one another through their interaction, including the authoring and circulation of intermediaries from one government agency to another (Callon 1991, 135). Networks are extremely dynamic and only momentarily stable. Much work is required to build strong networks. Furthermore, actors need to ally closely with other actors and intermediaries to maintain stability, a process referred to as *enrollment* in the ANT literature.

The methods above involve identifying, counting, arranging, and mapping; it is both a qualitative and quantitative process. In the paragraphs below, I will discuss the ANT concepts of *translation*, *convergence*, and *obligatory points of passage*.

Translation, Convergence, and Obligatory Points of Passage

When extending networks, actors must be enlisted and convinced that their goals and interests are aligned with those of scientists and their laboratories (Murdoch 1997a). *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 will 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" (Latour 1987, 259). Translations are inscribed into texts, technical objects, project guidelines, roundtable discussions, conference proceedings, newsletters, embodied skills, and countless other materials (Callon 1991). Translation is the process of making two different actors equivalent (Law and Hassard 1999). This requires a coming together or convergence of intermediaries like technical reports, forest assessments, GIS layers, and funding. Technologies such as GIS do not merely diffuse from one location to another; they are translated through a series of negotiations and agreements.

There are often multiple translations that emerge within a textual document or a network of documents. I identified and recorded some of the objectives, agreements, disagreements, and negotiations that held actor-networks together at the GDSC. Actors at the BIA GDSC attempted to enroll others in their networks so as to make the networks more durable, more justifiable. However, the BIA GDSC also wanted to control the behavior of the actors in order to make their actions predictable. Some actors will accept these terms unproblematically, creating a perfect translation that produces a strongly aligned, stable network. Other actors may not agree with the conditions and terms. This results in weakly aligned, unstable networks.

Another concept and method for describing the boundaries of networks is *convergence*. Convergence measures the extent of the translation process through the circulation of intermediaries leading to agreement among actors (Callon 1991). Intermediaries are inscribed with rules, laws, standards, and meaning embedded by actors. Such entities are said to display strong co-ordination, which contributes to network stabilization. In the case of this study, I counted and classified GIS layers found in the 1992 fourth-quarter technical report. Very simply, the BIA field offices and associated reservations with the most GIS layers are more convergent or more closely aligned with the GDSC. The GDSC also neglected developing GIS layers for some BIA field offices and some reservations. As a result, these actors are weakly aligned with the agency.

Successful translation processes lead to the stabilization of networks, and it is possible to trace these networks unproblematically. However, this alignment is not always the result of translation. Often there is controversy and conflict resulting from disagreement among actors about the translation process. This in turn can lead to betrayal when the actor refusing to accept the role assigned to them *aligns* with another competing network. These converging networks have boundaries that can be mapped to determine the reversibility or *irreversibility* of the network.

The concept of irreversibility is theoretically significant. Some actor-networks are very controlled, have specific objectives, and planned from a centralized location. For example, this kind of network is completely convergent in that GIS development and implementation translates very smoothly, without much controversy between actors in the network. The development and implementation of information technology such as GIS effectively transforms the way natural resources are managed within government agencies. As time goes on, computer software and hardware improve, costs are calculated, costs decrease, and human skills are shaped by the technology. The networks being constructed are known and very predictable, but limited and small. The network rarely goes beyond the targeted group of actors and intermediaries. This strategy leads to more controllable networks. The paradox is that the actors have no choice since they are acted upon by networks that hold them in place (Callon 1991). Over time, it becomes increasingly difficult to go back to old management practices. Going against the grain of a stabilizing network is equivalent to swimming upstream in a very strong current. Such networks become more and more irreversible over time (Callon 1991). However, even the strongest rivers can be dammed up. Elimination of important intermediaries like funding can cause the strongest networks to fail.

Some networks are full of controversy, full of challenges, and involve multiple actors that may have different agendas regarding such things as the management of natural resources. These dynamics create instability and networks that are more reversible. As a result, "The less convergent a network, the less it is irreversible and the more the actors composing it can be understood in terms of concepts such as strategy, the negotiation and variation of aims, revisable projects, and changing coalitions" (Callon 1991, 154). Negotiations and agreements are often conducted within virtual bottle-necks or *obligatory points of passage*.

Obligatory points of passage are nodes within networks that connect actors and intermediaries. They are obligatory in that weaker actors within the network have to pass through them to access resources including technical assistance, education materials, licensing agreements with contractual obligations and GIS software products. In other words, obligatory points of passage control resources and are partially responsible for the success of the network (Law and Callon 1992). The status and functionality of the obligatory point of passage varies from network to network and changes over time (Martin 2000). These nodes can be classified as either strong or weak.

Strong obligatory points of passage have absolute control over networks, perpetuating its existence, and maintaining strong connections with other actors through the flow of intermediaries (Martin 2000). Weak nodes of passage generally distribute the responsibility of the network among several key actors, and there is flexibility associated with such interactions (Martin 2000). The position of the obligatory point of passage within a network is constantly changing and must be tended by key actors within the node. Weaker nodes rely significantly upon the success of stronger networks that pass through. In this study, I will describe such a relationship that emerges between the BIA GDSC and ESRI. When obligatory points of passage are combined with centers of calculation, the node/hub becomes very strong and durable.

Centers of Calculation

Centers of calculation describe the reach of scientific institutions that go out to the periphery and collect information. Information is brought back to the center and turned into scientific knowledge. Latour uses the concept to describe early European inventories of distant lands on the periphery. Upon initial contact, indigenous people have a distinct advantage over explorers, including academic researchers. They possess 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. To overcome the disparity between indigenous knowledge and scientific knowledge, information has to be gathered from indigenous informants and inscribed on paper in a form familiar to scientists. One goal of science is to bring knowledge of the periphery back to the center (Latour 1987). Once back at the laboratory, the collected items can be studied, and more precise inscriptions made in the form of maps, manuscripts, models, and simulations.

Contemporary scientists construct facts within their laboratories, allowing officials and managers to exert a degree of control on the physical environment. The development and implementation of models and simulations are very important components of the control process. By collecting and processing real world data about the world, scientists and technicians create virtual maps, models and simulations, allowing them to experience the physical environment from within the controlled confines of laboratories. Engagement with models and simulations allows scientists and engineers to perfect techniques like space flight, controlling the flow of a river, or the management of natural resources before experiencing the real thing. Scientists create hundreds of models and run thousands of simulations in an effort to get the desired results in real-world situations. Through laboratory experiences, knowledge is created. The construction of scientific knowledge, tied to economic and political systems, gives those in the center an advantage over people, places, and things on the periphery. These conditions can convert a seemingly insignificant place into a center that can dominate the periphery from a distance (Latour 1987).

Cycles of Accumulation and Mobility

Centers of calculation are places were intermediaries holding information, data, maps, numbers, and inscriptions are brought and organized. Empires send actors such as naturalists, cartographers, geographers, anthropologists, and technicians out into the world to collect and make initial inscriptions of people, places, and things located in far away places. The process of going out, collecting, and returning to the center is known as a *cycle of accumulation*. There are often multiple cycles of accumulation. Each time an expedition goes out and returns it brings back more information that can be used to return and claim additional natural resources or other materials. The accumulation of information about distant places gives the centers of calculation advantages over the periphery,[9] allowing the centers to perform action from afar (Latour 1987). One geographer writes, "In the geography of actor-networks, a crucial issue is how actors are able to *mobilize* networks to act at a distance" (Murdoch 1995, 749). Ideas associated with centers of calculation have been incorporated into the works of some geographers (Kirsch 2002; Harris 2004; Martin 2000).

Colonial practices have been shaped by cartographers and their maps (Godlewska and Smith 1994). Many American and Canadian federal government agencies like the United States Bureau of Indian Affairs, the Canadian Department of Indian Affairs, and the United States Geological Survey have succeeded in carrying out multiple cycles of accumulating and the mobilization of geographic information on

North American Indian people and their lands over the past couple of centuries. These cycles include western expeditions, military mapping surveys, the Great Surveys of the West, ethnographic studies of North American Indian tribes, and the mapping of reservation and individual allotment land.

Geographer Scott Kirsch applied the idea of centers of calculation to describe how information about North American Indians and their land was collected, classified, and used by the United States federal government for controlling and confining Indians to reservations in the late nineteenth century. John Wesley Powell led one of the *Great Surveys of the West*, where he counted, collected, and conducted ethnographic-language studies on several tribes in the western United States and Great Plains (Mooney 1979). 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" (Kirsch 2002, 553).

Historical geographer Cole Harris (2004) referred to the North American Indian reserve as a spatial system used to manage both 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 native 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…firm quantitative information" (Harris 2004, 176). This kind of standardization process made the information stable and combinable. Canadian reserve agencies constructed maps so that British Columbia could be located within colonial space, and numbers used to keep track of populations, allocate land, and "enable a bureaucracy, essentially without local knowledge, to make decisions about localities" from afar using technologies of distance (Harris 2004, 176; Porter 1995).

The work by Kirsch and Harris is reflected in Latour's view: "Those who sit inside bureaucratic or scientific centers may combine, shuffle around, superimpose and recalculate figures and end up with a gross national product, the layout of an island, the taxonomy of animals, a new planetary system" (Latour 1987, 227). The BIA GDSC constructed new inscriptions and classification procedures that affectively limited the diversity of the landscape throughout Indian Country. The collection of materials and people are networked inside the centers so that other people and places on the periphery can be dominated. The BIA GDSC accumulated what Latour refers to as "traces" to make Indian Country "familiar, finite, nearby, and handy" (Latour 1987, 230).

The movement of people, material, and even the environment must be initialized by other actors who seek to further build their networks. Imperial expansion initiated the movement of materials from far-away places like the islands in the South Pacific, the Great Plains, and the Arctic to centers in London, Lisbon, Paris, Washington, D.C., and Berlin. Ethnic languages, cultural materials, flora, fauna, and rock materials are vast in number and variety, initially leading to confusion about what is valuable to the center and what is less valuable. Second, the collections go through several stages of classification, naming, and mapping to decrease their diversity. The job of classification is very difficult for scientists because they have to deal with the entire complexity of the world, to make their knowledge somehow universal. For example, an indigenous group of people like the Kiowas developed their own ethnobotany (Vestal and Schultes 1939). Because their knowledge was localized, they had to know only hundreds or at most thousands of different plant types used in all kinds of different applications. Scientific botany is also a localized knowledge, developed within centers of calculation like museums, botanical gardens, and academic laboratories. The scientific botanists want to know about all the plants of the world, most of which came from far away places. The centers construct museums, botanical gardens, and laboratories for the purpose of collecting, classifying, and dominating the world from afar. Collecting, classifying, and creating new inscriptions can be complex. Unlike the Kiowa botanist, the scientist must know millions of different plant types from all over the world. Classification and standardization are necessities for controlling the diversity and complexity of the world.

The scientific enterprise is an integral component of the hegemonic capitalist economic system that emanates from the center. All people, places, and materials are commodities to be extracted, produced, and consumed within the center and beyond. The only way the center can attempt to control and exploit the complexity of the world is to inventory, classify, and standardize data as a part of the science – economic enterprise, and make the unfamiliar familiar. The capitalist center is aware that commodities and potential sources of wealth may be found within indigenous knowledge systems, the land, or in the case of the Kiowas, plants.

Vestal and Schultes (1939) focus on the economic benefit plants, not only for the Kiowas, but also for the entire empire. The forward written by Professor Clyde Kluckhohn of the Division of Anthropology and the Peabody Museum at Harvard University clearly indicated the economic significance "of borrowing presented by Vestal and Schultes…as an example which ethnologists might study with great profit" (Vestal and Schultes 1939, xi). This kind of statement may encourage some academic researchers, like the fictional Indiana Jones, to go out and search the world for treasure in peripheral indigenous homelands. For instance,

> The main interest of man, regardless of his state of civilization, lies in the acquisition of a dependable and adequate supply of food and of the other necessities of life. To secure these, he is forced to rely upon a combination of his ingenuity and environment. Necessity and curiosity have led him to discover useful plants and animals. As a result of his industry, many fibers, medicines,

> narcotics, gums, dyes, tannins, and other plant materials have attracted his attention and have become integral parts of his economic life. (Vestal and Schultes 1939, 21)

Vestal and Schultes were especially interested in investigating the "Peyote-cult" and the Peyote plant itself. To learn more about the local Kiowa knowledge and the peyote plant's medicinal economic value, they consulted "a seventy year old Kiowa medicine man and peyote-leader" (Vestal and Schultes 1939, 9). Through their research and the research of others before them, they found that "Peyote is unquestionably the most important plant among Indians in the United States" (Vestal and Schultes 1939, 43). More importantly, the Kiowas considered Peyote as a cure for tuberculosis, colds, fever, pneumonia, intestinal ills, venereal diseases, and scarlet fever.

In the view of Vestal and Schultes, Peyote was a remedy to be studied at the Harvard University center of calculation. They believed that the colonization of Kiowas on the reservation created conditions that were:

> psychologically right for the introduction of a powerful physical and spiritual medicine, which could be fitted into a ceremony, around which the ancient traditions could be incorporated for preservation…the introduction of Peyote coming during an era of subjugation has played a prominent role in rendering bearable the Indian's complete subservience. (Vestal and Schultes 1939, 81)

Stability, Combinability, and Representations

It is important for the centers of calculation, like Harvard University, to maintain the *stability* of the materials collected and inscriptions created "so that they can be moved back and forth [between the center and periphery] without additional distortion, corruption or decay" (Latour 1987, 223). Specimens like plants, animals, bones, North American Indian medicine bundles, shields, weapons, housing, clothing, and maps need to be preserved so that the centers of calculation can produce more inscriptions and more knowledge about the periphery. Vestal and Schultes reasoned that the Kiowas used Peyote because they were colonized and crushed by the dominant society. Such reasoning was not produced on the periphery, by the Kiowa who lived there. Rather, information and specimens where relocated to the Harvard center of calculation were scientists formulated theories and attempted to systematically organize Indians in a era of Indian Reorganization (post-1934). Thus, the movement and stability of newly acquired information requires the funding of projects (to move things back and forth), central control (to construct knowledge among friends), and the scientists who create new inscriptions (the actors who author intermediaries).

Stabilization also involves taking indigenous knowledge out of its context and placing it into a scientific classification scheme and incorporating standards so that new materials and inscriptions can be made combinable. Vestal and Schultes incorporated fragments of Kiowa knowledge such as the word for Peyote (sen-ee) and its meaning, prickly cactus, as supplementary information to the plant's scientific classification as *Lophophora williamsii*. In order to extend networks, inscriptions must be *combinable*.

Centers combine past and present materials and construct maps, database layers, tables, and charts (Latour 1987). Once the materials are stable and combinable, the information and knowledge produced by anthropologists or geographers or geologists or biologists can be combined with seemingly distant entities such as economic institutions, missionary organizations, academic institutions, and corporations (Latour 1987). North American Indians and their land have been subjected to such cycles of accumulation that began at the time of first contact with Europeans and continues today. Often institutions such as the BIA will combine fragments of indigenous knowledge with scientific knowledge systems in an effort to further enroll actors into the network.

GIS networks gain strength when they have support from multiple allies (Latour 1987). The spokespersons associated with my study include employees of branches of the United States federal government, including Congress, the DOI, the BIA, the BIA GDSC, and the ESRI corporation. The extension of networks appears to be a never-ending process as the center(s) attempt to strengthen their positions within networks. Thus it is important to keeping informants aligned, and to be able to enlist other actors locally. For example, this means enrolling comprador American Indian tribal governments and their offices. As this occurs and GIS is translated successfully between at least two actors, then all actors will be able to speak for one another and "establish longer networks [and] make the many act as one" (Latour 1987: 235). One way that this has been done in relation to the U.S. federal government and American Indian tribes was through the rationing of materials.

Rations

Governments used food and supply rations as materials in colonial rule. For example, the United States and Australian governments used rations[10] to maintain order over indigenous people. The rationing system consisted of a network of donors and recipients. Recipients depended upon the flow of material goods and assistance for survival. Initially, indigenous people received rations as a form of welfare. However, over time, the United States and Australian governments used rations for leveraging indigenous people into a system of wage-work. Furthermore, rationing has a spatial logic, requiring recipients to go to designated places or obligatory points of passage to sign up for and receive rations. Records of individuals can become a surveillance system for keeping track of ration recipients and fixing them in place.

There is a limited body of literature focusing specifically on rations and the rationing systems in North America and Australia. One detailed study is *White Flour, White Power: From Rations to Citizenship in Central Australia* by Tim Rowse (1998). Rowse describes rations and the rationing system as “an institution of colonial order” (Rowse 1998, 3). The Australian ‘institution of colonial order’ consisted of several actors including government administrators, missionaries, miners, pastoralists, and indigenous people. Within this network, rations flowed between actors.

Rations contributed to the assimilation of indigenous people into Western society. In Australia, “the assimilationist intention [was] to induce Indigenous people to adopt the same way of life as the colonist” (Rowse 1998, 4). Rations helped governments nudge indigenous people into a new social and economic system,[11] one that mimicked that of the colonists.

The rationing of material goods involved donor – recipient relations between the general public, business, the federal government, and indigenous people. Settlers and the Australian government provided food and supplies to Aboriginal tribes to offset the impacts of settlement within their homelands. With settlement came the introduction of crops, cattle, and sheep to the physical environment. Other impacts included fencing off large sections of land to contain livestock and agricultural fields. Such action greatly transformed the migratory hunting and gathering social - economic systems of Aboriginal tribes. In fact, Australian Aborigiones hunted and killed cattle to provide food for their communities. Rowse argues that, “the colonists had little choice but to become donors of rations” to avoid having their cattle killed by Aborigines and to support the colonial administration’s goal of assimilation (Rowse 1998, 3).

The rationing system involved the flow of material goods from donors to recipients as an act of providing welfare to indigenous people. Some government agents, Christian missionaries, and businesses believed that rations pauperized indigenous populations, making them less industrious and more dependent upon government supplies. Rations as welfare was at odds with the promotion of individualism and work in the nineteenth century. Overtime, the objectives of rationing changed from one of providing welfare to indigenous people to one of providing rations as work-wages. This situation resulted in the re-working of the rationing system and the issuance of rations for work (Rowse 1998). Along with the change in ration policy in the United States came the development of schools and "instruction in mechanical and agricultural arts" (U.S. Congress 1877). Education and training provided skills needed to adapt to a new social and economic system.

The United States and Australian governments used rations to leverage indigenous people into labor. In both regions, indigenous people received rations as compensation for labor (Rowse 1998; Prucha 1962; 1986). In North America, the Commission on Indian Affairs argued that rations would act as an incentive "to industrious habits" and furnished as payment to those hard working individuals (U.S. Congress 1877). The leveraging associated with the rationing of materials nudged indigenous people into a new social and economic system. One tribal leader from a Pacific Northwest reservation charged,

> Washington has changed its face [in relation to ration distribution], and no longer gives us either the money or the rations, but sets work for us to do, and pays us the same money in wages. Is that right – to make us work for our own money? (Leupp 1910, 180)

Then Commissioner of Indian Affairs, Francis Leupp countered,

> Your money comes to you, as the Government promised it should. On the way to your pockets it makes your bodies do some work, and the work is as good for you as the money; so what Washington is doing is not taking away any of your dollars, but giving them to you with a benefit added. (Leupp 1910, 182)

Similar methods of leveraging work for rations occurred in Australia. "Rationing was a technique of frontier government…a continued policy of assimilation…it also helped overcome one of the common problems of pastoral enterprise: shortage of labor" (Rowse 1998, 17). This meant that indigenous people had to work for goods and increase their industry. At the same time, the pastoral enterprise gained cheap, available labor in the bush.

Rationing has a spatial logic. The act of distancing presents yet another problem in the donor-recipient relationship. Distancing refers to both proximity and relational space. Donors can be physically very close to recipients, but culturally very distant.

> One of the features of rationing which made it a transferable technique was that it was culturally undemanding. Rationing brought donors and receivers into close and even habitual contact without requiring their mutual understanding. (Rowse 1998, 5)

The American public is taxed and subsidizes the distribution of GIS rations emanating from the BIA. However, the American public may not be aware of this situation because they are both physically and culturally distant from the rations and reservations to which they flow.

Geographer Matthew Hannah argues that rationing is a method of social control based on visibility or knowing where people are located at all times. Hannah's study of the Oglala Lakota demonstrates this theory. The concept of surveillance revolves around the way in which federal agents distributed beef rations. The Oglala Lakota preferred to take beef cattle from the agency back to their camps sites. Once at camp, the Lakota slaughtered the beef at their convenience and distribute portions according to tribal ways. In this way, the Lakota maintained tribal customs and members of the tribe did not have to personally visit Fort Laramie to receive rations. However, the United States federal government's position on the matter was to break-up tribalism and develop a spatial system for identifying and fixing the locations of all Oglala Lakota tribal members in space.

> Bureau officials knew that if they could issue beef in individual portions, they would be able to establish a registration system for the receipt of rations, which would allow individual identification and punishment. The need to collect rations would bring individuals within the official field of vision as individuals; the wrongdoers among them could then be identified and denied rations. This plan constituted the first official attempt at efficient staging of the Oglalas, that is, making up the inability to observe everyone all the time by concentrating the official gaze on one location or activity through which all must pass [obligatory point of passage]. (Hannah 1993, 423)

The new rationing system required tribal members to go to the fort or obligatory point of passage to receive rations. At the fort they signed a list showing who received beef and who did not.

Some indigenous people faced penalties for not conforming to government policies. The expectation that rationed goods would shape the behavior of individuals evolved as a component of colonialism. For example, colonists in Australia rationed goods and supplies with the expectation of shaping the behavior of the indigenous recipients (Rowse 1998). Tribal members conforming to the ration system received rewards and those that refused faced penalties (Hannah 1993). In the case of the Oglala Lakota, not conforming to procedures resulted in the withholding of rations (Hannah 1993). Penalties hit at the heart of family life in other American Indian communities as well. For example, parents who refused to send their children to government or mission boarding schools faced serious sanctions including the withholding of annuities and rations. If the strategy of withholding material did not achieve its objective, the government could send the parents to jail. Government quotas regarding the number of America Indian children enrolled in boarding schools contributed to such harsh actions (Marr 2003).

The history of rationing shows that the quality of rations can degrade over time. For example, when the Oglala relocated further away from Fort Laramie, civilians assumed rationing responsibilities, and the overall quality of the food deteriorated. Tribal members received rotten beef, pork, soured flour and bacon. In fact, the Oglala did not even know what to do with flour, so wasted the material (Hannah 1993). Likewise, in some tribal offices, software packages remain unopened, software uninstalled, and eight thousand dollar GPS units and map plotters gather dust in the corners of dingy tribal government offices.

SUMMARY

In summary, this dissertation is an archival research study incorporating elements of actor-network theory as a conceptual framework for better understanding of GIS at the BIA GDSC. My analysis is based upon the idea that “The history of technoscience is in large part the history of the resources scattered along networks to accelerate the mobility, faithfulness, combination and cohesion of traces that make action at a distance possible” (Latour 1987, 226). These traces are made up of *intermediaries*, *actors*, and *networks*. *Enrollment* within a network is accomplished through *translation*. Translation represents the interest(s) between actors and is the means by which material intermediaries flow or diffuse from one location to another. Alignment within networks is referred to as *convergence*. Networks that translate smoothly and without controversy are said to be highly convergent and can become stabilized and *irreversible* over time. Major nodes within the network can become *obligatory points of passage* that control resources and are places that weaker nodes and actors must pass to gain access to resources. Very strong obligatory points of passage can become *centers of calculation*. The Latourian concept of centers of calculation is a core and periphery model and the major template for my research. Concepts associated with the center of calculation include *cycles of accumulation,* *mobility*, *stability*, *combinability*, *representations*, and extension of networks further through what I refer to as the *rationing* of GIS. These processes can be traced through government documents and their associated networks at the BIA GDSC.

CHAPTER THREE

STANDARDIZATION OF INSTITUTIONAL GIS

> The virtue of the mass commodity is its reliable uniformity. (Scott 1998, 31)

In this chapter, I will provide some evidence for the standardization of institutional GIS in North America. United States federal government legislation like the National Environmental Protection Act of 1970 helped facilitate the development of GIS. NEPA called for the collection of massive amounts of environmental and natural resource information. To address individual environmental and natural resource management problems, institutions developed a diverse set of geographic information technologies. Overtime, some institutions focused on the implementation of nationwide GIS projects, requiring the development of large data sets. Finally, there was a shift to standardized GIS across multiple agencies. For this standardization, federal government institutions turned to GIS corporations like Environmental Systems Research Institute (ESRI). As James C. Scott informs us in *Seeing Like a State*, modern institutions “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” (Scott 1998, 3).

National Environmental Policy Act and GIS

The National Environmental Policy Act (NEPA) of 1969 emerged in the wake of an increasing awareness about the condition and need for protection of the natural environment. The purpose of NEPA was:

> To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality. (United States Congress 1970)

Requirements associated with the implementation and application of NEPA had an impact upon federal agencies and their adoption and use of GIS.

The impact of NEPA on the adoption of GIS by federal government agencies has been tremendous. Historical studies of GIS reveal that, “NEPA has been recognized as the most significant motivating factor for the use of GIS technology by many federal agencies” (Foresman 1998, 10). Federal funding and new environmental protection applications forced government agencies, “into a new legal and ethical milieu in which comprehensive, interdisciplinary analysis were absolutely essential” (Dodson and Durfee 1998, 247). Automation of management processes evolved out of this complexity. For example, “along with NEPA, the formation of the U.S. Environmental Protection Agency served to motivate federal and state agencies to seek automation solutions for large-area resources inventory and assessement under the increasing litany of complex environmental laws” (Foresman 1998, 11).

Automation through GIS focused on the development of applications particular to NEPA requirements.

Early GIS applications needed to meet the interdisciplinary character of NEPA including environmental impact assessments, environmental management, land-use management, and planning (Foresman 1998; Warnecke 1998). Federal funding to support such activities trickled down to private industry and “helped finance the start of many GIS software vendors” (Foresman 1998, 10). NEPA requirements and subsequent federal funding to support such activities supported the early development of GIS technology (Foresman 1998).

The implementation and operational status of NEPA depended greatly upon the mobilization of vast amounts of data on the physical environment. NEPA was supported by actors such as the United States Congress, the Council on Environmental Quality (CEQ), the President of the United States, and the Environmental Protection Agency (EPA) who governed through additional national environmental policies[12] and CEQ regulations (United States Congress 1970). This top-down environmental policy and its adjoining requirements ignited yet another cycle of accumulating geographic information on the physical environment and its human inhabitants in the United States. NEPA was instrumental in protecting the environment from the impacts of American modernization, while maintaining close surveillance on the Earth’s decreasing renewable and non-renewable natural resources.

NEPA emerged in the late 1960s when the United States and the Soviet Union led the world in science and technology innovation, development, and diffusion. Some of the technological fingerprints marking this period of history included computerization, systems analysis, and cybernetics. These ideas were put into practice through the automation of industry and factories (Noble 1984) and through the operational digital battlefield in Vietnam (Edwards 1997). Such actions place much of the operational responsibilities on managers. Managing industrial, military, environmental, or natural resource systems requires feeding massive amounts of data into digital computers and producing computations. NEPA required massive amounts of information on the environment. Government agencies, however, tend to develop ways of decreasing complexity, selecting only what is important to meet management tasks, and standardizing data (Scott 1998).

When digital computers and later GIS came along, natural resource managers on the ground used them to reduce the burden of information overload on humans. Take for instance the following quote regarding NEPA, GIS, and the United States Department of Defense (DoD):

> Compliance with NEPA meant that the potential impacts of any of these actions need to be evaluated and alternatives considered before making changes to the physical landscape. Such evaluations required data on soil erodibility, species habitat, the potential or known location of cultural sites, topography and vegetation cover…Flipping through the paper maps and reports from contractors to try and integrate all these factors took on nightmarish dimensions, and the environmental managers were crying out for help. (Goran 1998, 201)

Following the passage of NEPA, managing the environment became a crisis for both the nation and the overwhelmed natural resource mangers.

The goal of NEPA was to address several regionally present and globally emerging environmental problems including “population growth, high-density urbanization, industrial expansion, resource exploitation” not only for the United States and the North American region, but to also “recognize the worldwide and long-range character of environmental problems…preventing a decline in the quality of mankind’s world environment” (United States Congress 1970). Environmental and natural resource management problems would require re-thinking the technologies to be used on the ground and also figuring out how to manage massive amounts of qualitative and quantitative data associated with environmental impact assessments.[13]

NEPA calls for the gathering of information about distant places and the environment, and the need “to accumulate necessary data and other information for a continuing analysis of these changes or trends and an interpretation of their underlying causes” (United States Congress 1970). This would be accomplished by, “collecting, collating, analyzing, and interpreting data and information on environmental quality, ecological research, and evaluation…initiate and utilize ecological information in the planning and development of resource-oriented projects” (United States Congress 1970). This included natural resource activities taking place on American Indian tribal land. The federal policy called upon government agencies to comply, and provide supplemental environmental information in addition to their primary missions.

It was the obligation of all federal government agencies, “to the fullest extent possible each agency of the federal government shall comply” through “action-forcing” provisions to make sure that federal agencies act according to the letter and sprit of the Act (United States Congress 1970; Council on Environmental Policy 1978). The policy reveals, “All federal agencies shall: 1) utilize a systematic, interdisciplinary approach which will ensure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which have an impact on man’s environment” (United States Congress 1970). NEPA was a nationwide program with aspirations of securing the environment including natural resources. Systematic management and integration of the environment into computers contributed to the independent development of GIS within some government institutions during the late 1960s through the 1970s.

Independent GIS Development within Agencies

Early GIS consisted of several different kinds of independently developed products including Canadian Geographic Information System (CGIS), Synagraphic Mapping System (SYMAP), ODSSEY, Map Overlay and Statistical System (MOSS), Geographic Resource Analysis Support System (GRASS), and others. Government and academic institutions develop the diverse array of technologies to meet the natural resource management needs of individual agencies. The relative independence of federal and state government agencies in the management of natural resources is conducive to the development of individual GIS projects within government agencies and academic institutions (Chrisman 1994). The federal system gives control of affairs, like mapping and GIS, to individual agencies to develop and implement as they see fit. Evidence of early GIS development in North American supports this position. Some North American GIS projects included the Canadian Geographic Information System (CGIS), the Harvard Computer Graphics and Spatial Analysis Laboratory, and GIS development within some federal government agencies.

The CGIS is often considered the first computer-based GIS used for natural resource management. Led by Roger Tomlinson, the CGIS was set up to handle large datasets that would eventually grow to cover Canada. The emphasis, like that of many early digital machines, was control and calculation of digitally embedded information (Tomlinson 1988), without a great emphasis upon cartographic representation and output. Prominent actors working on the project included the Canadian Department of Agriculture, the Canadian Agricultural Rehabilitation and Development Administration, a cadre of computer technicians from IBM, and Spartan Air Services using an IBM 360/65 mainframe computer to meet their objectives of creating nationwide GIS coverage with over 100 different themes (Coppock and Rhind 1991).

The linage of United States federal government GIS can be traced to Harvard University during the late 1960s and early 1970s. Howard Fisher and geographer William Wertz directed the Harvard Computer Graphics and Spatial Analysis Laboratory. The Harvard lab placed emphasis upon developing networks of scholars and disseminating information about the program through conferences at a national scale (Chrisman and Harvey 2004). Academic cartographers, however, did not necessarily play a significant role in GIS development at the lab, which consisted primarily of computer scientists, mathematicians, and a few geographers. Nick Chrisman writes, "The details of design were set by these people [programmers] without guidance for cartographic experience, since programmers in 1966 tended to have numerical and scientific backgrounds" (Chrisman 1988, 293). As at the CGIS, computer technicians played a major role in GIS developments at Harvard including; 1) the creation of a mapping software called SYMAP in 1964, 2) a raster-based program called GRID that allowed overlaying of spatial data; and 3) ODSSEY that some scholars view as the model for contemporary vector GIS (Chrisman 1988; Coppock and Rhind 1991).

The problem of decreasing complexity is also evident in the raster and vector GIS formats. Raster-based GIS incorporates 'fields' like aerial photography, false-color infrared images, or digitally-scanned maps. Much of the data needed to analyze and interpret natural resource management problems consists of fields. As a result, raster-based GIS became very valuable to resource managers on the ground. Storage of raster-based data is one of the main problems with the image based system. Aerial photographs take up significant amounts of computer memory, which can slow the entire system down. The Geographic Resource Analysis Support System (GRASS), developed by the U.S. Army Corp of Engineers, is an example of raster GIS. Vector-based GIS was designed to reduce the complexity and information overload associated with field data. Vector-based GIS allows the natural resource manager to digitize only what is necessary, to create ‘objects’ instead of fields. Entire forests can become a shaded polygon area, represented as a set of attributes in a GIS database. Both GIS configurations emerged out of CGIS and the Harvard lab. Other federal agencies, focusing on natural resource management, developed raster-based systems.

Of particular interest to this dissertation is the development of GIS within the United States Department of the Interior (DOI). Similar to CGIS, the DOI’s early GIS development efforts focused upon land and natural resource management. The USGS began experimenting with digital cartography in the 1960s through the digitization of topographic base maps. This led to the development of base map applications “with statistical or thematic data to automate the production of atlases” (Greenlee and Guptill 1998, 182). These projects later evolved into the development of land-use/land-cover databases, the integration of remote sensing data into map production, digital elevation models (DEM), digital line graphs (DLG), and digital raster graphics (DRG). All of these were nationwide projects representing an already existing topographic map system through the process of converting from manual to digital systems.

In general, agencies within the DOI place great emphasis on natural resource management. Natural resources as a common interest led to GIS network building between several DOI agencies. The United States Fish and Wildlife Service (USFWS) led another independent GIS development that would impact the BIA. In the mid-1970s the ‘USFWS’ in collaboration with the Western Energy and Land Use Team (WELUT), initiated the development of the Map Overlay and Statistical System (MOSS) in Fort Collins, Colorado. The USFWS used MOSS in map production for approximately 10 years. During this time the Bureau of Land Management (BLM) took a leadership role in the development and ultimately the transfer of MOSS to the BIA. The BLM compiled and mapped information associated with environmental management including land-use planning, soil conservation, range management, land ownership and public land survey (Greenlee and Guptill 1998). The BLM acted as a mentor to BIA GIS development as seen through the diffusion of MOSS and PRIME computers.

Even though the BIA is in the business of working with and presumably for American Indians and their land, GIS development did not take into account the extreme complexity associated with cultural diversity. Neglecting the complexity of cultural diversity eliminated a significant amount of particular information about people and places that did not have to be incorporated into a natural resource-based

GIS. GIS development at the BIA began in the mid-1980s (Marchand and Winchell 1992) although one BIA specialist mentioned that the earliest roots of GIS at the BIA can be traced to the Portland region in the mid-1970s (BIA 2005d). The first BIA GIS, appearing in the literature, was the Indian Integrated Resource Information Program (IIRIP) developed to support resource management on tribal land areas (Greenlee and Guptill 1998). Early GIS activities focused upon the development of a centralized database. In the early 1990s, the BIA claimed, "that more than two-thirds of reservation acreage is represented in ARC/INFO libraries in their [BIA] possession" (Rundstrom 1995, 54). However, according to one BIA GIS specialists very few tribes utilized GIS at the BIA GDSC (Marozas 1993). Other than some facts found in papers focusing on GIS and American Indians, relatively little is known about the BIA GDSC, and with exception of Marozas (1993) no significant articles analyzed the development and diffusion of GIS at the BIA GDSC. One of the purposes of this dissertation is to fill in more details on the development of BIA GIS and their accompanying networks.

An American Indian institution developed at least one GIS innovation. The Rez Mapper was an application that supposedly presented "cultural aspects of the Rosebud reservation in a range of maps, imagery, GIS layers and multimedia data in a dynamic interface" (Mannel and Winkleman 2005). Sinte Gleska University (Tribal College) and the consulting firm Spatial Data Technologies developed the software package that was distributed to schools within the Rosebud Reservation. The project has attracted the interests of federal agencies such as the USGS, EPA, and NASA.

All of these projects involved heterogeneous networks of human and non-human elements, putting materials, funding, and skills into circulation in the development of various GIS. Technicians, administrators, and funding agencies contributed greatly to the shaping of GIS technologies during the early developmental stage. Any one of these systems could have become the North American prototype GIS. Within the laboratories of government agencies and academia, such innovations are just good ideas, but in order to survive institutions must make them useful for the general public on a nationwide scale.

Nationwide Applications

Unifying natural resources and the physical environment under the umbrella of 'nationwide' has historically received political and financial support from the general public (Scott 1998). The same was true for institutional GIS in North America. Institutions and agencies needed to focus in on publicly visible 'nationwide' projects to support the continuation of GIS at the institutional level. What we find in the historical development of GIS is that developers must constantly seek financial support from patrons to stay alive. Funding generates momentum. Early GIS was not a necessary infrastructure like water lines or electricity supported by strong networks of government subsidies, loans, and paying customers. As with other federal government agencies, funding flow to the BIA GDSC was dependent upon the relevance of the center and the services it had to offer to BIA and tribal government offices. The idea of ‘nationwide’ coverage could achieve the goal of large-scale resource management applications, not only for agencies involved, but for the benefit of the general public as well.

The CGIS was the first nationwide GIS project in North America. Roger Tomlinson expressed the importance of nationwide GIS projects within government agencies by stating that, “The fact remains that Canada was the first nation in the world to be able to carry out continent-wide geographical analysis from high resolution map data (<1:250,000) concerning many aspects of its natural resources and socio-economic conditions” (Tomlinson 1988, 257). GIS demonstration projects such as CGIS show the technical capabilities of a federal, a state, or a tribal government in attaining high technical standards. Tomlinson also places an emphasis upon improved socio-economic conditions that GIS could help achieve for the nation.

Justification for U.S. federal government GIS as a nationwide program went hand in hand with the USGS’s status as the national mapping agency; a status that dates back to the early years of topographic mapping in the United States (Southard 1983). Because of their history and culture as the nation’s cartographic agency, the USGS became a major supplier of geospatial data and had a major influence on the development of GIS within the DOI. Public access to geospatial resources was important. Governmental policies including the free flow of information to citizens through the Freedom of Information Act (FOIA) and the Open Skies Policy giving unrestricted access to remotely sensed data also sustained the development of GIS at the USGS (Greenlee and Guptill 1998). These developments included nationwide coverages such as Digital Line Graphs (DLG), Digital Raster Graphics (DRG), and Digital Elevation Models (DEM). One of the primary criterion associated with the funding of GIS at the USGS rested on the continued cooperation between "the USGS's Geologic, Water, and Mapping Divisions" (Greenlee and Guptill 1998, 193). The USGS built upon historically strong networks. Perhaps the most important point is that the USGS did not set out to reinvent the wheel. The USGS digitally reproduced features off of existing topographic maps, a system that the American public was familiar with and supported for over a century. In fact, products developed at the USGS shaped GIS data at the BIA in the 1980s and 1990s.

For the BIA, the word 'nationwide' refers to both scale and a point of emphasis in describing the agency's development of GIS themes for Indian Country. Some tribal governments revealed that in the early 1990s, the BIA controlled many of their important forestry and natural resource GIS applications (Marchand and Winchell 1992). The BIA also maintained control of the Colville Confederated, Warm Springs, and Flathead reservation's GIS applications and vast storage of data. All three tribal governments made a request for the development of independent, locally controlled GIS, but were originally denied by the BIA (Adams 1999). Other tribes like the

Cherokee Tribe of Oklahoma have successfully used the BIA as a "springboard" for jumping into the GIS arena and developing local, tribally controlled GIS (Bond 2002). However, federally mandated downsizing of the GDSC occurred in the mid-1990s limiting the agency's ability to construct, develop and maintain geographic information data (Bond 2002). However, these papers do not reveal exactly how much the budget decreased during mid-1990s or how much funding fluctuated from year to year. Some literature shows that GIS development was well underway in tribal communities by the time the GDSC lost momentum in the mid-1990s.

Although this dissertation does not study tribal government GIS in detail, evidence suggests that some tribal GIS applications local and particular information. Much of data is unique to tribal communities and is not included in nationwide datasets or applications. The literature shows that some tribal communities use GIS for land claims (Duerden 1992), water rights litigation (Marozas 1991), and the documentation and protection of culturally sensitive sites (Williams 1994). Others have considered the idea of culturally appropriate (Natel 1999) and culturally relevant GIS to be deployed in North American Indian communities using government data sources (Marozas 1993). Access geographic information particular to local places is problematic in relation to the standardized, overarching nationwide GIS databases developed by federal agencies.

Once GIS development is underway and systems within agencies are operational, developers of the systems must justify their (the system, the technicians) existence through the discourse, of among other things, nationwide coverage. Historically the USGS attained a status as an important national mapping agency, thus through inter-agency cooperation sustained GIS development. Agencies like the BIA have taken on nationwide GIS projects as well, but lack the cartographic credibility that the USGS has built up over time. Sometimes tribal government GIS are unique to a particular place, yet still need geographic information on land-use, environmental protection, or natural resource management. Each agency is different in terms of what needs to be managed and for what purposes. However, one thing that many federal agencies have in common is that GIS technology, especially software, has standardized overtime.

Standardizing Institutional GIS

ESRI GIS products are the standard within many federal, state, local, and tribal governments. Mark (et. al 1996) stated, "Since these companies dominate GIS, the image of GIS projected by these companies helps to define GIS among GIS users and others." Within the history of GIS development these relationships are barely explored. Perhaps this is because commercial GIS are black-boxed and few controversies appear to be associated with their continued progress of stable development and diffusion. However, as I discussed above, the history is quite complex as innovations sprang up, died, and often were brought back to life (Chrisman and Harvey 2004). Studying the technical development of commercial

GIS is important. Equally important, however, is the development of networks among corporate GIS, federal government agencies and academia. As this research reveals, ESRI shaped the very meaning of GIS at the BIA GDSC.

ESRI has deep roots in the Harvard Laboratory (Chrisman and Harvey 2004). Jack Dangermond, originally a graduate student at Harvard and part of the Laboratory, founded ESRI in 1969. As a small non-profit company it focused on developing business relationships with government organizations, mainly through natural resource management applications. Since many government organizations lacked expertise in the areas of computer technology and GIS, ESRI filled that void. The company used software applications innovated at Harvard, including GRID, to develop their first turn-key GIS system ARC/INFO. This software package was extremely successful because of its ability to run on various computer platforms (Coppock and Rhind 1991). The success of the company also can be attributed to "the forging of close links with users in education and other sectors" (Coppock and Rhind 1991, 33). ESRI's early strategy for selling their products "was a matter of pressing GIS solutions on unaware and unwilling potential users, involving constant selling and subsequent support" (Coppock and Rhind 1991, 32). Again, this is a case of having a solution in search of a problem.

Over the past two decades, GIS software corporations have knowingly or unknowingly entered into the complex cultural, social, political and economic relationships between the United States federal government and American Indian tribes. As with past missionary activities, federal Indian policies, and present GIS technology, these corporate to government relationships are contradictory in nature. For instance, ESRI helped produce a GIS overlay map of “Zuni Lands Taken Since 1846” which “was created to aid the Zuni in a land claim against the United States” (Warhus 1997, 217). In another instance, plaintiffs in the Cobell v. Norton multimillion-dollar lawsuit against the DOI for alleged mismanagement of tribal funds used ESRI’s ArcView GIS software and BIA GIS data sets to analyze trust land assets (Dizzard 2003) to help prove their case. Yet at the same time, ESRI supplies western governments and transnational corporations with GIS software that could affectively colonize indigenous people on a global scale. Although ESRI may declare a neutral position and label such activities as “conservation GIS,” these activities are in themselves very political acts (Palmer 2007). Political relations are also inscribed in the materials used in GIS development in Indian Country.

Robert Rundstrom (1993) writes, “Assimilationist practices can and do emanate from the ways in which cartographic technology (including GIS) is used, and from the cartographers’ erstwhile desire for an easier job” (22-23). This is an important point as related to federal government agencies like the BIA concerned with completeness and cost-efficiency. One of the ways in which nationwide topographic map coverage is achieved and made combinable with other mapping agency projects is through the implementation of standards. These cartographic and GIS practices can affect the diversity of indigenous languages (Rundstrom 1993).

SUMMARY

Conventional histories of GIS can inform academic scholars on some of the important aspects of the perceived linear trajectory of GIS development within North America institutions since the late 1960s. Development of GIS corresponded with emerging environmental awareness and crises, including passage of an important piece of legislation known as the National Environmental Policy Act (NEPA). Three distinct stages of institutional development emerge from the literature. The first stage includes the independent development of GIS within institutions to address nationwide mapping and natural resource management issues in North America. It is during this phase of development that initial funding flowed to institutions, expertise was developed, and innovation occurred. The second stage of development was associated with the conception and implementation of nationwide GIS projects. The third stage of development is standardization dominated by the commercialization of GIS within institutions (Longley, et. al 2001). Often, institutions connect with corporate GIS vendors to support their management efforts. When GIS corporations enter relationships with the federal government and American Indian tribal governments, they are necessarily entering into relationships that are anything but neutral.

CHAPTER FOUR

CONDITIONS FOR CENTERING GIS IN INDIAN COUNTRY

> At every run of this accumulation cycle, more elements are gathered in the center; at every run the asymmetry between the foreigners and the natives grows, ending today in something that indeed looks like a Great Divide, or at least like a disproportionate relation between those equipped with satellites who localize the locals on their computer maps without even leaving their air-conditioned room in Houston, and the helpless natives who do not even see the satellites passing over their heads. (Latour 1987, 221)

The gathering of digital geographic information on Indian Country in the late 1980s through the mid-1990s represented yet another cycle of accumulation dating back to the Great Surveys of the West (mid-1800s), the reservation system (1870s), the allotment system (1890s), the Indian reorganization period (1930s), and the Indian Land Claims Commission (1950s – 70s). All of these cycles required gathering information on the ground and constructing maps to represent Indian Country on paper and as data. Computer-based GIS arrived in Indian Country as a set of technical artifacts used by natural resource managers to help address some of the requirements set forth by national environmental policy. Before explaining what was actually gathered and constructed at the BIA National GIS Center,[14] this chapter will theorize some of the conditions that led to this new cycle of accumulation.

Federal environmental policies, the centering of resources and GIS expertise and the BIA's enrollment within an emerging corporate GIS network increased the mobility, stability, and combinability of GIS within the BIA. Meeting these conditions led to the development of a top-down, technocratic system consisting of GIS specialists, bureaucratic administrators, BIA field offices, DOI agencies, computer hardware, software, and government contracts all for the purpose of managing the physical environment in Indian Country. The origins of GIS at the BIA provides some evidence that "an obscure laboratory, or a puny little company in a garage, that were at first as weak as any other place will become centers dominating at a distance many other places" (Latour 1987, 223). Transformation to a center of calculation requires building upon past cycles of accumulation, leveraging political policies, securing funding resources, building up skilled employees, networking with strong agencies and institutions, and making data and systems combinable.

BIA Cartographic Record

The BIA has accumulated geographic information of American Indian people and land resources over the past two centuries. With that said, there are very few articles or books on the BIA's cartographic history. The majority of historical maps are designated as Central Map Files coming from the Mails and Files Division of the BIA and transferred to the National Archives throughout the twentieth century. However, as will be seen in the next chapter, bureau maps were not significant in the construction of GIS at the BIA GDSC. The USGS topographic nationwide maps were much more important. However, a brief review of BIA mapping activities is in order. *Cartographic Records of the Bureau of Indian Affairs* compiled by Laura

Kelsay (1979), is a source of information regarding the availability of BIA maps at the National Archives in Washington D.C., and College Park, Maryland.

Most of the maps "date from the early 1800's to 1968 and include,

> Exploration routes, tribal lands, Indian cessions and reservations, areas selected for withdrawal from the additions to reservations, forts and military reservations, boundary lines, private land grants, roads and railroads, railroad grants, allotments to individual Indians, homestead claims, school lands, church lands, townsites, national forests and parks, timber and mineral lands, farming and grazing districts, cultivated and uncultivated lands, irrigable lands, irrigation projects, and rights-of-way through Indian lands of railroads, pipelines, telephones and telegraph lines, highways, electric transmission lines, canals, and irrigation ditches. (Kelsay 1979, 3)

The Land Statistics, Reservations, and Grants Division, established in 1846, also developed maps. Mapping activities within this division revolved around three federal land policies. The first coincided with the development and implementation of the reservation system in the mid to late nineteenth century. The second level of activity was brought on by the implementation of federal allotment policy in 1887, and increased in 1907 because of "expanded duties" associated with the allotment of Indian lands (Kelsay 1977, 72). The third began after passage of the Indian Reorganization Act of 1934.

> According to the 1934 Annual Report of the Office of Indian Affairs, the activities of the Land Division included work in land acquisition, mineral rights and leases, allotments of land in severalty, enrollment of individual Indians, tribal litigation in the Court of Claims, legislation, and hunting and fishing rights. (Kelsay 1977, 72)

In addition to land, the BIA conducted inventories of water resources, infrastructure associated with irrigation, forestry and grazing lands.

The mapping of natural resources included the establishment of the Irrigation Division that was

> Formally established until 1924…by 1931 irrigation was practiced on Indian Reservations in 12 western states. The Division was responsible for investigating new Indian irrigation projects, carrying out irrigation programs approved by Congress…Some are maps of the reservations showing allotments, irrigable and nonirrigable lands, locations of irrigation projects, cultivated areas, acreage under irrigation, canals and ditches, wells, pump stations, and dams. (Kelsay 1977, 98)

Also established in 1924, the Forestry Division of the BIA developed maps pertaining to national forest, transportation routes, fire control, and lumber areas. In 1936, reorganization occurred and the Forestry and Grazing Division emerged as an integrated department (Kelsay 1979). Although maps related to natural resources were abundant, there was very little evidence that the Service Center used these maps in the development of GIS. However, one map that did emerge from the center was of Indian land areas in the United States.

The BIA developed a series of maps called *Indian Land Areas* in 1971, 1987, and 1989. These maps were "a highly generalized view of Indian reservation lands" that did not include indigenous place-names or even the presence of people on the land (Cole 1993, 47). Cole mentioned the development of GIS layers in 1992 that ultimately led to the development of a map called *Indian Lands in the United States* published in 2003. One thing that is significant about the name of this map is the reference to the United States. Reference to the United States presents that map as nationwide in scale, a product that the general public can use, and firmly freezes American Indian land in place.

Although the Bureau of Indian Affairs developed and implemented a cartographic program during the nineteenth and twentieth centuries, there is very little evidence to suggest that such maps had a major impact on the development of GIS at the Service Center. As will be shown in chapter five, the linage of BIA GIS was connected more with John Wesley Powell, the USGS, and topographic maps. So it was no surprise that other nationwide political initiatives strongly shaped GIS at the BIA, as a justification to further mobilized geographic information on Indian Country.

MOBILITY

What forces led to the mobilization of digital geographic information within Indian Country? Of course, one explanation would point towards the computerization of government and a move towards the so-called information economy in post-World War II North America.[15] Though this may be partially true at the scale of national economy, I am interested in teasing out key factors that led to GIS development at the institutional scale. There needs to be a reason or a catalyst that mobilizes men, women, machines, money, and institutions who in turn mobilize data that are used to exploit natural resources. Congress mobilizes people, funding, data, and technology through the implementation of laws and acts. Congressional legislation presents citizens, government organizations, and private corporations with a specific set of regulations and requirements necessary to meet legislative obligations, reducing their chance of facing litigation or the loss of federal funding and other subsidies. Legislation can have both intended and unintended consequences. Relating to the most recent cycle of accumulating geographic information, two programs supported by the United States Congress that contributed to the origins of GIS at the BIA are: 1) the Indian Integrated Resource Information Program (IIRIP) and 2) the Integrated Resource Management Plan (IRMP). Each of these programs supported the other either directly or indirectly, in the collection of geographic information on Indian Country.

Indian Integrated Resource Information Program (IIRIP)

Stitching and weaving the BIA GIS cloth together through environmental policy and natural resource management leads to the Indian Integrated Resource Information Program[16] (IIRIP). The IIRIP supported integrated and systematic federal policies like NEPA and later the Integrate Resource Management Plan (IRMP). Connections between the three programs represented a continuous flow of regulations and funding from the Congressional halls of Washington to the BIA National GIS Center in Lakewood, Colorado. To deal effectively with environmental concerns in Indian Country, the BIA initiated a pilot study on GIS in 1981 and 1982, and implementation of the IIRIP in 1983. The IIRIP provided spatial data systems support for GIS and remote sensing applications, directly related to environmental resource management throughout the agency.

The IIRIP is a bureaucratic – technocratic network involving the BIA Office of Trust Responsibilities (OTR) which oversees NEPA compliance. BIA Area and Agency office personnel carried out compliance procedures in the field (Bureau of Indian Affairs 1996). Yet GIS implementation and the program's objectives was the responsibility of the BIA National GIS Center

The mobility of Indian Country digital geographic information rested on the foundation of four objectives associated with the IIRIP, which included creation of a digital database, installation of computer hardware and software infrastructure, establishment of GIS expertise within the BIA, and establishment of the National GIS Center in Lakewood, Colorado (Bureau of Indian Affairs 1988a). American Indian tribal governments and communities did not initiate the development of the BIA GIS network. The BIA GIS network represents a top-down, technocratic system established for federal government control, while (purposefully or inadvertently) marginalizing American Indian tribal governments that were supposed to participate and benefit from environmental management policies established in the 1970s.

To initiate the mobility of geographic information that would be exchanged between the hubs and nodes of the GIS network, the BIA required the, "Creation of digital databases in which all relevant map data reside" (Bureau of Indian Affairs 1988a). Concern with the environment or perhaps more correctly, concern about the amount of data needed to manage the environment can be found within the BIA produced IIRIP issue paper. The IIRIP stresses the importance of relevant map data and suggests that some geographic features would be more relevant than others within the database. Geographic relevancy also meant connecting with particular BIA field offices as well.

> Today's environment demands highly accurate and timely information on the extent, distribution, and quality of natural resources in order to make realistic and effective decisions. The sheer volume of hard copy maps coupled with the virtually impossible process of overlaying large numbers of maps and map overlays, mitigates against continued manual techniques…BIA opted for a "systems" approach…to respond to requirements of land managers with respect to environmental concerns. (Bureau of Indian Affairs 1988a, 1)

Mobilization of the relevant digital geographic information required "…the acquisition and installation of appropriate computer system hardware and software to allow managers to interact with their digital databases" (Bureau of Indian Affairs 1988a). These were the physical materials used to construct and connect the emerging network of hubs and nodes throughout Indian Country. Early mobility of digital geographic information required computer hardware such as Data General model 20 mini-computers, digitizing tablets, printers, plotters and MOSS software. A network of hardware and software was installed at the National GIS Center and relevant BIA Area and Agency Offices including the Albuquerque Area Office, Billings Area Office, Portland Area Office, Fort Apache Agency Office, San Carlos Agency Office, and Mescalero Agency Office.

Another vital ingredient for collecting and moving data was, of course, human beings with the technical expertise to make the network functional. The mobility and engineering of the BIA GIS network required "…the establishment of a cadre of GIS specialists at BIA field offices, and the establishment of a BIA national GIS program manager at a centralized location…the National GIS Service Center to support GIS activities at the field level" (Bureau of Indian Affairs 1988a). This resulted in the concentration of GIS expertise and data at the National GIS Center in Lakewood, Colorado. Those BIA field offices or tribal governments wishing to participate in the BIA GIS network had to pass through this central hub, making the National GIS Center an obligatory point of passage and the center of data for integrated resource management in Indian Country.

Integrated Resource Management Plan (IRMP)

The IRMP[17] is a comprehensive natural resource management plan for American Indian reservations. The plan calls for collaborative decision-making regarding natural resources by BIA field personnel, tribal government personnel, and tribal communities. According to the IRMP program, "The ultimate goal of an IRMP is to create a balance within natural resource management actions which reflects the social, cultural, economic, and natural resource values of reservation residents" (Bureau of Indian Affairs 2001b). If this sounds like NEPA guidelines, it is because the IRMP is the BIA's NEPA document and complies with the required systematic and integrated approach to natural resource management by federal environmental policy. The IRMP was both directly and indirectly connected to GIS development at the BIA in the 1980s.

The connection between BIA GIS and the IRMP was revealed in a BIA cost/benefit analysis[18] for the development and implementation of GIS that stated,

> The most obvious potential application for all agencies is the preparation of Indian Resource Management Plans. Each agency will be required to develop a comprehensive plan for resource utilization on the reservation. The plan will consist of inventories of resources, identification of geographic areas with potential for various types of land uses, and spatial information useful for resource management functions… Related to the integrated planning is the need to produce a National Resource Management Plan Atlas…An Integrated Resource Management Plan has been produced for the Northern Cheyenne Reservation by the Billings Area Office. (Battelle 1988, 69)

Tracing the Northern Cheyenne IRMP atlas through BIA documents led me to the Western History Collection of the University of Oklahoma libraries. The IRMP atlas is a paper document designed for manual tasks associated with natural resource management. The atlas is 18 inches by 25 inches white poster board with spiral binding w/black and white image of two Indians (tribe not revealed) positioned in the center of the atlas cover. The scale of the atlas is 1:100,000 and contains a total of fourteen maps featuring: land management unit areas, dryland agriculture, irrigated agriculture, coal development, oil and gas exploration, cultural resource survey areas, suitable housing area, land purchase priority, transportation system/row problem areas, forested rangeland, allotted/fee rangeland, rangeland features, public land survey, recreation areas, public land survey mylar overlay. In addition, each of the maps contains hydrology and transportation line features. At the bottom of many of the maps are sets of statistics like these:

Rangeland – 391,852 acres
Total Grazing Capacity – 102,000 AUM's
Number of Range Units – 101
Size of Range Units – 329 to 19,843 acres
Average Reservation Herd Size – 8,000 head

It is difficult to assess the success of the IRMP initiative. However, incorporation of tribal communities into the development of natural resource planning is a departure from past authoritarian practices at the agency. The IRMP still has major short-comings and participation by tribal communities is not completely successful. The BIA wanted a one-hundred percent implementation rate of the IRMP. Only nine IRMPs had been completed for all of Indian Country by 1994. Furthermore, a United States Senate report revealed that while the BIA held, "substantial resource inventory information such as maps, surveys and other data necessary for the development of IRMPs, many Indian tribes have had difficulty gaining access to this information and the assistance necessary to develop their IRMPs" (U.S. Congress 1994). Equity and access to data demanded by NEPA legislation for increased public participation in decision-making regarding natural resource use, but perhaps not fully implemented at the BIA.

Federal environmental policies like NEPA and the IRMP can mobilize people, places, and geographic data in a variety of ways. The forced relocation of North American Indians onto reservations and allotted areas is well-documented (e.g., Palmer 1998). Although most scholars do not refer to these processes as mobilization, the harsh truth is that native peoples were moved out of the way and placed on reservations so that land and natural resources could be accumulated. Some American Indian tribal communities are vulnerable to United States federal government relocation and environmental management programs (Warren 2004). Relocation occurred because American politicians and agriculturalists accused American Indians of neglecting and/or misusing land resources.[19] Other examples of American Indian mobilization involved the reduction of Navajo sheep stock because of federal regulations to reduce erosion and to protect the Hoover Dam from siltation in the lake (White 1983). Runstrom et al., in a recent article in the publication *American Indian Culture and Research Journal*, state that:

> The infamous government-ordered Navajo sheep-reduction program of the 1930s may stand alone as the worst example of the government's willingness to pauperize the population by eliminating animals. Will Graf and others confirmed that where Indian-white relations are concerned, "a little scientific knowledge [is] a dangerous commodity. "Graf, a physical geographer, states that the Navajo were right in asserting that climate variation was the cause of Colorado River sedimentation, not the number of sheep they grazed. (Rundstrom et. al, 2000, 90)

Another example involves the physical removal of the Hidatsa people from their homes to accommodate reservoir development along the Missouri River (Hanson, 1987).

The IRMP lays out the lineaments of scientific management principles and defines, “the policies and priorities land managers are to use to insure their actions move the tribe towards its vision for the reservation” (Bureau of Indian Affairs 1998, 1). Throughout the IRMP document are bits and pieces of traditional[20] statements by American Indians regarding environmental management. The statements are sprinkled in like inscribed subliminal messages on a page consisting of pure scientific management practice. Italicized wisdom is placed at the corner of pages and presented as fragmented contributions that are not integrated into the overall management scheme or policy of the IRMP and accompanying GIS.

It is such action that gives the illusion that the IRMP will include American Indian groups as full participants. For example, several tribal officials contributed to the IRMP, including the fragments of traditional ecological knowledge residing on the page margins. The program stresses the benefits to be gained by tribal communities and their land base, echoing the same call for public participation found in the NEPA document. Wording and the presence of traditional ecological knowledge appears to turn such discourse on its head. However, this position is quickly reversed when one examines some of the GDSC quarterly reports. Some reservations are more susceptible to the tentacles of progress emitting from the BIA center of calculation than other land areas. For example, the Fort Apache tribe's "participation in the development of the Fort Apache IRMP was terminated…the [BIA Fort Apache] agency is continuing the process without tribal participation" (Bureau of Indian Affairs 1990, 18). Moving North American Indians to the margins of environmental resource management is further supported by the BIA's IIRIP geographic information system.

Congressionally supported environmental policies including NEPA, IIRIP, and IRMP contributed to the development and implementation of GIS and geographic information. Movement of real and virtual materials required a GIS network of interconnected BIA offices throughout Indian Country. To achieve stability, the agency centralized their system.

STABILITY

What factors led to the stabilization of GIS at the BIA? With environmental management policies in place, the BIA needed mechanisms for stabilizing their emerging GIS network. For the National GIS Center, stability meant being able to move geographic information, computer hardware, GIS software, and technical information throughout the network without fear of distortion or corruption (Latour 1987). Like electronic plumbers, technical specialists from TGS Technology Inc. and the BIA attempted to stabilize the virtual materials that flowed between the network hubs and nodes, in an effort to keep it viable and functioning for the agency. Stability at the BIA GIS center included the flow of funding, centralized technical support, and institutional control.

Funding

Congress mobilized funding to the BIA, via the DOI, for the development and implementation of GIS. Funding also served to stabilize GIS efforts at the BIA. An important document found at the GDSC entitled, *Table of Funding for Geographic Data Service Center* (Bureau of Indian Affairs 2005c), contained general budget information for the years 1981 to 1988 (Table 4.1). Original funding for the IIRIP came from the United States Congress, which provided $100,000 in 1981 and $200,000 in 1982 to the BIA OTR for special programs and studies on the viability of GIS within the agency (Bureau of Indian Affairs 2005c). The Congressional flow of funding allowed the BIA OTR to explore alternatives to manual mapping systems in an attempt to become more efficient both in terms of workloads and labor costs. The BIA's cost-benefit analysis showed that,

> In summary, the economic analysis clearly indicates that the GIS is a more cost effective and beneficial technology for producing the geographic information and analysis required by the BIA. Any decision-maker faced with a choice between implementing the GIS or a manual system would select the GIS system if the decision was based on pure economic criteria. (Battelle 1988, 72)

Other BIA documents refer to budgetary concerns such as personnel ceilings and on-the-job training for BIA personnel (Battelle 1988; Bureau of Indian Affairs 1988a) in preparation for institutional changes associated with computerization. Computerization and digitization required an increasing amount of technical support, additional implementation of computer hardware and GIS software, while extending networks further by bringing new offices onto the system (Battelle 1988). The above information paints a picture of standardized GIS development within most government agencies. What may have been different was the way that GIS development at the BIA was to be funded.

The BIA's cost/benefit analysis reveals, "the GIS support of timber sales activities would be a strong foundation from which to recover investment costs incurred by the DOI" (Battelle 1988). This meant that the financial foundation of BIA GIS was deeply rooted in the physical environment in which trees were profits to be extracted for the purpose of supporting the emerging network and rooting the National GIS Center in place.

Table 4.1. GDSC general budget summary for the years 1981 to 1988.

Fiscal Year	Funding Sources	Funding Level
1981	BIA Office of Trust Responsibilities	$100,000
1982	BIA Office of Trust Responsibilites	$200,000
1983	BIA Office of Trust Responsibilites	$500,000
1984	BIA Office of Trust Responsibilities	$1,150,000
1985	BIA Office of Trust Responsiblities	$1,150,000
1986	BIA Office of Trust Responsibilities	$1,500,000
1987	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$3,047,000
1988	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$2,087,000

Source: Bureau of Indian Affairs 2005c.

In 1983, Congress provided $500,000 to the OTR as base funding for initial IIRIP operations (Table 4.1). In 1984 Congress provided the BIA OTR with $1,150,000 to move their GIS program towards operational status. Development and implementation of the IIRIP at the National GIS Center and throughout the BIA depended greatly upon funding from the DOI.

> Monies approved for IIRIP are expended as follows: 1) ADB hardware, software, peripherals, and support receives 17% of the available funding; 2) GIS and remote sensing technical support to field offices is allocated 40% of the IIRIP budget; 3) Salaries for field office GIS coordinators is programmed for 11% of the budget; 4) the remaining 32% is proportionately divided between training, special project requirements, and daily operations. (Bureau of Indian Affairs 1988a)

Major fluctuations in funding occurred from 1987 to 1988, 1990 to1991 and 1995 to 1996. In 1987, the GDSC received $3,047,000, including $1,837,000 as base funding for the IIRIP, $500,000 from the Office of Information Resources Management (OIRM) for acquisitions, operations, and maintenance costs, and a one time $710,000 increase for the purchase of Prime 9955 Super mini-computers. In 1988, a total of $250,000 of the base funding was redirected to BIA Area Offices and the $710,000 was not carried over. In sum, 83% of the funding went towards technical support (Bureau of Indians Affairs 1988a).

Technical Support

How did technical support stabilize BIA GIS? During the early IIRIP implementation period, the BIA collaborated with other DOI agencies including the

United States Fish and Wildlife Service (USFWS) and the Bureau of Land Management (BLM). These natural resource oriented agencies assisted the BIA in developing their initial GIS capabilities. In addition, national environmental policy encouraged, “agency cooperation early in the NEPA process…any other federal agency which has special expertise with respect to any environmental issue…may be a cooperating agency upon request of the lead agency” (Council on Environmental Quality 1978). Similar GIS collaborations among other federal agencies evolved in relation to NEPA requirements:

> In the Army, many environmental managers had already beaten a path to the doors of the U.S. Army Corps of Engineers and Construction Engineering Research Lab (CERL) for assistance with environmental databases and computer systems. (Goran 1998)

Collaborations between the BIA and the USFWS involved the implementation of the Map Overlay and Statistical System[21] (MOSS) the BIA’s first GIS “inscription device”[22] (Latour 1987).

Collaborative development of MOSS continued during the early 1980s between the BLM, the USFWS, the BIA, the USGS, the U.S. Forest Service, the Soil Conservation Service, the Minerals Management Service and the U.S. Army Corps of Engineers. Both the BLM and USFWS collaborated on the development of MOSS software with the goal of implementing a standardized package including MOSS software and PRIME computer network across the DOI. Of all the DOI agencies, the USGS rejected the standardized GIS proposal arguing that such a model might hinder the development of their own GIS efforts (Greenlee and Guptill 1998). Most importantly for the BIA, the MOSS network lacked the technical support needed for the development of GIS at the BIA.

> The policies of this office [GDSC] 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 as we implement ARC/INFO in the Bureau. MOSS can be available for distribution with BIA by May 2, 1988. The MOSS software shall be distributed only to those sites which request it in writing. (Bureau of Indian Affairs 1988b)

In 1988 and 1989 the BIA took full control of what they refer to as "in-house" GIS development with other DOI agencies only providing data (Bureau of Indian Affairs 1988a). The BIA began "the process of transferring GIS and remote sensing capability" internally in 1987, aiming towards a centralized and self-contained system. They practiced their own brand of self-determination in the stabilization of GIS development supported by a cadre of private technical consultants.

The most important actor regarding the shaping and stabilization of GIS at the BIA was Technicolor Government Services, Inc., (TGS). Located in Sioux Falls, South Dakota, TGS employed "professionals in agriculture, geology, hydrology, agronomy, and related fields" to support technical services for USGS EROS data center and GIS development at the BIA. As the BIA's primary GIS technical support, TGS technical specialists were very visible in the quarterly technical reports produced for the BIA in 1986 and 1987. According to the reports, "TGS staff began full-time support for the

BIA IIRIP" in 1987 and were hired to provide on-site technical capability at the BIA. TGS performed such tasks as land cover mapping, data processing, digitizing, GIS technical support for Area and Agency Offices, and GIS training support (Bureau of Land Management 1987c). Outside of Lakewood,, the BIA relied upon TGS-CMD of Fort Collins, Colorado, DocuScan of Denver, Colorado, and Chicago Aerial Photo for the table digitizing and scanning of maps and aerial photographs. According to the first- and second-quarter BIA GDSC technical reports for 1991, one of the highlights of the year was the entrance of an Indian-owned small business into a contract with the GDSC for digitizing services. The group was called First Computer Concepts (FCC) located in Rosebud, South Dakota. Most of the digitizing work the FCC did for the GDSC took place at their Albuquerque office (Bureau of Indian Affairs 1991c).

The GDSC enrolled an actor to strengthen their position with the GIS network in Indian Country by giving the BIA credibility. One of the primary actors was the Battelle Corporation. According to a current self-description by the consulting firm, Battelle is,

> A global science and technology enterprise that develops and commercializes technology and manages laboratories for customers…Battelle has a vast science and technology reach…with more than 800 federal, state and local government agencies, providing cost-effective science and technology in the areas of national security, homeland defense, health and life sciences, energy, transportation and environment…Battelle (Memorial Institute), began operations in 1929, was established in Columbus, Ohio…the Battelle family – leaders in America's early steel industry. (Battelle 2005)

Having leaders of the previous industrial revolution and the twentieth-century modernization of the American landscape on their side added credibility to the BIA GDSC's participation in the latest post-industrial information technology revolution. Battelle conducted and complete a cost – benefit analysis for the GDSC in 1987 and 1988 supporting and ultimately justifying the GDSC's position within the emerging GIS networks not only in Indian Country but the DOI as well (Battelle 1988). The most significant translation that Battelle and the GDSC had to convey to all those many Indian Country actors yet to be enrolled in the GIS network was making the transition from manual to automated systems. Enlisting actors into the network required translations.

> Given the demands associated with today's environmental concerns, personnel ceilings, budget reductions, and the like, the BIA move toward automated systems for geographic solutions is logical. The alternatives to such an approach are limited. (Bureau of Indian Affairs 1988a)

Manual systems are one of many options available, that aid in natural resource management practices and require a certain level of professional skills. However, Battelle describes manual systems as though they represented a road-block, going against the grain, or moving against the wave of progress presumably sweeping the United States federal government system.

> A return to the past is an option, but may not be viable. Conceivably, the historic process of manually overlaying maps and map overlays, manually mensurating line and polygon information, visually optimizing results, and entering new data via pen and ink change could be re-initiated. Such a move would negate the tremendous improvements which have resulted in the management of natural

> resources through computer aided GIS process. This alternative would also result in a loss of quality and accuracy in all subsequent planning activities. (Battelle 1988)

The cost – benefit analysis strengthened the GIS networks originating at the GDSC, and strengthened its networks with experienced technical support, contributing to the development of the BIA GIS center of calculation. Mobilization of these actors into a network consisting of computer software, hardware, and the flow of cartographic materials gave the digital-center an advantage over the manual-periphery. Further strengthening would arise from central control of important stabilization processes like funding.

Central Control

I have discussed stability on two fronts: funding and the need for reliable technical support. The path taken by the BIA to further stabilize these processes and to move forward with GIS and the IIRIP at the National GIS Center was centralized development. The National GIS Center became more technically competent while surrounded by a cadre of TGS technicians, and in 1987, funding increased dramatically. A BIA declaration of GIS independence revealed itself in several correspondence memos passed between the BIA and the BLM in 1987. One particular incident involved the costs of digitizing maps by TGS and charging to the wrong account (YA-433). The BLM COR stated,

> BLM: I [Keith Francis, Contracting Officer's Representative, Bureau of Land Management] personally feel TGS has been seriously over-estimating, and over-charging as well…Don Hall reviewed all work going to TGS and resulting estimates. I don't know Don 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 TGS 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. (Bureau of Land Management 1987b)

Acting BIA National GIS Center Director, Bill Bonner responded to this memo:

> BIA: Don Hall 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. (Bureau of Indian Affairs 1987a)

> BIA: Considering that BIA has funded BLM to manage this function [another action] 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 TGS/CMD 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. (Bureau of Indian Affairs 1987a)

> BIA: You make several serious allegations against TGS/CMD. Your implication being that TGS/CMD 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 TGS/CMD in no way supports your allegations. In addition, BIA disassociates itself from past and former charges with respect to any such accusations. (Bureau of Indian Affairs 1987a)

BLM restated its position as the cartographic center of calculation for the DOI and the nation:

> BLM: [Keith Francis] 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 the new System Manager for the Denver Service Center (DSC) Cartography Branch…I feel I can offer some assistance on some of the digital projects you encounter. (Bureau of Land Management 1987b)

The BIA did not accept the BLM translation that the BLM was the center of geographic information for the federal government, for it was a direct attack upon the BIA's emerging GIS network. The most important actors holding the BIA's GIS network together were the TGS technical specialists. TGS constructed an elaborate network of hardware and software, connecting one remote site to another. In this case, the primary network hub was the National GIS Center in Lakewood connecting with the BIA Area Offices and Agency Office nodes. Without TGS, no work would be done. The allegations by the BLM and rebuttals by the BIA National GIS Center may have weakened the MOSS GIS network and further strengthened the BIA GIS network. The next step involved control over GIS development and the construction of a centralized library of geographic information in the form of a database housed at the National GIS Center. This was where geographic information data layers were to be combined with others in the development of applications using new corporate GIS software.

COMBINABILITY

What factors led to increased combinability of GIS at the BIA? Federal environmental policies and the stability generated by centralized funding and technical support helped establish the National GIS Center in Lakewood, Colorado. It was here that GIS and geospatial data would be brought together, tying seemingly very different actors and materials together into an interagency network. The BIA sought to establish what I will refer to as a GIS empire (the National GIS Center and a periphery of BIA field offices) by spreading its tentacles of progress throughout Indian Country (Headrick 1988). Geographic information at the National GIS Center would have to be made combinable, allowing for the data to flow through the hub and node networks consisting of bureaucratic administrators, skilled technical specialists, environmental resource managers, hardware, software, digitizing tables, telephone lines, and modems. All of these human and non-humans combining seemingly distant and unrelated actors like timber companies, coal mining corporations, non-Indian farmers and ranchers, and water rights litigation along rivers would be made possible through the automation of Indian Country.

Like so many other federal and state agencies, the BIA employed GIS to assist with the requirements of national environmental policies, while at the same time leading the way in GIS development and becoming an innovative force within Indian Country and the DOI; a center of calculation at the institutional scale. The desire to combine resources within and outside Indian Country can be seen in the National GIS

Center's proposed GIS applications and enrollment in an emerging corporate GIS network.

Targeted Applications

IIRIP GIS was primarily developed for forestry and timber sale applications and for meeting the environmental requirements at the agency office level. However, proposed GIS applications at the BIA varied. This is because "there [was] a dramatic difference between the number and type of projects supported at the Area Offices versus those at the Agency Offices" (Battelle 1988). The Area Offices sought to develop a much wider variety of projects than the Agency Office. On the other hand, "The Agency Office is clearly supporting the most important day-to-day activities of the local BIA office and the key management issue for the reservation" which would include meeting NEPA standards and developing IRMPs and atlas' for each reservation (Battelle 1988). In addition to the IRMP, the National GIS Center planned to attempt the following GIS applications: Land Ownership (plat maps, lease transactions, keep records current, working on-the-fly, making changes in real-time, used for Annual Realty Reports); Land Use (revenue generated for the various uses of land, mineral rights and forestry leases); Ranch Plans; Transportation Plans; Recreation Plans; Wilderness Plans; Fish and Wildlife Plans; Wildlife Sightings, Agricultural Pests; Noxious Weeds, Housing Suitability; Threatened and Endangered Species; Archeological and Religious Areas (Battelle 1988). MOSS had limitations that included a raster-only format, its compatibility with only Prime computers, and lack of technical assistance. As a result, the BIA sought out a more compatible GIS, allowing for more combinability of technicians, data and applications.

From Public Domain to Corporate GIS

Besides the lack of technical support, other major disadvantages of the MOSS software included its limited applicability. For instance, “Because MOSS was designed with a specific application in mind [raster-based natural resource applications], enhancements to the overall package have been limited” (Battelle 1988). Another limitation was MOSS reliance upon specific computer hardware, meaning that “Transportability of this software to more modern computer hardware technology has proven to be a substantial task” (Battelle 1988, 13). When building and maintaining a digital network this presented a major problem associated with combinability and connecting with other agencies in Indian Country. During the late 1980s and 1990s, the USFWS and the BLM had “not kept pace with technological developments” in the area of MOSS GIS development (Battelle 1988).

Combinability at the National GIS Center meant having the flexibility to address issues important to the agency as a whole and having the most advanced GIS within the DOI. This resulted in the BIA enrolling in the newly emerging corporate GIS network woven together by the Environmental Systems Research Institute (ESRI) and featuring their newly developed software called ARC/INFO. The implementation of

GIS at the BIA and the technical development of GIS at ESRI almost paralleled one another. ESRI released its GIS software ARC/INFO in 1982 and ARC/INFO for personal computers in 1986 (ESRI 2005). ARC/INFO was compatible with the BIA's 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. According to current BIA GIS manager Mark Zundel, ESRI worked closely with the agency and promised to support the development of GIS to be compatible with the BIA's hardware network in 1988.[23] Furthermore, the BIA National GIS Center and TGS technical specialists attended ESRI user conferences that expanded from 16 attendees in 1981 to 366 attendees in 1987. BIA GIS technicians made up some of those attendees, and the conference provided yet another vehicle for networking. ESRI's networks flowed not only through federal government agencies, but also tribal communities in Indian County.[24]

SUMMARY

The BIA National GIS Center met the three conditions required for a lab to become a center of calculation. Federal environmental policies generated the momentum needed to gather and mobilize geographic information and GIS throughout Indian Country. The centralized control of funding and technical support/expertise contributed to the stabilization of the BIA National GIS Center and the initial development of digital geographic information at the agency. Finally, the agency increased the combinability of their GIS by proposing applications beyond those required by national environmental policy and by enrolling in an emerging corporate GIS network. Meeting these requirements led to the development of the BIA Geographic Data Service Center in 1988. It was from this office that the digitization and automation of Indian Country would initiate. In the chapters to come, I will explain the construction of the digital Indian Country and the spatial asymmetry of the emerging GIS network and its associated data.

CHAPTER FIVE

UNEVEN DEVELOPMENT OF GEOGRAPHIC INFORMATION

How did the BIA represent Indian Country in their GIS? They represented Indian Country as GIS layers in the BIA Nationwide Database (BND). Between 1988 and 1995, the BND made up the foundation for centralized GIS development at the GDSC, and it also supported integrated resource management activities in Indian Country. Some tribal governments, including the Colville Confederated Tribes, pushed for greater tribal control of GIS development at the GDSC. The control and protection of culturally sensitive data was an important issue among tribal leaders and elder groups. Issues of control concerning the development and storage of GIS databases and applications by the GDSC emerged within the Colville Confederated Tribe in the early 1990s (Marchand and Winchell 1992). Tribal leaders, elder groups, and some scholars had reason to be concerned since one former BIA GIS manager advocated a culturally-based GIS for incorporating sensitive and traditional information, to be developed into GIS applications by GIS specialists (Marozas 1993).

The BND represented yet another core-periphery geography of Indian Country. In this chapter, I will argue four main points. First of all, the BND did not contain sensitive, cultural data that was previously unavailable to the public. Rather, the database represented Indian Country as a partial natural-resource inventory based primarily on USGS topographic map features. Second, the BIA did hold a considerable amount of GIS data (Rundstrom et. al 2000). However, the BND was unevenly developed in terms of geographic content and BIA regional coverage. This produced a core-periphery geography of Indian Country. Third, this core-periphery geography is not explained by the size of regional American Indian populations. Rather, BND GIS layer development was influenced by the presence of timberland resources and the development of IRMPs. The periphery resulted from ownership fractionation[25] and the fragmentation of Indian allotment land areas. Fourth, fluctuations in funding led to the demise of the BND as an updated GIS resource in Indian Country. GIS at the BIA could have developed in many ways. Tribal governments could have shaped the direction of development at the GDSC. However, the BIA believed that a centralized system would be more cost effective (Bureau of Indian Affairs 1988a).

THE BIA NATIONWIDE DATABASE (BND)

One of the primary components of the BIA center was the BND. Originally, the agency planned to develop a database to hold geographic information for "representing all BIA resource activities" (Bureau of Indian Affairs 1988a). The database consisted of GIS layers representing an assemblage of the geographic information materials designed to connect to and control distant places in Indian Country. Similar to the USGS topographic map project, but much smaller in scale, the database required funding, human labor, and the use of technical artifacts. The

GDSC standardized geographic information and stored it in the BND. Standardization made the digital version of Indian Country less complex. On the one hand, data standards maintained stability and combinability of data. On the other hand, standardization decreased the number of alternative natural resource management options for American Indian tribal governments.

Classifications and taxonomies allow for the management of complex systems associated with such things as ecosystems, hydrological systems, or even indigenous knowledge systems. To reduce the complexity of Indian Country, the GDSC assembled only pertinent geographic information as it related to natural resource management. The agency developed the BIA GIS Database Organizational Guidelines (DOG) with the mission of creating a GIS "standard structure" that could be "portable across reservations" (Bureau of Indian Affairs 1997e, 1). Mark Monmonier explained that, "nothing better reflects the government cartographer's bureaucratic mentality than the standards and specifications for a nationwide series of topographic maps…the national mapping organization willingly sacrifices political, ethnic, and physical boundaries to the convenience of uniformly spaced meridians and parallels – a divide and conquer strategy that makes complete coverage seem both doable and essential" (Monmonier 1996, 123-124). The GDSC accumulated a diverse group of geographic inscriptions to complete the task of building the BND.

GIS and geographic information at the GDSC was not a stand-alone system. Instead, the centralized development process involved the weaving together of heterogeneous materials. The DOG reveals the source materials used in the construction of the BND. It was one of the many materials authored by the GDSC that circulated throughout the BIA GIS network.

> The Database Organization Guidelines (DOG) originated as part of the library modification process in the early 1990s. At that time, there was a need to attempt to define a standard item structure for attribute data in order to efficiently re-work the data originally captured in MOSS. The DOG has since evolved into a collection of layer descriptions and item definitions for all data stored in ARC/INFO map libraries maintained at the GDSC…pertaining to database development which may be beneficial throughout Indian Country. (Bureau of Indian Affairs 1997e, 1-2)

As the center of calculation and emerging repository of geographic information for Indian Country, the document guidelines flowed down through the network reaching out to the BIA field offices, representing a top-down technocracy designed to maintain control of data production at the center.

The GDSC could not physically bring Indian County into its center of calculation. Rather, BIA personnel had to go out and accumulate information on the forests, agricultural fields, wetlands, mountain ranges, lakes, and streams. And the GDSC did this by exploiting inscriptions from previous cycles of accumulation. Such inscriptions included topographic maps, aerial photographs, satellite images, and natural resource inventories of forests, rangeland, wetlands, and wildlife. Because of funding and staffing limitations, the GDSC acquired manually-inscribed geographic information resources and fixed or digitally-inscribed them within the memory of computers.

A brief list of inscriptions used by the GDSC in the construction of the BND includes BIA Area and Agency Office Maps, USGS maps, USDA soil survey maps, USDA natural resource maps, USDA conservation maps, Federal Emergency Management Agency (FEMA) flood zone maps, BLM 100K ownership maps, the National Wetlands Inventory (from the source Classification of Wetlands and Deepwater Habitats in the United States), BLM 1:100,000 maps in the Arizona Land Records and Information System, Environmental Protection Agency (EPA), Carson National Forest Cartographic Feature files, Indian Land Commission, Minnesota Land Management Information Center, New York State Department of Health, The Petroleum Institute, and Washington State Department of Natural Resources (Bureau of Indian Affairs 1997e). Not all of these materials contributed equally to the development of the BND. The strongest networks emanated from the USGS topographic maps. The United States federal government invested a tremendous amount of time, labor, and money in developing and implementing topographic maps into the fabric of America.

Thousands of USGS 1:24,000 scale topographic maps strongly shaped the BND. Throughout the twentieth century, the United States federal government used topographic maps for natural resource management activities and industrialization through the building of major dams, the construction of canals, and the management of property. Topographic maps resulted from multiple cycles of accumulation associated with natural resource inventories, exploration, military surveys, biological surveys, ethnographic surveys, and public land surveys. In fact, the nationwide topographic mapping network replaced the other Great Surveys.

> In the years following the Civil War, rivalries among the four separate Great Surveys of the American West surveys led Congress in 1878 to ask the National Academy of Sciences to recommend a plan for surveying and mapping the Territories of the United States on a system that would "secure the best possible results at the least possible cost." The U.S. Geological Survey (USGS) came into being with the Organic Act of March 3, 1879, when the 45th Congress and President Rutherford B. Hayes enacted a major portion of the reforms recommended by the National Academy. (United States Geological Survey 2005)

A single topographic map contains vast amounts of information including contours of the land, elevation data, township and range, hydrology, landforms, place-names, towns-cities, transportation infrastructure, vegetation, home sites, water tanks, just to name a few features. BND development included other USGS products as well.

In addition to topographic maps, other products such as USGS Digital Line Graphics (DLG), USGS Digital Elevation Models (DEM), and USGS aerial photographs, 1:62,500 scale Geologic Maps flowed to the BIA center. Once at the center, TGS technical specialists mobilized everything from hydrology and landforms to a subsurface view of Indian Country in an intricate weave of scientifically constructed models of the earth's surface. Much of the BND development relied on materials that were physically surveyed by men and instruments on the ground, but its connections also extended into space.

The GDSC connected with a vast network of airplanes and satellites that encircled the earth further extending the technologies of location (Curry 1998). The BIA center network incorporated satellite imagery and remote sensing images. This included the National High Altitude Photography Program, a USGS sponsored program and involved using thousands of black and white and color infrared photographs taken from an altitude of 40,000 feet. The centralized system connected with probes circling the earth through “The production of image maps [in] a cooperative project with EROS Data Center” (Bureau of Land Mangement 1989a,b,c). The BIA also had a French connection through the utilization of SPOT images within SPOT’s global network of field offices in every region of the world except Africa. The networks are so dense in relation to satellite geographic information that the lines blur between the military, natural resource management, natural hazard mitigation, economics, and surveillance that it scarcely makes sense to designate the satellites for one particular purpose. On the other hand, all this weaving of human and non-human elements had a purpose. The development of GIS at the BIA signified a transition from industrial to post-industrial systems of mapping natural resources at the agency.

Creative Destruction

GIS transformed and shaped the way federal government agencies constructed geographic information and has replaced the manual topographic mapping process. For over 100 years, the United States federal government invested millions of dollars and employed, “thousands of surveyors, photogrammetrists, cartographers, and others who labored for more than 33 million hours, using primarily manual processes, to complete the more than 55,000 USGS topographic maps covering the United States" (United States Geological Survey 2005). By the late 1980s and early 1990s, computer technologies and GIS became prominent within the agency. Just as science, public land surveys, and topographic maps ushered in the westward expansion of in the United States, GIS and other digital technologies simultaneously shaped and was shaped by the information-based economy associated with what some call the post-industrial society (Bell 1973). Social, cultural, and economic transitions often marginalize old familiar systems and empower new ones. Geographer David Harvey refers to such processes as "creative destruction" (Harvey 1989).

> The effect of continuous innovation, however, is to devalue, if not destroy, past investments and labor skills. Creative destruction is embedded within the circulation of capital itself. Innovation exacerbates instability, insecurity, and in the end, becomes the prime force pushing capitalism into periodic paroxysms of crisis. Not only does the life of modern industry become a series of periods of moderate activity, prosperity, over-production, crisis, and stagnation, but the uncertainty and instability to which machinery subjects the employment, and consequently the conditions of existence, of the operatives become normal. (Harvey 1989, 105-106)

Creative destruction occurred when GIS entered federal government agencies, especially those that already practiced cartography. Geographic information was fragmented and lifted from stable USGS topographic maps at the BIA in the 1980s and 1990s.

> During the first 100 years of USGS, the thousands of surveyors, photogrammetrists, cartographers, and others could not have foreseen the rapid acceleration of computer technology that has transformed the mapping profession today. (United States Geological Survey 2005)

Unlike the USGS, the BIA focused specifically upon American Indian land, not the entire nation. The agency set out to reproduce topographic map features and convert them into a digital format. This process involved the flow of thousands of paper maps from one center of calculation to another. Chris English of the BIA Western regional office mentioned that, "The GDSC worked through the USGS National Mapping Division in Lakewood, buying the quads, often transferring data to mylar, and having it digitized" (Bureau of Indian Affairs 2005d). Digital computation and GIS allowed actors at the BIA to capture and reproduce features off of topographic maps. Like breaking the bonds of a chemical compound, individual elements became separated and at the same time provided a stable medium from which to construct the digital, customized representation of Indian Country.

In summary, the GDSC developed the BND to support the integrated management activities of BIA natural resource managers in the field. Technical and data-entry specialists gathered and digitized a heterogeneous collection of maps, aerial photographs, satellite images, manuscripts, and field notebooks into the memory of computers at the agency. USGS topographic maps represented the most significant inscriptions used in the development of the database. By studying what the BIA collected, how they developed GIS, and how they used the systems, "we can get a window into their understanding of what is important and what is not" (Curry 1998, 59).

UNEVEN GEOGRAPHIC INFORMATION NETWORKS

The quarterly technical reports (1988-1992) and the DOG showed that the BIA Nationwide Database was only a partial natural resource inventory. One assessment of natural resource management on American Indian lands stated,

> 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. (IFMAT 2003, 13)

Evidence I gathered showed that some effort was made by the BIA to create natural resource information in the form of GIS layers for the IIRIP. The majority of geographic information contained in the nationwide database consisted of selected base theme features digitized from USGS topographic maps. The base themes included: buildings, camp grounds, county boundaries, lakes-pond-reservoirs, land status, other agency management, public land survey, pipelines and transmission lines, reservation boundary, roads, state boundary, springs-tanks-wells, streams, and transportation. Considering that the BND was a nationwide project, some would assume that all American Indian reservations received complete GIS coverage. This was not the case.

The BND contained 358 individually named GIS layers. Sometimes, multiple layers had the same name. For example, the BND contained GIS layers called streams and rivers and were abbreviated as STR. The STR2 file was linear and STR3 was polygonal. In this dissertation, streams and rivers (STR) counted as only one entity. I applied this method to other repetitively named layers. Each layer or "tile" was equivalent to a 1:24,000 USGS quadrangle, and was projected in UTM coordinates. Only seven BIA agencies had access to between 30 and 45 themes (Table 5.1). Based on the total number of layers, the Northern Cheyenne, Flathead, Jicarilla, Warm Springs, Yakama, Fort Belknap and Zuni BIA Agencies had access to the most diverse database content.

A second finding showed the uneven flow of GIS layers from the GDSC to BIA Area and Agency offices.[26] The GDSC classified their layers into groups including: agriculture, archaeology, base, boundary, buildings, coal, fire, fish, geology, human, infrastructure, land, library specific, ownership, plants, planemetric reference, range, remote sensing, soils, timber, topography, transportation, valuation/assessment, water, and wildlife. Some layers existed within multiple groups. For example, the layer entitled soils (SLS) was found in the following groups: agriculture, base, library specific, and soils. To deal with the problem of mapping all the GIS groupings, I generalized the data into new classifications. For example, the new classification for Range Management includes layers from the DOG groupings: agriculture, range, plants, and soils.

All of the mapped data represents a compilation of GIS layers developed by the BIA between the years of 1988 and 1992. I simply counted all the layers found in the 1992 fourth-quarter report. I found there to be a total of 1706 layer coverages. The map findings show the geography of the BND networks that extended throughout

Indian Country. The next few paragraphs contain brief descriptions of the Service Center networks.

Table 5.1. Thirty (30) BIA Agencies with the Highest GIS Layer Counts

AREA OFFICE	AGENCY	%LAYERS	TOTAL LAYERS
Billings	Northern Cheyenne	13	45
Portland	Flathead	12	44
Albuquerque	Jicarilla	11	39
Portland	Warm Springs	11	39

Portland	Yakama	11	38
Billings	Ft. Belknap	9.2	33
Albuquerque	Zuni	8.9	32
Phoenix	Fort Apache	7.8	28
Navajo	Navajo	7	25
Albuquerque	Mescalero	6.7	24
Albuquerque	Southern Ute	6.7	24
Billings	Crow	6.1	22
Phoenix	San Carlos	6.1	22
Portland	Umatilla	6.1	22
Albuquerque	Southern Pueblos	6	21.6
Portland	Spokane	6	21.5
Billings	Wind River	5.9	21
Eastern	Choctaw	5.6	20
Portland	Colville	5.3	19
Billings	Blackfeet	5	18
Albuquerque	Northern Pueblos	5	17.8
Muskogee	Osage	4.7	17
Phoenix	Hopi	4.3	15.5
Aberdeen	Rosebud	4.2	15
Billings	Ft. Peck	4.2	15
Billings	Rocky Boy's	4.2	15
Minneapolis	Red Lake	4.2	15
Aberdeen	Pine Ridge	3.9	14
Phoenix	Truxton	3.8	13.5
Aberdeen	Lower Brule	3.6	13

Source: Bureau of Indian Affairs 1992d.

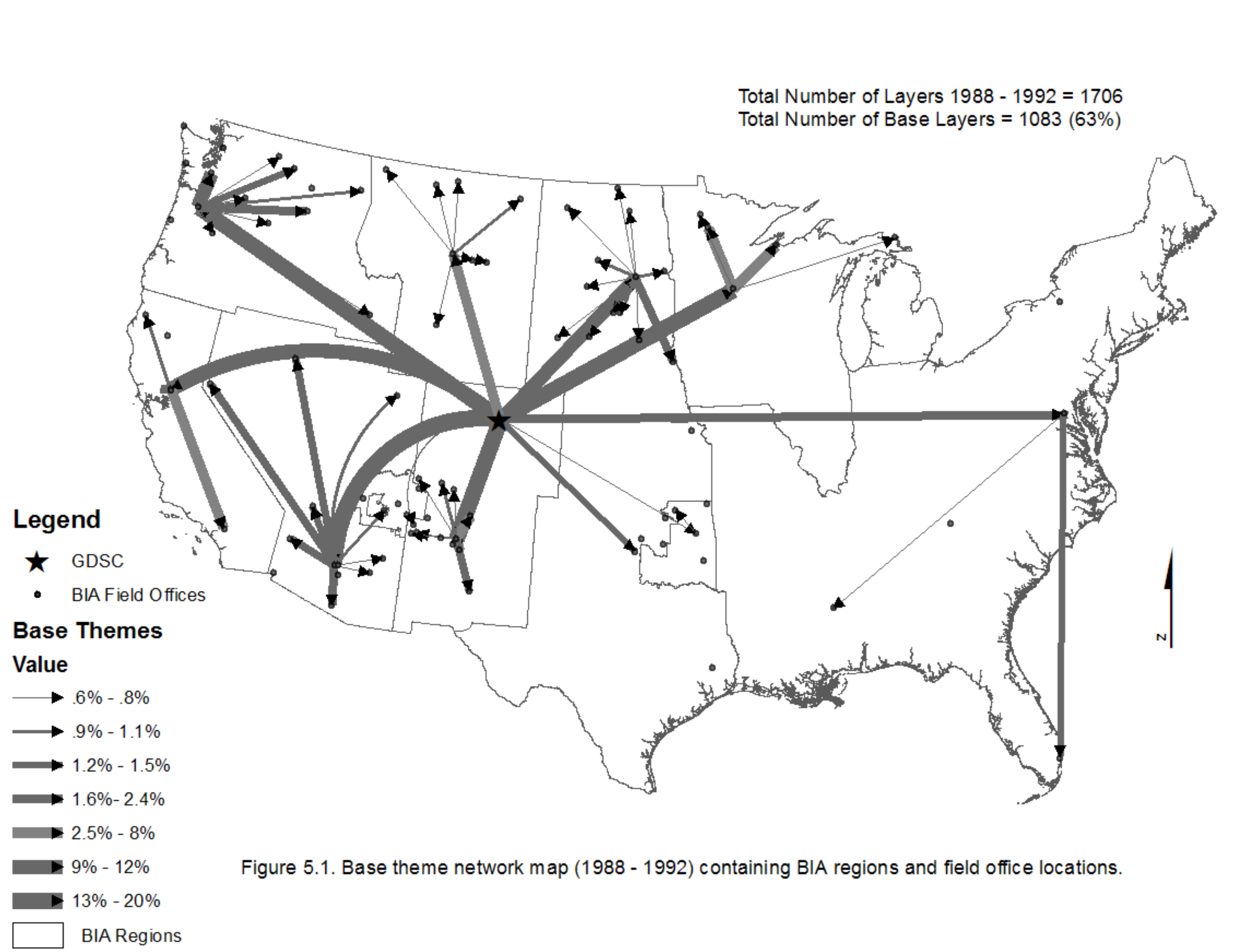


Figure 5.1. Base theme network map (1988 - 1992) containing BIA regions and field office locations.

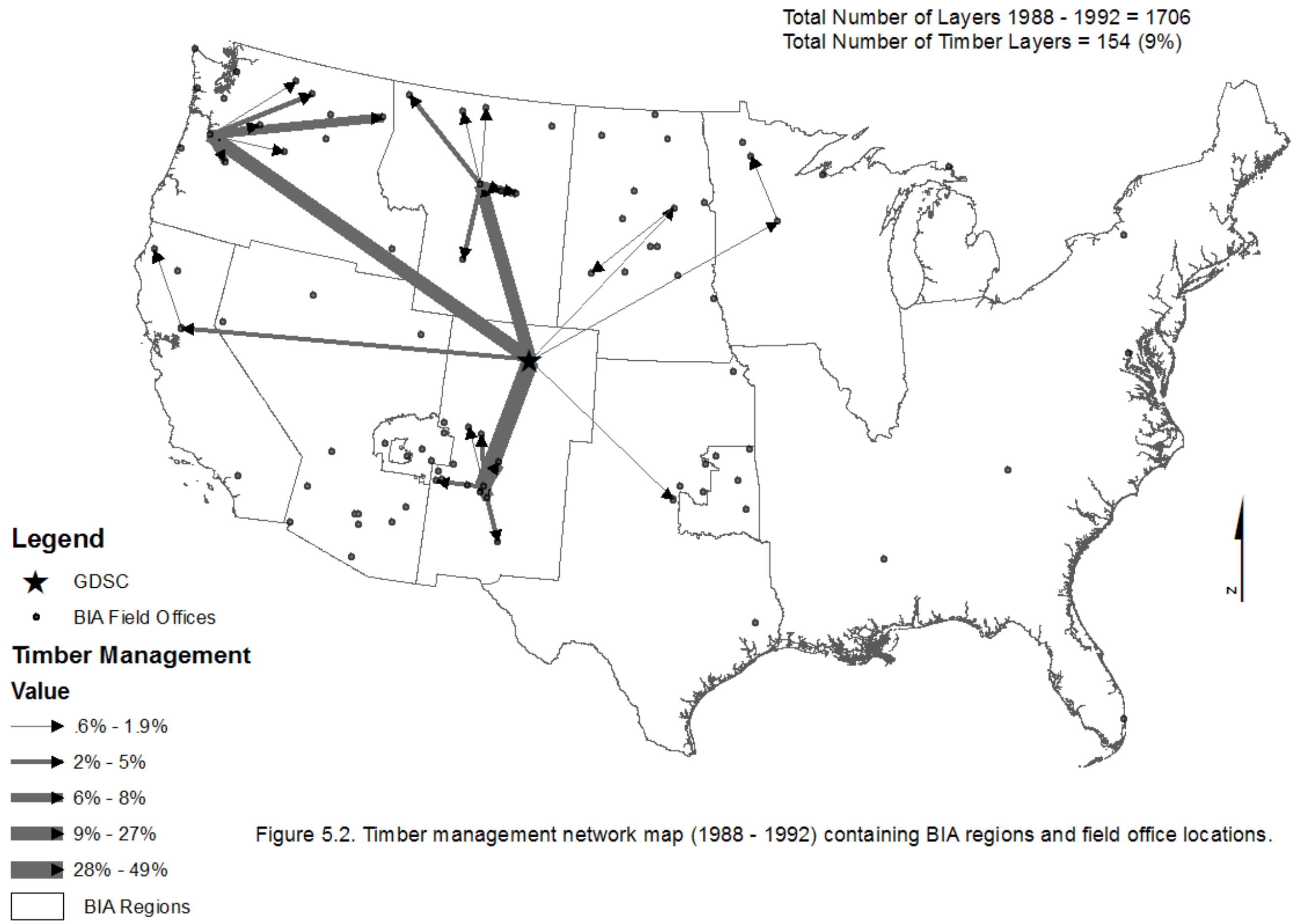


Figure 5.2. Timber management network map (1988 - 1992) containing BIA regions and field office locations.

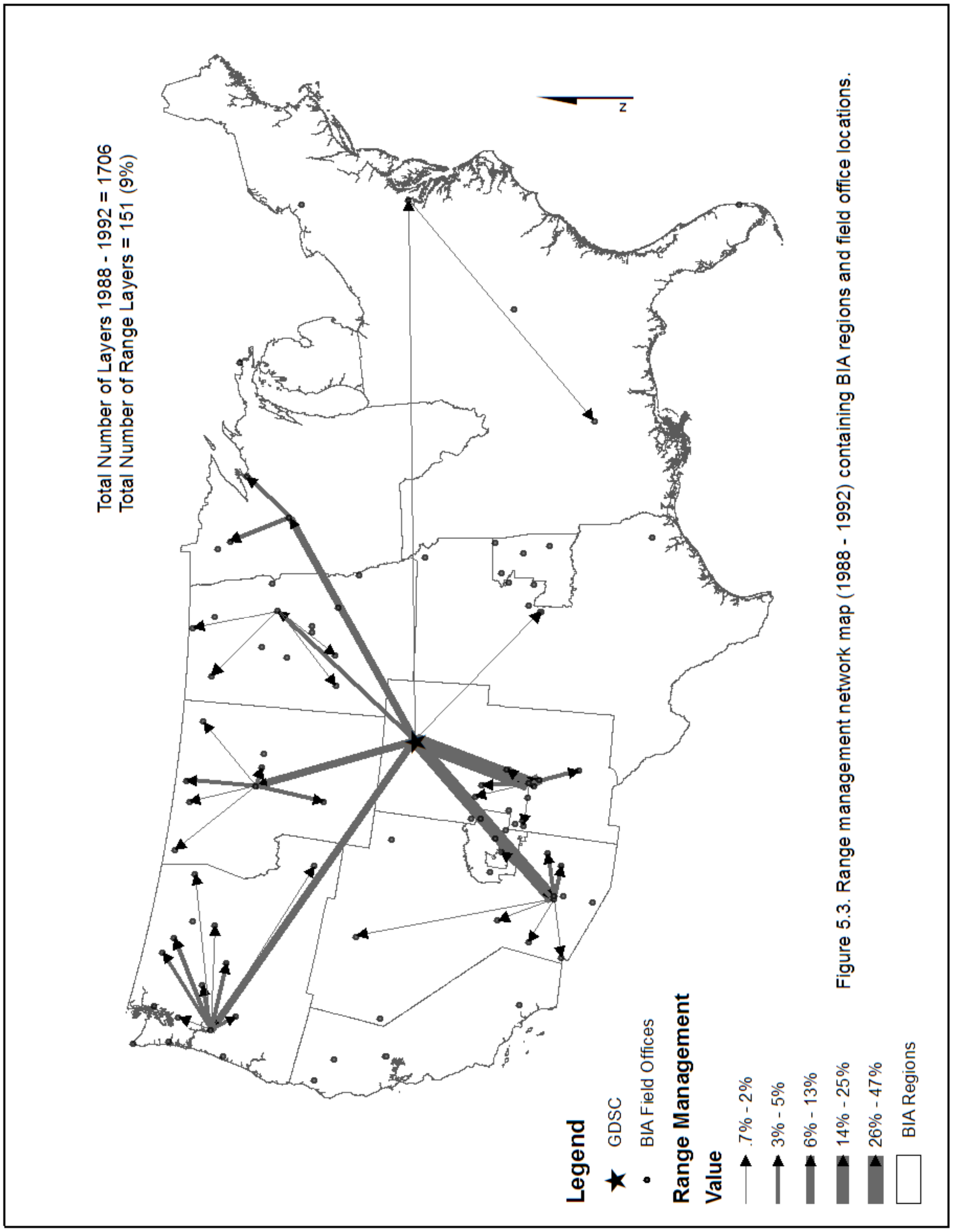


Figure 5.3. Range management network map (1988 - 1992) containing BIA regions and field office locations.

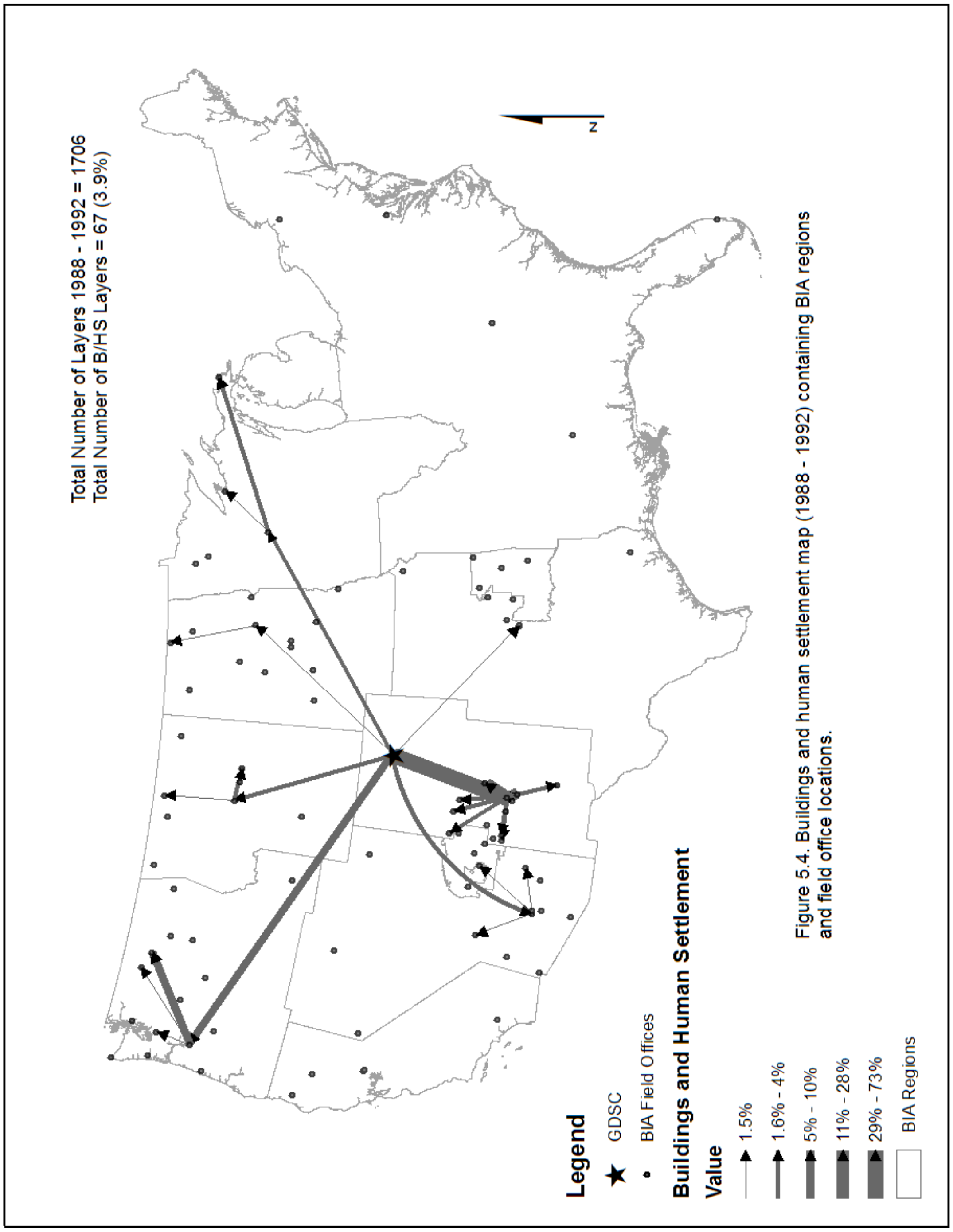


Figure 5.4. Buildings and human settlement map (1988 - 1992) containing BIA regions and field office locations.

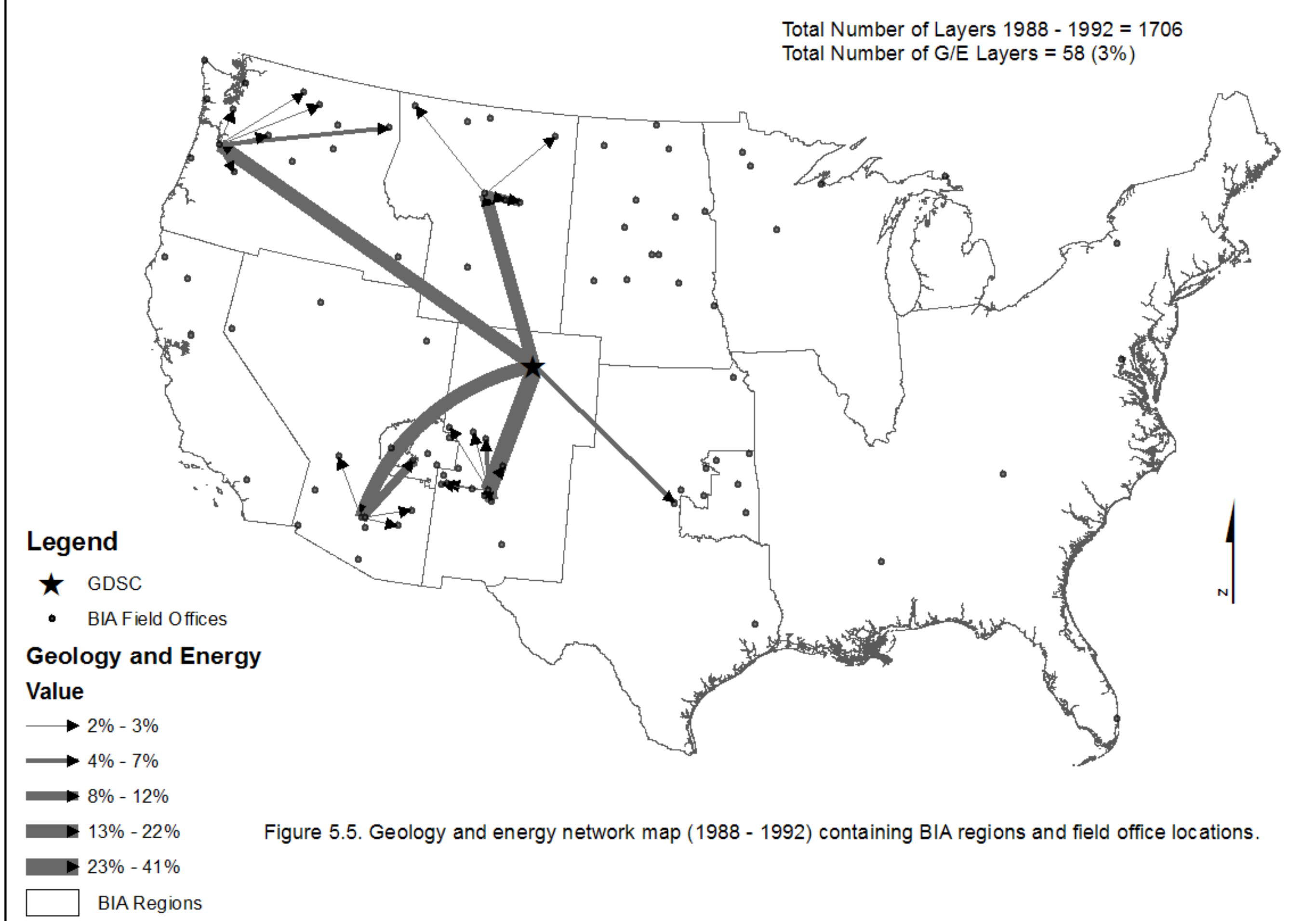


Figure 5.5. Geology and energy network map (1988 - 1992) containing BIA regions and field office locations.

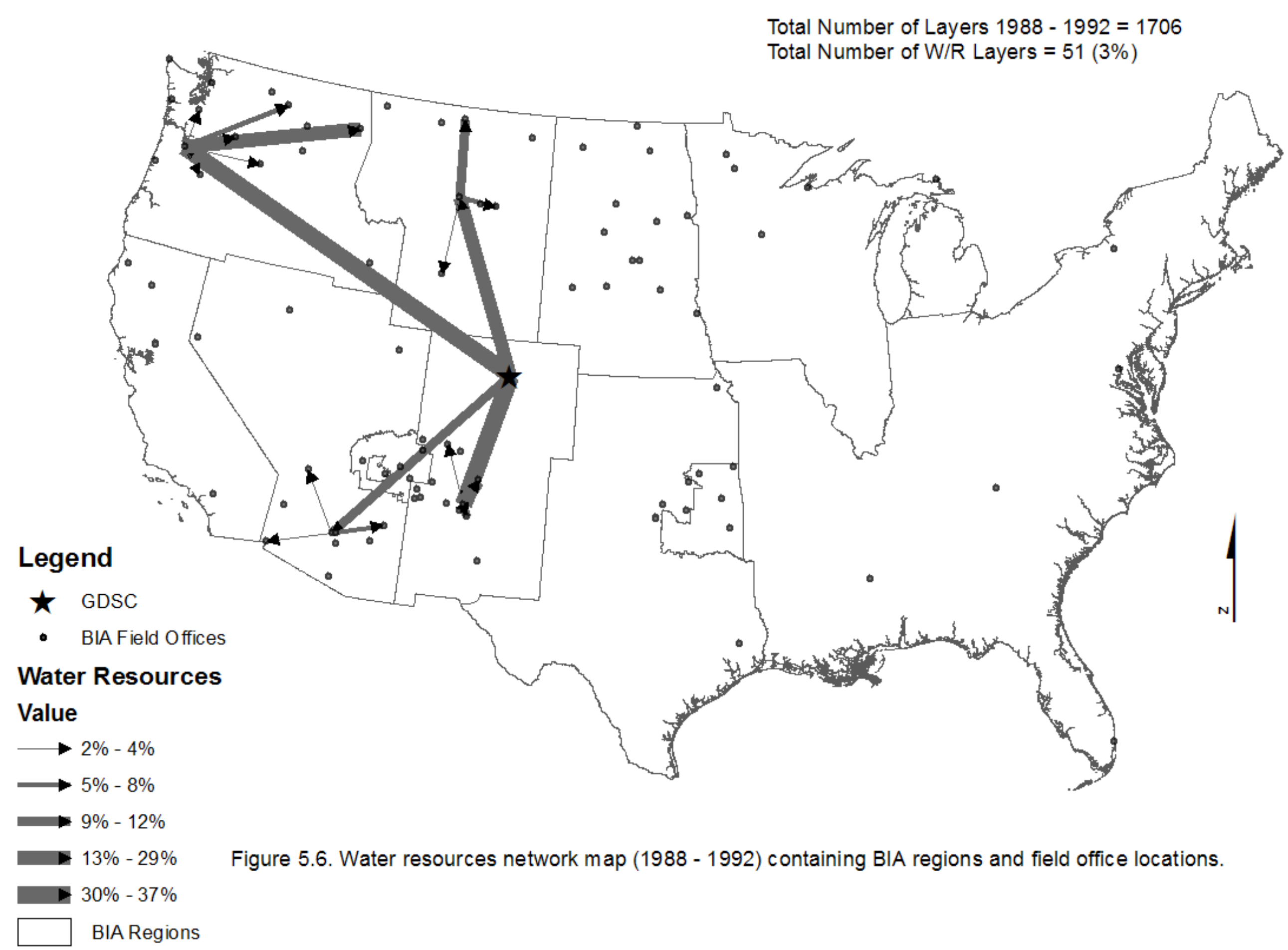


Figure 5.6. Water resources network map (1988 - 1992) containing BIA regions and field office locations.

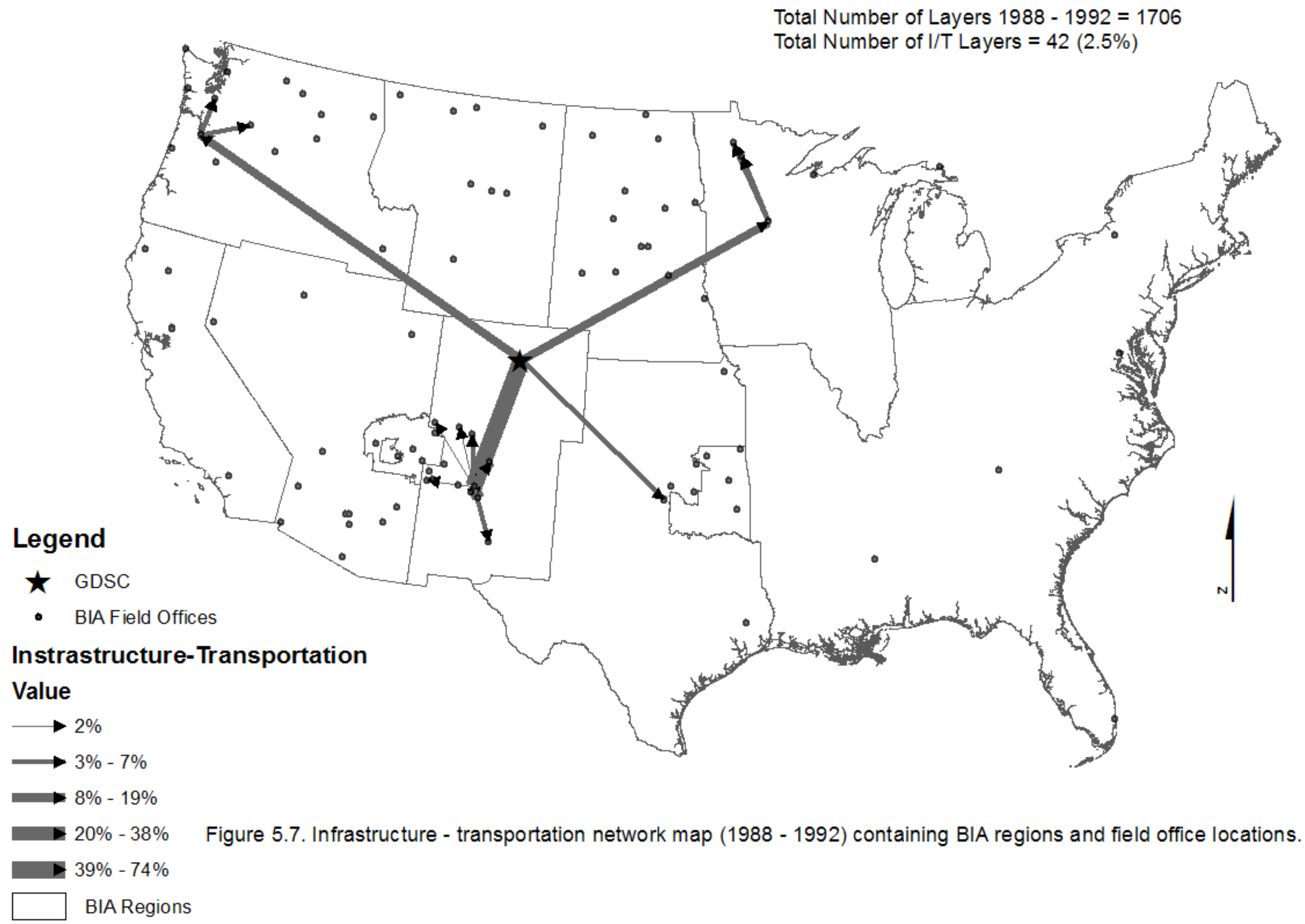


Figure 5.7. Infrastructure - transportation network map (1988 - 1992) containing BIA regions and field office locations.

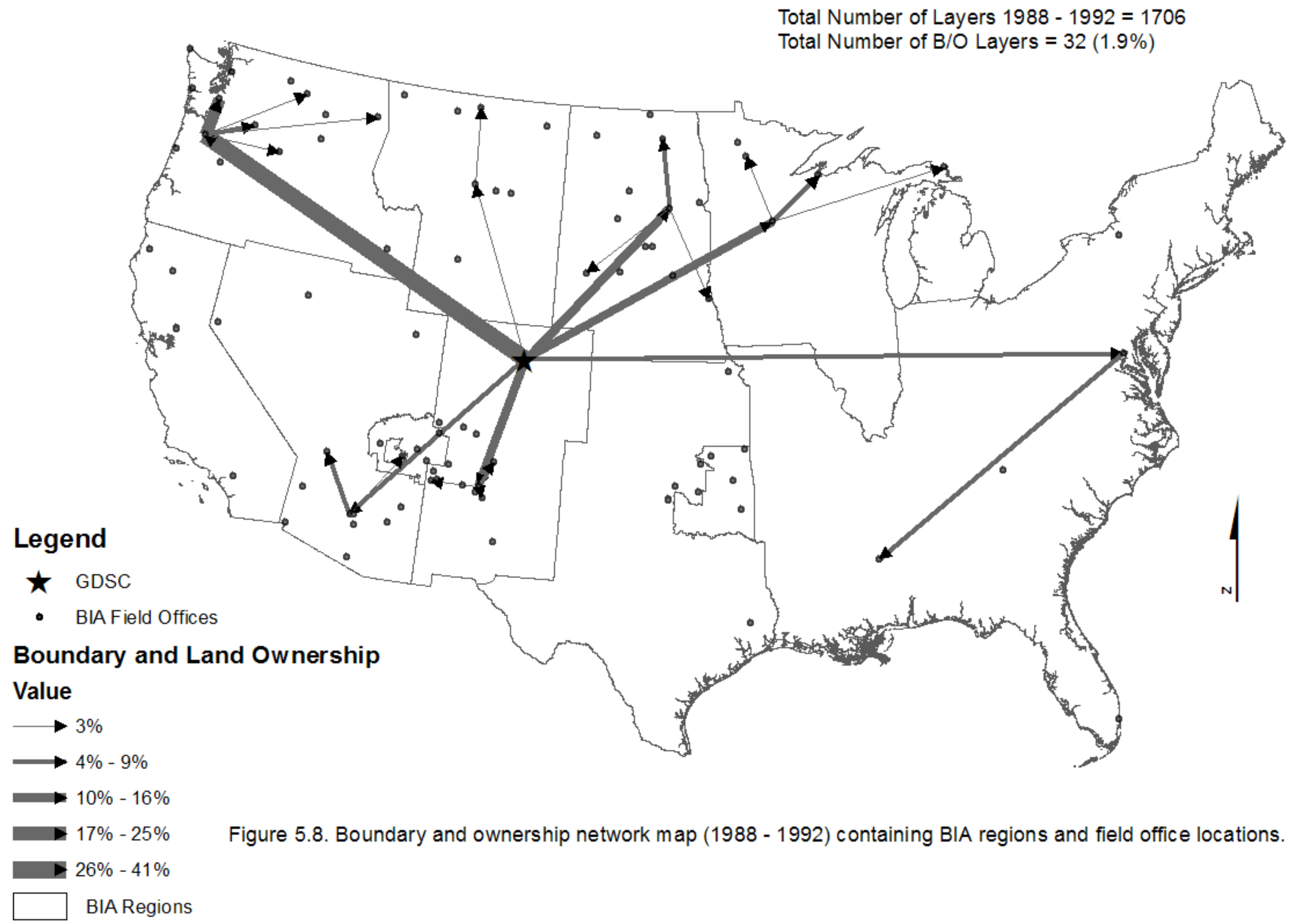


Figure 5.8. Boundary and ownership network map (1988 - 1992) containing BIA regions and field office locations.

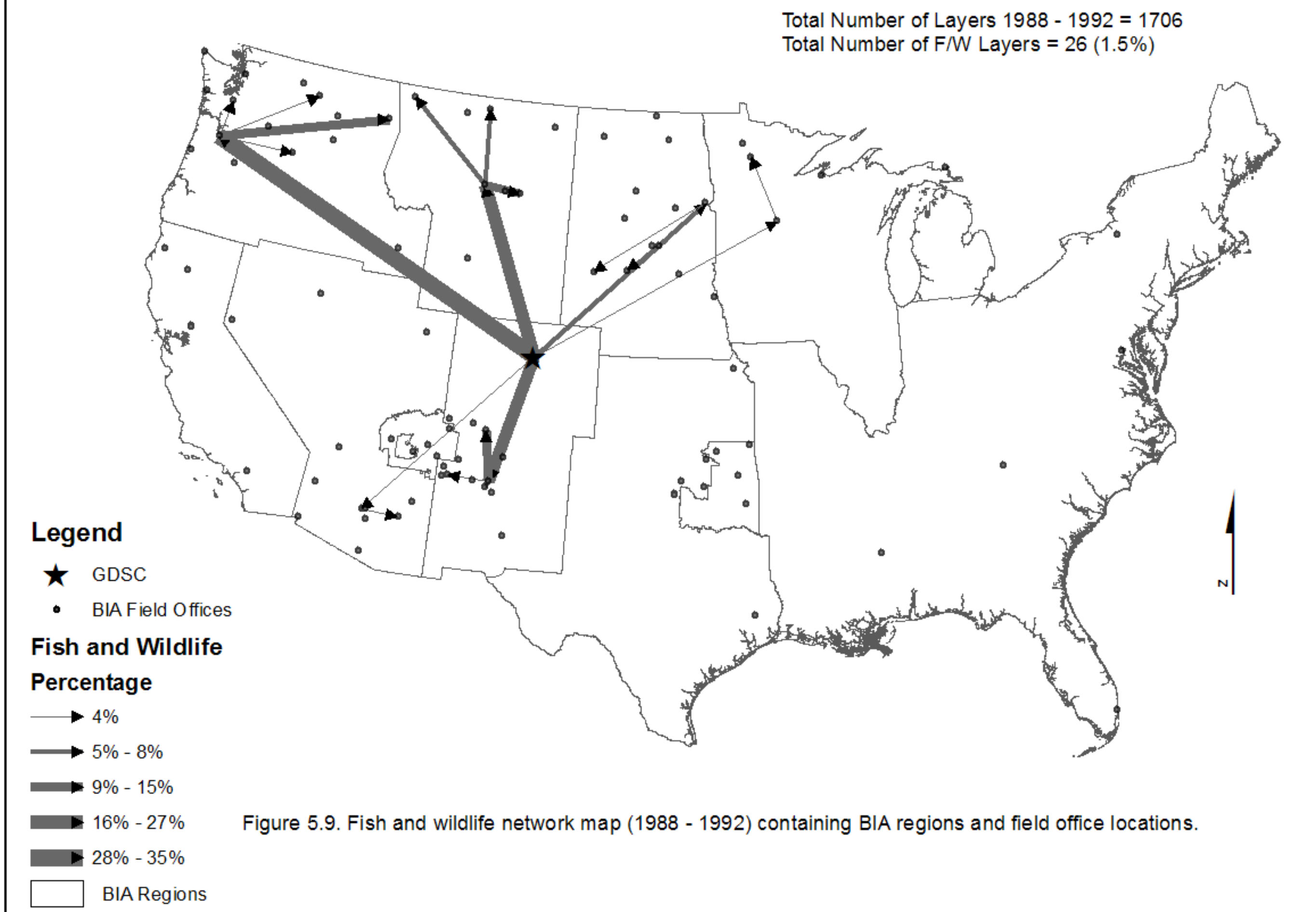


Figure 5.9. Fish and wildlife network map (1988 - 1992) containing BIA regions and field office locations.

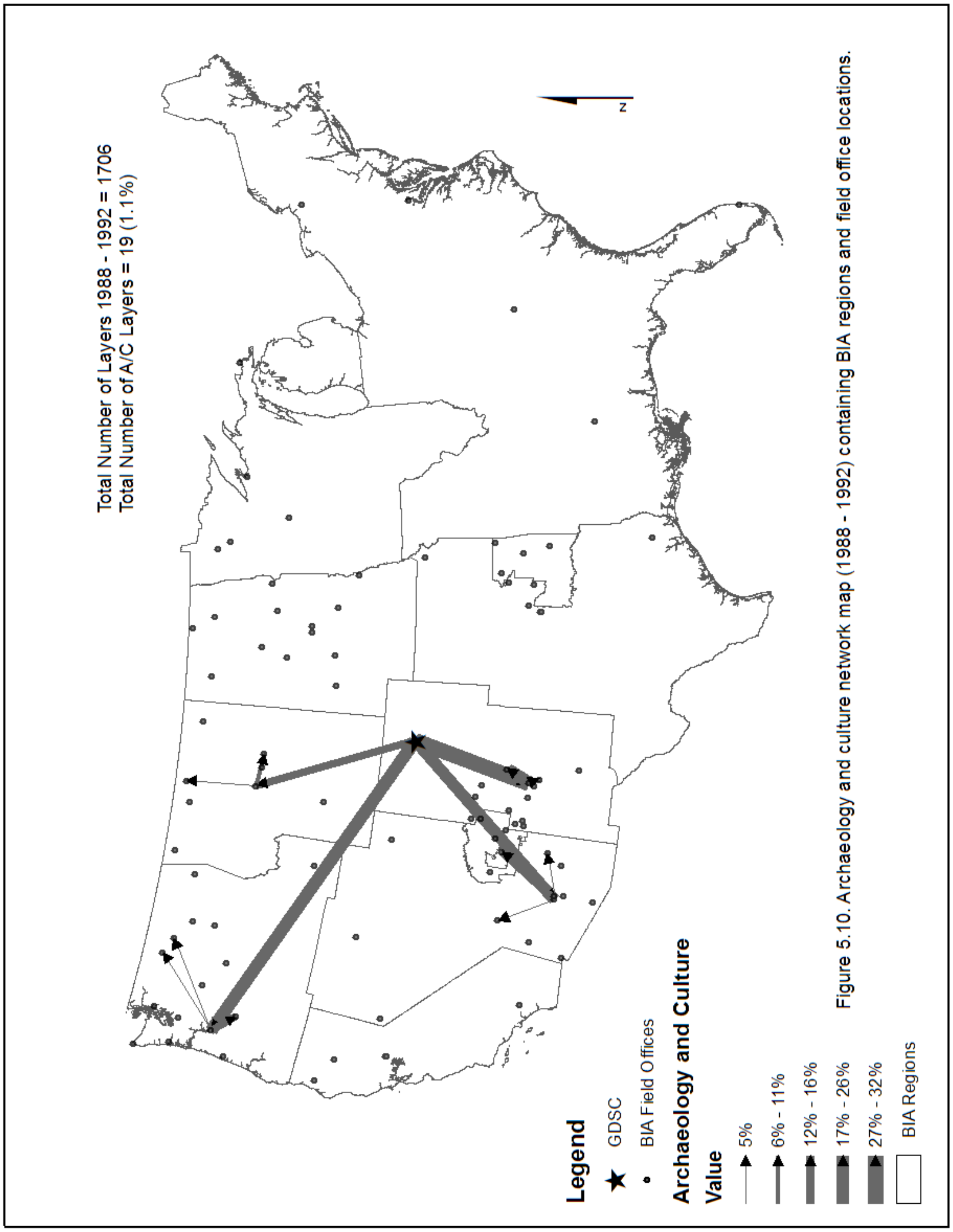


Figure 5.10. Archaeology and culture network map (1988 - 1992) containing BIA regions and field office locations.

Base Themes

Figure 5.1 shows the geographic distribution of base themes throughout Indian Country. Base themes represent 63% of the total layers counted. The GDSC digitized base features off of 1:24,000 topographic maps. Geographically, the base themes constituted the most-developed network of GIS layers in Indian Country. The map represents the network as a star-like shape containing hubs and nodes.[27] Very strongly aligned offices include the Portland, Albuquerque, Phoenix, and Minneapolis Area Offices. The Sacramento Area Office, Western Washington Agency Office, and the Aberdeen Area Office are strongly aligned with the BND.

Timber Management

The timber management category consists of layers for timber and fire. Related layers in the 1992 report make up 9% or 154 of the total counted. In addition to 1:24,000 topographic maps, other sources of information used in the construction of these layers included aerial photography and some field surveys (Bureau of Indian Affairs 1997e). Figure 5.2 shows that the BND timber management layer network is very strongly aligned with the Albuquerque Area Office. The timber management layers are also strongly aligned with the Portland Area Office, the Northern Pueblos Agency, and the Billings Area Office. A well developed hub and node network is found in the Southwest, Northwest, and Rocky Mountain regions. However, there is disparity between the networked western and the disconnected eastern field offices.

Range Management

The BIA used information from aerial photography, satellite images, manuscripts, and field surveys to construct the range management GIS layers (Bureau of Indian Affairs 1997e). Layers in this category consist of the following DOG groups: agriculture, range, plants, and soils. A total of 151 layers (9%) exist for this group in the 1992 fourth-quarter report. Figure 5.3 shows that the range management layer network is fairly extensive, oriented towards the south-southwest, and moderately oriented towards the north. Also, the network has a star-like shape emanating from the center. The Albuquerque Area Office is very strongly aligned with the BND. This office is followed by the strongly aligned Phoenix Area Office. The Pacific, Southern Plains, Eastern Oklahoma, and Eastern BIA regions remain marginal in this network.

Buildings and Human Settlement

Layers for buildings and settlement represent 4% of the total layers counted in the 1992 technical reports. This network resembles a weak star-like shape. Figure 5.4 shows that there is a very strong network connection between the BND building layers and the Albuquerque Area Office. Within this region, the Southern and Northern Pueblos Agencies are strongly aligned. However, disparity exists between the strongly aligned offices and the peripheral field offices in the Pacific, Southern Plains, Eastern Oklahoma, and Eastern BIA regions.

Geology and Energy

The geology and energy layers are another partially developed network. Geology and energy layers make up 3% of the total counted. These layers consist of oil and gas well points, coal mining operations, and topography including digital elevation models. The BIA Office of Minerals provided the oil and gas data in digital format for the GDSC. Other layers incorporated into the geology and energy layers included USGS DLG files, DEMs, and several 1930 1:300 scale tribal land maps (Bureau of Indian Affairs 1997e). Figure 5.5 shows a very strong alignment between the Albuquerque Area Office and the BND geology layers. The network is strongly aligned with the Portland Area Office, Southern Pueblos Agency Office, Billing Area Office, and the Phoenix Area Office.

Water Resources

Water resource layers make up 3% of the layers counted. This network is shaped like an incomplete star, with the Southwest region maintaining a strong hub and node network. Figure 5.6 shows that both the Portland and Albuquerque Area Offices are very strongly aligned with this network. Strongly aligned field offices include the Northern Pueblos Agency, the Billings Area Office, and the Flathead Agency.

Marginal BIA field offices include all of the BIA regions east of the Rocky Mountains.

Infrastructure and Transportation

Figure 5.7 shows that the infrastructure – transportation network is not very extensive. Only 42 infrastructure and transportation layers (.5%) are found in the 1992 fourth-quarter report. Once again, the Albuquerque Area Office is very strongly aligned with the BND. The Southern Pueblos Agency is strongly aligned in the network.

Boundary and Ownership

These groups of layers make up 2% or 32 of the total layers counted in the 1992 technical reports. In Figure 5.8, the network resembles a weak star-like shape. The Portland Area Office is very strongly aligned in this network. The Western Washington Agency, within the same region, is strongly aligned with the BND. Marginal field offices include the Pacific, Southern Plains, Eastern Oklahoma, and Eastern BIA regions.

Fish and Wildlife

The fish and wildlife themes represent a small network of connections (2%). The BIA digitized most of the Fish and Wildlife layers from aerial photography. Figure

5.9 shows a network with a weak star-like shape, with weakly connected hubs and nodes. The Portland Area Office and the Flathead Agency are very strongly aligned in this network. The Albuquerque Area Office is strongly aligned with the BND. Marginal regions include the Pacific, Southern Plains, Eastern Oklahoma, and Eastern BIA regions.

Archaeology and Culture

Perhaps the most critical network within the BND is the archaeology and culture layers. This is because such information can be culturally sensitive and proprietary for tribal governments and elder groups. Figure 5.10 shows a network with an incomplete star-like shape and is weakly developed. The network targets only some BIA Area and Agency Offices. The Albuquerque Area Office is very strongly aligned. The strongly aligned Phoenix and Portland offices follow.

A CORE – PERIPHERY GEOGRAPHY EMERGES

The composite map of the total GIS layers reveals a core – periphery geography based on the number of layers counted in the 1992 GDSC quarterly report (Figure 5.11). According to the map, network alignment between BIA regions and the BND varies. The regions most strongly aligned include the BIA Southwest region with 472 layers, the Northwest region with 307 layers, and the Western region with 231 layers (Table 5.2). The moderately aligned regions comprise the semi-periphery, the BIA

Midwest, Rocky Mountain, Great Plains, and Pacific (Table 5.2). Peripheral regions include the BIA Eastern, Southern Plains, Navajo, and Eastern Oklahoma regions (Table 5.2). What are some of the explanations for this geography?

Table 5.2. The core-periphery regions as represented in the BND (Bureau of Indian Affairs 1992d). .

BIA REGIONS	# OF BND LAYERS IN 1992
Southwest Region	472
Northwest Region	307
Western Region	231
Midwest Region	192
Rocky Mountain Region	174
Great Plains Region	134
Pacific Region	134
Eastern Region	25
Southern Plains Region	22
Navajo Region	8
Eastern Oklahoma Region	7

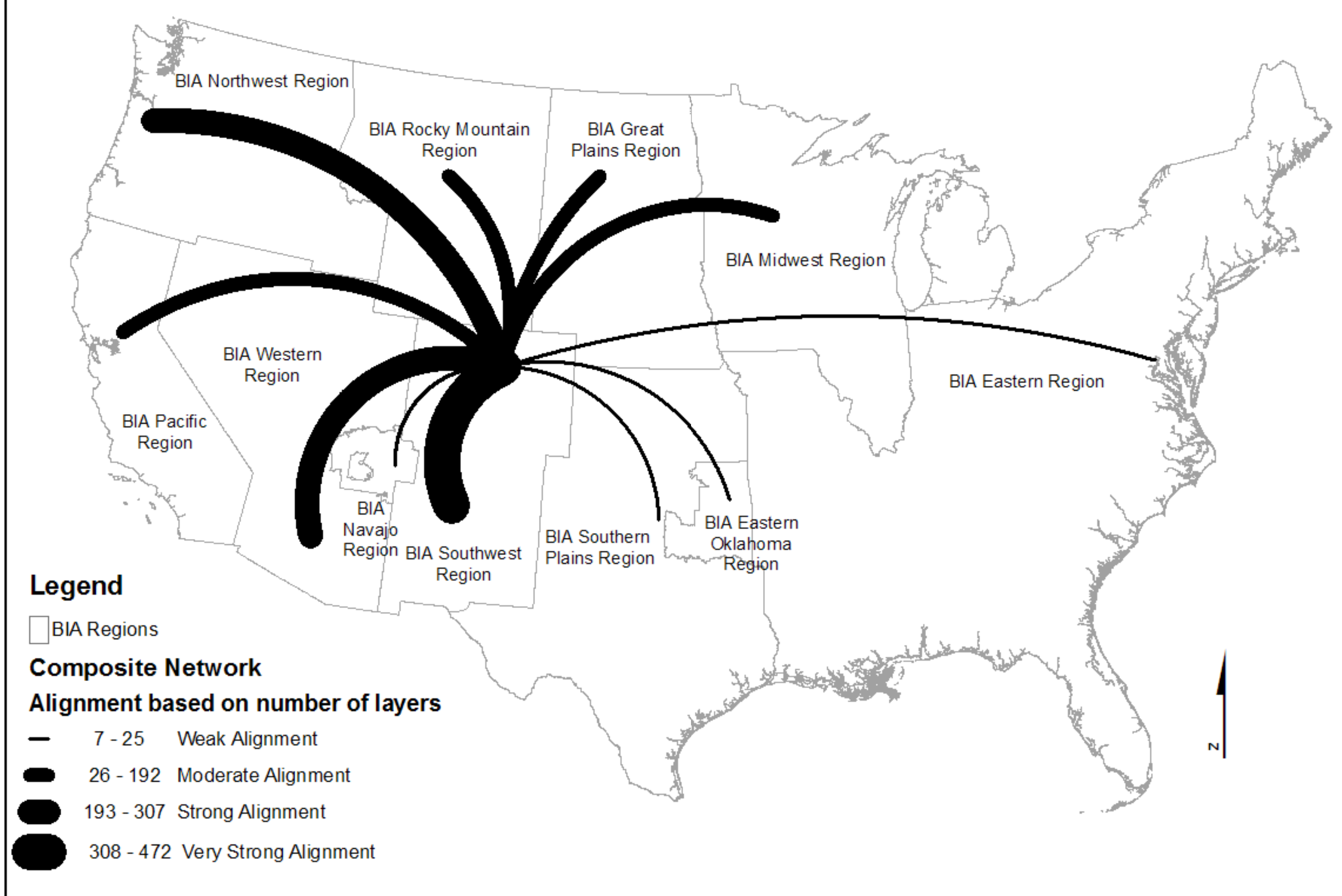


Figure 5.11. This is the composite GIS layer network and BIA region overlay map showing the core - periphery geography in Indian Country.

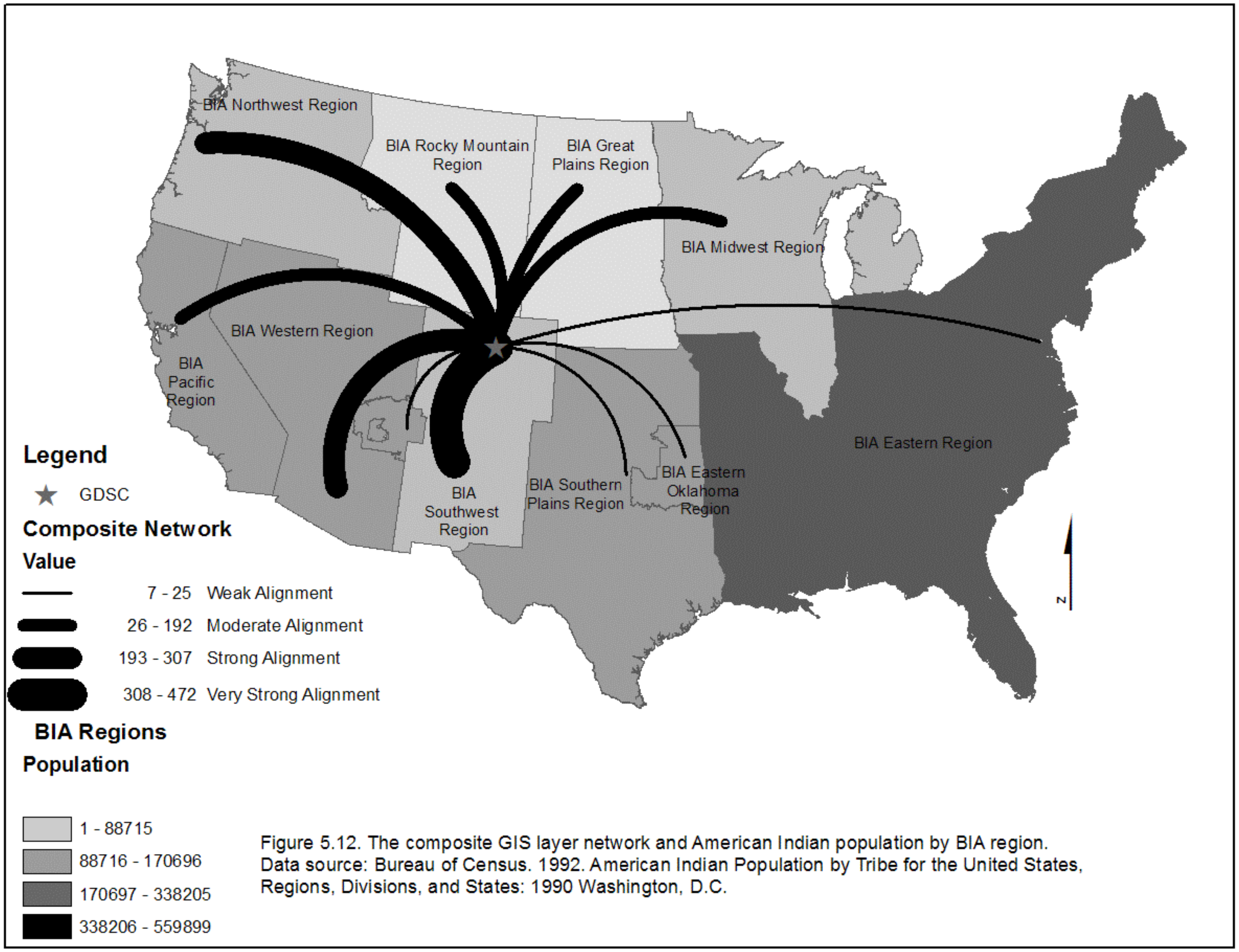


Figure 5.12. The composite GIS layer network and American Indian population by BIA region.
Data source: Bureau of Census. 1992. American Indian Population by Tribe for the United States, Regions, Divisions, and States: 1990 Washington, D.C.

One might assume that the flow of GIS layers and the strongest alignment with the BND and GDSC would be found in BIA regions that held the largest American Indian populations. However, this assumption is incorrect. Figure 5.12 shows that the core regions of BND development, the Southwest and Northwest regions, held 161,368 and 128,664 people respectively (U.S. Census Bureau 1992). Combined, both regions held 209,032 American Indians. The periphery, the Southern Plains, Eastern Oklahoma, and Eastern regions, held a total of 898,104 American Indians (U.S. Census Bureau 1992). In addition, the Navajo reservation held 143,405 people (U.S. Census Bureau 1992). Yet, GIS layer development for the peripheral regions was minimal between 1988 and 1992. How well did the BND connect with regions holding timberland resources?

Influence of Timber

One explanation for the uneven development of the BND was the presence of timberland and rangeland resources found on selected tribal areas throughout the BIA regions. The GDSC was not a stand-alone agency and GIS was not a stand-alone technology. Rather, it was intricately connected with other natural resource management policies and projects that impacted Indian Country. Intermediaries such as federal natural resource management policies and proceeds from the sale of timber contributed to the shaping of the network as well. GDSC quarterly technical reports contain references to other intermediaries such as the IRMP. Other intermediaries are identified within the IRMP documentation including the National Indian Forest Resources Act (NIFRA) of 1990 and the American Indian Agricultural Resource Management Act of 1993. These documents provide information on some incentives for the BIA GDSC to develop GIS data for some regions while neglecting other regions.

Federal funding distributed in the 1990s to support BIA natural resource management on American Indian land areas ranked far below funding granted to other federal resource management programs like national forests (IFMAT 2003). The overall lack of funding had an impact on the GDSC's support of BIA natural resource management activities in Indian Country. One of the most important aspects of GIS development at the GDSC involved the recovery of funds associated with the integrated natural resource management programs it supported. The NIFRA provided the potential for sustaining the further development of GIS at the GDSC through the acquisition of funding from timber sales on tribal lands:

> [Sec. 3105. Forest management deduction stated:] the Secretary [Department of the Interior] shall withhold a reasonable deduction from the gross proceeds of sales of forest products harvested from Indian forest land under a timber sale contract, permit, or other harvest sale document, which has the approval by the Secretary, to cover in whole or part the cost of managing and protecting such Indian forest land. (U.S. Congress 1990)

BIA integrated management programs are dependent upon the continued extraction of timberland resources; the same timber resources they were set up to protect.

Another requirement of NIFRA and AIARMA included the development, operation and maintenance of databases as an important aspect of the "forest land management activities" (U.S. Congress 1990). Such integrated activities included,

> All aspects of the development, preparation and revision of forest inventory and management plans, including aerial photography, mapping, field management inventories and re-inventories, inventory analysis, growth studies, allowable annual cut calculations, environmental assessment, and forest history consistent with and reflective of tribal integrated resource management plans [IRMP]. (U.S. Congress 1990)

And in the case of the AIARMA,

> To manage agricultural resources consistent with integrated resource management plans in order to protect and maintain other values such as wildlife, fisheries, cultural resources, recreation and to regulate water runoff and minimize soil erosion. (U.S. Congress 1993)

The IRMP, NIFRA, and AIARMA intermediaries formed the foundation of natural resource management in Indian Country and thus their connection to the IIRIP and geographic information development at the GDSC.

Tracing documents further connected the IIRIP, IRMP, NIFRA, and AIARMA with two assessments of Indian forestland management in the United States. The National Indian Forest Resources Act (NIFRA) required reporting of activities,

> Within 1 year after November 28, 1990, the Secretary, in consultation with affected Indian tribes, shall enter into a contract with a non-Federal entity knowledgeable in forest management practices on Federal and private lands to conduct an independent assessment of Indian Forest land and Indian forest land management practices. (U.S. Congress 1990)

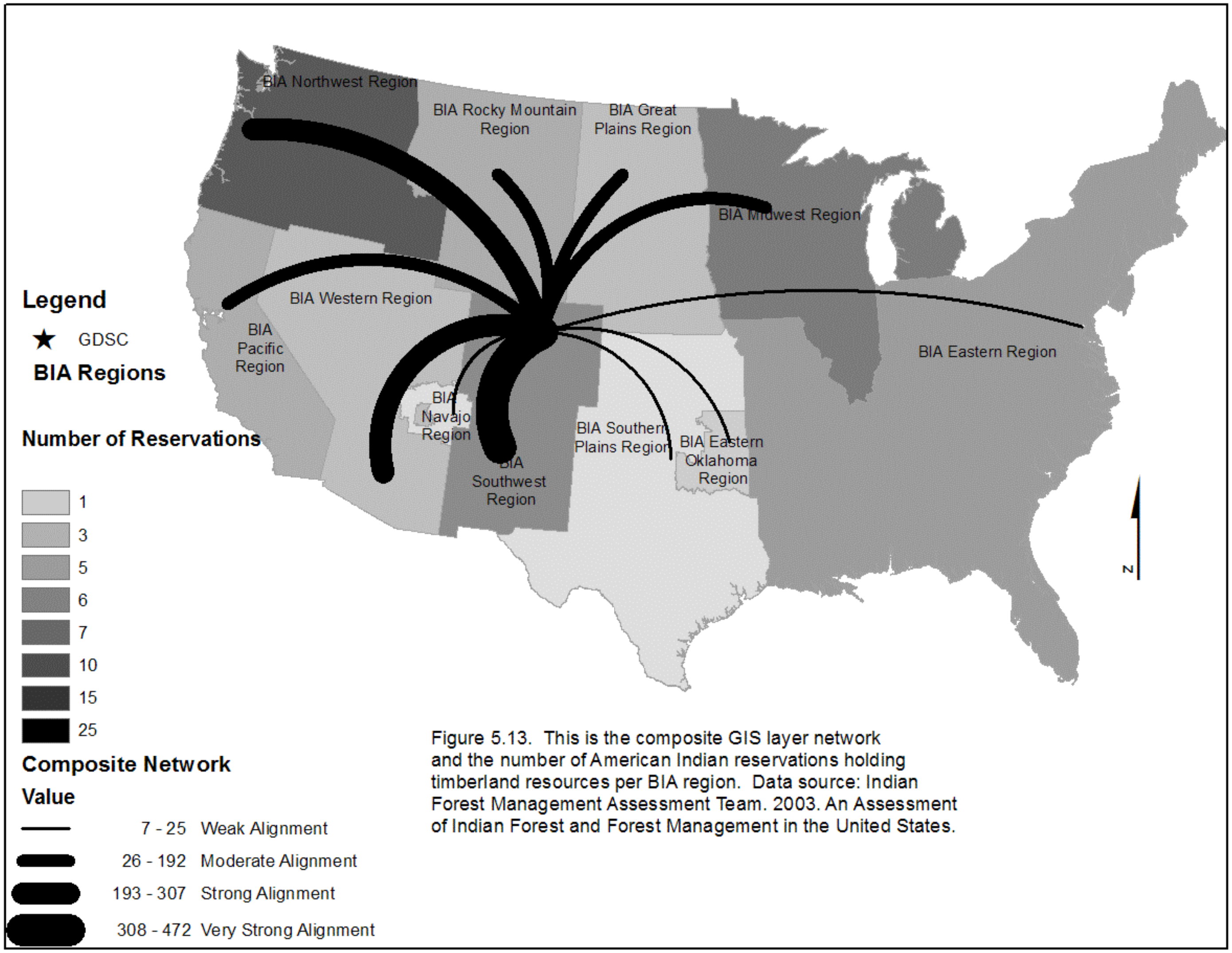


Figure 5.13. This is the composite GIS layer network and the number of American Indian reservations holding timberland resources per BIA region. Data source: Indian Forest Management Assessment Team. 2003. An Assessment of Indian Forest and Forest Management in the United States.

NIFRA also required periodic assessments, including,

> On each 10-year anniversary of November 28, 1990, the Secretary shall provide for an independent assessment of Indian forest lands and Indian forest land management practices…which shall include analyses measured against findings of the previous assessments. (U.S. Congress 1990)

These calls for assessments led to two documents entitled *An Assessment of Indian Forests and Forest Management in the United States* Part I and II published in 1993 and 2003 as "Congressionally mandated report[s] on the state of Indian forests and forestry" (IFMAT 2003, 2). The Indian Forest Management Assessment Team, consisting of non-federal natural resource management professionals, wrote the documents for the Intertribal Timber Council.[28] Information found in the documents identifies tribal land areas containing timberland resources.

> Such assessment shall include specific examples and comparisons from each of the regions of the United States where Indian forest lands are located. (U.S. Congress 1990)

Cross-referencing information from these assessments with BND activities found in the GDSC quarterly technical reports helps explain some of the uneven development associated with the BND. The BND was partially designed for reservations holding timberland and rangeland resources. This finding is revealed in the core – periphery geography of the BND.

Figure 5.13 shows that the very strongly aligned Southwest region, the strongly aligned Northwest region, and moderately aligned Midwest BIA region contain the most reservations with timberland resources. In fact, "the Portland [Northwest] region accounted for over 70 percent of the harvested timber volume and more that 85 percent of the revenue [in 2001]" (IFMAT 2003, 5). The Midwest region also holds a considerable number of small reservations and tribal land areas. A total of 15 tribal areas from the BIA Midwest region are found on the timberland resources list in the 1993 and 2003 assessments (IFMAT 1993; 2003). In 2001, the Great Lakes tribal areas "accounted for 13.5 percent of the harvested timber volume and over seven percent of the revenue" (IFMAT 2003, 5). Such harvests contributed to the BIA Midwest region becoming the second most productive tribal forestry region. However, the digital version of this region consisted almost entirely of base themes. The only tribal area covered with five timber management layers was the Menominee reservation.

Figure 5.13 shows that the strongly aligned Western region contains five reservations with timberland resources including the White Mountain Apache, Hualapai, San Carlos, and Uintah and Ouray Reservations (IFMAT 2003). The GDSC developed BND layers for each of these reservations (Bureau of Indian Affairs 1992d). The Pacific region was similar in that most of the reservations were covered by base themes, except the Hoopa Valley Reservation with five timber management coverages. Finally, the Great Plains region held five reservations with timberland resources, but the BND coverages consisted primarily of base themes with some range management coverage. The most diverse BND coverage among the moderately aligned regions was the Rocky Mountain office.

The total number of BND layers covering the Rocky Mountain region was not as extensive as the Southwest or Northwest databases. However, layer content covering some of the Rocky Mountain reservations was quite diverse. Table 5.1 shows that the Fort Belknap and Northern Cheyenne database contained 33 and 45 individually named layers in the BND. One might expect forest GIS to be much more developed for the Rocky Mountain region, but reservations in that region are primarily located on the High Plains, east of the mountains, and do not have as much forest as those in the Midwest region. Many of the forested areas in the Rocky Mountains are found on private, federal non-Indian lands.

The presence of prairie dogs also influenced the development of BND layers for the Ft. Belknap and Northern Cheyenne Reservations. Technicians and data entry specialists relied upon satellites to remotely sense the rangelands of the two reservations. Connections with space technology allowed technicians at the GDSC to identify prairie dog towns using 1:24,000 SPOT satellite images, and adding the data to the BND. BIA managers on the ground used these layers "in preparing EAs [environmental assessments] detailing proposed [prairie dog] control actions" for the Fort Belknap and Northern Cheyenne Reservations (Bureau of Indian Affairs 1990d). Grizzly bears impacted the development of the Blackfeet database in 1988. The Threatened and Endangered Species Act protected Grizzly bears, and influenced the development of GIS layers within the BND.

The core and semi-periphery regions received the greatest attention in terms of GIS layer development for the BND. Evidence within the quarterly technical reports, IRMP guidelines, and other documents points to the presence of timberland and, secondarily, agricultural resources as main driving forces behind BND development between 1988 and 1992. Integrated management practices also influenced BND development.

Integrated Management and the BND

The BIA established the IRMP program in 1988. The United States Congress was aware that the BIA intended to develop an IRMP for each reservation (U.S. Congress 1994). By 1994, a total of nine (9) IRMPs had been completed (U.S. Congress 1994). Ten years later, in 2004, only twenty-eight (28) IRMPs had been completed (Office of Management and Budget 2004). These documents show that the BIA fell significantly short of their 100 percent goal. The GDSC's IIRIP supported the BIA's aggressive implementation strategy for IRMPs in 1990. Evidence within the 1990 quarterly technical reports show a correlation between BND development and the development of IRMPs on selected reservation areas within the very strongly, strongly, and moderately aligned BIA regions.

Association between the IRMP and BND development is prominent in the 1990 quarterly technical reports. For instance, in the strongly aligned Northwest region, the Flathead, Yakama, Coliville, Umatilla, and Warm Springs Reservations actively developed IRMPs. The Warm Springs Tribe and BIA Agency used GIS extensively for IRMP (Bureau of Indian Affairs 1990a). However, GIS database development at Umatilla was slowed by funding problems (Bureau of Indian Affairs 1990b). Other IRMP activities took place on the Fort Hall, Tulalip, Lummi, and Spokane Reservations.

The GDSC digitized base themes, soils, and land status GIS layers for the Aberdeen Area Office (Bureau of Indian Affairs 1990a). Fort Berthold was active in IRMP development in the Great Plains region. However, the Fort Berthold IRMP was ultimately limited by personnel and funding issues (Bureau of Indian Affairs 1990d).

IRMP development was very active in the Southwest BIA region and included the Iseleta Pueblo, Southern Ute, Sandia Pueblo, Acoma Pueblo, Jicarilla Apache, and Mescalero Apache (Bureau of Indian Affairs 1990a,b,d). The GDSC also planned to develop base themes and range management GIS layers for all of these Southwest reservations (Bureau of Indian Affairs 1990a,b,d).

Some Rocky Mountain IRMP activities included completing "GIS output products…for Fort Belknap" (Bureau of Indian Affairs 1990b). The Rocky Boy's and Blackfeet tribal governments initiated IRMP activities for their reservations. However, shortages in funding severely inhibited IRMP development for the Blackfeet Reservation. One quarterly report reveals that, "IRMP is on a indefinite hold until funds can be identified to build the GIS database" (Bureau of Indian Affairs

1990c). This is another piece of evidence that links BND development with the IRMP program.

The Midwest region actively developed GIS layers for their IRMPs at the GDSC. Reservations included Lac du Flambeau, White Earth, Fond du Lac, and Lac Courte Orielles band of the Chippewa Tribe (Bureau of Indian Affairs 1990a,b). The White Earth Reservation provided $20,000 for IRMP planning and base theme development (Bureau of Indian Affairs 1990a).

IRMP and BND base theme development in the Western region included the Hopi, Fort Apache, San Carlos, and Summit Lake. Fort Apache used GIS extensively for their IRMP activities (Bureau Indian Affairs 1990a). A total of $70,000 was applied to GIS data entry on the San Carlos Reservation (Bureau of Indian Affairs 1990a). Finally, there was IRMP and BND database development for the Hoopa Tribe and Central California Agency Office (Bureau of Indian Affairs 1990a).

Evidence found in the quarterly technical reports and on the flow maps show that BIA regions with timberland resources and IRMP development were very strongly, strongly, and moderately aligned with the GDSC BND network. What was the status of the peripheral regions in terms of integrated management?

Ownership Fractionation, Fragmentation and Integrated Management

The Anadarko, Muskogee, and Eastern BIA offices made up the peripheral regions of the BND network between 1988 and 1992. The peripheral regions were the least developed, the most fragmented, and disconnected within the BND (Bureau of Indian Affairs 1992d). The lack of activity was a result of federal allotment policy and the status of land allotments within the context of integrated management practices.

Federal Indian land policies like the General Allotment Act of 1887[29] reduced GIS development in the peripheral BIA regions a century later. Implementation of allotment policy allowed the United States government to dissolve larger reservations by allotting land to individual Indians and selling the "surplus" to non-Indian settlers. The impact of allotment policy continues as BIA and tribal government administrators toil with complex ownership fractionation, erosion of the Indian land base, and land-use issues (Palmer 1998). This geography of American Indian allotments shaped the development of GIS at the GDSC. However, the GDSC did not develop the BND equally for all allotment areas. Areas holding timberland resources received more attention.

The BND emerged as a tool to assist managers at BIA Area and Agency offices in the implementation of integrated management activities (Bureau of Indian Affairs 1988a). The 2003 IFMAT records,

> The administration of allotments is still complex and an impediment to modern integrated management of Indian lands…The division of Indian forests into allotted lands and tribal lands makes forest management more complex and frequently results in disagreement between allottees, tribes, and the BIA and other agencies. (IFMAT 2003, 15, 20)

This complexity was primarily due to ownership fractionation. Land-use policies associated with Indian land allotments require each Indian land owner to sign consent forms before pursuing any kind of land-use activity, including timber extraction, farming, ranching or leasing of land (Palmer 1998). According to the IFMAT,

> Fragmentation of ownership now hampers or prevents integrated management of Indian forests at many locations. If integrated management of natural resources is to become more prevalent on tribal forests, consolidation of ownership and management is a high priority. (IFMAT 2003, 18)

Federal allotment policy integrated American Indians into the U.S. federal government's land tenure system. However, the new economic regime associated with the centers of calculation, cycles of accumulating natural resource inventories, and the potential extraction of natural resources further marginalized some allotment areas. This was particularly true for Oklahoma.

The 2003 IFMAT assessment shows that "smaller reservations and allotments pose special management problems due to larger per acre management costs" (IFMAT 2003, 23). In other words, the proceeds generated from the sale of natural resources on small reservations and allotment areas would not subsidize the management of land, including the development of geographic information at the GDSC.

The 1990 quarterly reports reveal that the scattered nature of trust land geography contributed to the lack of IRMP activity at the Anadarko Office (Bureau of Indian Affairs 1990a). Yet, of all the large tribes in the Southern Plains region, the only reservation deemed qualified for integrated management was the Alabama – Coushatta Reservation in Texas. According to the 1990 quarterly reports,

> Alabama-Coushatta was selected as the most likely reservation for an IRMP. Basic thematic data were digitized for the reservation, but no formal IRMP activities have been initiated. (Bureau of Indian Affairs 1990b)

According to the IFMAT I and IFMAT II listing of timberland resources on tribal lands, IFMAT I listed the Alabama – Coushatta, Cherokee, Chickasaw, and Choctaw tribes as having timber resources (IFMAT 1993). The Alabama – Coushatta was on the list of 84 tribal areas with timberland resources (IFMAT 2003). Although the GDSC produced GIS base themes and oil and gas layers for Caddo County, Oklahoma, the only tribe within the Southern Plains region that had a GIS database developed for them, in 1992, was the Alabama – Coshatta tribal government. This is evidence that the BND integrated with the IRMP which integrated with forest management.

The 1990 quarterly reports reveal similar remarks about the Muskogee Area Office. According to the reports,

> Staff and funding limitations have combined to limit accomplishments to data. No data entry projects are underway. Much of the trust land is widely dispersed, complicating integrated planning. (Bureau of Indian Affairs 1990a,b)

This is clear evidence that land allotment geographies in Oklahoma had an impact on the development of IRMPs and the BND layers to support the program. However, not all land allotment areas experienced the same extreme marginal conditions.

The development of the BIA Eastern Region GIS database was shaped by the presence of timberland resources. Three BIA agencies containing tribal allotment areas received GIS database development. Once again these areas contained timberland resources and did experience some IRMP activities. The BIA GDSC completed base theme coverage for the Seminole areas of Brighton and Big Cypress which appeared on the IFMAT I list of reservations with timberland resources. Big Cypress also appeared as one of the 84 tribal areas with such resources in 2003 (IFMAT 2003). The Mississippi Band of Choctaw was the other tribe that had initiated an IRMP in 1990 (Bureau of Indian Affairs 1990d). The tribe was also listed as having timberland resources (IFMAT 2003). The Big Cypress, Brighton, and Mississippi Choctaw were the only Eastern regional tribes represented in the BND in 1992.

The geography of Indian land allotments led to the underdevelopment of the BND at the GDSC center of calculation. The center relied heavily upon the flow of federal funds from Congress and the trickle of funding that came from BIA field offices and tribal government natural resource departments. However, Congress was fickle and the political landscape of Indian Country changed in terms of tribal governments gaining more control of the management of natural resources and having the ability to express self-governance through other federal agencies, not just the BIA. The sweeping changes associated with the executive and legislative branches of United States government in 1992 impacted development of the BND. These impacts stemmed from changes in federal funds flowing from Congress to the BIA GDSC.

FUNDING

The final element of BND development involved yet another transition. This time the transition was associated with fluctuating funding support. The availability of funding represented perhaps the greatest threat to the overall management of natural resources and ultimately the development of GIS at the GDSC. Risks associated with potential funding shortfalls and reduction in resource managers at the BIA and tribal government offices increased automation, and the need to absorb resource management costs especially in the core regions with their significant natural resource bases (IFMAT 2003). Fluctuations in funding were the result of initial base funding for the IIRIP, one-time support for computer hardware upgrades, and loss of significant operational funding in the mid-1990s that led to the destabilization of the BND network.

Funding Fluctuations

In 1990, $2,087,000 supported the IIRIP, $500,000 from OIRM supported acquisitions, operations, and maintenance, and a one-time increase of $500,000 was provided for computer hardware upgrades to Prime 6650 Super Mini-Computers. The OTR decreased the IIRIP budget by $10,000 and did not carry over the computer upgrade funding in 1991 (Bureau of Indian Affairs 2005c). These fluctuations revealed the movement of funding from the OTR, to the GDSC, to database development, and the incorporation of BIA Area Offices. Also, the highest levels of funding correspond with the initial development of the IRMP and the corresponding development of the BND in 1989, 1990, 1991, and 1992 as revealed in the last section. Successive years of $25,000 reductions in the IIRIP budget between 1991 and 1994 corresponded with lack of information in the quarterly technical reports on the state of the IRMP in relation to the GIS development at the BIA GDSC.

Table 5.3. GDSC general budget summary for the years 1989 to 2005. (Bureau of Indian Affairs 2005c).

Fiscal Year	Funding Sources	Funding Level
1989	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$2,587,000
1990	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$3,087,000
1991	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$2,562,000
1992	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$2,840,000
1993	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$2,512,000
1994	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$2,487,000
1995	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$1,992,000
1996	BIA Office of Trust Responsibilites	$1,320,000
1997	BIA Office of Trust Responsibilites	$1,320,000
1998	BIA Office of Trust Responsibilites	$1,445,000
1999	BIA Office of Trust Responsibilities BIA Office of Integrated Resource Management	$1,445,000
2000	BIA Office of Trust Responsibilites	$1,314,000
2001	BIA Office of Trust Responsibilites	$1,314,000
2002	BIA Office of Trust Responsibilites	$1,314,000
2003	BIA Office of Trust Responsibilites	$1,307,000
2004	BIA Office of Information Operations	$1,294,000
2005	BIA Office of Information Operations	$1,269,000

Loss of Operational Funding

Two political positions emerged in the 1990s that influenced American Indian tribal government relations with federal agencies. First, there was an emphasis on increased American Indian self-government, giving tribes greater authority to manage their own affairs locally. This position is found within the National Indian Forest Resources Management and American Indian Agricultural Resource Management Acts.

> [Self-Determination in National Indian Forest Resources Management] Indian forest land management activities undertaken by the Secretary shall be designed to…[regulate] Indian forest lands through the development and implementation, with the full and active consultation and participation of the appropriate Indian tribe, of forest management plans which are supported by written tribal objectives and forest marketing program. (U.S. Congress 1990)

Second, there was an increased emphasis placed on integrated resource management practices in American Indian tribal governments between 1993 and 1995. Integrated resource management required significant input from tribal governments and communities. This was not the case in the 1980s and early 1990s. For example, some members of Congress criticized the BIA's natural resource management policy that occurred during this period by arguing, "

> The Department of the Interior and the Bureau of Indian Affairs have provided little support or assistance to tribal efforts to manage fish and wildlife resources. (U.S. Congress 1993b)

And furthermore,

> Although the Department of the Interior has compiled substantial resource inventory information such as maps, surveys and other data necessary for the development of IRMPs, many Indian tribes have had difficulty gaining access to this information and the assistance necessary to develop their IRMPs. (U.S. Congress 1994)

In addition, passage of the Title IV Indian Self-Determination and Education Act of 1994 reorganized the political landscape, including the management of natural resources, throughout Indian Country. Following passage of this legislation, the GDSC underwent massive budget cuts.

Table 5.3 shows that within two years of the new legislative changes and calls for greater tribal participation in the management of natural resources (between 1994 and 1996) the GDSC budget declined by a whopping $1,167,000. One of the most devastating fluctuations in funding involved a reduction in the IIRIP program by the OTR for $495,000 and the loss of the annual OIRM payment of $500,000 for acquisitions, operations, and maintenance. The GDSC newsletter reported that,

> The FY 1995 budget for the operation of the GDSC was reduced by 24 percent. At that time, the GDSC was forewarned by personnel in the BIA Division of Financial Management that the GDSC budget for FY 1996 may be reduced…or even zeroed out. (Bureau of Indian Affairs 1995c, 14)

The newsletter went on to say,

> To be fully successful…will require new and increased funding support. The GDSC is committed to seek this funding and to implement these efforts to maximum extent possible. (Bureau of Indian Affairs 1995c)

However, a $495,000 funding reduction by the OTR in support of the IIRIP and discontinued support of $500,000 from the OIRM was too much to overcome. According to GDSC acting director Mark Zundel loss of the OIRM funding to support operation costs was devastating and resulted in the laying-off of technical and data-entry specialists, which in turn led to the decline of the BND.[30] As a result, "BIA staffing to provide technical support has significantly declined over the last decade (1991 to 2001). Tribes are receiving less assistance for forest inventory [like GIS database development], management planning, marketing, and economics" (IFMAT 2003, 10).

The overall decline of the BND network correlated with the destabilization of, the most important intermediary, funding for forest management at the federal government level. Funding for both GIS development and forest management in Indian Country was low compared with national projects and declined throughout the 1990s. Both of the IFMAT studies "identified a large gap between funding provided by the federal government for national forests and federal government funding for Indian forests (IFMAT 2003, 8). For instance, in 1991, the U.S. federal government spent $15.18 per acre on the management of national forests as compared to $3.29 per acre on tribal forests. In 2001, national forest received $9.51 per acre while tribal forests funding declined to $2.83 per acre.

SUMMARY

The BND did not contain sensitive or proprietary tribal information that was not already available to the public. Instead, the database consisted primarily of topographic map features. Base themes made up the vast majority of data, and the base theme network had the strongest alignment in Indian Country. Timber management and range management layers were the next most prominent networks. The GDSC selectively developed GIS layers for some regions while neglecting others. This kind of uneven development represents a core-periphery geography. Some reservations in the core, semi-periphery, and peripheral regions held timberland resources and were active in IRMP development. These regional attributes influenced the production of GIS layers. Most of the BND semi-periphery regions consisted primarily of base theme layers. Emergence of the periphery was influenced by ownership fractionation and the fragmentation of American Indian land allotments in Oklahoma and the BIA Eastern region. By the mid-1990s, changes in federal Indian policy and fluctuations in funding led to the demise of the BND. Although this shift might be understood as anti-colonial, this decline in federal funding opened the door for yet another network to disseminate through Indian Country. The implementation strategy would take on an increasingly privatized and corporate appearance.

CHAPTER SIX

GIS AS THE NEW GOVERNMENT RATION

In this chapter, I explain how the BIA maintained core-periphery networks in Indian Country. One of the early missions of the GDSC was to facilitate the transfer of GIS technology to tribal governments and organizations (Bureau of Indian Affairs 1991a,b). Following the implementation of E-government policy in 2002, the GDSC announced that it was responsible for the establishment and promulgation of policies, procedures, standards, and goals for all spatial data technologies and applications throughout Indian Country (Bureau of Indian Affairs 2004). I argue that the GDSC maintained GIS networks by facilitating the transfer of GIS technology to dependent tribal governments through technical assistance, top-down GIS training, and the distribution of GIS software rations. Tribal government dependency increased the irreversibility of the networks.

BIA collaborations with non-governmental entities are deeply engrained in the history of the BIA. Third parties, like Christian missionaries and now transnational corporations have used the BIA as a vehicle for accessing the people and places in Indian Country. During the late nineteenth and early twentieth centuries, missionary groups and administrators, "largely viewed the BIA as somehow their bureau, with the assimilation process being their responsibility to guide and shape" (Daily 2004: 35). Missionaries gained access to American Indian people through the reservation system, boarding schools, and through the development of churches in Indian Country; all of which promoted the implementation of the English language and westernized education. The late American Indian scholar and activist Vine Deloria "argued that it is because Indians perceive themselves as sovereign that they resisted assimilation, fought termination, and preserved their cultures as much as possible" (Deloria quoted in Gross 1989: 8).

Between the late nineteenth century and 1933, Christian missionary groups and the BIA often supported one another politically in the assimilation of American Indians. For missionaries, this cooperation gave them direct access to American Indians on the reservations through the establishment of churches and the administration of government-funded boarding schools.

> Missionaries offered their political support for the ongoing work of the BIA in exchange for the BIA's extension of unique privileges to Christian workers. This relationship was further grounded in a larger belief that America enjoyed a unique calling as a beacon of Christian civilization. (Daily 2004: 79)

After 1998, the new post-industrial mission included the privatization and automation of government functions. This occurred at the BIA through the creation of corporate and governmental networks.

Computer Data Systems, Inc. (CDSI), Advanced Technology Common Sense Solutions (ACS) and Lockheed-Martin after 2003. CDSI began working with the GDSC in 1996 and retained most of the previous TGS, Inc. technical staff from past years. CDSI supplied computer hardware and software assistance to federal government agencies. In 1996, the company added the development and implementation of GIS throughout Indian Country to its list of activities. ACS was a subsidiary of Lockheed-Martin. Lockheed-Martin assumed responsibility of the BIA's GIS operation in 2004 – 2005.

The aerospace corporations Lockheed Aircraft Company and Martin Marietta merged in 1995 to form Lockheed-Martin. The new corporation became "the largest military contractor in the United States and largest arms exporting company in the world" (Juhasz 2006, 138). In 2004, Lockheed-Martin earned approximately $35.5 billion dollars. The company earned approximately $37 billion in 2005. According to the Arms Trade Resource Center "almost 80 percent of Lockheed's 2004 earnings were paid for by U.S. taxpayers (Juhasz 2006, 138). In addition of jets and weapons, Lockheed-Martin is a leader in the development and implementation of information technologies in federal government agencies like the BIA.

> In the past decade [1995 – 2005], Lockheed's Information Technology sales have increased by more than four hundred percent. The bonanza began during the Clinton administration, when Al Gore's 'reinventing government' scheme auctioned off most of the data-management tasks of the federal government to the private sector. Now nearly 90 percent of the federal government's Information Technology has been privatized, most of it to Lockheed, which is not only the nation's top arms contractor but also its top data-management supplier. (St. Clair 2005)

CDSI, ACS, and Lockheed-Martin worked to develop a seamless network of computer hardware, software, government institutions, and private technical support that many began to call E-government.

THE E-GOVERNMENT MODEL AND GIS

E-government emerged in 1993, when *Technology for America's Economic Growth, A New Direction to Build Economic Strength* was written by the President William J. Clinton and Vice President Albert Gore, Jr. A new crisis had arisen following the end of the Cold War. According to the document, America faced new economic challenges from competitors around the world. Clinton and Gore called for "accelerating the introduction of an efficient, high-speed communication system [that] can have the same effect on U.S. economic and social development as public investment in the railroads had in the nineteenth century. It would provide a critical tool around which many new business opportunities can develop" (Office of the President 1993, 16). The development of less costly computer hardware and software products and increased access to the internet would provide the digital infrastructure needed to develop and implement E-government on a massive scale.

Carrying on the Clinton and Gore legacy, the computerization of government represents a shift in practice to reduce costs, reduce inefficiency, and to decentralize federal government bureaucracies. The policy calls for the total integration of governmental functions into automated systems. E-government promotes the leveraging of IT investments to connect separate "islands of automation" into a seamless network of agencies. However, there is resistance to the implementation of this model by bureaucratic agencies fighting to maintain the status quo and their jobs (Office of Management and Budget 2002). The federal government invested more money in information technology (IT) over the past twenty years than any other organization in the world, yet has very little to show in terms of "improvements in productivity, quality and customer service" (Office of Management and Budget 2002, 5).

GIS represents an important component of the E-government process.

> [GIS would] provide access to the federal government's spatial data assets in a *single location* and help make state and local spatial data assets more accessible. Federal agencies will also make their planned and future spatial data activities available to state and local governments to promote collaboration and reduce duplication efforts. Data standards developed through an intergovernmental process will result in data that can be used multiple times for multiple purposes, saving taxpayer money (hundreds of millions of dollars). It will also help empower the private sector by communicating the characteristic of a desired standardization data product…[through] cost-sharing opportunities. (Office of Management and Budget 2002, 29) [emphasis added]

Through the implementation of this model, geospatial information will be available to citizens in the form of a one-stop internet site like the USGS National Map. Citizens can meet all their geospatial needs at GIS super-sites, presumably at the lowest costs to taxpayers. One-stop GIS sites are composed of "technologies of location," or the all-encompassing virtual map created within government institutions, one that provides geospatial data to citizens at little or no cost (Curry 1998).

On December 20, 2002 the DOI and ESRI signed a three-year contract for the purchase of GIS software. The program is called the Enterprise Licensing Agreement (ELA). In turn, ESRI supported the DOI politically when the corporation presented its President's Award for Exemplary use of GIS to the DOI on July 7, 2003 thus reassuring the Office of the President and Congress that the DOI was reading the right roadmap (Department of the Interior 2003). According to Mark Forman, Associate Director for IT and E-government in the federal Office of Management and Budget, "GIS is the glue for government management in the future [and has] more executive level support than virtually any other initiative of E-government" (Sinha 2003).

In summary, E-government represents a model for the automation of government services by providing greater access to American citizens and businesses. GIS contributes to holding E-government together. Tribal governments are a part of this network. Considering that the U.S. government spent in excess of, "$48 billion dollars in 2002 and $52 billion dollars in 2003" on information technology and the automation of governmental functions, the roadmap to development has already been determined for American Indian tribal governments (Office of Management and Budget 2002, 1). Part of this roadmap, includes GIS networks associated with the BIA GDSC and the ESRI GIS transnational corporation.[31] However, tribal government offices have engaged with ESRI for the past two decades.

THE ESRI – TRIBAL GOVERNMENT CONNECTION

The GDSC provides a disclaimer at the beginning of the 2001 quarterly technical reports saying that the agency does not endorse commercial products mentioned in the report (Bureau of Indian Affairs 2001a). In truth, the GDSC advocates a certain *brand* of GIS. This advocacy is similar to academic geography departments attempting to present themselves as objective, unbiased, and free from the shackles of corporate America by announcing that they do not endorse a particular brand of GIS software, while their bulletin boards, laboratories, and announcements for employment are full of ESRI marketing brochures. Like most academic geography departments, the GDSC and tribal governments now enroll within the ever-expanding imperial GIS networks emanating from ESRI.

GIS did not emanate from American Indian tribal governments. Rather, tribal institutions connected with emerging GIS networks associated with ESRI. Relationships between ESRI and some tribal governments occurred before, during, and after the GDSC established connections in Indian Country. As mentioned earlier, ESRI assisted the Zuni Tribe in the development of GIS layers and maps to support land litigation activities in the 1980s. Other ESRI marketing activities included the inclusion of American Indians and GIS within the Environment and Conservation sessions at the 1993 ESRI User Conference in Palm Springs, California. The sessions featured papers by BIA GIS manager Brian Marozas, Paul Danks (Fort Berthold Reservation – Three Affiliated Tribes), and Beverly Bird, each raising questions regarding GIS, federal government, tribal government, and industry relationships.[32] ESRI also supported GDSC promotional activities. ESRI's President, Jack Dangermond, presented a paper entitled, "*What's new in GIS technology*" at the 1996 GDSC Users Forum in Golden, Colorado (Bureau of Indian Affairs 1996). Tribal GIS managers attended the forum.

ESRI's most visible work with American Indian tribal groups is through a non-profit organization called the ESRI Conservation Program. The program collaborates with a number of non-profit conservation organizations as well as tribal governments and grassroots community groups. Through the Conservation Program, tribes have come into direct contact with ESRI software products.

By 2005, ESRI enrolled hundreds of thousands of customers, all represented as unique numbers and stored as such in their databases. The BIA - ESRI Enterprise Licensing GIS software records reveal that 30 American Indian tribal government offices were among ESRI's first 16,000 customers. The Navajo Nation Water Resources Department was one of the first 50 customers connected with the emerging GIS corporation in the 1980s. In fact, the Navajos connected to the network before the GDSC, one of ESRI's very earliest customers.[33]

Table 6.1 shows that the BIA Northwest region holds 13 of the 30 tribal governments enrolled in the early ESRI network. The Western, Navajo, and Midwest regions follow with 3 tribal offices each, the Rocky Mountain and Alaska BIA regions with 2 tribal offices each, and the Pacific, Southwest, Great Plains, and Eastern regions hold 1 tribal office each. Tribal governments within the Southern Plains and Eastern Oklahoma regions do not appear in the top thirty, in keeping with their status as peripheral regions of GIS development in Indian Country.

Table 6.1. The first thirty (30) tribal governments enrolled in the ESRI software network during the 1980s and 1990s.

Tribal Government (BIA Region[34])	**Department**
Navajo (NAV)	Water Resources
Confederated Tribes and Bands of the Yakama (NW)	GIS Department
Confederated Salish & Kootenai (NW)	GIS Department
Quinault (NW)	Administration
Shoshone of the Wind River Reservation (RMT)	Environmental
Navajo (NAV)	Utilities
Confederated Tribes of the Warm Springs Reservation (NW)	GIS Department
Puyallup (NW)	Administration
Assiniboine and Sioux (RMT)	Natural Resources
Nez Perce (NW)	Land Services
Sisseton-Wahpeton Sioux (GPL)	Environmental
Tohono O'odham Nation (WES)	Water Resources
Confederated Tribes and Bands of the Yakama (NW)	Water Resources
Minnesota Chippewa, Fond du Lac Band (MID)	Natural Resources
Pueblo of Santa Ana (SW)	Natural Resources
Hoopa Valley (PAC)	Forestry
Confederated Tribes of Umatilla (NW)	Administration
Menominee (MID)	Forestry
Coeur D'Alene (NW)	GIS Department
Confederated Tribes of the Colville Reservation (NW)	Administration
Navajo (NAV)	Forestry
Tanana Chiefs Conference, Inc. (ALA)	Administration
Central Council of the Tlingit & Haida (ALA)	Administration
Colorado River (WES)	Planning
Gila River (WES)	Water Resources
Klamath (NW)	Administration
Confederated Tribes of the Siletz Reservation (NW)	Planning
Red Lake Band of Chippewa (MID)	Natural Resources
Miccosukee (EAS)	Real Estate
Lower Elwha (NW)	Administration

Source: Data found in Table 6.1 was extracted from GDSC GIS software records.

Tribal governments enrolled directly into the ESRI network through the purchase of software from the corporation, or indirectly by acquiring software through the BIA, EPA, or other federal agency. Technical assistance and training were methods for tying all allies together and extending GIS networks further. Eventually, the GDSC would provide ESRI technical assistance, ESRI training courses, and manage ESRI customers.

TECHNICAL ASSISTANCE

> Every domain enters the 'sure path of science' when its spokespersons have so many allies on their side. (Latour 1987, 232)

Implementation of information technologies like GIS creates disparities between the center and the periphery. Technical problems that evolved in the center transferred to the periphery upon implementation of GIS within tribal governments. As an obligatory point of passage, the GDSC was dependent upon the underdevelopment of tribal government GIS programs. Some of these underdevelopments included limited access to GDSC centralized resources, cartographic assistance, and problems with ARC/INFO software. An extensive network of dependency developed though the flow of technical assistance.

Underdevelopment of tribal GIS often was reported as an access problem. Access to the GDSC BND and other data was extremely difficult for some tribal government offices because of poor telephone infrastructure. The BIA blamed this problem on the "ma and pa" telephone services in some parts of Indian Country, and described some tribal GIS access as "running on a 386 world [that was] real slow and frustrating" (Guerra 1998). Yet, in its technical reports, the GDSC does not discuss the growing disparity between the BIA and tribal governments.

Another example of the technical disparity between the GDSC and some parts of Indian Country is represented in the case of the Hoopa government's access to data held at the GDSC in 1990. According to the 1990 fourth quarter technical report,

> The Hoopa Reservation's database was copied onto 64 floppy diskettes so that Kevin Britton at the Hoopa Tribal Office could work with the data on his PC. Many of the files on the Prime computer are too large to fit on one floppy, so the data had to be downloaded first to the hard disk of a PC and then copied onto floppy disks. The process took 45 hours to download to a PC and an additional 16 hours to copy the data on floppy disks. The SC is not supporting this inefficient and time-consuming method of converting data. (Bureau of Indian Affairs 1990d)

The GDSC chose not to support the only means by which some tribal governments could access data. In other words, the GDSC was not willing to shape their system to meet the needs of governments like the Hoopa's.

In another case, Minneapolis BIA GIS Coordinator, Carl Hardzinski reported access problems in the Midwest region,

> Offices at Red Lake have chosen pcARC/INFO as a GIS since it is a PC-based product and is less expensive than Workstation Arc. The offices at Red Lake have poor telecommunications facilities and we have been unable to establish them as dial-up sites [with the GDSC]…Several of the users [at Red Lake] are looking at the acquisition of data through third parties [including]…USGS Digital Line Graphs, TIGER Census files and Fish and Wildlife National Wetland Inventory. (Bureau of Indian Affairs 1993d)

In short, the BIA developed a GIS that was extremely difficult for many tribal governments to access independently, which led some tribes to seek assistance in cartographic production at the GDSC.

The GDSC provided cartographic assistance to several tribal governments and organizations between 1991 and 1995. The GDSC assisted the Standing Rock Sioux Tribe in the design and production of several land status maps (Bureau of Indian Affairs 1991b). The GDSC designed a map of timber types for a group of Pine Ridge tribal representatives during the fourth quarter of 1993 (Bureau of Indian Affairs 1993c). The number of GDSC-assisted cartographic products increased during 1994 and 1995. For example, the agency produced eighteen base maps for the Fort Mojave Tribe. GDSC staff also produced a national Indian lands map for the Tribal Agricultural Council; several land cover and land ownership maps for the Bad River Tribe; a set of base maps for the Round Valley and Quileute Tribes; and a 1:24,000 scale map of soil types for the Agua Caliente Band of Cahuille Indians (Bureau of Indian Affairs 1994a, 1995a). However, access to data and dependency upon cartographic production were moderate problems compared to the use of ARC/INFO.

The purposes of technoscience are consistent: to build strong, durable networks; to enroll as many allies as possible; and to combat competing networks. ESRI shaped the GDSC through its software ARC/INFO. Despite the Lockheed-Martin and GDSC disclaimers[35] in the 2001 quarterly reports, ESRI products are standard at the agency. The influence of the software is evident not only in the technical jargon within all of the quarterly technical reports, but also through statistics regarding technical assistance flowing from the GDSC to BIA field offices and some tribal government personnel. The calculations, statistics, pie charts, and ticket counts found in the quarterly technical reports show the one-way, top-down flow of publicly subsidized technical assistance used to maintain the durability of the GIS networks.

Between 1990 and 1995, most of the calls for technical assistance pertained to the use of ARC/INFO software, and ranged between 26% and 44% of the total incoming calls. More than anything, enrollment of tribal governments boosted the numbers and calculations and statistics to justify and maintain the center's existence in an increasingly competitive geospatial environment. The GDSC implemented a new strategy of tribal government inclusion at the beginning of the center's relationship with the consulting firm CDSI.

It was during CDSI's tenure with the BIA GDSC that tribal government connections begin to emerge in the technical reports, giving the GDSC a more privatized, business-oriented appearance. CDSI reports show that during 1997, half of the phone calls pertained to ARC/INFO – Mapping and Analysis operations. The majority of these calls came from tribal governments (Bureau of Indian Affairs 1997a). The Help-Desk records contain an even more detailed geography of tribal GIS involvement.

The Help-Desk records for the years 1998 to 2004 contain hundreds of entries including the BIA region, name of the tribe, name of the tribal office (e.g., environmental, planning, etc.), the ticket number,[36] and the number of tickets counted for each tribal office.[37] The map in Figure 6.1 shows an extensive network of dependency between the BIA GDSC and tribal governments in Indian Country between 1998 and 2005. The flow lines represent the number of Help-Desk calls processed by the GDSC. Figure 6.2 shows that tribal governments and organizations within the BIA Northwest region are very strongly aligned and dependent upon technical assistance from the GDSC. Strongly aligned and dependent tribal government organizations are found within the BIA Southwest, Western, Pacific, Great Plains, and Midwest regions. Moderately aligned regions include tribal governments within the Rocky Mountain, Eastern, Eastern Oklahoma, and Navajo regions. Weakly aligned tribal governments exist within the Southern Plains region.

Seven years of data (1998 – 2004) shows calls made by the Navajo (142), Coeur d'Alene (72), Cheyenne River Sioux (69), Nez Perce (58), and the Cherokee Tribe of Oklahoma (57). Such numbers indicate that these tribes continue to develop GIS programs, take advantage of the free technical services, and conduct GIS activities associated with federal agency grants. For example, the Coeur d'Alene government has been working on a *nationwide* American Indian place-name project funded by the USGS.[38] The Cherokee developed a very active program including an environmental agency that mapped Indian land allotments for the EPA in the late 1990s.[39] Not only did tribes enroll in the BIA GIS network, they connected to other islands of automation in an effort to produce seamless networks across several government agencies.

ARC/INFO was a problem for tribal GIS managers. Statistics and graphs found within the quarterly technical reports indicate that tribal governments depended upon the GDSC for accessibility, cartographic production, and help with ESRI software. The GIS networks that passed through the BIA GDSC not only shaped the agency, but also initiated the enrollment of many tribal governments. Furthermore, dependency on ESRI GIS software strengthened the irreversibility of the technical assistance network. Equally important, many tribal governments participated in GIS training at the GDSC.

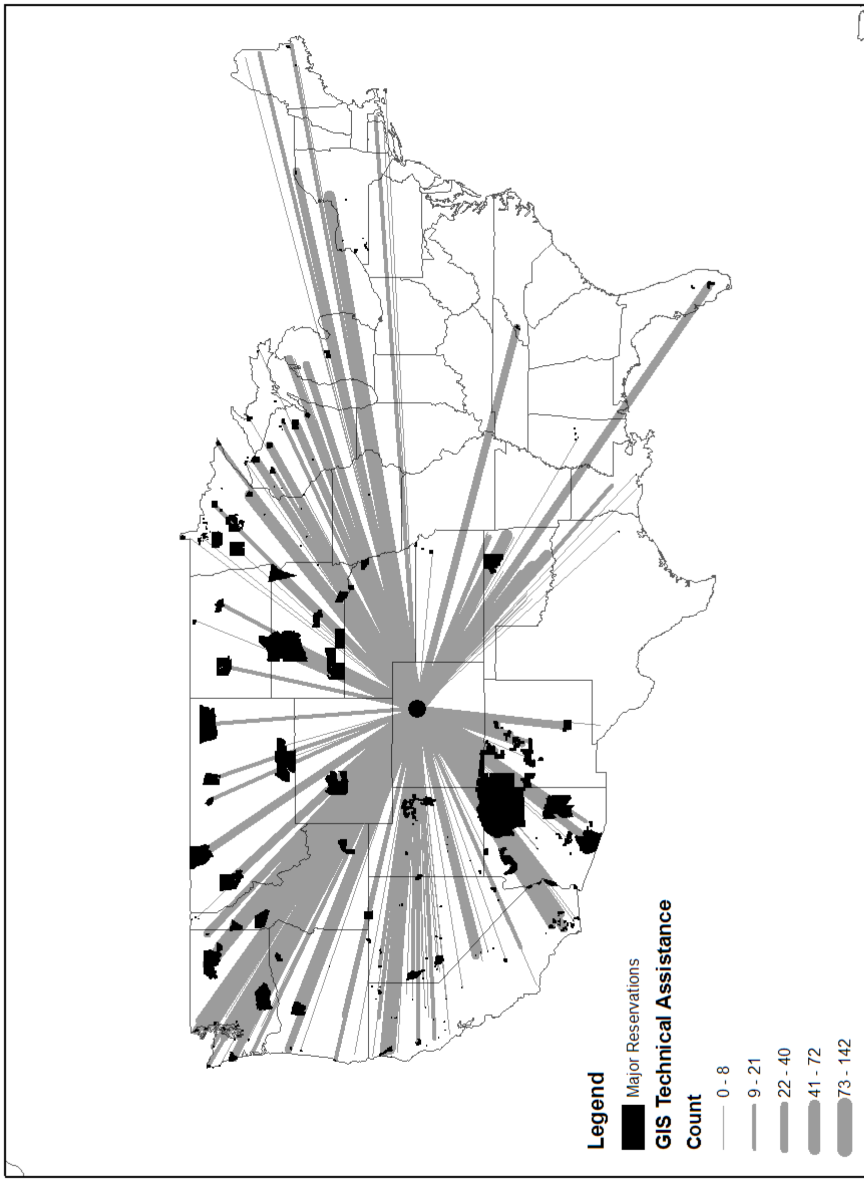


Figure 6.1. The flow of technical assistance from the GDSC center to tribal areas in Indian Country (1998 - 2004)

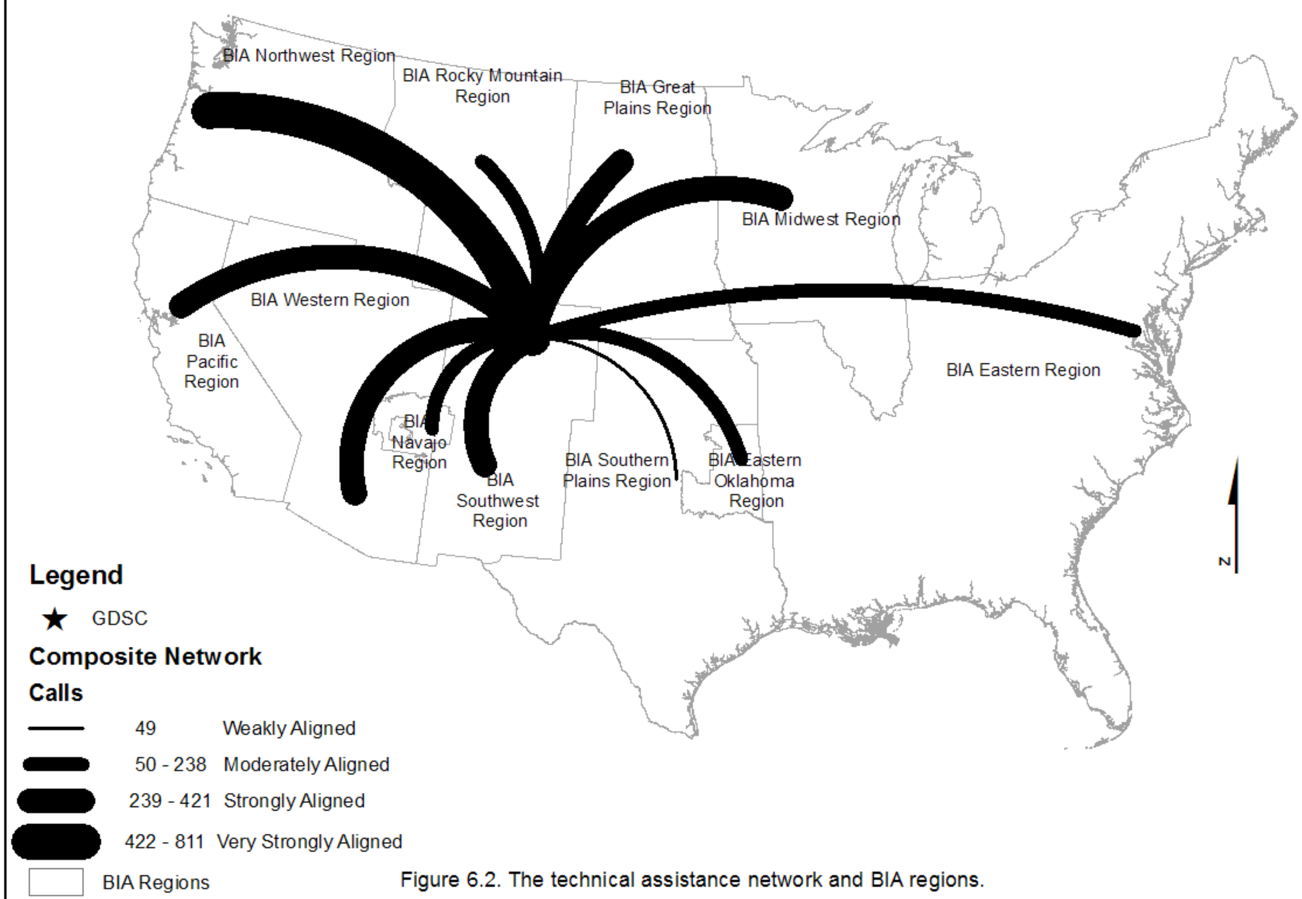


Figure 6.2. The technical assistance network and BIA regions.

GIS TRAINING

> The federal government's expenditures in Indian education and welfare gave it the presumptive authority to regulate virtually every aspect of Native life to achieve the most efficient use of federal funds. (Daily 2004, 39)

The GDSC regulated every aspect of free GIS training. GIS training at the GDSC was a top-down practice. As Headrick notes,

> Colonial governments and enterprises also taught the basic skills needed by industry, public works, railroads, and the like in trade schools and apprenticeship programs…What we will call technical education was training for such mid-level jobs in the modern sector as surveying, typography, draftsmanship, telegraphy, and machine repair…[and the development of] subordinate technicians. (Headrick 1988, 305)

The managerial and creative aspects of GIS representations, technical assistance, and training resided at the BIA. To extend its GIS networks further into Indian Country, the one-way flow of 'best practices' had to be extended not only to BIA field offices, but to their comprador tribal governments as well. Extension of the training network maintained GIS networks emanating from ESRI and the BIA. Subordinate technicians work within the offices of tribal governments. The BIA, the EPA, the United States National Park Service, or the Office of Homeland Security subsidizes tribal government positions through external funding. It is of utmost importance for tribal governments to adhere to each agency's guidelines regarding the use, collection, storage, and sharing of geospatial information resources.[40] These same dependent tribal governments also create opportunities for the GDSC to exist and live another day, and provide momentum and a foundation for federal government actors to build upon. Early on, the GDSC developed some training programs to meet the management needs of tribal governments and BIA field offices.

Some of the quarterly technical reports indicate there was at least an interest in addressing the GIS concerns of tribal governments through specialized training. The agency reported that, “Course manuals, documentation, and classroom presentation materials have been developed [by the BIA GDSC] for BIA and Tribal GIS applications” (Bureau of Indian Affairs 1997b). Between 1990 and 1995, the basic ARC/INFO course attracted BIA field personnel as well as personnel from the Colville, Navajo, Menominee, San Carlos Apache, Blackfeet, Yakama, Jicarrilla Apache, Southern Ute, Quinault, Zuni, Grand Portage Band of the Chippewa, Hoopa Valley, Agua Caliente, White Earth Chippewa, and Consolidated Salish and Kootenai tribal governments. Early on, while funding was sufficient, the BIA held some classes at the Flathead, the Navajo, the Puyallup, and the Menominee government offices.

In 1990, the *GIS for Managers* course taught in Denver,[41] attracted BIA field personnel as well as GIS personnel from the Navajo, Colville, Hoopa, Oglala Sioux, Mescalero Apache, Ramah Navajo, Ute Mountain, and Jicarilla Apache tribal offices (Bureau of Indian Affairs 1990a,b,c,d). Between 1990 and 1995, the BIA developed a diverse set of courses including: *Database Management*, *Introduction to Computer Technology*, *Cartographic Production*, *GPS Data Entry Workshop* at Menominee and Fort Totten, Miccosukee, Winnebago-Wisconsin, Puyallup, and Colville; *Data Entry* *by Digitizing* at Makah, Lummi, and Colville; *Librarian with UNIX* at Warm Springs; *GIS for Supervisors* at Fort Mojave; *Watershed Analysis* at the Blackfeet Reservation; *Introduction to UNIX ARC/INFO*, *Introduction to ArcView* taught at San Carlos, Coeur D'Alene, and Colville; *In-House UNIX*, *UNIX Transition* training at the Jicarilla and San Carlos Reservations; and a *ARCEDIT Workshop*.

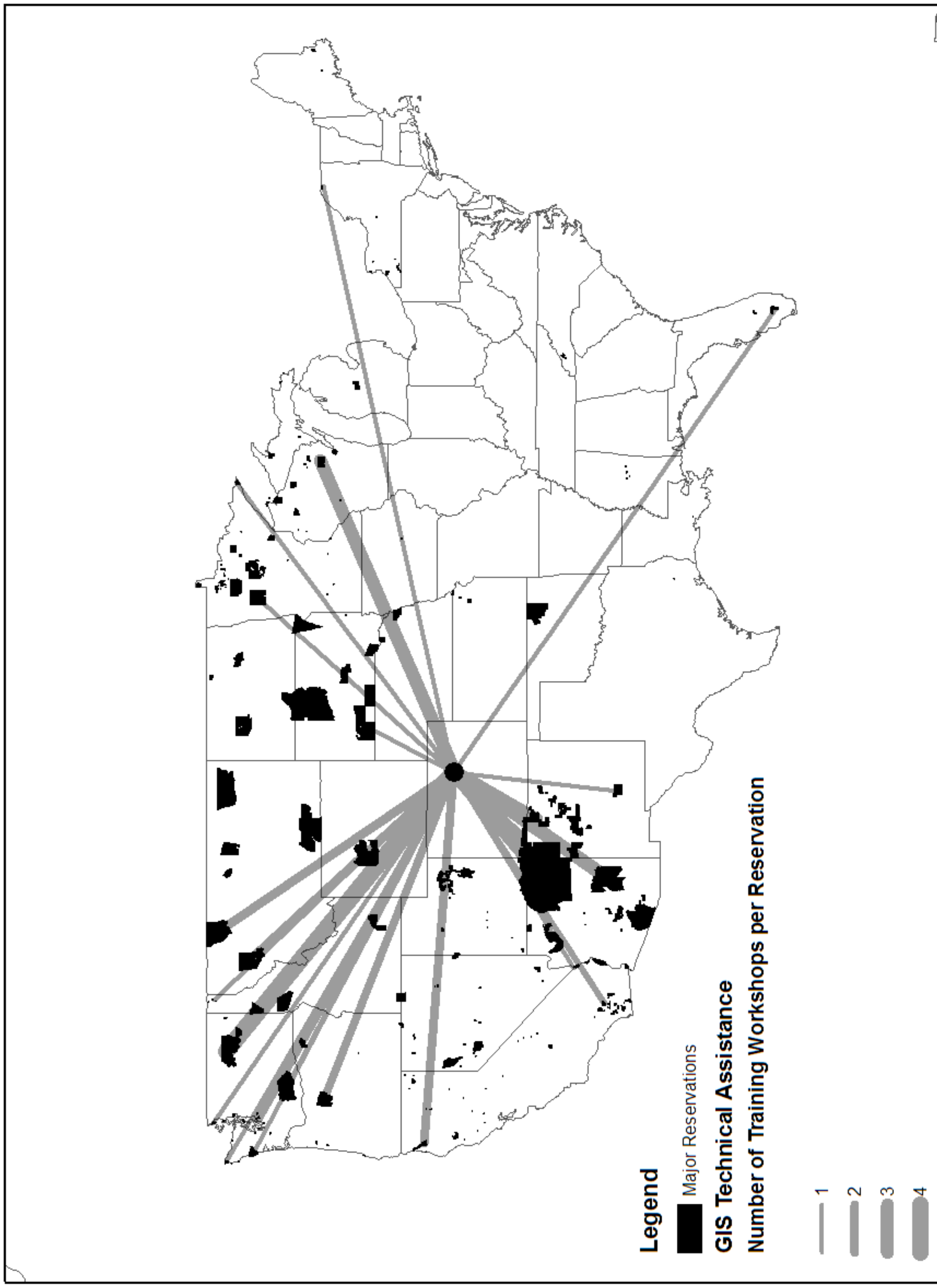
The mid-nineties budget cuts no doubt affected the diversity of the courses offered by the agency and the mobility of instruction. After the transition in funding, an important training regime emerged. The GDSC adopted ESRI training modules and materials.

Figure 6.3 shows the frequency and distribution of early training workshops held between 1990 and 1997. The Navajo, Colville, San Carlos Apache, Jicarilla, and Menominee had the most workshops. BIA regions with the strongest alignment within the training network include the Northwest and Southwest. The Pacific, Midwest, Western, and Eastern regions are moderately aligned. Weakly aligned regions include the Rocky Mountain and Great Plains. Peripheral regions with no connections to the early training network include the Southern Plains and Eastern Oklahoma regions.

With the transition of training to CDSI, ACS, ESRI, and Lockheed-Martin, training descriptions moved from the back to the front of the quarterly technical reports in 1997 and to the middle of the reports between 2001 and 2005. This suggests an increased emphasis upon training at the GDSC. It was also during this period that the agency shifted from specialized GIS training modules to 'canned' ESRI courses as rations diffused from ESRI's urban center in Southern California. The diffusion of canned training modules required ESRI's authorization and endorsement of instructors.

> One ACS 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. (Bureau of Indian Affairs 2001a)

The courses offered in 2001 were less diverse in content. They included *Introduction to ArcView GIS* and *Working with ArcView Spatial Analyst*, the more user-friendly and inexpensive GIS software that some BIA field offices and tribal GIS managers used by 2001. When the ESRI software package ArcGIS hit the market, the GDSC offered the ESRI designed courses *Introduction to ArcGIS I, II*, and *Migrating from ArcView 3.x to ArcView 8* and migrating from all the programs written in Avenue computer programming language supported by ArcView to Visual



6.3. Map of the frequency of GIS training workshops held at tribal government offices: 1990 - 1997.

Basic supported by ArcGIS. Funding shortages centralized the instruction of the canned training modules at the BIA GDSC training facility and some BIA regional offices.

The GIS training network supported many tribal government nodes and advocated only one brand of GIS software. The marketing of benefits lured more and more customers into the network, while those customers that didn't conform to licensing agreements faced penalties. During the last quarter of 2005, Lockheed-Martin and the GDSC applied a 'straight-jacket' approach to training, disciplining those dependent upon the new government rations. According to the report,

> Due to an abnormally high absentee rate this quarter, new policies are now in effect. After each course suspension a fax is sent to each absentee stating they are banned for one year from attending any GDSC training course, and course enrollment reminder faxes are sent approximately two weeks before the start of a class. (Bureau of Indian Affairs 2005b)

The GDSC was also not immune from such discipline. In the market model, the GDSC had to be productive and efficient or face extinction and exclusion from the network. Meanwhile, ESRI's position in Indian Country was further strengthened through the distribution of free software rations.

GIS SOFTWARE RATIONS

> As the rations program evolved into a full-blown system of guardianship, the Indians' ward status became the basis for still further assaults on tribal practices. (Daily 2004, 38)

The scattering of GIS resources and attempts to stitch networks together can be traced through the history of the GDSC. What began as a closed, centralized attempt at GIS development evolved into a full-scale distribution of software and further enrollment of tribal governments into the BIA GIS networks. More tribal enrollees meant that GIS was more accessible to tribal governments through the BIA. However, there are "strings" attached to the current GIS implementation project. What look like connections within a free-flowing network actually are steps in the total integration of tribal government functions within the new imperial networks of contracting agreements, copyright policies, standards, restrictions, tracking, surveillance, and penalties for non-compliance.

According to the 2003 first-quarter technical report, the ELA is an agreement between ESRI and the DOI for the blanket purchase of GIS software (Bureau of Indian Affairs 2003a). It provides GIS software free of charge to American Indian tribal governments that meet ELA requirements. However, the ELA is anything but a stand-alone system. Instead, the system combines Congressional funding, the Office of the President, the Office of Homeland Security, the U.S. military, the Office of Budget and Management, ESRI, IT corporations, computer hardware and software, federal government agencies, state government agencies, and tribal government departments, just to name a few.

GDSC officials require first-time GIS users at tribal government offices to fill out the ELA application. The application makes it clear that the flow of software to a given tribal office is not guaranteed. Orders must first be approved by the GDSC.

> Enterprise License Agreement activities for this quarter continued review of new customer applications to ensure organizations requesting licenses are eligible and have adequately trained or experienced GIS personnel. (Bureau of Indian Affairs 2003d)

In other words, the BIA GDSC reasserts and strengthens its position now as a legal obligatory point of passage for licenses, technical assistance, and GIS training. The GDSC is now a network node in the ESRI GIS network, and a distribution point for the corporation's software products.

Unlike the rationing of food and clothing to Indians in the nineteenth century, tribal governments do not own GIS rations. Rather, tribal governments merely lease GIS from ESRI. The ELA grants tribal governments and BIA field offices the right to use ESRI software for specific purposes. As a license the ELA application is a legally binding agreement between ESRI, the DOI, the BIA, and tribal governments. Michael Curry wrote about topics germane to legality and GIS through ownership and intellectual property.

> The very idea of ownership that has undergirded the development of science over the last two hundred years is coming apart, replaced by a system in which, increasingly, hardware, software, and even data are leased from the real owners, with their uses strictly restricted. As technological developments make it

increasingly important where we are on the map and not on the ground, we can no longer be said to stand on the ground. We no longer own our own location. (Curry 1998, 88)

What looks like simply a good deal for tribes is actually a tight legal arrangement holding tribal GIS users to account in a variety of ways. For instance, the ELA contract requires tribal governments to "describe in detail," future projects for which your department intends to use ESRI GIS software. Include a description of the data types you might create or have archived [and] describe past projects for which your department has used GIS applications" (Bureau of Indian Affairs 2006). The ELA application asks for important and often private, proprietary information regarding tribal GIS. This information goes into an Oracle database held at the GDSC for tracking, analyzing, and reporting on tribal government entities (customers) participating in the network (Bureau of Indian Affairs 2003d).

The ELA model incorporates a component known as "business intelligence." Business intelligence can theoretically be used for data mining, planning, and forecasting (Moore 2004). The ELA links GIS use to a corporate-governmental surveillance system tracking the IT – GIS activities of citizens including tribal governments, another attempt by the federal government and transnational corporations to act at a distance by extending GIS networks further into Indian Country. And the distribution of free government rations shapes the geography of this network in Indian Country.

Appendix 1 shows the expansion of the GDSC – ESRI GIS networks between 2003 and 2005. The BIA-ESRI software network enrolled a total of 232 tribal governments and organizations between 2003 and 2005. Within the list of tribal governments shown in Appendix 1, there are offices already connected to the ESRI GIS network. These offices have ESRI customer numbers, and can access both ESRI and GDSC technical assistance. Although ESRI customer numbers are not necessary to receive technical assistance from ESRI technical specialists, having such a number allows the caller to identify their organization, which speeds up a response from ESRI. Many tribal offices already enrolled in the ESRI network receive GIS rations from the BIA GDSC as software upgrades or new extensions. However, the ESRI customer numbers allow tribal government personnel to go directly to the source, the real center of this newly developed GIS network in Indian Country.

Some tribal government offices do not have ESRI customer numbers, but rather have a GDSC customer number. Following implementation of the ELA program, the management of “customer” records now resides at the BIA GDSC. New users in Indian Country no longer receive an ESRI customer number, but are instead given a GDSC customer number. This practice enhances the GDSC’s position as an obligatory point of passage since all first-tier service calls have to be placed with the BIA GDSC. In other words, ESRI out-sources technical assistance and the tracking of customers to the GDSC. Only when the GDSC toils with and deems a problem unsolvable will ESRI be contacted with second-tier questions. The practice of outsourcing defers much of the technical assistance pressure away from ESRI, which indirectly gains scores of new tribal government “customers.”

Of the tribal governments shown in Appendix 1, 138 contain offices and departments that do not have an ESRI customer number, but are listed as GDSC customers (Bureau of Indian Affairs 2005e). Some of these offices work alongside other well-established GIS departments in tribes like the Yakama, Colville, Hoopa Valley, Colorado River, Tohono O’odham, and the Confederated Salish and Kootenai. Such ELA GIS first-time users typically are satellite departments like fish and game, forestry, realty, cultural preservation, administration and environmental offices. Multiple departments within tribal governments like the Blackfeet, Turtle Mountain Band of Chippewa, Cherokee Nation, and Sault Ste. Marie Tribe of Chippewa use GIS rations provided by the GDSC. Although all BIA regions contain their share of first-time users, those BIA regions with highest levels of first-time participation include Alaska, Pacific, Rocky Mountain, Great Plains and Southern Plains BIA regions.

What is the geography of tribal departments connected to the GIS software ration network in Indian Country? Figure 6.4 shows the BIA – ESRI GIS software network is very strongly aligned with the Northwest, Alaska, Pacific, and Midwest BIA regions. The Western and Southwest BIA regions are strongly aligned within the network. These regions are followed by the moderately aligned Southern Plains, Eastern Oklahoma, Great Plains, and Eastern regions. The Rocky Mountain and Navajo regions are weakly aligned.

The data in Appendix 2 shows that natural resource management is still a priority among tribal governments in Indian Country. The Northwest, Western, Southwest, Rocky Mountain, Great Plains, Midwest, and Eastern regions contain mainly natural resource departments using GIS. Many of these departments include natural resource management, forestry, range management, water resources, mineral resources, and irrigation just to name a few. Tribal environmental programs in the Pacific, Southern Plains, and Eastern Oklahoma regions actively engage with GIS. This activity may be the result of the EPA's involvement with tribal allotment land areas in Oklahoma and California that developed in the mid-1990s. Although administration departments make up a good portion of many of the tribal offices participating in the GIS network, a total of 40% of all tribal offices enrolled in the Alaska region were administration. Although I suspect many of the offices under administration are GIS departments, relatively few tribal governments are listed as GIS departments.

Tribal "administration" departments in the Alaska, Eastern, Midwest, Northwest, Pacific, Southern Plains, and Western regions acquired GIS software from the BIA GDSC. The category "administration" refers to the fact that "many new offices are using the new ELA, often choosing to submit one organizational [tribal government] application and combining separate department orders so as to have one contact person managing all licenses; thus reducing the paperwork of many users centralizing records [like the GDSC did with geographic information]. This new trend encourages communication between disparate departments and may lead to more license networking [interagency networks]" (Bureau of Indian Affairs 2003c). Tribal administration offices are themselves becoming nodes of control and obligatory points of passage for GIS technology within their own governmental system.

This evidence suggests that GIS is being used as a tool to supplement larger and stronger tribal government networks, and is not a stand-alone technology. The data also indicate that employees within tribal governments perform duties in different departments simultaneously. Environmental managers are also GIS specialists, surveyors, and cartographers. The technology that is supposed to help tribal governments integrate into the nation's natural resource management program actually creates more work for employees.[42] Future research should include a more detailed investigation of GIS use within tribal government offices, and their relations with other federal government agencies.

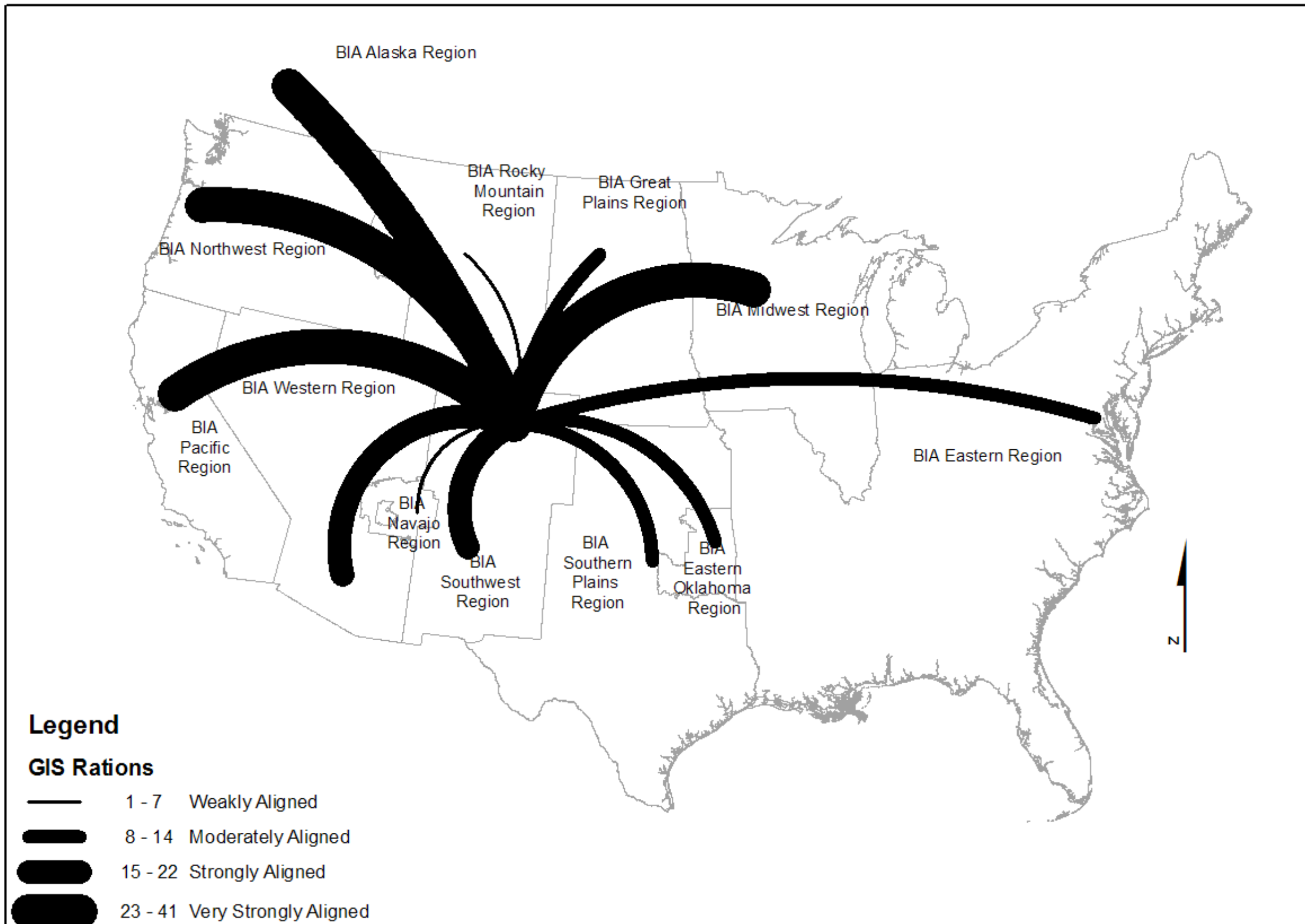


Figure 6.4. The GIS software ration network as it diffuses throughout Indian Country.

SUMMARY

GIS is the new ration in Indian Country. Historically, the BIA has worked closely with external groups, like Christian Missionaries, to implement federal policies. At the same time, external groups gained access to American Indians and their land resources through such collaborations. The same dynamic occurred as GIS corporations collaborate with the BIA GDSC in an effort to implement a new federal government policy called E-Government. The final stage of implementation involved the GDSC connecting with the Enterprise License Agreement network. The program offered free GIS software to BIA and tribal agencies. However, there was more to the agreement than just free software. Through the application process, tribal governments who wanted to participate in the network had to justify a need by revealing what GIS would be used for and what GIS projects had been completed in the past. The ELA was both a rationing and surveillance system. However, hundreds of tribal governments uncritically enrolled in the network that has diffused throughout Indian Country and connects with several diverse tribal government departments.

CHAPTER SEVEN

SUMMARY AND CONCLUSIONS

This dissertation shows that that GIS development at the BIA is not a linear march to progress, but rather a recycling of traditional colonial practices. The BIA initiated, represented, and maintained GIS networks that emanated from the GDSC and extended throughout Indian Country. In this final chapter, I provide a brief summary of the findings and provide some conclusions. Next, I briefly discuss counter-mapping and GIS activities performed in some North American Indian communities. And finally, I suggest some directions for future research.

SUMMARY

Latour's center of calculation framework provides some important theoretical insights on the initiation, representation, and maintenance of networks emanating from within scientific institutions. The development of industrial societies and the perpetuation of capitalism forces imperial powers to seek natural resources and labor in distant lands, taking action at a distance. Action at a distance initiates cycles of accumulating information about distant people, places, and materials. In the 1980s, the BIA GDSC carried out a cycle of accumulation through the initiation of GIS.

This dissertation research showed that the initiation of GIS networks emanated from the BIA centers of calculation, in Lakewood, Colorado. According to Latour, there are three conditions necessary for development of a center of calculation development. These conditions include mobilization, stabilization, and combinability of information. The findings show that the GDSC met these three theoretical conditions. First, federal environmental and natural resource management policies, including the IIRIP and the IRMP, initiated the mobilization of digital geographic information, computer hardware, and software within Indian Country. Initiation of the IRMP and IIRIP provided the momentum and justification to gather and mobilize geographic information and GIS. Second, centralized funding, technical assistance, and control initiated the stabilization of the geographic information and the agency itself. Third, the agency made geographic information, people, and management practices combinable through the development of GIS applications and through the agency's enrollment in the ESRI ARC/INFO networks. The next phase of center development involved the construction and representation of Indian Country.

The BIA Nationwide Database (BND) represented a core-periphery geography. The BND was the foundation for GIS development in Indian Country. Some tribal leaders and elder groups expressed concern about the control and storage of sensitive and proprietary tribal information. However, the BND did not contain sensitive or proprietary information. Rather, the GDSC used existing geographic inscriptions to develop the BND. USGS topographic maps contributed to the shaping of the BND's geographic content. The GDSC's GIS technicians did not leave the center and physically go to individual reservations to gather information. Rather, they digitized existing geographic inscriptions at the center.

Network maps reveal the uneven development of the BND in terms of content and regional coverage throughout Indian Country. A total of 63% of the BND content consisted of base themes. The GDSC developed GIS layers for some regions, while neglecting other regions. Mapping layer networks shows a core-periphery geography of Indian Country. The core regions of BND development include the very strongly aligned Southwest and the strongly aligned Northwest and Western BIA regions. The semi-periphery consists of the Midwest, Rocky Mountain, Great Plains, and Pacific regions. And the Eastern Oklahoma, Southern Plains, Eastern, and Navajo regions make up the periphery.

This dissertation provides three explanations for the core-periphery geography. First, the GDSC developed GIS layers for core, semi-periphery, and peripheral regions containing reservations with timberland resources. The GDSC also developed layers for BIA regions and agencies that actively developed IRMPs. Owner fractionation and the fragmentation of American Indian land allotments led to the development of the periphery. By the mid-1990s, changes in federal Indian policy and fluctuations in funding led to the demise of the BND. However, the BIA collaborated with ESRI to further extend and maintain GIS networks in Indian Country.

The extension and maintenance of GIS networks builds upon past practices including BIA collaborations with external groups to carry out United States federal government policies. In the nineteenth and early twentieth centuries, Christian missionaries helped the BIA carry out its mission of cultural assimilation, while the missionaries gained direct access to Indian people. The extension and maintenance of GIS networks by the BIA and ESRI represents the new government mission in Indian Country. The rapid dissemination of GIS throughout Indian Country supports federal government policies including E-government. E-government represents an attempt to automate governmental functions, cut costs, and increase the sharing of data between disparate government agencies. Fundamentally, the automation of governmental functions represents an effort to decentralize government and decrease the central control of bureaucracies. The BIA maintains networks through technical assistance, training, and the distribution of free GIS software rations to dependent comprador tribal governments.

The maintenance of technical assistance networks requires the enrollment of dependent tribal government offices throughout Indian Country. GDSC archival documents like the quarterly technical reports and proceedings from the GDSC user conference in 1993 contain references to some of the technically underdeveloped areas in Indian Country. Many tribal governments depended upon GDSC technical assistance for the creation cartographic products. In addition, many tribal governments had problems using ARC/INFO software, and needed assistance from the GDSC. Between 1998 and 2005, the number of technical assistance calls to the GDSC, from tribal entities, increased. Tribal governments strongly aligned with the technical assistance network reside in the Northwest region. Strongly aligned regions included the Southwest, Western, Pacific, Great Plains, and Midwest. Moderately aligned regions are the Rocky Mountain, Eastern, Eastern Oklahoma, and Navajo. The Southern Plains is weakly aligned with the technical assistance network and least dependent upon the GDSC. Following technical assistance, the BIA maintained GIS networks through training.

GIS training at the GDSC represented a top-down and one-way flow of information from the technically oriented center to dependent tribal governments in Indian Country. The managerial and creative aspects of training existed at the GDSC and later at ESRI headquarters in Redlands, California. Initially, the GDSC developed training to meet the needs of tribal GIS personnel. First of all, the center developed specialized training modules for GIS users. Next, the GDSC traveled to several reservations, primarily in the Northwest and Southwest regions. However, following funding cuts, the GDSC converted their training regime to canned ESRI training modules, and most of the training occurred at the GDSC in Lakewood, Colorado. During the late 1990s, the GDSC developed relationships with the consulting firms CDSI, ACS, and Lockheed-Martin. These actors presented the GDSC as a privatized, business oriented agency. In fact, the new consultants moved the training and technical assistance sections from the back of the reports to the front and middle sections; indicating the agency's emphasis on service to tribal governments and organizations. Also during the period, the GDSC placed new restrictions on tribal government personnel who were absent from training. Nevertheless, a significant number of dependent tribal governments enrolled in the GIS software ration network.

The final findings of this dissertation showed that ESRI and the GDSC further extended and strengthen GIS networks in Indian Country through the historical process of rationing. In this case, the GDSC rationed GIS software to dependent tribal governments in Indian Country. However, tribal governments did not own the software products. Rather, they leased them from the real owner, ESRI. To receive the new government rations, tribal government offices signed the Enterprise License Agreement and agreed to adhere with agency regulations. The image of free-flowing connections within the GIS networks was full of copy-right polices, standards, restrictions, tracking and surveillance.

Nevertheless, a total of 232 tribal governments and organizations enrolled in the ESRI – BIA network between 2003 and 2005. Tribal government office enrollees included departments already incorporated into the ESRI network, and many newly enrolled tribes. Newly enrolled tribes received a GDSC user number and had to go through the GDSC for technical assistance. This strengthened the GDSC's position as an obligatory point of passage. After reviewing GDSC GIS licensing records, an initial geography of tribal government GIS use emerged. Although most tribal GIS usage focused upon natural resource management, other tribal government offices like environmental programs, planning, transportation, emergency management, cultural preservation, and administration acquired GIS as well. The GDSC reported that some tribal governments obtained a single license and divided GIS among different offices themselves. Future research should focus on GIS development within tribal governments.

CONCLUSIONS

Core-periphery GIS development at the BIA was not a linear march to progress, but rather a recycled interpretation of history. This is based on the following historical conditions: 1) the lack of American Indian participation in GIS development; 2) continued representation of Indian Country as core – periphery geographies; 3) the continued influence of external groups working through the BIA; 4) the one-way flow of technology, ideas, and materials from the center; and 5) the continued dependency of comprador tribal governments on the BIA.

Lack of American Indian Participation

The lack of participation by American Indians in BIA development projects is a continuation of authoritarian processes. In the so-called post-colonial and post-industrial eras, progress should be measured by how much people are allowed to participate in government decision-making policies. The National Environmental

Policy Act called for public participation in terms of environmental planning and decision-making activities. Furthermore, the Integrated Resource Management Plan required that American Indian tribal governments and communities participate in the development of the plans. 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 BIA. Furthermore, BND development was not for American Indian people, tribal governments, or community organizations. Rather, BND development was specifically designed to meet the interagency geospatial needs of the BIA. TGS technical specialists, data-entry technicians, and BIA personnel constructed GIS content for Indian Country. I found no evidence to suggest that tribal government, elder group, or community organization actively participated in the construction of GIS at the GDSC. Paternalistic development deviates from public participation models and the Indian Self-Determination and Education Act.

Core-Periphery Geographies

The imperial representation of center/margin binarism is a historical condition of colonialism (Ashcroft, et. al 1995). The BIA maintained a binary between the federal government and among American Indian tribal areas, through BND representations of Indian Country as a core-periphery geography. The core-periphery geography was not inevitable. It was constructed by the hegemonic federal system through regulations, funding, and rationing. In the case of the BND, the core GIS development did not occur where the majority of American Indian people lived, but rather where timber resources and integrated management occurred. Allotment areas continued to be marginalized by GIS development. The impacts and legacy of federal allotment policy continues to haunt many areas of Indian Country.

Influence of External Groups

BIA collaboration with external groups, instead of American Indians, to achieve the goals and objectives of federal policy, is a historical process at the agency. In the past, the BIA collaborated with Christian missionary groups to achieve federal government policies throughout Indian Country. Contemporary collaborations between the BIA and ESRI are created to meet the goals and objectives of the E-government mission and the automation of governmental functions in the United States. This new mission of integration also targeted American Indian tribal governments. ESRI engaged in and became a part of the relationship between the United States federal government and American Indians.

One-way Flow

The one-way flow of technology, expertise, education, and data from the technological center to the underdeveloped periphery is not progressive. Rather one-way flow from the center is a historical condition in Indian Country. Installation of GIS infrastructure by the federal government is yet another means to extend networks and maintain tribal offices as comprador governments. Comprador tribal governments carry out the policies and technological projects that do not emanate from within American Indian communities.

Dependency

Finally, the rationing of GIS software products is not progressive. Rationing can keep comprador tribal government dependent upon external groups for assistance, training, and addition aid. Rationing maintains the networks of dependency. Maintenance of GIS and IT networks, at the BIA, continues to be expensive and technically difficult to operate. This is especially true considering that other federal government agencies aggressively solicit American Indian tribal governments for their business in the ever-increasing environment of privatization in the United States.

The degree of network irreversibility varies from network to network at the GDSC. For example, the BND was a small, stable, and irreversible network. There was very little tribal government could do to shape the development and construction of BND and its representations. However, technical assistance, training, and software distribution networks are large, less stable, and more reversible. Alternatives to federal government control of GIS processes exist within Indian Country.

COUNTER-MAPPING AND GIS

Since the 1980s, there has been an effort by some American Indian communities and tribal governments to "reassert the Native Americans' place on the map of North America" through counter-mapping and GIS (Warhus 1997, 211). Some North American Indian groups use mapping and GIS to counter federal government control of cartographic and now GIS processes. Counter-mapping and GIS offer tribal communities and governmental offices an opportunity to participate in government legislation and decision-making regarding land claims, water right claims, hunting and fishing rights, and the inscription of place-names on official base maps. Recent conferences including the *International Forum on Indigenous Mapping* in Vancouver, British Columbia and a conference on *Indigenous Cartography and Representational Politics* at Cornell University in March 2006 showcased several paper sessions and discussions on indigenous counter-mapping and GIS. The list of counter-mapping activities over the past twenty years is extensive. I will provide only few examples from Canada and the United States.

The Inuit people of northern Canada constructed a map entitled, *Inuit Place Name Map Series of Nunavik, 1991*, printed in Inuktitut, English, and French. Each of the maps in the series contains an extensive list of indigenous place-names, inscribed on to 1:50,000 scale topographic base maps. This map series is an example of a North American Indian tribe taking a proactive stance towards the integration of new technologies into their communities; proactively merging some of their traditional information onto the map; and using the map not as a historical artifact, but a contemporary educational tool to be discussed among the members of the community and maintained over time (Warhus 1997). Also in Canada, several First-Nations' tribes actively use GIS and cartography for land claims, land-use, land occupancy, fishing and hunting rights, and bioregional mapping (Grossman 2006).

In the United States, several tribes in the northern Great Plains and along the Rio Grande corridor in New Mexico limited the access of federal agencies to their proprietary GIS databases (Rundstrom et. al 2000). The Zuni developed an atlas of their ancestral homeland, used in land claims activities in the 1980s. Zuni elders contributed to the production of the atlas. The Coeur d'Alene tribal government's GIS department actively engages in a community-based place-name project. The tribe's GIS department incorporates multimedia such as photographs, oral histories, and video clips with GIS. This results in the re-emergence of Coeur d'Alene history and culture on maps and in GIS. As with the Inuit and Zuni mapping project, elders played a significant role in the project's content. Some non-proprietary geographic information can be found on the Coeur d'Alene website. Other proprietary information, including photographs, is only available to Coeur d'Alene tribal members. Tribal members can access the system through a password protected area on the internet. Like the Inuit example, the Coeur d'Alene place-name project is a proactive tool to aid in the education of future generations. In 2005, a newly formed network of tribal GIS users and federal agency GIS users came together in Tulsa, Oklahoma. The meeting resulted in the formation of a new indigenous mapping and GIS organization.

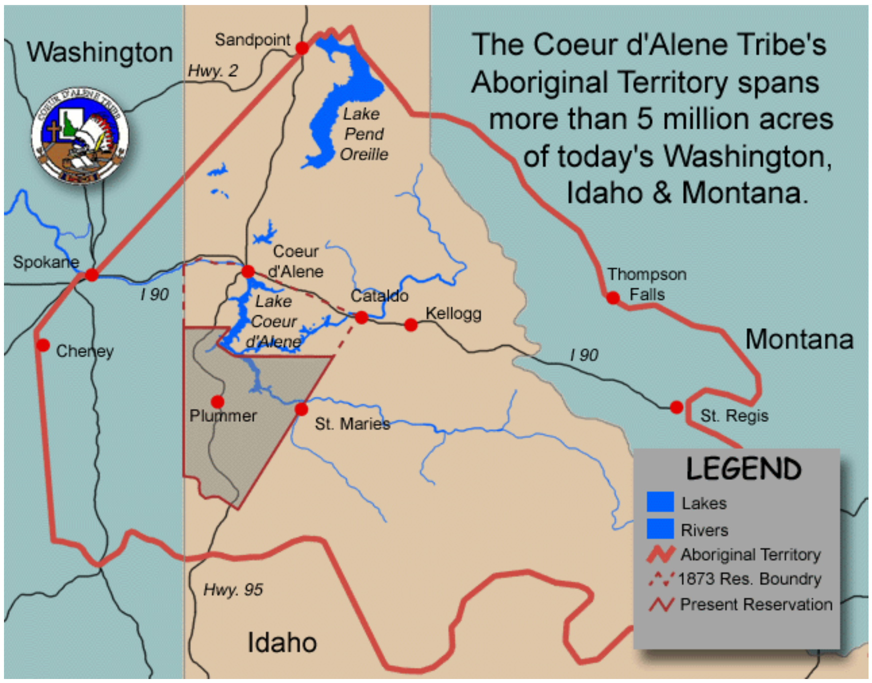


Figure 7.1 Map of the Coeur d'Alene tribal territory. (Source: Coeur d'Alene tribe).

The Indigenous Mapping Project[43] initiated in March 2005 and consisted of tribal GIS managers, federal government GIS managers, and some academic geographers.[44] Tribal GIS users discussed many concerns with federal government and academic representatives. One of the main concerns focused on tribal data protection including data storage, public access, securing proprietary information, and sharing tribal data with other government agencies.

A second issue that emerged from the conference concerned GIS training. Many of the tribal GIS users want to develop a network of peer-to-peer training. Such a training regime could focus on implementation strategies and development of applications important to tribal communities and not training shaped by corporate or governmental training programs. This type of training differs from canned-training that is currently taking place at the GDSC. Canned-training is a valuable resource for some tribal governments, but may not be the best method for developing intertribal relationships.

A third issue focused on the involvement of both tribal elders and youth in the development and use of maps and GIS within tribal communities. Tribal GIS users and some of the geographers in attendance suggested (with caution) the initiation of community-based or public participation mapping and GIS within tribal communities. One of primary problems facing this group is the problem of incorporating oral histories into a digital technology like GIS. All parties involved believe that indigenous mapping projects are good activities for tribal communities to participate in. This is especially true for informal, roundtable mapping activities that includes elders and youth. However, GIS requires technical skills, expertise, and resources that may not be available in some tribal areas. Incorporating government and academic GIS users may result in top-down systems and create yet another layer of bureaucracy to navigate through. Considering the complexity of some GIS, this may be unavoidable.

Digital information technologies are not the answer to all the problems facing indigenous people in North America. Alternative projects would assimilate GIS into indigenous knowledge systems and not the other way around.

FUTURE RESEARCH

This research makes a contribution to the literature on critical GIS and society, including a critical history of GIS development within government institutions. This dissertation is positioned among the work on the social construction of GIS with an emphasis on science and technology studies (STS). My work presents a modified ANT framework and concept of centers of calculation. ANT provides room for indigenous peoples to connect with networks that emit from distant places. Furthermore, ANT can also demonstrate how American Indians and other indigenous groups may counter or resist imperial information technology networks. Thus, this work contributes to an emerging research area called information technology and indigenous people that includea the adoption, resistance, and impacts of GIS. This dissertation is a jumping off point into research on American Indian tribal government and community-level GIS.

My findings identify regions within Indian Country that have significant contact with GIS, ESRI, and the federal government over the past twenty years. On the other hand, many tribal governments on the so-called GIS periphery have only very recently begun acquiring and incorporating GIS into their governmental functions.

What factors accelerate or inhibit the adoption 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. Then one might compare and contrast GIS development between American Indian tribal governments in the Pacific Northwest and Oklahoma.

A more theoretical analysis would incorporate concepts and insights on the digital divide. Empirical evidence might be used to determine if a flattening of geographic information hierarchies is occurring or are new hierarchies emerging? ANT would be useful for re-assembling network geographies and presenting alignment within a horizontal or vertical GIS networks.

Building upon the work of Michael Curry, one might explore GIS, ownership, and cultural property as they relate to GIS and more generally information technology. 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 members of American Indian communities as well. In the end, studies of tribal GIS should yield much information on the cultural production of GIS in Indian Country.

Appendix 1. List of Tribal Governments that Received GIS Software from the GDSC between 2003 and 2005 (Source: Bureau of Indian Affairs 2005e)

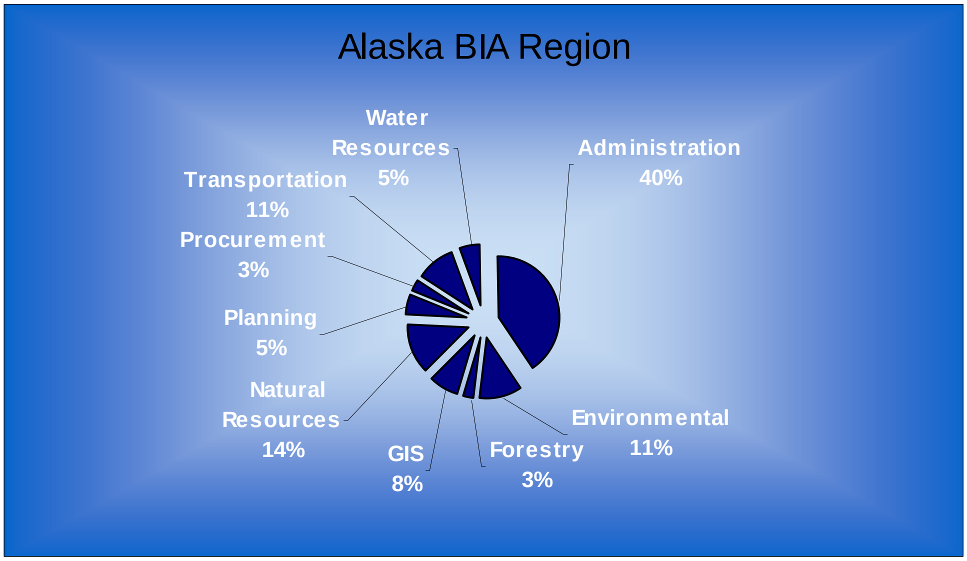
Alaska BIA Region (32)	**Northwest BIA Region (41)**
Association of Village Council Presidents, Inc. Central Council of the Tlingit & Haida Indian Tribes Chalkyitsik Village Council Chevak Native Village Chickaloon Native Village Chickaloon Native Village Chugachmiut, Inc Council of Athabascan Tribal Governments Curyung Tribal Council Eklutna Native Village Kawerak, Inc. Kenaitze Indian Tribe Louden Tribal Council McGrath Native Village Native Village of Afognak Native Village of Eyak Native Village of Fort Yukon Native Village of Georgetown Native Village of Kwinhagak Native Village of Port Lions Native Village of Ruby Native Village of Tanacross Native Village of Tazlina Ninilchik Village Organized Village of Kasaan Pribilof Islands Aleut Communities of St. George Islands Sitka Tribe of Alaska Skagway Village Tanana Chiefs Conference, Inc. Ugashik Village Village of Sleetmute Yakutat Tlingit Tribe	Coeur D'Alene Tribe Confederated Tribes and Bands of the Yakama Indian Nation Confederated Tribes of the Colville Reservation Confederated Tribes of the Coos, Lower Umpqua & Siuslaw Indians Confederated Tribes of the Grand Ronde Community Confederated Tribes of the Siletz Reservation Confederated Tribes of the Warm Springs Reservation Confederated Tribes of Umatilla Indian Reservation Coquille Indian Tribe Cow Creek Band of Umpqua Indians Cowlitz Indian Tribe Hoh Indian Tribe Jamestown S'Klallam Tribe Kalispel Indian Community Klamath Indian Tribe Kootenai Tribe Lower Elwha Tribal Community Lummi Tribe Makah Indian Tribe Metlakatla Indian Community Muckleshoot Indian Tribe Nez Perce Tribe Nisqually Indian Tribe Nooksack Indian Tribe Port Gamble Indian Community Puyallup Tribe Quileute Tribe Quinault Tribe Samish Indian Tribe Sauk-Suiattle Indian Tribe Shoalwater Bay Tribe Shoshone-Bannock Tribes Skokomish Indian Tribe Snoqualmie Tribe Spokane Tribe of Indians Squaxin Island Tribe Stillaguamish Tribe Suquamish Indian Tribe Swinomish Indians Tulalip Tribes Upper Skagit Indian Tribe

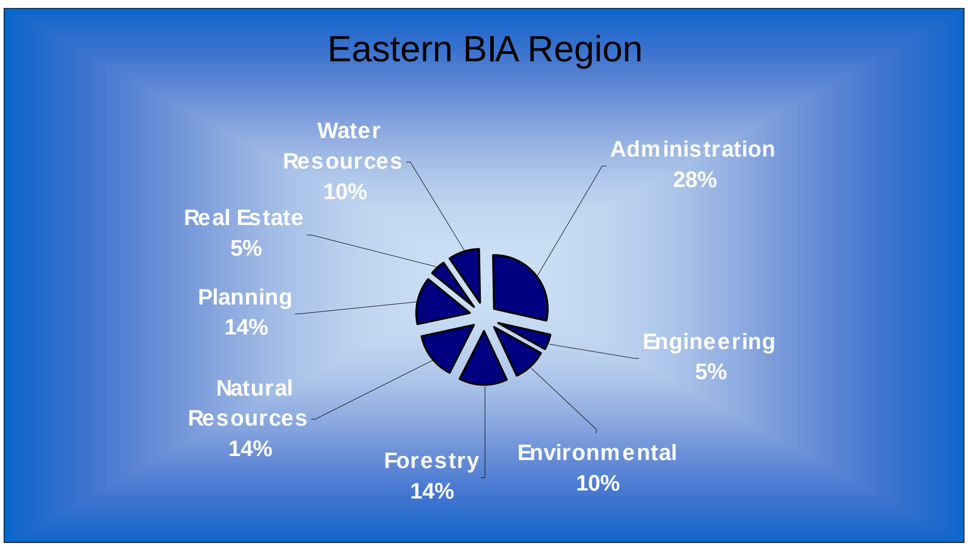
Pacific BIA Region (31)	**Western BIA Region (22)**
Agua Caliente Band of Cahuilla Indians Big Pine Band of Owens Valley Paiute Shoshone Indians Cabazon Band of Cahuilla Mission Indians Cahuilla Band of Mission Indians Cortina Indian Rancheria of Wintun Indians Elk Valley Rancheria Fort Independence Indian Community of Paiute Indians Graton Rancheria Hoopa Valley Tribe Kashia Band of Pomo Indians La Jolla Band of Luiseno Mission Indians	Colorado River Indian Tribes Duckwater Shoshone Tribe Ely Shoshone Tribe Fort McDowell Yavapai Nation Gila River Indian Community Hopi Tribe Hualapai Indian Tribe Moapa Band of Paiute Indians Paiute-Shoshone Tribe Pascua Yaqui Tribe Pyramid Lake Paiute Tribe

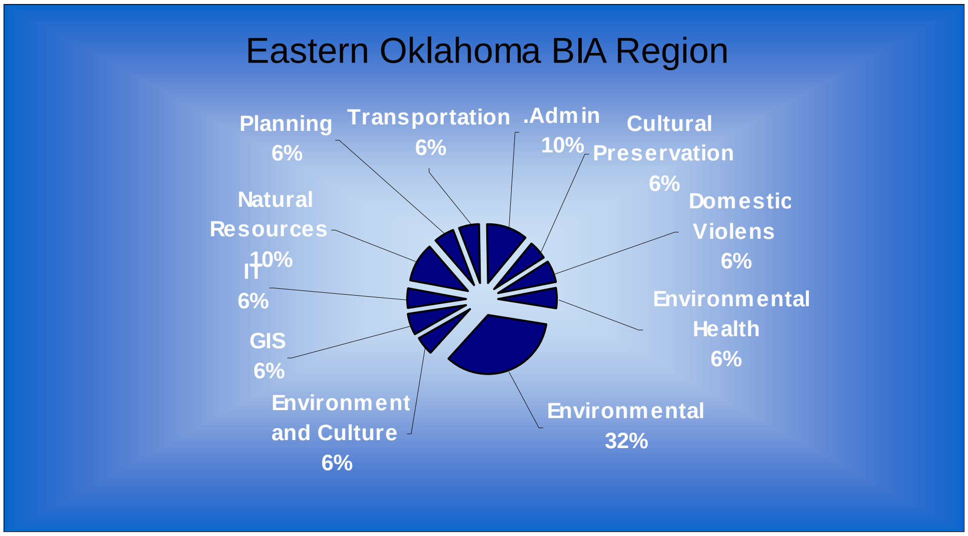
Mechoopda Indian Tribe of Chico Rancheria Morongo Band of Cahuilla Mission Indians North Fork Rancheria of Mono Indians Owens Valley Indian Water Commission Paiute-Shoshone Indians of the Bishop Community Pala Band of the Luiseno Mission Indians Pauma Band of Luiseno Mission Indians Pechanga Band of Luiseno Mission Indians Quartz Valley Indian Community Ramona Band or Village of Cahuilla Mission Indians Rincon Band of Luiseno Mission Indians Round Valley Indian Tribes San Pasqual Band of Diegueno Mission Indians Sherwood Valley Rancheria of Pomo Indians Shingle Springs Band of Miwok Indians Susanville Indian Rancheria Torres-Martinez Band of Cahuilla Mission Indians Tule River Indian Tribe Twenty-Nine Palms Band of Mission Indians Yurok Tribe of the Yurok Reservation	Reno-Sparks Indian Colony Salt River Pima-Maricopa Indian Community San Carlos Apache Tribe Shoshone-Paiute Tribes Summit Lake Paiute Tribe Te-Moak Tribe of Phoenix Shoshone Indians Tohono O'odham Nation Ute Indian Tribe Walker River Paiute Tribe White Mountain Apache Tribe Yerington Paiute Tribe
Southwest BIA Region (20)	**Rocky Mountain BIA Region (7)**
Jicarilla Apache Nation Mescalero Apache Tribe Navajo Nation Pueblo of Acoma Pueblo of Cochiti Pueblo of Isleta Pueblo of Jemez Pueblo of Laguna Pueblo of Pojoaque Pueblo of San Felipe Pueblo of San Ildelfonso Pueblo of San Juan Pueblo of Sandia Pueblo of Santa Ana Pueblo of Santa Clara Pueblo of Santo Domingo Pueblo of Taos Pueblo of Tesuque Southern Ute Indian Tribe Ute Mountain Tribe Zuni Tribe	Arapahoe Tribe Assiniboine and Sioux Tribes Blackfeet Tribe Chippewa-Cree Indians Confederated Salish & Kootenai Tribes Fort Belknap Indian Community Shoshone Tribe
Great Plains BIA Region (11)	**Southern Plains BIA Region (13)**
Cheyenne River Sioux Tribe Lower Brule Sioux Tribe Oglala Sioux Tribe Rosebud Sioux Tribe Sisseton-Wahpeton Sioux Tribe Spirit Lake Sioux Tribe Standing Rock Sioux Tribe Three Affiliated Tribes of the Fort Berthold Reservation Turtle Mountain Band of Chippewa Indians Winnebago Tribe Yankton Sioux Tribe	Absentee-Shawnee Tribe Apache Tribe of Oklahoma Citizen Potawatomi Nation Comanche Nation Delaware Nation Iowa Tribe Kaw Nation Kickapoo Tribe Pawnee Nation Peoria Tribe Prairie Band Potawatomi Nation Sac and Fox Nation Wichita & Affiliated Tribes

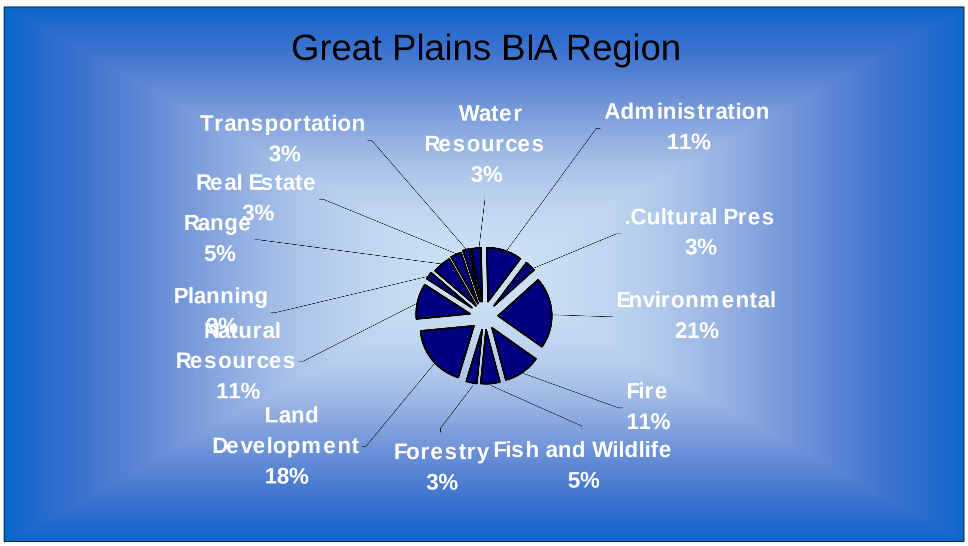
Eastern Oklahoma BIA Region (10)	**Midwest BIA Region (30)**
Cherokee Nation Chickasaw Nation Choctaw Nation Delaware Tribe of Indians Eastern Shawnee Tribe Muscogee (Creek) Nation Osage Tribe Seminole Nation United Keetoowah Band (UKB) of Cherokee Indians Wyandotte Tribe	Bad River Band of Lake Superior Tribe Bay Mills Indian Community Forest County Potawatomi Community Grand Traverse Band of Ottawa & Chippewa Indians Ho-Chunk Nation Huron Potawatomi, Inc., Keweenaw Bay Indian Community Lac du Flambeau Band of Lake Superior Chippewa Lac Vieux Desert Band of Lake Superior Chippewa Little River Band of Ottawa Indians Little Traverse Bay Bands of Odawa Indians Lower Sioux Indian Community Match-e-be-nash-she-wish Band of Pottawatomi Indians Menominee Tribal Enterprises Minnesota Chippewa Tribe Minnesota Chippewa Tribe, Bois Forte Band Minnesota Chippewa Tribe, Fond du Lac Band Minnesota Chippewa Tribe, Grand Portage Band Minnesota Chippewa Tribe, Mille Lacs Band of Ojibwe Minnesota Chippewa Tribe, White Earth Band Oneida Tribe of Indians Prairie Island Indian Community Red Cliff Band of Lake Superior Chippewa Indians Red Lake Band of Chippewa Indians Sac and Fox Tribe of the Mississippi In Iowa Saginaw Chippewa Indian Tribe Sault Ste. Marie Tribe of Chippewa Indians Shakopee Mdewakanton Sioux Community Stockbridge Munsee Community Upper Sioux Community
Eastern BIA Region (14)	**Navajo BIA Region (1)**
Aroostook Band of Micmac Indians Chitimacha Tribe Eastern Band of Cherokee Indians Houlton Band of Maliseet Indians Miccosukee Tribe Mississippi Band of Choctaw Indians Narragansett Indian Tribe Passamaquoddy Tribe Penobscot Tribe Seminole Tribe Seneca Nation St. Regis Band of Mohawk Tunica-Biloxi Indian Tribe Wampanoag Tribe	Navajo Tribe

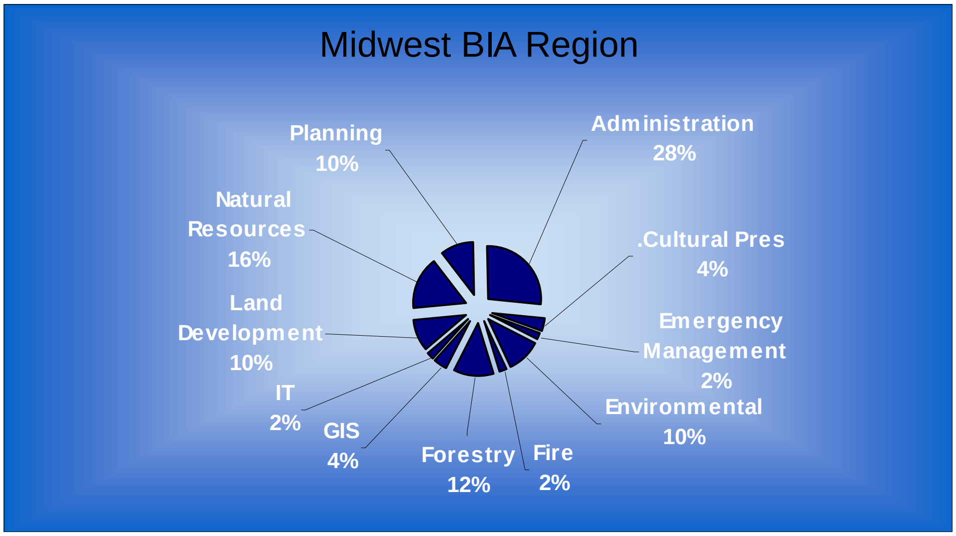
Appendix 2. The percentage of tribal government departments per BIA region.
(Source: Bureau of Indian Affairs 2005e)

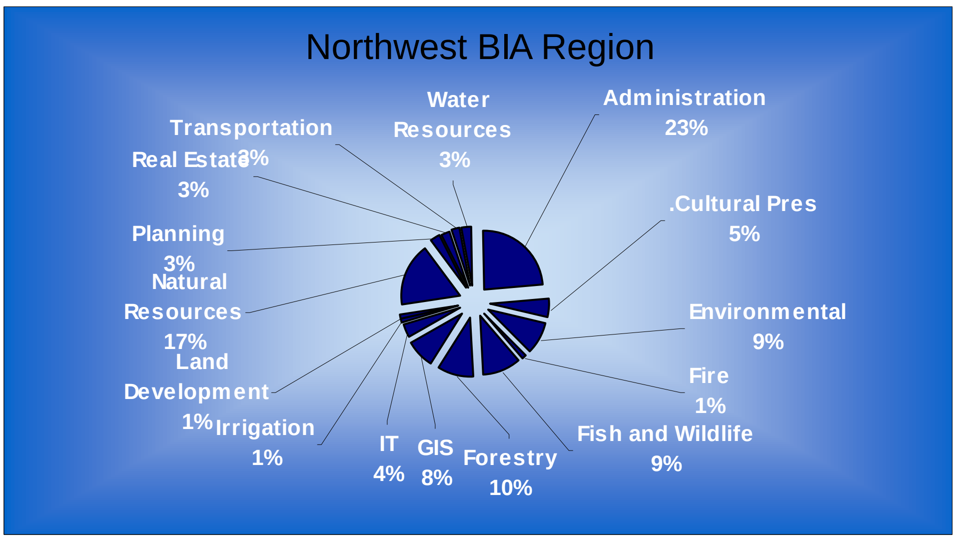


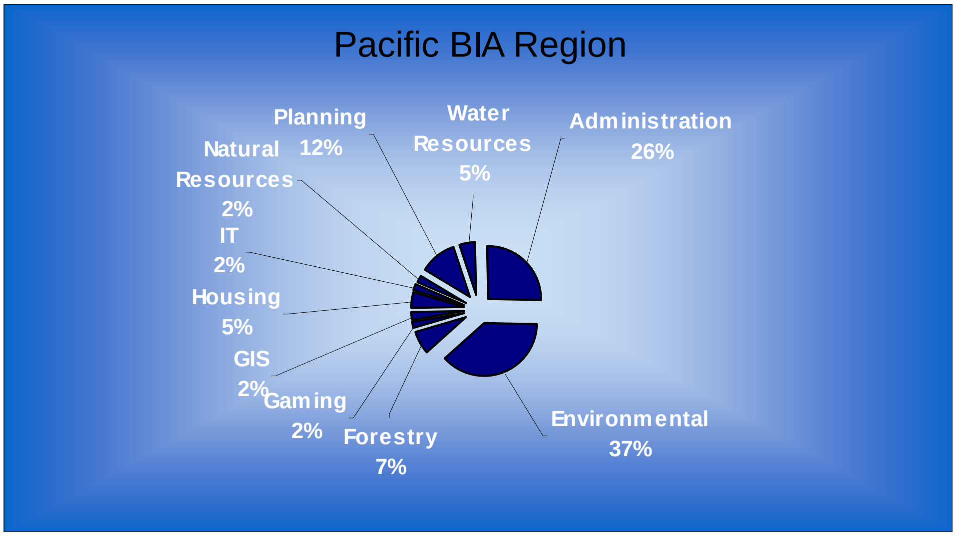


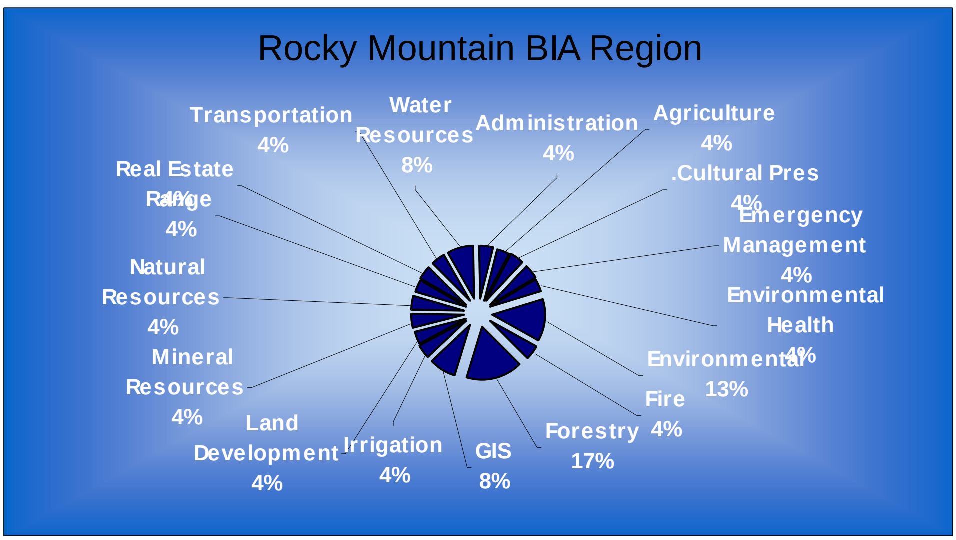

Eastern Oklahoma BIA Region
Planning 6%
Transportation 6%
.Admin 10%
Cultural Preservation 6%
Natural Resources 10%
Domestic Violens 6%
IT 6%
Environmental Health 6%
GIS 6%
Environment and Culture 6%
Environmental 32%

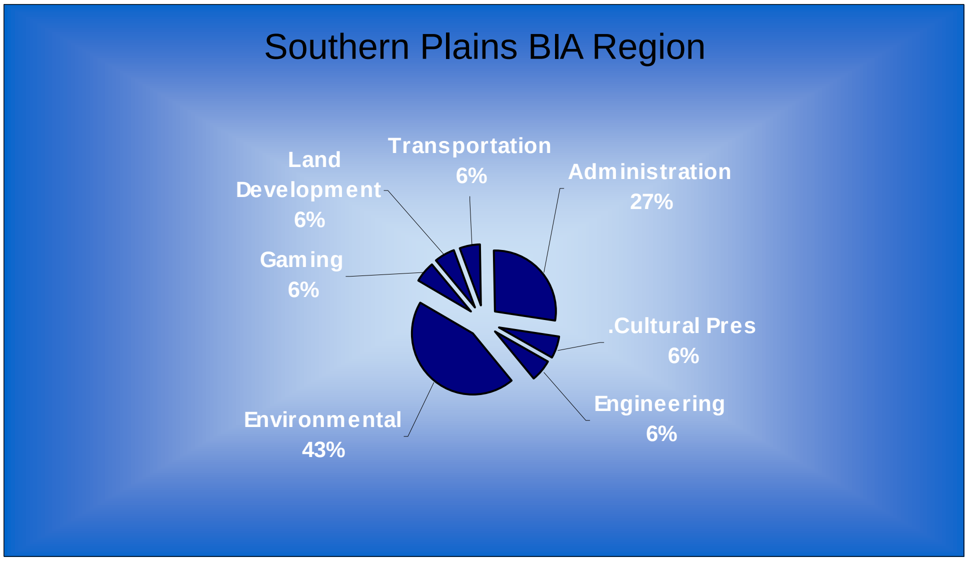

Great Plains BIA Region
Transportation 3%
Water Resources 3%
Administration 11%
Real Estate 3%
Range 5%
.Cultural Pres 3%
Planning 3%
Environmental 21%
Natural Resources 11%
Fire 11%
Land Development 18%
Forestry 3%
Fish and Wildlife 5%

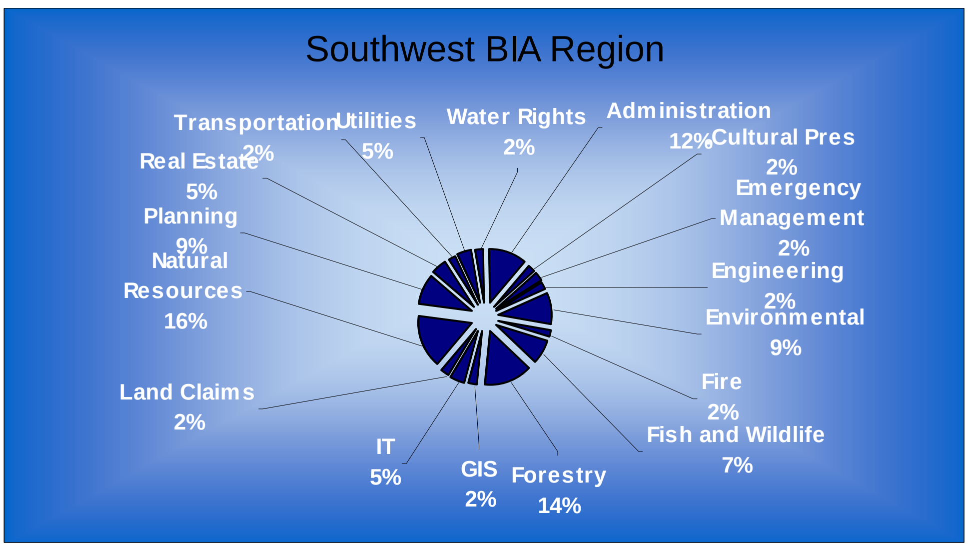

Midwest BIA Region
Planning
10%
Administration
28%
Natural
Resources
16%
.Cultural Pres
4%
Land
Development
10%
Emergency
Management
2%
IT
2%
Environmental
10%
GIS
4%
Forestry
12%
Fire
2%

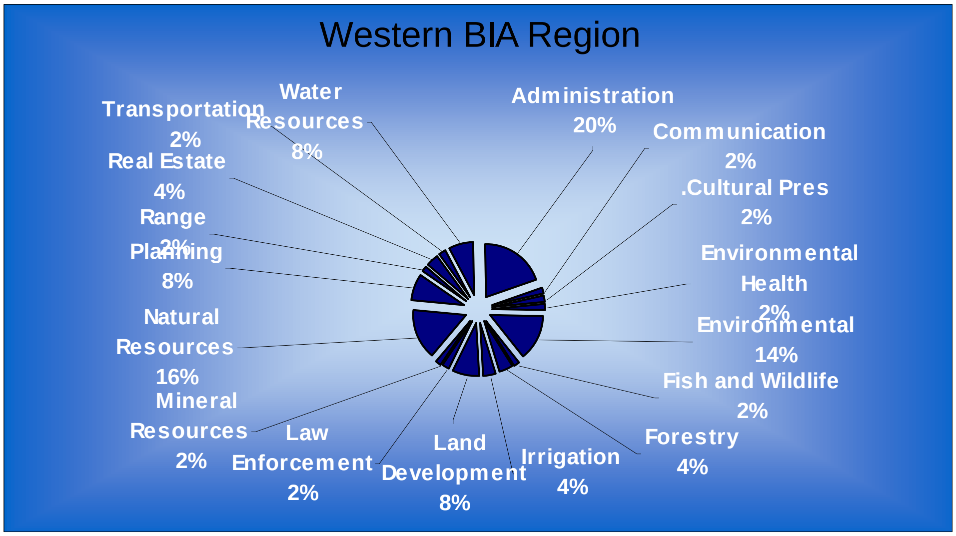

Northwest BIA Region
Water
Resources
3%
Administration
23%
Transportation
3%
Real Estate
3%
.Cultural Pres
5%
Planning
3%
Natural
Resources
17%
Environmental
9%
Land
Development
1%
Fire
1%
Irrigation
1%
IT
4%
GIS
8%
Forestry
10%
Fish and Wildlife
9%


Pacific BIA Region
Planning 12%
Water Resources 5%
Administration 26%
Natural Resources 2%
IT 2%
Housing 5%
GIS 2%
Gaming 2%
Forestry 7%
Environmental 37%


Rocky Mountain BIA Region
Transportation 4%
Water Resources 8%
Administration 4%
Agriculture 4%
.Cultural Pres 4%
Real Estate 4%
Range 4%
Emergency Management 4%
Natural Resources 4%
Environmental Health 4%
Mineral Resources 4%
Environmental 13%
Fire 4%
Land Development 4%
Irrigation 4%
GIS 8%
Forestry 17%


Southern Plains BIA Region
Transportation
6%
Land
Development
6%
Administration
27%
Gaming
6%
.Cultural Pres
6%
Engineering
6%
Environmental
43%


Southwest BIA Region
Transportation
2%
Utilities
5%
Water Rights
2%
Administration
12%
Cultural Pres
2%
Real Estate
5%
Emergency
Management
2%
Planning
9%
Engineering
2%
Natural
Resources
16%
Environmental
9%
Fire
2%
Land Claims
2%
Fish and Wildlife
7%
IT
5%
GIS
2%
Forestry
14%



Western BIA Region
Water Resources 8%
Administration 20%
Transportation 2%
Communication 2%
Real Estate 4%
.Cultural Pres 2%
Range 2%
Planning 8%
Environmental Health 2%
Environmental 14%
Natural Resources 16%
Fish and Wildlife 2%
Mineral Resources 2%
Forestry 4%
Law Enforcement 2%
Land Development 8%
Irrigation 4%

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Endnotes

[1] "Indian Country" means all land within the limits of any Indian reservation under the jurisdiction of the United States government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation, (a) all dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state, and (b) all Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same (Environmental Protection Agency 2005).

[2] "The Congress hereby recognizes the obligation of the United States to respond to the strong expression of the Indian people for self-determination by assuring maximum Indian participation in the direction of educational as well as other Federal services to Indian communities so as to render such services more responsive to the needs and desires of those communities" (U.S. Congress 2006).

[3]The core-periphery model is "a model of the geography of human activity based upon the unequal distribution of power in the economy, society, and polity. The core dominates (although it in turn may be dominated from the outside) whilst the periphery is dependent" (Lee 2000, 115).

[4] Letter from Hedy Levine to Robert Rundstrom, email correspondence entitled, Native Americans and GIS – Part 3, sent on May 13, 1994.

[5] Critical human geography is "a diverse and rapidly changing set of ideas and practices within human geography linked by a changing set of ideas and practices within human geography linked by a shared commitment to emancipatory politics with and beyond the discipline, to the promotion of progressive social change and to the development of a broad range of critical theories and their application in geographical research and political practice. While most critical human geographers resist attempts to prescribe a single theoretical orthodoxy, some seek to develop, extend and work within just one or two theoretical traditions, while others draw on a range of different approaches" (Painter 2000, 126-127).

[6] Social constructivism is a form of idealism. However, some geographic information scientists engaging with STS, GIS and society treat the 'social construction' of GIS more as a form of realism. ANT lends itself better to 'realism.'

[7] As in Walter Rostow's stages of economic development.

[8] Centers of calculation are places were inscriptions are brought, representations are constructed, and calculations are made. It is based on a core and periphery model.

[9] In relation to the field of geography, the center of calculation is a core and periphery model.

[10] Rations are portions of materials like food, clothing, and water dealt out, shared, or allotted to individuals or organizations. In this research framework, rations are materials dealt out to American Indian tribal governments.

[11] Some indigenous tribal people survived as communal hunting and gathering societies. The new social and economic system imposed on indigenous tribal people focused upon individualism, Christianity, farming, and ranching. Some indigenous tribes maintained migratory, nomadic, or semi-nomadic lifestyles. The new system implemented fixity and sedentary lifestyles.

[12] Additional policies include the Clean Air Act and Clean Water Act among others in the 1970s.

[13] According to the *Dictionary of human geography* (2000), environmental impact assessments are a process of systematically identifying and assessing anticipated environmental impacts prior to a proposed project, policy, program or plan being implemented.

[14] The BIA National GIS Center referred to in most of this chapter would become the BIA Geographic Data Service Center in 1988.

[15] More detailed histories on post-war computerization in the United States can be found in Noble (1984) and Edwards (1997).

[16] A document found at the GDSC entitled, *Issue paper: Indian integrated resource information program* is another intermediary through which the BIA translates the objectives associated with GIS development throughout the agency. The eight page document gives the most detailed description of the IIRIP found at the agency. This intermediary is part of the document network consisting of the IRMP guidelines, the Battelle cost-benefit analysis, and the GDSC quarterly technical reports, that give the BIA GIS network structure. The IIRIP document is referenced as, Bureau of Indian Affairs. 1988a. *Issue paper: Indian Integrated resource information program*. Geography Data Service Center. Lakewood, CO.

[17] The BIA Integrated Resource Management Plan (IRMP) is one of the primary intermediaries that is put in circulation and contains references to other important intermediaries like the Indian Forest Resource Management Act and the American Indian Agriculture Resource Management Act. The GDSC supported IRMP activities through the development and diffusion of some GIS layers for selected BIA Area and Agency Offices participating in integrated programs. The IRMP documentary source is referenced as Bureau of Indian Affairs. 1998. *Guidelines for Integrated Resource Management Planning in Indian Country*. Washington, D.C., and Bureau of Indian Affair. 2001b. *Guidelines for Integrated Resource Management Planning in Indian Country*. Washington, D.C.

[18] Another important intermediary in the mobilization of the digital version of Indian Country was a cost-benefit analysis entitled, *Final report on cost and benefit analysis of geographic information system implementation to Bureau of Indian Affairs* published in 1988. The consulting firm Battelle conducted the analysis. It is an excellent source of translations as goals, objectives, and justifications for why the BIA should automate natural resource management processes through GIS. It is part of the network of documents that helps construct the relations and geography of BIA GIS in Indian Country. This intermediary is referenced as, Battelle. 1988. *Final report on cost and benefit analysis of geographic information system implementation to Bureau of Indian Affairs.* Washington, D.C.

[19] My work on Kiowa land allotments reiterated that Euro-American settlers complained that Plains Indians were not using reservation land in ways that it should. Many of these settlers argued for the opening of reservations like the Kiowa, Comanche, and Apache Reservation. Pressure from settlers and general pubic forced government officials in Washington D.C. to open the reservations up for settlement (Palmer 1998).

[20] Louis Warren informs us that the management of natural resources among American Indian tribal members is often framed in a traditional versus progressive dualistic relationship. He wrote that, “traditional is almost always synonymous with environmental, an implication that should make scholars leery” (302). Furthermore, I agree with Warren that the traditional – mythology of Indian environmentalism is a tool for all factions associated with tribal management of resources.

[21] MOSS was originally developed by the Phoenix Energy and Land Use Team a Division of Biological Services Research and Development for the U.S. Fish and Wildlife Service (DOI) as a general purpose GIS used for the specific purpose of assessing the environmental impact of natural resource development on fish and game. MOSS was a public domain, open code program. Thus, the only setup costs were for training and hardware (Battelle, 1988).

[22] Latour’s definition of an inscription device is an instrument “that provides a visual display of any sort in a scientific text” (Latour, 1987, 68).

[23] Re: a personal conversation with Mark Zundel in October 2005.

[24] According to Mark Warhus, a map of Zuni Lands Taken Since 1846 “was created to aid the Zuni in a land claim against the United States. The map of Areas of Zuni Lands Taken Since 1846 was made by the Environmental Systems Research Institute” (Warhus, 1997: 217)

[25] When the federal government allotted land (following the break-up of large reservations in Oklahoma) to individual Indians in the late nineteenth and twentieth century, only one land owner appeared on BIA records. Overtime, families grew but the land base stayed the same. Today, a single

10 acre parcel of Indian trust land might belong to 40 owners. Each owner must sign a consent form regarding any kind of land use or land sale. Tracking down each land owner and getting them to sign consent forms is difficult at best.

[26] BIA Area and Agency offices are also referred to as BIA field offices.

[27] Latour describes the center of calculation network as a "star-like shape in a very striking form" (Latour 2005, 178).

[28] The Intertribal Forestry Council (ITC) was established in 1976 as a non-profit nationwide consortium of tribal government, Alaska Native Corporations, and individuals within Indian communities for improving natural resource management practices within American Indian communities (Intertribal GIS Council. 2006. About the ITC. http://www.itcnet.org/AboutITC.html)

[29] The General Allotment Act is one of the most important pieces of Indian legislation and federal policy related to Indian land holdings. The act was meant to dissolve Indian reservations, to end tribalism, and to convert Indians to farmers (Otis 1973).

[30] Mark Zundel revealed this information during an informal discussion at the GDSC in 2004.

[31] As a jumping off point for those interested in the networks and rhizomes (Delueze and Guattari 1987) associated with the development of ESRI, I recommend a paper by Nicholas Chrisman and Francis Harvey, 2004, "The imbrication of geography and technology: The social construction of geographic information systems" in *Geography and Technology* edited by Brunn et. al, 2004.

[32] Personal notes of Robert Rundstrom in regards to planning a tribal GIS session at the ESRI User Conference in 1993.

[33] BIA GDSC Director Mark Zundel mentioned that the GDSC was one of ESRI's earliest customers.

[34] Alaska (ALA), Northwest (NW), Pacific (PAC), Western (WES), Southwest (SW), Rocky Mountain (RMT), Great Plains (GPL), Midwest (MID), Eastern (EAS).

[35] The 2001 quarterly technical reports provide the following disclaimer: "The mention of trade names or commercial products does not constitute an endorsement or recommendation for use by the government" (Bureau of Indian Affairs 2001a,b).

[36] Each time a tribal government employee or customer calls in a problem to the GDSC, a ticket is issued to them. Tickets are records of all calls coming into the BIA.

[37] All calls are handled by phone, email, or fax. Inquires are recorded in an Oracle database available for statistical tracking (Bureau of Indian Affairs 2003d).

[38] The Coeur d'Alene GIS department announced this program through mass emails to the Indigenous Mapping group in 2005 and 2006.

[39] Ryan Callison of the Cherokee Environmental Office told me that his office secured funding from the EPA Region 6 to map Indian land in Oklahoma (2000).

[40] An EPA technical specialist was shocked to learn that some tribal offices were using EPA supported GIS for governmental activities other than environmental protection. Contractual agreements between federal government agencies and tribal governments regulate GIS use (Bureau of Indian Affairs 2006).

[41] The GDSC taught several courses, including "GIS for Managers," at the USGS training facility in Denver, Colorado (Bureau of Indian Affairs 1990a,b,c,d).

[42] The Kaw Tribal environmental manager was unsure about the usage of GIS, mainly because GIS took too much time and effort to learn. This took time away from his everyday environmental projects (author's visit to the Kaw tribe in 2003).

[43] Information on the Indigenous Mapping Project comes from an unpublished compilation of conference notes and findings. Laura Harjo, formally with Cherokee GIS, wrote the summary.

[44] The academic geographers included: Laura Harjo (Muscogee Tribe – University of Southern California), Renee Louis (Hawaiian – University of Hawaii), and Mark Palmer (Kiowa – University of Oklahoma).