Project Title:
Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program

University:
North Dakota State University

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Research Needs:
As the oil boom in the Bakken oil field changes the way of life on the Fort Berthold Indian Reservation and increases the need to adapt to rapid change, the leaders are assessing the reservation's government structure, needs, and vision for the long term. The tribal members' awareness of the need for change is a starting point for planning for a sustainable social and economic development on the reservation. (Hall 2012).

For sound sustainable development, maintaining close relationships among federal, state, county, and reservation agencies is critically important. Because of jurisdiction and long-standing traditions, the relationship among the entities might be complex, sensitive, and challenging. Through well-established information systems and by sharing data/information, these challenges can be overcome to achieve synergy in establishing a plan and vision for the reservation.

In addition to the macro level impacts from such collaboration, micro level impacts cannot be ignored. These include potential improvements to ambulance service, emergency dispatch service, road travel information, assessment of oil development impact, land use management, etc. Applications to handle these services need basic information from fundamentally structured data sets. For example, UGPTI implemented HERS-ST (Highway Economic Requirements System) on the reservation by converting Indian Reservation Road (IRR) data into HPMS data format to provide sound transportation planning tools to tribal transportation planners (Benson 2010). Planning toolsools are readily available, but creating new datasets and converting from one format to another is cumbersome.

Indian Reservation Roads are the reservation's primary transportation facilities and are the public roads located in tribal reservations or provide access to the tribal lands. MAP-21 removed the definition of Indian Reservation Roads, but supported tribal transportation programs (TTP). Funding for the TTP is accompanied by numerous "tribal consultation" requirements for States, MPOs, and other transportation public agencies (Glaze, 2012).

(a) Local roads from ND DOT (b) local roads from TIGER®
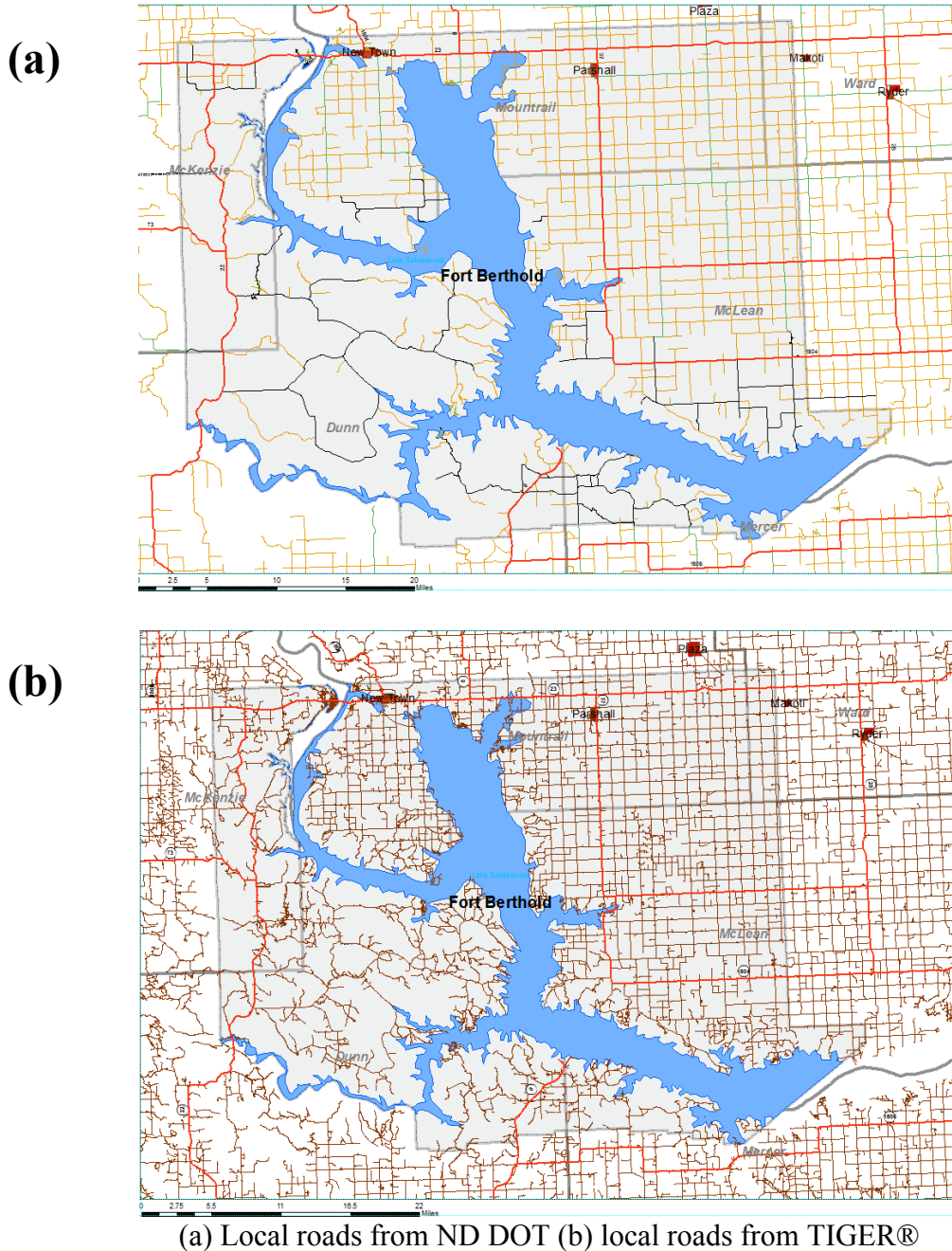
Figure 1: Road networks and government boundaries in the reservation (Data Sources: ND GIS Hub)

The Environmental Scientific Research Institute (ESRI) provides ArcGIS to the Indian reservations and the Bureau of Indian Affairs (BIA) (U.S. Department of Interior). ESRI also serves the reservations by providing GIS training. However, the reservation is in needs of specialized and reservation-oriented training and consultation services with limited data input and capability (MacGowan 2010). Figure 1, for example, shows the gaps between two data sources: (a) NDDOT and (b) TIGER®. NDDOT local roads and TIGER® can be utilized to generate the tribal roads for the baselines.

Research Objectives:
This project investigates the spatial information system needs for transportation in the reservation and supports development planning by providing consulting spatial information systems. Through project and application development, UGPTI will develop a relationship with the reservation which will provides a strong basis for statewide comprehensive transportation and land use analysis.

The project will support data collection, database and table construction, data set analysis and training.. The goal of the project is not only transferring technology knowledge, but also promoting safety and livability in the community and enhancing self-sufficiency of the reservations.

Research Methods:
This project will focus on the construction of database and spatial features in the geodatabase to support the visionary systems of the tribe. The tables are gathered from public sources such as the North Dakota GIS Hub, the U.S. Census Bureau's TIGER®, and the National Transportation Atlas Database (NTAD). Not all the public data sources adequately describe the reservations' traits and may not be compatible for use with the various applications. Thus, the data sources will be updated by adding to the existing attributes and modifying current data.

If some necessary information is missing from public sources, new tables and features will be created. For generating data, geographic positioning systems (GPS) and surveys will be utilized to assure the quality of the generated data..

Quality assurance (QA)/quality control (QC) will be conducted for each process for total quality management. The quality of the data will be measured by a covariance-variation method for location referencing systems (LRS), and root-mean-standard-errror (RMSE) for other spatial features along with visual inspection.

Expected Outcomes:
This project creates two tangible products: Phase I will create data sets, and Phase II will create an application framework including manuals and system descriptions.
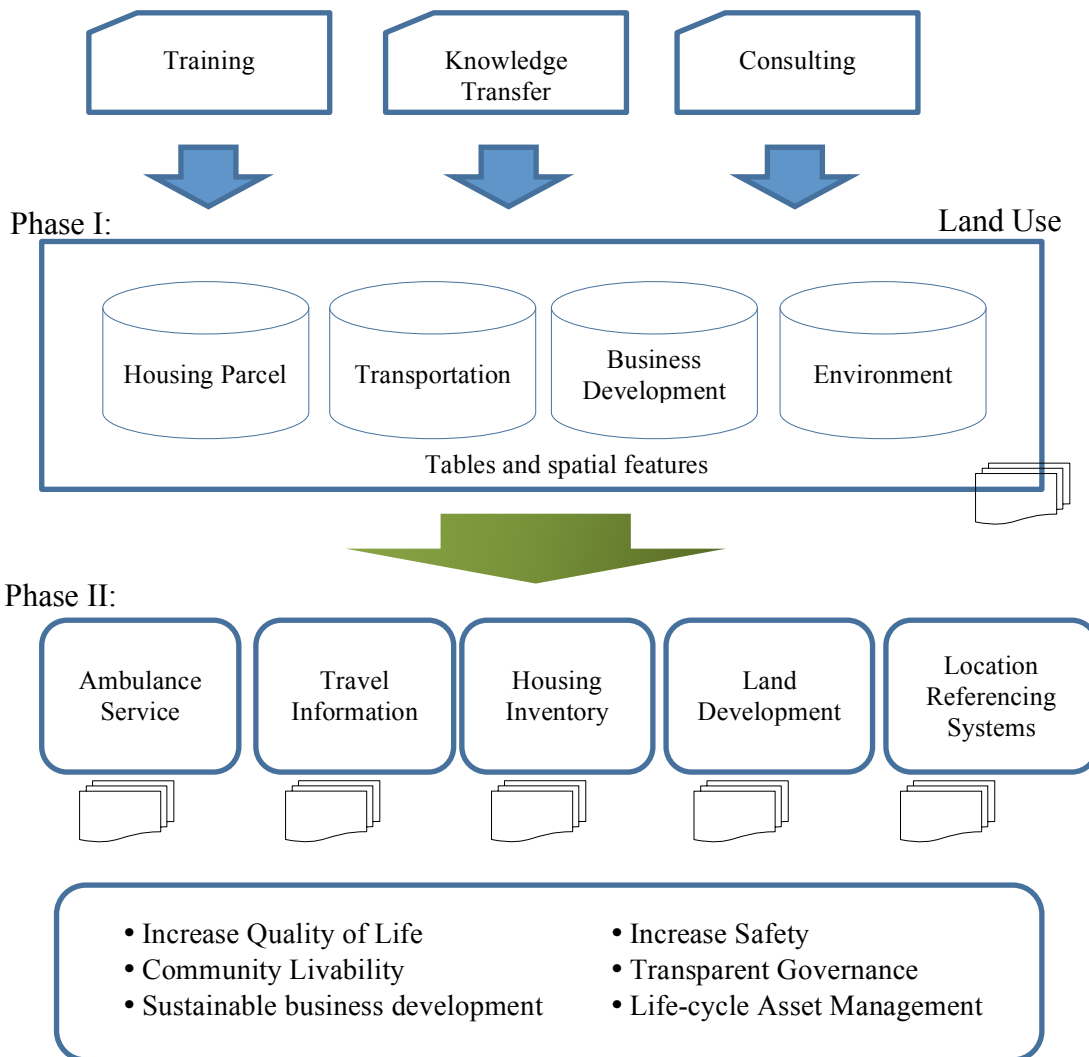
Figure 2: Project framework describing input, output, and benefits.

In Phase I, datasets describe spatial features: housing parcel polygons, transportation networks, business development features, and environment features. Housing parcels will be digitized into polygons with unique parcel id, parcel ownership, and history of development.

Transportation networks include locations, links, and parking lots and bridges with an inventory depository of history, condition, geometry, speed limit, pavement, emergency route, and ownership.

Business development data sets include oil development features, business district zone, agriculture-related features, and tourism information. Any other business features related to transportation operation and planning can be added to the database. These features may include casinos, fisheries, and hunting activities. For example, scenic byways can be created in conjunction with tourism and transportation planning to deal with context-sensitive solutions.

Environmental features such as rivers, hills, animals, and plants will also be protected as part of community sustainability efforts on behalf of future generation. Similarly, the reservation plays an important role in North Dakota and the United States in terms of historic and

geographical features.. Lake of Sakakawea, Lewis and Clark trails, and historic sites in and near the reservation are examples of the importance of the region. All the spatial features will be generated with meta data, and the attribute tables with table schemas.

In Phase II, frameworks for applications using spatial information would be constructed. In the framework, the model builder embedded in ArcGIS would be utilized for workflow processes. Therefore, the reservation agencies would utilize the model builder and application framework by customizing it for its own needs and goals.

Relevance to Strategic Goals:

The proposed project and its expected outcomes are related to the goals of Economic Competitiveness, Livable Communities, State of Good Repair, Safety, and Environmental Sustainability. The project supports Fort Berthold Reservation's zoning system for business development to increase efficiency and effective use of land in six segments of the reservation. The spatial features will include bike lanes, pedestrian facilities, and trails as well as general roads. Thus, the outcomes would make the community sustainable in accordance with Environmental Sustainability. Location referencing systems (LRS) and crash records will provide analysis tools to improve Safety in light of the increasing traffic in the region. By creating a standard format for datasets, HERS-ST for economic analysis and MOVES for environmental analysis can be utilized efficiently for transportation planning, thereby providing a way to achieve the strategic goal, State of Good Repair.

Educational Benefits:

Graduate students will be involved in this project in several ways as graduate research assistants and through participation in capstone projects. Capstone projects from TL752 (Spatial Analysis in Transportation) at North Dakota State University will be collaborative projects related to this project. As a result, graduate students can be involved in real-world projects to gain invaluable experience and to provide diverse views on the project. From this active involvement, the students can learn project scheduling and management, spatial analysis skills, and cooperation with team members for spatial and transportation projects.

The spatial technology can be transferred to the tribal government and the Forth Berthold Community College in collaboration with faculty in engineering, computer information system, and environmental science. From the experience, the students involved in the project will move on to related careers or pursue a higher academic degree. The students can also work with Upper Great Plains Transportation Institute as summer interns and or to complete independent study as required by the college.

The project will be presented during the GIS-T symposium supported by American Association of State Highways and Transportation Officials (AASHTO), the National Tribal GIS Conference, and the National Tribal Transportation Conference in 2014. The project implement process and models can be shared with other tribal agencies through the Local Technical Assistance Program (LTAP) located at UGPTI and the Tribal Technical Assistance Program (TTAP) located at the United Tribes Technical College serving the Northern Plains region.

Work Plan:

The strategic plan is developed to transfer technology and develop relevant applications for the reservation: Phase I – Identifying and Collecting Data and Phase II – Design and Develop Applications.

Phase I:
1. Conduct an interview with tribal leaders in order to analyze tribal vision and application needs. (Three months)
2. Design database architecture and develop attribute tables for feature datasets. (Two months)
3. Conduct field survey and generate data. (six months)
4. Quality assurance and calibration. (one month)

Phase II:
5. Develop application framework. (two to three months)
6. Write final report of findings and present at professional meetings.
7. Conduct training and deliver final products. Present to NDDOT and Tribal Council. (one month)

Project Cost:
Total Project Costs: $146,000.00
MPC Funds Requested: $73,000.00
Matching Funds: $73,000.00
  Source of Matching Funds:
    o NDDOT ($5,000 for developing LRS in the reservation)
    o Bush Foundation ($20,000)
    o Northwestern Area Reservation ($20,000)
    o North Dakota State University ($28,200 for two doctoral student tuition)

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TRB Keywords: Indian Reservation Roads, GIS, Land Use, Spatial Data

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