Summary of Final Report, BC-851
August 2003

MODELING THE INTERACTIONS BETWEEN LAND USE AND TRANSPORTATION INVESTMENTS USING SPATIOTEMPORAL ANALYSIS TOOLS

PROBLEM STATEMENT

In conventional travel demand modeling procedures, the interaction or feedback mechanism between transportation and land use is not adequately modeled, which means that the following are not given due attention: the implications of transportation investments with regard to the patterns of land development, time lags between transportation projects and land development, growth rate of development, and the "equilibrium point" (i.e., the point at which development levels off for a given level of service of the transportation system). While travel demand models consider the impacts of land use on transportation systems (e.g., trip generation is determined based on land use variables), most lack the ability to reflect the implications of transportation investments on the patterns of land development except in a limited way (e.g., considering accessibility measured in interzonal travel time). Furthermore, any changes in the transportation system are usually fed into a land use model assuming an immediate response (in land use) to transportation improvements. However, the responses of land use to transportation improvements usually lag, and the processes by which land use and transportation systems influence each other are dynamic and co-evolving. This co-evolutionary process is either not captured in traditional transportation models or it is over-simplified, including the lag effects of transportation improvements on land use.

The time lag between the completion of transportation projects and the changes in land use stimulated by these projects call for the collection and examination of historical data on both transportation projects and land use in order to understand how they interact. In the past, there has been a lack of digital data on historical land-use changes and transportation systems. Although historical data in digital format are becoming more readily available, there has been a lack of necessary analytical tools, such as the geographic information system (GIS) technology that supports the modeling and analysis of spatiotemporal data. The lack of data and appropriate analytical tools has limited studies on the interaction between land use and transportation.

OBJECTIVES

This research has two main goals. The first is to develop a temporal GIS to support management of historical data on land use and transportation and to support visualization and analysis of the data for travel model improvement efforts. The second is to design a methodology for analyzing the interactions between land use and transportation. Specific objectives include the following:

1. Design a temporal GIS data model that supports the storage, retrieval, and analysis of spatiotemporal data.
2. Implement a prototype temporal GIS program that supports the analysis of historical land use and transportation data.

3. Identify availability of historical data on land use and transportation, and collect and process such data to build temporal GIS databases.
4. Identify the types of new land developments that occur in transportation project areas.
5. Study the temporal patterns of land developments, including time lags between transportation improvements and land developments, the rate of development, and the length of intensified land developments stimulated by transportation improvements.

FINDINGS AND CONCLUSIONS

This project has resulted in the development of TransLand, a GIS program implemented in the ArcGIS 8.0 environment, which is capable of handling and manipulating spatiotemporal data. A spatiotemporal data model was designed and databases of historical land use and transportation were constructed. A framework for identifying the spatial and temporal interactions between transportation and land use was also developed to allow for the visualization and analysis of transportation and land interactions.

There is a lack of systematic archival of historical data on land use and transportation projects. Much of the problem may be attributed to the limited use of digital technologies, including databases and GIS. In addition to greater use of such technologies, solving the problem will require agencywide enterprise databases and data sharing between government agencies.

The results of the statistical analysis of time series of transportation and land use data in selected corridor areas in Miami-Dade County, Florida indicated that transportation improvements impacted land uses at varying rates and intensities. The estimated lag effect for Lag1, or the time span between the completion of a roadway expansion project and increased building permit applications by developers for new developments, ranged from a few months to one and one half years. Lag2 (the institutional lag for the building department to review applications and issue permits) and Lag3 (the construction period for new developments) averaged four months and ten months with standard deviations of four and nine months, respectively. Consequently, it took two to four years for travel demand to respond to road investments in the growing areas in Miami-Dade County. Researchers also found that congestion negatively impacted development and that there is a need to develop integrated land use-transportation models that capture all the market factors.

BENEFITS

This research resulted in the development of a temporal GIS tool that allows urban and transportation planners to examine historical land development and transportation data interactively and visually. The data model developed may also be used in the future to preserve land use and transportation data to enable the development of future integrated land use and transportation models. The time-series analysis provided empirical evidence of transportation and land use interaction, including the time lags and the qualification of impacts of transportation investments on land use. The result will help to improve the existing land use models and processes and to develop integrated land use transportation models.

This research was conducted by Fang Zhao, Ph.D., P.E., of the Lehman Center for Transportation Research at Florida International University, and Shih-Lung Shaw, Ph.D., of the University of Tennessee, Knoxville. For more information, contact Shi-Chiang Li, Project Manager, at (954) 777-4655, shi-chiang.li@dot.state.fl.us .