

GIS TOOLS

FOR TRANSPORTATION AND COMMUNITY PLANNING

This case study describes innovative applications of GIS techniques that TCSP grantees have used to support transportation and community planning.

The Federal Highway Administration’s Transportation and Community and System Preservation Pilot Program (TCSP) has funded projects in all 50 states and the District of Columbia that link transportation, community, and system preservation practices. Many of these projects have applied innovative analytical approaches to assess and communicate the impacts of transportation and land use decisions on mobility, the environment, and economic development. Geographic Information Systems (GIS) have played a key role in supporting these analytical methods.

TCSP projects are demonstrating analytical methods supported by GIS for:

- Combining local land use data sources to provide a regional database for forecasting and scenario analysis;
- Creating and evaluating alternative transportation and development scenarios;
- Estimating a range of community, economic, fiscal, and environmental impacts associated with transportation and development scenarios; and
- Forecasting the land use impacts of transportation plans and projects.

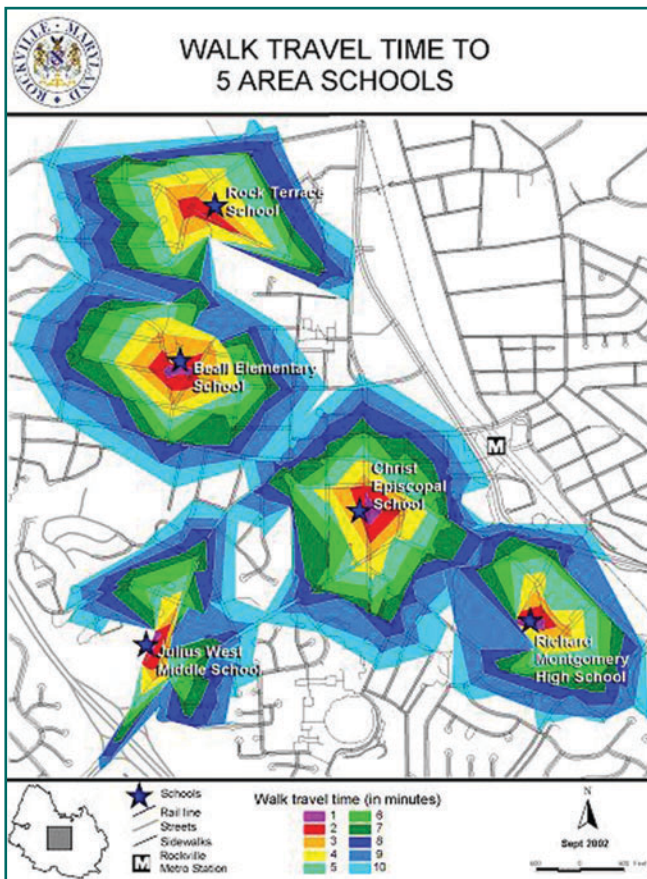
TCSP project sponsors are using GIS to enhance the transportation planning process as well as project design and development. GIS is being applied to support transportation and land use decisions at both regional and local levels. It is improving staff analytical capabilities as well as helping the public and decision-makers better understand the impacts of various alternatives. As a result, projects selected and designed by communities are reflecting a broader range of community impacts and more informed citizen input.

Furthermore, the results of project analysis show a common theme: that transportation and development plans proposed by TCSP projects will, indeed, achieve the program’s objectives of reducing infrastructure costs and environmental impacts while increasing the efficiency of the transportation system.

DEVELOPING REGIONAL LAND USE DATA

The idea of creating regional growth scenarios and modeling the transportation and other impacts of these scenarios is not new. Advances in GIS-based tools and data, however, have made it easier to construct and model such scenarios. At the same time, increasing concern over the impacts of development patterns have led more areas to undertake efforts to consider and analyze land use from a regional perspective.

One of the major challenges faced by TCSP grantees has been to construct regional growth scenarios that are not entirely hypothetical, but instead are consistent with existing constraints on development and realistic land use policy alternatives. Local comprehensive plans and zoning policies can provide a basis for such scenarios. Separate plans and zoning policies, however, are typically maintained by tens or even hundreds of local jurisdictions within a metropolitan area. Each jurisdiction typically uses a different classification system and many have plans only in hard copy format.



Courtesy City of Rockville, Traffic & Transportation Division.

Walk travel times to schools in the City of Rockville, Maryland. GIS can be used to measure the accessibility impacts of adding links to the pedestrian network.



To support regional planning efforts, TCSP project sponsors in Phoenix, Arizona; Lansing, Michigan; and Salt Lake City, Utah have used GIS to integrate local land use plans and zoning into a regional database.

While providing useful information for planning, this is not a straightforward endeavor. Staff at the Tri-County Regional Planning Commission (TCRPC) in Lansing, Michigan explained how they assembled data from over 50 jurisdictions to support a regional growth visioning effort as part of a Fiscal Year (FY) 1999 TCSP project. Maps were obtained in both electronic and hard copy format; hard copy maps were scanned or digitally photographed. These maps were manipulated to create polygons corresponding to different land use areas, and to create identifying information for each polygon. Then, different land uses for each jurisdiction were converted into a uniform land use classification system. The resulting regional land use database was used as a basis for creating maps of population and employment under trend, alternative, and build-out scenarios which were used in public workshops.

“The TCSP project has helped local jurisdictions see the value of consistent and cross-boundary mapping of parcel-based land use data.”

– Paul Hamilton, Tri-County Regional Planning Commission, Lansing, Michigan

TCRPC staff estimate that it took a technician approximately 25 percent time for three years to develop the regional database. This included collecting and analyzing data from other sources in addition to assembling local planning and zoning data. Keeping the data current will require additional staff time, as well as assistance from local jurisdictions in reviewing maps and providing updates as they occur. Nevertheless, the regional land use database in Lansing has been useful not only for regional but also for local planning. A number of local jurisdictions have requested copies so that they can easily identify planned land uses in adjacent jurisdictions.

CONSTRUCTING AND TESTING ALTERNATIVE SCENARIOS

Once a multi-jurisdictional database of land use plans has been constructed, it can be used for a variety of purposes, including allocating growth in alternative land use scenarios, and conducting a build-out analysis. Other GIS data sources are also helpful, such as inventories of existing development constructed from city or county parcel-level tax assessor’s data; and environmental constraints such as wetlands or soil conditions, which may be available from regional or state databases.

The Envision Utah regional planning effort in northern Utah, supported in part by an FY 1999 TCSP grant, used regional land use data in conjunction with information gathered from public forums to allocate future growth for different scenarios. The land use data were assembled from local comprehensive plans and state inventories by a state office established to provide technical support to the regional planning effort.

The first step in the scenario development process was to identify land suitable for development (i.e., which was not already developed and did not have environmental constraints). Developed land was identified using satellite imagery merged with LANDSAT multi-spectral data. Environmentally constrained land was identified using state databases of wetlands, slopes, floodplains, and riparian buffers. Potential areas for redevelopment and infill also were identified using GIS: redevelopment by comparing assessed property value with the mean value in the surrounding area within 300 meters; and infill by identifying areas with existing low residential density in areas with higher residential density as identified in local general plans.

Once developable lands were identified, hands-on workshops were held with local planning staff, elected officials, and the general public to allocate development to future scenarios. Participants, at tables of ten people, were asked to label and designate important green spaces in their community. They placed desired development “chips” in agreeable patterns and locations, avoiding green space and other unbuildable constraints. Project staff then analyzed the results of the workshops for similarities and created future land use scenarios reflecting common themes from the workshops. The final land use allocation for each scenario was summarized by traffic analysis zone (TAZ) and fed into the regional travel demand model to test the transportation impacts of each alternative. The GIS land use data were also used to test a range of other impacts, including infrastructure costs, water use, open space, and exposure to emissions, using custom-developed models.



Participants in a workshop map alternative growth scenarios for the northern Utah region. The results were used as input to a GIS database to forecast transportation, air quality, and water use impacts of regional development.

Courtesy Envision Utah.



Throughout this process, all the Envision Utah GIS data layers were maintained in a “raster” format consisting of 50.3-meter (156-foot) square grid cells. Extensions to common GIS software packages can be used to translate polygon data into raster data. The use of raster data eliminates the problem of having to overlay and perform calculations on polygons of different shapes.

“Governor Leavitt previewed the data shortly before its public release. When he saw the difference in cost among scenarios, he seemed to have another pivotal moment that reinforced his support and participation with Envision Utah.”

– FROM “The History of Envision Utah”
(Envision Utah, December 2001)

The entire Envision Utah technical analysis was a multimillion-dollar effort conducted over a period of roughly three years. State agencies provided an estimated 50,000 to 70,000 person-hours of time for technical support, including development of the baseline scenario, alternatives, and quality growth strategy. As part of this process State and local agencies agreed to adhere to guidelines and standards for future data collection and recording. As a result, as new data become available, the ability to create, model, and analyze future scenarios will become much easier.

For the Eastern Planning Initiative project in Charlottesville, Virginia (FY 1999), planners took a slightly different approach to constructing future growth scenarios. They created a spreadsheet-based model known as CorPlan to tie growth to specific urban design patterns. CorPlan is based on “community elements” that contain different amounts and mixes of density, design, and infrastructure within a quarter-mile radius. Planners associate each TAZ in the region with combinations of community element types, providing a variety of scenarios. The community element information, which is stored in a spreadsheet, can be linked with ArcView to graphically display the proposed development scenario. The TAZ-level forecast population and employment for each scenario can be exported for input into the regional travel demand model.

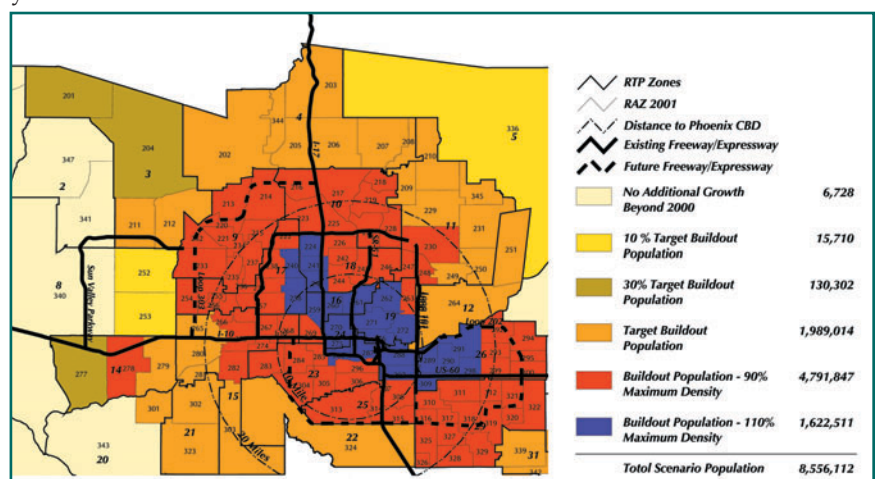
The community elements and CorPlan model were used in conjunction with public workshops in Charlottesville. The elements illustrated to the public what growth might look like under different land use policy scenarios. The model was used by project staff to construct alternative regional development scenarios

(Urban Core, Town Centers, and Dispersed) based on principles identified at the workshops.

The total cost of the Charlottesville project – including model development, scenario analysis, the public involvement process, and development of final recommendations – was estimated to be about \$760,000, of which \$244,000 represents regional planning agency staff time and resources provided prior to the TCSP grant.

FY 1999 and 2000 TCSP projects in Lansing and Phoenix have conducted “build-out” analysis and tested transportation impacts under different build-out scenarios. In Phoenix, four different regional growth scenarios were constructed in support of an update to the Regional Transportation Plan. The scenarios, based on the local comprehensive plan information assembled in a common GIS database, show population and employment by planning area relative to build-out levels in existing plans. These scenarios were run through a sketch-plan version of the regional travel demand model. The results provide an idea of the extent to which changes in local policies affecting the location of development will impact the regional transportation system performance and needs. A similar effort was undertaken in Lansing, where baseline and alternative versions of a build-out scenario were compared.

In Gainesville, Florida, an FY 1999 TCSP project developed sketch-plan adjustments to the regional travel model to better evaluate the travel demand impacts of future land use scenarios. Land use and urban design variables were quantified for each TAZ using field observations and GIS techniques. These variables were then included in models of “car shedding” (automobile ownership) and intrazonal trip-making. The purpose of the model enhancements was to better reflect the impacts of concentrating development in the regional core or in mixed-use activity centers.



Phoenix, Arizona Regional Transportation Plan: Alternative population growth scenario number 2, infill/urban revitalization (draft).

Courtesy, Maricopa Association of Governments and BRW.



Land Use Variables Included in Gainesville Model Enhancements

Variable	Data Source
<i>Car-shedding (auto ownership) model</i>	
Accessibility to employment	Regional travel demand model
Proportion of area within quarter-mile of bus route	GIS analysis
Proportion of streets with sidewalks	GIS database previously assembled for bicycle and pedestrian planning
<i>Intrazonal trip model</i>	
Commercial land use mix	GIS analysis of county property appraiser's database
Presence of grocery store	County GIS
Presence of school	County GIS

Note: Numerous other variables were tested but not included.

Three scenarios were compared: a “westward growth” (trend) scenario, an “activity center” scenario with growth concentrated in nodes on the current fringe of development, and a “compact development” scenario with growth concentrated in the center of the region. The car shedding model produced intuitive results that showed modest decreases in vehicle ownership rates and single-occupancy vehicle trip rates for the activity center and compact development scenarios compared to westward growth. The intrazonal trip model, however, produced some surprising results that reflect broader limitations in the ability of four-step travel demand models to quantify certain types of land use changes.¹ The total cost of this modeling effort, including a supplemental household travel survey, was approximately \$180,000.

FORECASTING LAND USE IMPACTS OF TRANSPORTATION ALTERNATIVES

The projects described above focus primarily on testing the transportation impacts of alternative land use scenarios. Two TCSP-sponsored projects in Maryland have examined the reverse question: the impact of transportation on land use patterns. In 1996, the state of Maryland adopted a set of “Smart Growth” principles, which have been implemented through various state agency policies and programs. Under this initiative, the Maryland DOT established a policy to fund transportation infrastructure in locally designated “priority growth” areas while limiting potential growth-inducing investment outside these areas.

Supported by FY 1999 and 2000 TCSP grants, the Maryland Department of Planning and Maryland

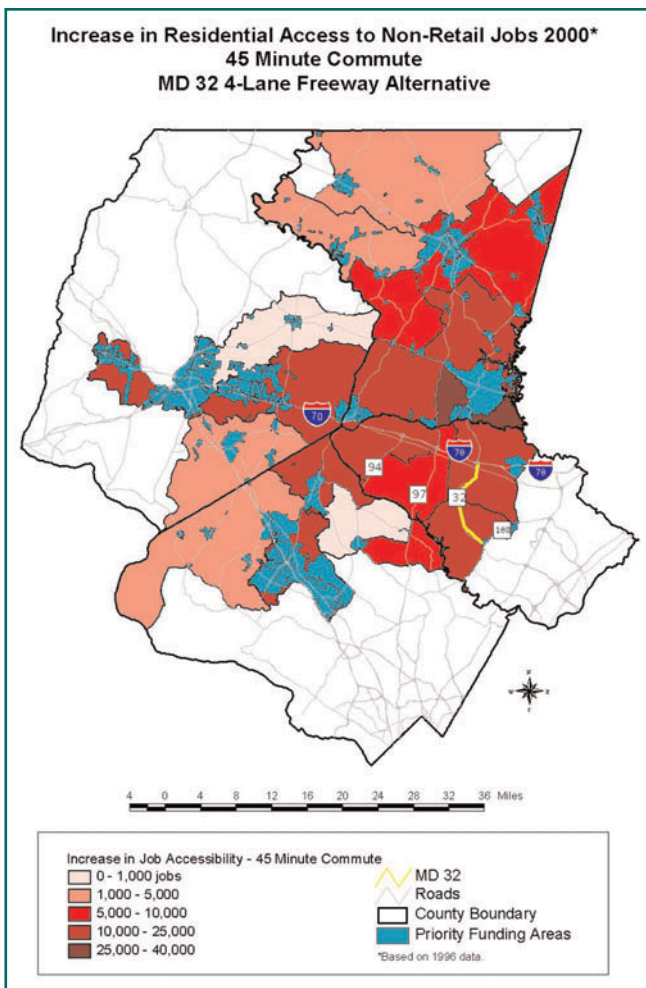
¹ The intrazonal trip model estimated that intrazonal trips would account for over 35 percent of all trips under the activity center and compact scenarios, compared to 12 percent under the westward growth scenario. However, when introduced into the regional travel demand model, the increase in intrazonal trips led to an increase in single-occupancy vehicles and a decrease in transit trips. Project staff suggested this might be a result of the mode choice model forecasting a shift towards automobile travel as a result of reduced congestion on area roads.

Department of Transportation (DOT) developed methodologies to assess the land use consequences of transportation investments. The subject of the Department of Planning’s FY 1999 project was the proposed widening of State Route (SR) 32 from a two-lane road to a four-lane freeway between I-70 and SR 108 to address congestion and safety issues. In response to concerns that upgrading the road to four lanes would fuel growth outside of priority funding areas, an additional alternative was added to the study – a two-lane, limited access road that would improve safety but would not significantly increase capacity or operating speeds.

To evaluate the land use impacts of each alternative, the Department applied GIS data analysis and mapping in conjunction with a DOT-sponsored expert-panel approach to land use forecasting. The commute-shed of the road was first evaluated by mapping the origin locations of work-trips using the road, as estimated from the travel model covering the Baltimore metropolitan region. Land use data in the commute-shed were then mapped, including zoned densities, the amount of land recently developed, and the amount of land available for development. This provided background on growth trends, pressures, and opportunities in the area. For each alternative, the increase in accessibility to jobs (measured as the change in number of jobs accessible within 45 minutes) was then estimated from the regional travel demand model and mapped for each planning area. This showed the potential impact of the highway project on the desirability of each area for new development.

This information was provided to an expert panel who individually and jointly assessed the potential impact of each alternative. While opinions on the panel varied, most members felt that the four-lane alternative would provide a significant incentive for increased development in the study area, while the two-lane limited-access alternative would not. Staff from the Department





Courtesy Maryland Department of Planning.

Increases in job accessibility after expanding MD 32 to a four-lane freeway.

of Planning therefore concluded that the four-lane option would contradict Smart Growth objectives and the desire to preserve rural land within the commute-shed. In contrast, they concluded that the two-lane option would address safety concerns without contradicting Smart Growth principles.

Supported by an FY 2000 TCSP grant, the Maryland DOT applied a similar expert panel method to forecast the land use impacts of highway and transit investments in the I-270 corridor. The lessons learned from this study are being incorporated into a National Cooperative Highway Research Program (NCHRP) report for Project 8-36 on the use of expert panels in land use forecasting.

COMMUNITY INDICATOR MODELS

TCSP projects also have demonstrated the use of GIS-based models to assess community impacts associated with land use and transportation patterns. The outputs of these models include measures such as percent of population with walk access to transit, jobs/housing

balance, average distance to closest parks or recreational facilities, percent impermeable surface area, and energy consumption from buildings and transportation.

“A developer proposed a suburban style grocery store next to a transit station. Using the PLACE3S model and the developer’s own pro forma, we showed that if he incorporated a grocery store in a transit-oriented development, his rate of return would increase from eight to ten percent.”

– Nancy Hanson,
California Energy Commission

The PLACE3S method (PLANNING for Community Energy, Environmental, and Economic Sustainability) is both a planning approach and a GIS-based analytical tool to support community land use and transportation planning. Utilizing parcel-level land use data, PLACE3S is designed to estimate the community, environmental, economic, and transportation benefits associated with alternative development scenarios. PLACE3S was applied in the Mid-City neighborhood of San Diego to help the community identify redevelopment options in conjunction with the completion of a freeway through the neighborhood. The model was used interactively in community workshops in order to help people understand the impacts of different zoning policies on redevelopment potential, energy use, vehicle-travel, and other performance measures. The results helped shape a master plan for the neighborhood. PLACE3S also can be used for regional analysis, using less detailed but more broadly available data inputs.

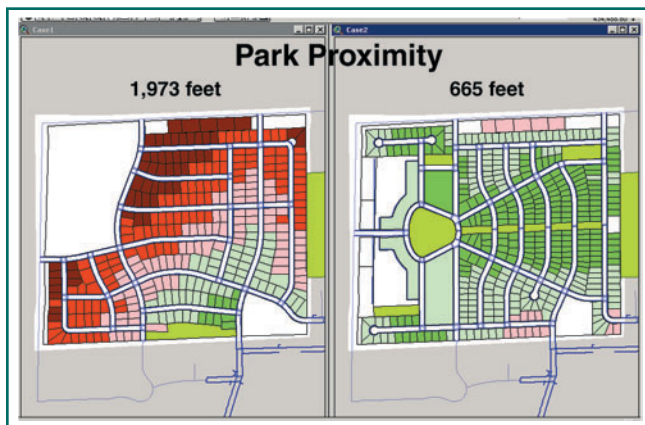
The Dane INDEX model is a custom adaptation of the INDEX model to Dane County, Wisconsin. INDEX, which also utilizes parcel-level land use data, produces a variety of indicators associated with alternative development patterns, such as land use mix, pedestrian connectivity, and related changes in vehicle-trips. With the support of an FY 1999 TCSP grant, it has been applied in two pilot communities in the Madison area: the city of Stoughton and the rural township of Vienna.

Like PLACE3S, INDEX can compare indicators for two or more alternative land use scenarios. The analyst must supply the characteristics of each scenario, including a street layout and land use type and planned densities by parcel. If the model is applied to a specific proposed development, computer-aided design (CAD) files from the developer can be imported into the model’s GIS environment.

Dane County added two components to the INDEX model that were of particular interest to local planners: fiscal impacts and stormwater runoff. The fiscal impact



model, a spreadsheet model linked to the GIS land use data in Dane INDEX, was developed by a local firm and utilizes locally collected data, including municipal budget information from the last 10 years and interviews with local staff. An existing stormwater model developed at Purdue University, known as Long-Term Hydrologic Impact Assessment (L-THIA), was also integrated into Dane INDEX. From land use, soil hydrology, and rainfall data, L-THIA estimates runoff, recharge, non-point source pollution load, and other hydrologic impacts of land use changes. L-THIA is available separately as a spreadsheet application, a web-based application, or as an ArcView extension.



Courtesy Dane County Planning and Development Department.

Two alternative street and parcel layouts for a subdivision in Stoughton, Wisconsin, as shown in the Dane INDEX model. The blue lines are sidewalks. The color on parcels represents walking distance to the nearest park (green is closer, red is farther). Average walking distance from all parcels is shown.

The effort required to develop the data to support the Dane INDEX model will vary depending upon the availability of local land use data. In Vienna, much of the data were already contained in the county's GIS databases, although some format conversion was required. For the Stoughton pilot study, a local cartographic firm developed data by converting orthographic photos, county parcel lines, tax assessor data, and other available data to digital layers, including street centerlines, sidewalks, building footprints, impervious surface area, and parcels with land use categories. The total cost of the Design Dane project effort, including model customization and pilot application, is estimated at \$445,000.

GIS tools are increasingly being used in conjunction with global positioning systems (GPS) to gather data on pedestrian facilities and assess needs. With the support of an FY 2001 TCSP grant, the City of Rockville, Maryland is using GIS with GPS to create a city-wide inventory of pedestrian, bicycle, transit, and roadway facilities. The data are being collected by local college students using handheld personal computers

and GPS devices. Examples of data include bus stop and transit line details; sidewalk specifications; bicycle facility specifications and speeds; roadway types, cross-sections, and congestion levels; and truck restrictions.

An initial use of the data is to develop pedestrian travel time contours to area schools using a GIS network analysis module. The city plans to use the database for applications such as quantifying the multimodal accessibility benefits of capital improvements such as sidewalk extensions.

ESTIMATING INFRASTRUCTURE COSTS

The cost implications of alternative development patterns are increasingly of interest in many areas. Proponents of Smart Growth believe that more compact development patterns can reduce infrastructure costs, both for regional infrastructure, including major roads, transit systems, and utilities, and for local roads and utilities. TCSP funds have helped project sponsors in Kansas City, Missouri; Salt Lake City, Utah; and Madison, Wisconsin develop fiscal impact models for assessing the consequences of alternative development patterns.

In Salt Lake City, a comprehensive assessment of regional and local infrastructure costs was performed as part of the Envision Utah regional visioning project, which compared a "trend scenario" with a "quality growth strategy" developed through an extensive public participation process. Infrastructure costs were estimated at three levels: regional, local off-site (municipal), and local on-site. Regional highway, transit, and utility needs under each growth scenario were assessed through modeling, and costs associated with these needs were estimated. Local, off-site infrastructure costs per unit of development were then estimated from municipal impact fee studies of selected municipalities and special districts. On-site costs for roads and utilities were estimated using a simulation model to evaluate different subdivision designs. Off-site and on-site costs were estimated as a function of development density and whether the land was "raw," infill, or reuse. Total costs for each regional growth scenario were then estimated using the GIS land use data developed for each scenario. The infrastructure cost estimates were one of a number of performance measures provided to the public to help them compare the inputs of different growth scenarios.

The Mid-America Regional Council (MARC) in Kansas City, Missouri also created and applied a cost-of-development tool as part of its Smart Choices FY 1999 TCSP project. The goal of this project was in part to educate developers, local officials, and the public about the benefits and inputs of different growth patterns. In

contrast to Envision Utah’s regional model, MARC’s spreadsheet-based tool was designed to be applied at the site level. MARC used the tool to compare the costs of alternative site development plans for six case study sites selected from throughout the region. This effort complemented a public design process to create transit-supportive development designs for each site as an alternative to standard auto-oriented development patterns.

The alternative site designs typically included a greater amount of mixed-use development and higher residential densities, with the same amount of overall development. Unit costs for the infrastructure components – including streets, sidewalks, and utilities – were compiled in consultation with developers, engineers and subdivision planners who work in this area. Total and per-acre costs for each development were then calculated based on the estimated length of infrastructure and land area devoted to each type of development. The analysis found that overall costs were lower for the “alternative” than for the “conventional” developments at four of the five sites evaluated, although the average difference in costs was relatively small (3.5 percent across all sites). The total cost of the cost-of-development analysis was approximately \$150,000, including consultant fees and staff time.

ASSESSING ECOLOGICAL IMPACTS

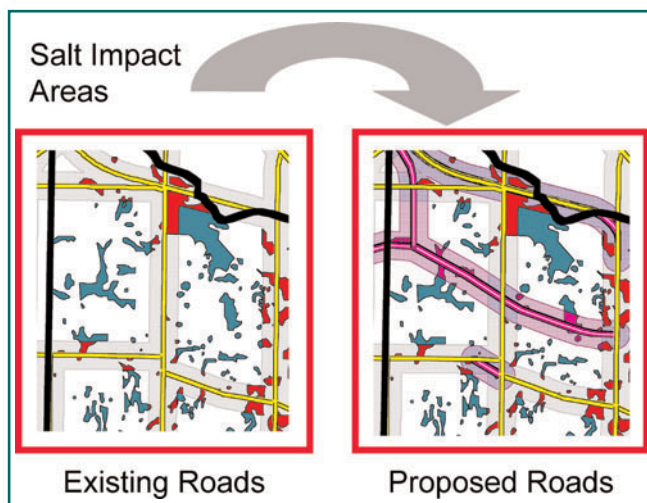
Awareness is increasing of the potential habitat fragmentation and destruction and related ecological impacts caused by transportation infrastructure and land development. Fortunately, transportation facilities and land use policies can be designed to minimize impacts on wetlands and other sensitive natural areas.

An FY 2000 TCSP project sponsored by local communities in McHenry County, Illinois and the Conservation Research Institute is working towards a sustainable transportation and land use plan for the Route 47 Kishwaukee River Corridor. Route 47 transects much of the headwaters of the Kishwaukee River, which has been rated by the state of Illinois Department of Natural Resources as a Unique Aquatic Resource. However, the eight-mile corridor is also experiencing strong growth pressures due to its location on the suburban fringes of Chicago. The purpose of the TCSP project was to bring together local jurisdictions, state agencies, and the general public to create a corridor transportation and land use plan that protects the Kishwaukee River and adjacent natural areas.

Project sponsors used GIS analysis to support the development of corridor alternatives, including the placement of roads and the designation of land uses. The first step was to collect comprehensive plans from

all six jurisdictions in the corridor and digitize these plans. A build-out analysis was performed by cropping areas that were already built (based on aerial photographs), and then calculating total build-out potential based on densities and land use in the comprehensive plans. The environmental GIS data were used to map suitable habitat for five ecological indicators: sandhill cranes, frogs, the darter (a fish), vegetation remnants, and salt-tolerant plants in wetlands.

Next, an alternative, conservation-based land use plan was developed. This alternative includes the same amount of total development by type, but concentrates it in areas of lower ecological sensitivity, away from wetlands, streams and rivers, and other critical areas. The GIS data were used to design alternative land use designations and transportation alignments that would reduce the impacts on the indicator habitat areas. In addition, GIS analysis allowed the impact of each transportation and land use alternative to be quantified, through measures such as percent of frog habitat lost.



GIS was used in McHenry County, Illinois to assess the potential impact of road construction on salt-intolerant species in wetlands. “Salt impact area” buffers 400 meters wide were drawn around existing and proposed roads and overlaid on wetlands to estimate the amount of wetland area affected. The analysis showed that roads proposed under the existing comprehensive plan would increase affected wetlands from 27 to 35 percent of the total wetland area.

The alternative plan considers transportation concepts such as road or interchange realignments to avoid wetlands. Transit options, including locations for park-and-ride lots and potential future bus and rail service, were investigated to minimize road infrastructure requirements. Transportation impacts were assessed using a trip table-based spreadsheet model. While an alternative plan has not yet been finalized, transportation concepts were discussed with the county transportation agency as well as the Illinois DOT to ensure their feasibility. Successful implementation will also rely on

Courtesy Conservation Design Forum and Conservation Research Institute.



the cooperation of local jurisdictions to revise land use plans consistent with the recommendations of the study.

“GIS is helping us develop a multi-jurisdictional transportation and land use plan that accommodates development while respecting the natural environment of the corridor.”

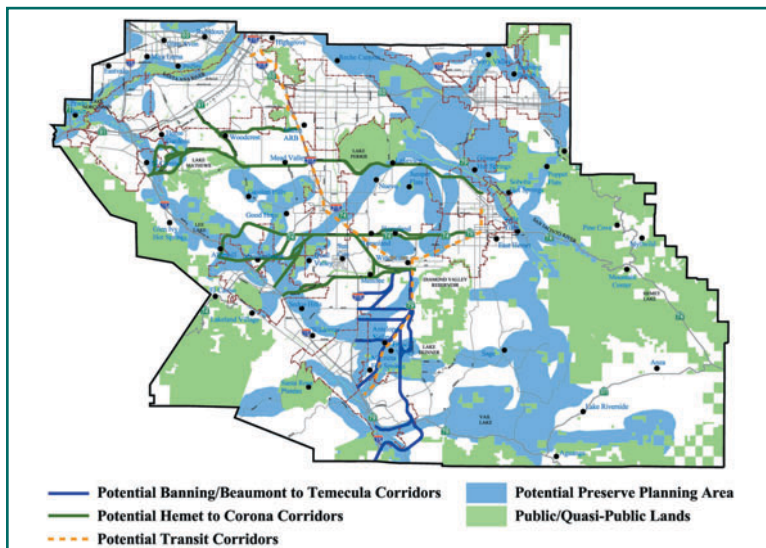
– Charles McGhee Hassrick,
Conservation Design Forum

The total cost of this corridor planning effort, including GIS land use and environmental data collection and analysis, public involvement and outreach activities, and plan development, is estimated at \$310,000.

A major effort is also underway to integrate transportation, land use planning, and habitat conservation in Riverside County, California. Funded in part by an FY 2000 TCSP grant of \$435,500, the Community and Environmental Transportation Acceptability Process (CETAP) is directed at identifying and preserving future transportation corridors while minimizing environmental impacts and coordinating local land use planning. GIS is helping the county use data on high-priority conservation areas, identified through a parallel multi-species habitat planning effort, to select transportation corridors that reduce ecological impacts by avoiding sensitive areas or minimizing fragmentation of these areas.

COMMON FINDINGS

With the aid of geographic information systems, TCSP projects have undertaken analytical efforts to quantify the transportation, infrastructure cost, and other community and environmental impacts of local and regional



Western Riverside County, California. Transportation corridor alternatives are shown overlaid on potential habitat preserve areas identified through a county-wide habitat conservation planning effort. GIS is helping the county preserve right-of-way for future transportation needs while minimizing ecological impacts.

development patterns. These projects have typically compared a “trend” growth scenario with one or more “alternative” scenarios in which the same amount of development is concentrated in a more compact pattern in infill locations, transit nodes, villages, or other activity centers. While each of these projects was undertaken in a different context, using different assumptions and tools, it is interesting to compare the results of these analysis.

In most cases, measures of traffic impact – whether total VMT, vehicle-trips, percent of travel under congested conditions, or average trip time – were improved for the alternative growth scenarios. An interesting finding from the Lansing work was that congestion was slightly higher in the short-run – probably due to greater concentration of development in specific areas – but significantly lower in the long-run (at build-out), due largely to shorter trip lengths resulting from a more compact development pattern. The findings of shorter trip lengths, along with lower levels of congestion, are reinforced by modeling results from the Charlottesville and Salt Lake City TCSP projects.

The Gainesville work shows that land use variables can be incorporated into models of vehicle ownership to more fully reflect the impact of future land use policies. This analysis, however, also showed a somewhat surprising finding of fewer single-occupancy vehicle trips but higher VMT under one of the alternative scenarios. Additional research is needed to determine whether this finding is realistic, or whether it reflects limitations in the ability of current four-step travel demand models to address micro-scale land use changes.

Another common theme from the results of TCSP analysis efforts is that net infrastructure costs are lower for the alternative than for the trend growth scenarios. Regional infrastructure costs are lower because less roadway investment is required to serve newly developing outlying areas, and because lower VMT requires less enhancement to existing capacity. In the case of Salt Lake City, the reduction in regional road costs was enough to more than offset a significant increase in transit investment. Findings from Salt Lake City also showed that local infrastructure costs were lower under conditions of higher residential density and for infill versus greenfields development. The Kansas City analysis suggests, however, that simply changing the layout of development on a specific site (e.g., increasing the mix of uses and local density) may have a relatively small impact on infrastructure costs, even though the design changes may produce other benefits such as greater walkability and



Transportation and Land Use Alternatives Analysis

Project Location	Scenarios Compared	Transportation Impacts	Infrastructure Impacts
Gainesville, Florida	“Compact” and “activity centers” versus “regional trend”	<ul style="list-style-type: none"> • SOV trips decrease by 10 to 13 percent • Little change in VMT 	
Lansing, Michigan	“Wise growth” versus regional trend	<ul style="list-style-type: none"> • Slightly higher congestion in 2025 • Significantly lower congestion at build-out 	<ul style="list-style-type: none"> • Long-run costs savings for regional infrastructure
Kansas City, Missouri	“Alternative” versus “conventional” (5 sites)		<ul style="list-style-type: none"> • Average 3.5 percent decrease in site infrastructure costs
Salt Lake City, Utah	Regional “quality growth strategy” versus “trend”	<ul style="list-style-type: none"> • 5 percent decrease in VMT and average trip time 	<ul style="list-style-type: none"> • Net savings of \$2.0 billion (13 percent) in transportation infrastructure and \$2.5 billion in water, sewer, utility costs
Charlottesville, Virginia	“Urban” and “Town Center” versus “Dispersed” regional development	<ul style="list-style-type: none"> • 22 percent decrease in VMT • Travel under congested conditions decreases from 44 to 20 percent 	<ul style="list-style-type: none"> • Roughly 50 percent cost savings for regional transportation network with Town Center scenario

land preservation. The cumulative benefits of land use design changes throughout a region may be greater than the sum of benefits of design changes at individual sites, when evaluated in isolation.

Findings from environmental and community indicator models are consistent with what might be expected based on the land use and transportation characteristics of alternative scenarios: pollutant emissions are reduced, land consumption is reduced, and transportation options are increased because of more pedestrian- and transit-oriented design characteristics.

CONCLUSIONS AND LESSONS LEARNED

A number of conclusions and lessons learned emerge from this review of GIS as being used through the TCSP program:

- **GIS tools help support the public process** of creating and identifying preferred alternative scenarios. Planners with projects in Charlottesville, San Diego, and other areas have found these methods helpful in creating realistic land use scenarios with the input of local staff, stakeholders, and the general public. They also have found the results useful in communicating the implications of alternative transportation

and development choices. As a result, people are able to make better-informed decisions.

- **GIS technology is enabling the development of more detailed and sophisticated land use and environmental data and analysis tools.** Integrated regional land use databases are becoming more common. At the same time, GIS facilitates the development of detailed, parcel-level land use databases that support environmental and community indicator models. GIS further provides data display capabilities to readily communicate information to policy-makers and the general public.

“We succeeded in developing a simple yet reliable tool that has helped people understand the impacts of future growth patterns, not only through quantitative measures but also through visual depictions of what growth might look like.”

– Hannah Twaddell, Former Assistant Director,
Thomas Jefferson Planning
District Commission

- **Seamless integration of data sources remains an elusive goal.** Land use data such as comprehensive



plans, zoning, and existing development are maintained by local jurisdictions. Especially for smaller jurisdictions with limited resources, these are often still in hard copy format. Also, data formats are often incompatible among different jurisdictions in the same area. In most parts of the country, regional land use databases still require significant effort to construct and maintain. Lack of readily available data is one barrier to the broader application of land use and community indicator models.

- Projects sponsored by TCSP appear to be achieving TCSP's objectives – namely, reducing infrastructure costs, environmental impacts, and increasing the efficiency of transportation infrastructure. While impacts vary in magnitude, the direction of these impacts for “alternative” versus “trend” growth scenarios is consistent across projects.

FOR FURTHER INFORMATION

Riverside County, California Community and Environmental Transportation Acceptability Process

Cathy Bechtel
Riverside County Transportation Commission
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San Diego, California PLACE3S Planning Method

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www.energy.ca.gov/places/
See also: *TCSP Case Study #4*

Gainesville, Florida Integrated Land Use and Transportation Sketch-Plan Methods

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McHenry County, Illinois Kishwaukee River Corridor

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Maryland Maryland Integrating Smart Growth and Transportation

Joe Tassone
Maryland Department of Planning
410-767-4500
Tassone, Joseph and Feng Liu. “Transportation Enabling Smart Growth” Paper presented at the 81st Annual Meeting of the Transportation Research Board, Washington, D.C., January 2002.

Rockville, Maryland Rockville Town Center Accessibility Study

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Lansing, Michigan Tri-County Regional Growth Study

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517-393-0342
www.tricountygrowth.com

Kansas City, Missouri Smart Choices

Marlene Nagel
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816-474-4240
www.marc.org/cqp.htm

Salt Lake City, Utah Envision Utah

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801-538-1529
www.envisionutah.org

Charlottesville, Virginia Jefferson Area Eastern Planning Initiative

Harrison Rue
Thomas Jefferson Planning District Commission
434-979-7310
www.tjpd.org
See also: *TCSP Case Study #6*

Madison, Wisconsin Design Dane

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Long-Term Hydrologic Impact Assessment (L-THIA) Model:
www.ecn.purdue.edu/runoff/

TCSP Program:

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FHWA-EP-03-009

