

A Report of the
Expert Panel on Analytical Tools

A report to:
The Chesapeake Bay Program's
Land, Growth and Stewardship Subcommittee
and
Scientific and Technical Advisory Committee

Sponsored by:
Virginia Tech Institute for Innovative Governance
and
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Selection of Panel Members

Members of the panel were selected based on their knowledge of growth and related land-use models. The panel members have extensive knowledge of the nuisances of the considered analytical tools and techniques. In addition, each panel member has significance experience in the application at the local jurisdiction level of these and other analytical tools and techniques.

Thanks to Debbie Weller of the Maryland Office of Planning and the Chesapeake Bay Program's Development, Redevelopment and Revitalization Workgroup for significant background information as well as providing focus to the panel efforts.

Waldon R. Kerns of the Virginia Tech Institute for Innovative Governance and the Bay Program's Scientific and Technical Advisory Committee organized the panel and prepared this report.

Review of List of Available Tools and Techniques

A Task Force of the Development, Redevelopment and Revitalization Work Group of the Chesapeake Bay Program's Land, Growth and Stewardship Subcommittee reviewed a number of analytical tools and techniques for potential use by local jurisdictions to assess the impacts of growth, development and transportation decisions. A major objective of this overall effort is to help local jurisdictions meet selected C2K commitments.

Jointly with the Virginia Tech Institute for Innovative Governance, the Chesapeake Bay Program's Scientific and Technical Advisory Committee sponsored and organized the "Analytical Tools Expert Panel" to conduct an evaluation of a selected group of analytical tools and techniques to determine which ones are most appropriate for use in the Bay watershed and to recommend how the tools or techniques would have to be modified for use by local jurisdictions.

The list of tools and techniques considered by DRRW and submitted to the Panel were:

- CUF-2
- DRAM/EMPAL
- GSM
- INDEX
- LUCAS
- MEPLAN
- SAM-IM
- SLEUTH
- SMART GROWTH INDEX
- SMART PLACES
- TRANUS
- UPLAN
- URBANSIM
- WHAT IF?
- FEARLUS
- MARYLAND GROWTH MODEL
- OTHER (others unspecified tools and techniques were considered)

Upon receiving information on the list of potential tools and techniques from DRRW in early November 2002, the materials were edited, copied and sent to each panel member for review and study.

Decisions at the December 20, 2002 meeting of the
Expert Panel on Analytical Tools and Techniques

On December 20, 2002, the first meeting of the panel was conducted. The following recommendations were made:

Recommendation 1:

The Chesapeake Bay Program should take necessary steps to develop a regional model of the Bay Watershed area that can provide analysis to be used to make growth and land-use allocation decisions on a regional basis. The model should be capable of handling physical factor inputs as well as socio-economic and fiscal factor inputs. This effort would provide the framework for local jurisdiction models to provide information to build up to the regional analysis and to tie together efforts on the overall C2K Commitments. Data needs for the Bay level regional model must be spelled out and a procedure developed to obtain these data.

Recommendation 2:

Panel members reviewed details of each of the available analytical tools and techniques that were provided by DRRW. Four analytical tools or techniques were selected for recommendation to local jurisdictions to be used to analyze growth and land-use decisions:

The four tools or techniques are:

- A. Data Sets/Spreadsheets/Graphs
- B. Build-Out Analysis
- C. What If? Analysis
- D. Urban Simulation Model

Specific characteristics of each tool or technique are provided in Appendix B of this report. Listed below are some general characteristics of each tool or technique.

A. The first tool (Data Sets/Spreadsheets/Graphs) represents the least sophisticated approach. Some jurisdictions will require assistance to collect and organize data and output but most have necessary capacity to use the material to assist decision-making. Bay Program personnel in conjunction with state agency personnel should help develop a procedure to assure more consistency in the output. The more consistent output would be used for necessary watershed and/or regional level analysis.

These tools and techniques:

- Provide a framework for use of information in analysis and decision-making.
- Need limited forecasting capacity.
- Use easily understood graphics to display data and information.

B. The second tool (Build-out Analysis) represents a middle-level of sophistication. Some jurisdictions will require outside expertise to collect and analyze data and develop output products. Other jurisdictions will have the capacity to conduct the analysis on their own.

“Build-Out Analysis” is a technique to estimate the future development potential of specified geographic areas. It uses population projections, local zoning regulations, other ordinances, by laws, policies affecting land management, and physical constraints.

“Build-Out Analysis” can be applied to a variety of geographic areas and scales. It may be full or partial. It is often done using a geographic information system and may be combined with water quality or other modeling to predict environmental impacts of alternative development scenarios.

C. The third tool (What If? Analysis) is characterized as somewhat more sophisticated than Build-out Analysis in actual analysis of the available information.

“What If” Analysis is an interactive GIS-based system that supports all aspects of the land use planning process. The system allows users to quickly and easily create alternative development scenarios and to determine the likely impacts of future land use patterns and associated population and employment trends. The package is easy to use, can be customized to the users data base and policy issues, and provides outputs in a variety of easy to understand maps, charts, and tables.

“What If” Analysis provides an integrated package of modules that enable users to: 1) conduct a land suitability analysis, 2) project future land-use demand, and 3) allocate projected demand to the most suitable locations. “What If” Analysis helps communities create alternative visions for their area’s future by mapping alternative development patterns determined by local land development policies. It provides evaluation of likely impacts of alternative policy choices and assumptions.

The “What If” Analysis tool can be used for education purposes as well as for analysis. It provides consideration of preferences.

It is good for use with lay audiences.

It provides an interactive approach for local governments.

It provides for use of connecting models.

In many cases, “build-out analysis” can be used with “What If?” Analysis.

The system does require good although not necessarily sophisticate data sources.

D. The fourth tool (Urban Simulation) is a highly sophisticated model used for rather large-scale analysis. A major characteristic of this model is that it provides for consideration of behavioral and market aspects of the issues. Jurisdictions must either develop the capacity to use the model or contract with experts to develop and run the model. Some jurisdictions may choose to develop their own tailored model. The model can be coupled with special situation models. All jurisdictions should eventually strive for this level of analysis.

Urban-SIM is a behavioral simulation of the choices made by key actors in the urban development process: households, businesses, developers, and government. It operates in a quasi-dynamic manner over one-year increments in time, for short to long-term horizons.

Urban-SIM is a software-based system designed for integrated planning and analysis of urban development, incorporating the interactions between land use, transportation, and public policy. It is designed to interface to existing travel modeling procedures, including both current four-step as well as newer activity-based travel models. It is currently being extended to address environmental impacts of development by simulating land cover, water demand and nutrient emissions.

Urban-SIM is a highly intellectual approach.

It is a good theoretical model.

It requires high quality data.

It includes both physical and fiscal analysis.

It can be coupled with other special situation tools.

It must have parcel data.

It is best for large jurisdictions or multi-jurisdictional decisions.

It includes behavioral as well as physical capabilities.

Recommendation 3:

The Bay Program needs to investigate the existence:

- a. of tools and techniques being used by state/local jurisdictions that can be used as add-on components to the four recommended tools and techniques,
- b. of availability of data needed for the regional and local models,
- c. of data deficiencies, and
- d. of capability and capacity to analyze growth management.

Recommendation 4:

The Bay Program must do more than select a set of analytical tools and techniques. It must help buy access to the selected tools and techniques and help fund adoption and use of the tools and techniques by local jurisdictions. For the more sophisticated tools, the Bay Program must arrange with experts to help adapt the tools and provide analysis of the output. Of course, some state agency personnel, many university groups and many consulting firms have the capability to assist with the application of the selected tools.

Process to Enhance Use of Analytical Tools by Local Jurisdictions

On March 24, 2003, the second and final meeting of the panel was held. Additional information was added to the characteristics for each tool or technique as defined in Appendix B. In addition the panel prepared a recommended process to enhance use of analytical tools and techniques at the local jurisdiction level.

As a component of the process, the Panel organized the four selected analytical tools or techniques as a tool kit (set of tools) as a continuum to be used to augment and enhance local jurisdictions' efforts and capacity to analyze land-use changes. The "Analytical Tools Continuum" that builds from low complexity to a degree of high complexity for the four selected analytical tools and techniques is provided in Appendix A of this report.

After careful evaluation of the narrowed list of four analytical tools (Graphs/Spreadsheets/Charts, Build-Out Analysis, What If? Analysis and Urban-Simulation), the Panel members concluded that there is little need for additional analytical tools or need to consider modification of the existing tools at this time. These tools are being used and can be used successfully by local governments in their existing form. Also, given the gap between what is available and what is now being used, these tools are sufficient in their existing form. This is true because:

- At the macro level, a sufficient number of people understand how to use the tools. No major constraint exists with respect to mechanics of the tools.

- The input needs, the output capabilities and the predictive capacity of the tools are known with some certainty.

- Added predictive capacity is not needed at this time.

- All the tools have some limitations but operational capability of the tools is not a constraint.

The major needed activity at this time is to build capacity at the local level to apply the tools. Top down demonstration is needed to enhance use of available analytical tools or techniques and to add additional rigor to the many analytical tools or techniques already being used by local jurisdictions.

An important part of the process is to consider the investment portfolio with respect to where along the "Analytical Tools Complexity Continuum" localities buy into the process. Only when the community invests more will they get more capacity and get more analysis. Additional technical assistance and financial resources should be provided by the Chesapeake Bay Program and/or Bay partner state programs.

It is strongly recommended that steps be taken to further identify existing groups with expertise in understanding of the analytical tools or techniques and then solicit assistance from these groups to help local jurisdictions in the application of analytical tools and

techniques. Many entities with this expertise exist within the watershed. The following list includes some but not all of those entities:

- Centers for Local Government Services
- Each state planning association
- Colleges and universities
- National Center for Smart Growth
- Cooperative Extension
- Institutes for Innovative Governance
- Center for Watershed Stewardship
- Metropolitan Research Center

Suggestions on Resources, Data and Funding

This process section provides suggestions on resources, data and funding.

Resources:

It must be recognized up front that, with few exceptions, an overwhelming constraint exists with respect to availability of human capacity to apply the analytical tools.

Other resource constraints include:

- Funding to provide facilitators.

- Incentive mechanisms to support the involvement of localities.

- Local level capacity to use systems.

- Inventory of existing input information.

Data:

It must be recognized up front that good data is a major need. Without good data, none of the tools are very useful. It also must be recognized that many local jurisdictions do not have or maintain good data.

Other data requirements:

- Must determine type of data needed for analytical tools.

- Must inventory what is there then design system to fill the gaps.

- Must acquire right kind of data (usually spatially referenced).

Funding:

The Panel recommends that the Chesapeake Bay Program set aside money to fund a facilitator to create interactive systems to enhance local capacity.

Funding will be needed to support involvement in local level capacity building.

Jurisdictions that use Build-Out Analysis or What If? Analysis probably need funding to carry out the analysis.

Jurisdictions that want to use Urban-SIM will need funding to support those efforts.

The Panel recommends that the Chesapeake Bay Program publish a RFP designed to establish an urban-simulation-type demonstration model in a regional area. The demonstration RFP could be managed by STAC. This urban-simulation-type model in a regional setting would be a great addition to the existing tool kit that is described in Appendix A.

The Chesapeake Bay Program Office needs to provide grants to buy license agreements or to purchase software for each of the analytical tools or techniques.

Appendix A

ANALYTICAL TOOLS CONTINUUM

-----Complexity increases---->>>

	CHARTS DATA SETS SP-SHEETS	BUILD-OUT ANALYSIS	WHAT IF?	URBAN SIMULATION
ANALYSIS	<ul style="list-style-type: none"> -Current trends -Simple projections -No structural change -No feedback 	<ul style="list-style-type: none"> -Top down Techniques not model -No structural change -Some interactive -Need increased analytical rigor 	<ul style="list-style-type: none"> -Mechanistic tool -Staged expansion -No structural change -Interactive 	<ul style="list-style-type: none"> -Dynamic process -Analyze transition -Analyze structural change -Includes transportation -Behaviorial aspects
DATA NEEDS	<ul style="list-style-type: none"> -Basic info -Inventory existing policy 	<ul style="list-style-type: none"> -Need parcel level or summed total 	<ul style="list-style-type: none"> -Uses set plan -Need disaggregated land data 	<ul style="list-style-type: none"> -High data requirement -Need Land transition data -Generate data from existing sources
HUMAN RESOURCE NEEDS	<ul style="list-style-type: none"> -Enhance existing capacity -Augment capacity 	<ul style="list-style-type: none"> -Need to augment analytical support 	<ul style="list-style-type: none"> -Need knowledge of GIS -Augment capacity 	<ul style="list-style-type: none"> -Costly -Knowledge of econometric software -Outside expertise

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	CHARTS DATA SETS SP-SHEETS	BUILD-OUT ANALYSIS	WHAT IF?	URBAN SIMULATION
COST	-Negligible	-Constraint is human resources	-Fairly low -Hardware -Software	-Expensive -Funding for demonstration -Funding to develop regional analysis
OUTPUT	-Charts -Graphs	-Spreadsheets -Small changes -Small shocks potential	-Good learning tool -Parcel suitability	-Fiscal analysis -Infrastructure cost -Revenue projections -Human capacity becomes available

Appendix B

DATA SETS/GRAPHS/SPREADSHEETS

SHORT DESCRIPTION

Provides a framework for use of data and rather unsophisticated analysis in decision-making.

Generally uses easily understood graphics to display data and information.

Should provide basis for everything we want to do over a continuum of available analytical tools.

These tools let the community see current trends and help them understand the trends.

One objective is to make jurisdictions with lowest capacity level aware of available data sources such as inventories and census demographics.

Another objective is to improve ability of local staffs.

IMPORTANT CONSIDERATIONS

Generally provides somewhat limited trend analysis for socio-economic information.

Generally provides somewhat limited trend analysis for local fiscal impacts.

Parcel maps, aerial maps provide information on recent land use changes that helps provide realization of land-use change decisions – provided by graphical representation of projections such as competing land use demands.

PROPERTIES OF TOOL

GEOGRAPHIC SCALE

Generally local scale and for relatively small size areas.

Confidence limits decrease considerably when move from small scale to larger scale.

Useful GIS (multiple census tracts data.) Get mean but what limited information on what is happening in variations.

EXPERTISE NEEDED

- EMPLOYEES

Must have some expertise to explain and to use the data sets, graphs and charts.

Most jurisdictions do understand graphics that display data and information.

Must understand what data is available.

Some level of GIS understanding to produce basic output.

- CONSULTANTS

Need some assistance to collect and organize data and output.

Need some assistance to evaluate output.

Need some assistance to obtain forecasting capacity.

AVAILABILITY OF DATA

Need inventory of data.

OUTPUT

Fairly simple organization of data for decision-making.

Provides local area trends such as population and land use.

- GEOGRAPHICAL

local area

- GIS

Often used as source of input information

TEMPORAL CAPABILITY

Mostly documenting past trends.

Limited forward prediction capability.

Future prediction limited because does not provide consideration of structural change.

COST

A major limiting factor is availability of human resources.

A need exists to augment locality's capacity.

- HARDWARE

Local computer capability only

- SOFTWARE

Usually limited

- O&M

Existing

BUILD-OUT ANALYSIS

SHORT DESCRIPTION

Build-out analysis is a technique to estimate the future development potential of specific geographic areas. It uses population projections, local zoning regulations, other ordinances, by laws, and/or policies affecting land management and physical constraints. Build-out analysis can be applied to a variety of geographic areas and scales, may be full or partial, often done using a geographic information system and may be combined with water quality or other modeling to predict environmental impacts of alternative development scenarios.

Build-Out Analysis is traditionally a land-planning tool, but may be combined with water quality or other modeling to predict environmental impacts of alternative development scenarios.

IMPORTANT CONSIDERATIONS

Build-Out Analysis is a technique and not an analytical model.

It is a top-down consideration of land use that primarily considers in place planning and zoning ordinances.

Provides some socio-economic aspects.

Provides some consideration of static fiscal impacts.

Provides for limited consideration of behavioral aspects.

The value added for us is to provide data, maps and some limited analytical support.

PROPERTIES OF TOOL

GEOGRAPHIC SCALE

Variety of geographic areas and scales but generally used for towns and small watersheds.

Provide full or partial analysis.

Can provide consideration of small changes or small shocks to the system.

EXPERTISE NEEDED

- EMPLOYEES

Most communities do Build-Out Analysis in some form.

Our value added is to increase the analytical rigor of the existing process.

Most communities need additional human resources to complete the process.

TRAINING NEEDED

- OPERATION OF TOOLS

General knowledge of GIS helps facilitate the process.

Our value added is to take steps to increase rigor of process.

- INTERPRETATION OF RESULTS

Need to be able to use in consideration with WQ or other models.

DATA REQUIREMENTS

Requires inventory of existing land uses, especially to identify type and extent of current land development. Needs estimate of amount and type of development that could occur in currently undeveloped areas.

- ACCURACY

Needs good data sources, but not sophisticated sources.

Needs parcel level or summed total acreage.

- RESOLUTION

Estimates extent of development that will occur for population projections of 100,000 people.

OUTPUT

Provides estimate of future development potential of area.

Uses an interactive approach.

Provides spreadsheet type information.

- GIS

Often done using GIS based system.

COST

Major constraint is human resources .

Our value added is to use resources to feed into larger picture.

WHAT IF? ANALYSIS

SHORT DESCRIPTION

What If? Analysis is an interactive GIS-based system that supports all aspects of the land-use planning process. It involves conducting a land suitability analysis, projecting future land use demand, allocating this demand to suitable locations, and evaluating the likely impacts of alternative policy choices and assumptions. The system allows users quickly and easily to create alternative development scenarios and to determine the likely impacts on future land use patterns and associated population and employment trends. What If? Analysis provides an integrated package of modules that enables users to: 1) conduct land suitability analysis, 2) project future land-use demand, and 3) allocate projected demand to the most suitable locations.

IMPORTANT CONSIDERATIONS

Many local jurisdictions actually use this process whether explicitly or implicitly. It is a mechanistic tool. It is not set up to respond to changes in socio-economic (broad based market) and behavioral (individual) aspects. Does not provide for analysis of underlying changes – no consideration of constraints and no market considerations. Does not identify weaknesses in systems. Based on set plans – looks at what planners are actually doing. But, policy choices such as staged expansion of public infrastructure and implementation of alternative land-use plans and zoning ordinances can be considered. Assumptions for the future that can be considered in the model include future population and employment trends, assumed household characteristics and anticipated development densities.

Provides only limited information on fiscal impacts.

Provides limited information on preferences except as imbedded in present plan documents.

PROPERTIES OF TOOL

GEOGRAPHIC SCALE

Generally town or city application.

EXPERTISE NEEDED

What If? Analysis requires at the minimum an ability to work with Arc View and similar packages and a familiarity with local land use planning principles and procedures.

- EMPLOYEES

The What If? Analysis planning support system is designed for use by non-technical people.

But, many local employees do have knowledge of how to use GIS output.

- CONSULTANTS

Some jurisdictions need some outside assistance to conduct GIS analysis.

Many outside sources available.

TRAINING NEEDED

- OPERATION OF TOOLS

Must understand interactive GIS-based output

- INTERPRETATION OF RESULTS

Most jurisdictions need assistance to apply and interpret GIS output.

DATA REQUIREMENTS

Is capable of including any kind of land-use data available from the community.

Land use categories are defined by the community and can be as detailed or general as needed.

Need GIS coverage, growth projections, development scenarios, land-use classifications, infrastructure plans.

- ACCURACY

Requires good, but not sophisticated data sets.

- RESOLUTION

Homogeneous land units or uniform analysis zones (UAZ). UAZs are GIS generated polygons which are homogenous in all respects.

Must be more specific but need parcel data or some other disaggregated unit of land use.

AVAILABILITY OF DATA

Land use data exists in some form.
If available, parcel data is best.

OUTPUT

Often used for suitable location analysis.
Can be customized for population, future land use and employment patterns.
All model outputs are provided in easy-to-understand maps and tables.
Output is suitability maps, growth analysis reports and allocation analysis reports.

- GEOGRAPHICAL

Easy to understand maps, charts and tables.

- QUANTITATIVE

Limited

- GIS

Often used as input

Planning support system can incorporate information stored in GIS systems such as ARC/INFO, Arc View, and other systems that can generate ESRI "shape" files. Since What If? was designed with ESRI's Mapobjects it is probably fully integrated with GIS. So, it shouldn't require any other GIS for data input and output. This also suggests that since Mapobjects is limited in capacity, What If? Analysis can be extended and linked with other models. Capability for use of parcel and shape size exists in the software.

Limitation: What If? Analysis does not attempt to predict future conditions exactly. Instead, it is an explicitly policy-oriented planning tool that can be used to determine what would happen if clearly defined policy choices are made and assumptions concerning the future prove to be correct.

What If? Analysis lacks a firm theoretical basis.

Doesn't include measures of spatial interaction.

Unlike the acknowledged "state of the art" in urban models, it doesn't rely on random utility or discrete choice theory to explain and predict the behavior of urban players such as households, investors, and firms.

Doesn't explicitly model the behavior of urban actors.

The over-arching goal, after all, is not projecting the future exactly but providing a meaningful foundation for community dialog and debate. Allows for interactive approach that could be facilitated by entities such as Extension, Centers for Local Government or consultants.

TEMPORAL CAPABILITY

Land-use projections can be prepared at ten-year interval for use in build-out analysis for a specific time period.

It is not a dynamic process and does not have feedback loops associated with structural changes.

Allocation is based on land suitability.

Structure is given and projections are stuck into boxes. That is best suitable land is allocated first, then next best and so on.

COST

- HARDWARE

Professional price is \$2,500 for a single user.

Site license available.

- SOFTWARE

Incorporates window interface.

The What If? Analysis planning support system is a standalone system which requires no additional GIS or non-GIS software.

- O&M

Requires a 300 MHz Processor Intel Pentium II or above, 64 MB of RAM, 1 GB of free hard-disk space, A CD-ROM drive, a monitor that is SVGA compatible or better, and an MS Windows 95, 98 or NT 4.0 package system, but no additional software. It is a fully self-contained software package.

TRANSFERABILITY

It is an easy model for people to use to learn about resources, trends and existing policy decisions. It can be used effectively to expand capacity of human resources. Those human resources can then apply the concept in other locations and with other groups.

URBAN SIMULATION MODEL

SHORT DESCRIPTION

Urban-Sim is a behavioral simulation of the choices made by key actors in the urban development process: households, businesses, developers and government. It operates in a quasi-dynamic manner over one-year increments in time, for short to long-term horizons. Urban-Sim is a software-based system designed for integrating planning and analysis of urban development, incorporating the interactions between land use, transportation and public policy. It is designed to interface with existing travel modeling procedures, includes both current four-step as well as newer activity-based travel models. It can be extended to address environmental impacts of development by simulating land cover, water demand, air pollution and nutrient emissions. A major characteristic is that the model provides for consideration of behavioral and market aspects of the issues.

IMPORTANT CONSIDERATIONS

-- CONSIDERATION OF SOCIO-ECONOMIC (aggregate market) AND BEHAVIORAL (individual choice) ASPECTS

The model includes consideration of market behavior and government actions.
The model demonstrates the impact of land use on travel demand.
Simulates land market as the interaction of demand and supply with prices adjusting in response to short-term imbalances between supply and demand.

-- CONSIDERATION OF FISCAL IMPACTS

The model includes fiscal data and fiscal output analysis.
The model provides consideration of land use infrastructure costs and local tax revenue projections.

-- CONSIDERATION OF BEHAVIORAL ASPECTS

The model provides consideration of behavior aspects.
Incorporates governmental policy assumptions explicitly, and evaluates policy impacts by modeling market responses.
The demand side simulates consumer preferences of households and businesses by market segment for locations and development types. The demand side groups parcels into clusters of the same development type.
The supply side attempts to simulate the development activity of private developers. The model is based on a micro-simulation of the expected profitability from the development or redevelopment of individual land parcels.

-- USE OF EXISTING COEFFICIENTS

Model provides for use of available futures type coefficients.

PROPERTIES OF TOOL

GEOGRAPHIC SCALE

City to regional scale.

Best for large scale jurisdictional analysis and/or multi-jurisdictional decisions.

Is designed for high levels of spatial and activity disaggregation, currently using a 150 meter grid.

EXPERTISE NEEDED

Calibration of the model requires knowledge of statistical software to perform multiple regression and logit model estimation using external econometric software such as Alogit or Limdep. Further work on calibration tools may make the use of external software unnecessary in the future. Use of the model requires land-use and transportation planning expertise and general computer experience. The user interface for the model, planned for future release, is intended for relatively non-technical users.

The present objective should not be to augment local capacity for Urban Simulation but it should provide a base for a longer-term program of regional analysis and regional-type policy decisions.

At the present time, expertise is needed for a regional approach such as an applied case study or a demonstration project. The demonstration project is designed for the high end of the continuum of analytical tools. It would be most appropriate for locations such as the greater Philadelphia Area, the Harrisburg area, the Metropolitan Washington Council of Governments area, the Richmond area or the Hampton Roads area.

- EMPLOYEES

A few jurisdictions will develop their own tailored model.

Most will need outside expertise help.

Need fairly sophisticated computer knowledge.

- CONSULTANTS

In most cases consultant help will be required.

Whether employees or consultants apply the model, they must have good knowledge of applied econometrics in order to understand the transition data and to determine if the output and results makes sense.

Theoretically, this is a good model. It is a simulation based on structural change coefficient. Much of the analysis is based on land transition data. The model is based on a convergence of the data sets.

The model will require use of existing coefficients or newly developed coefficients.

Therefore, availability of land transition data is problematic. The available data is poor at this time.

TRAINING NEEDED

- OPERATION OF TOOLS

Need land use and transportation planning expertise.

Significant training is needed.

Need knowledge of statistical software to perform multiple regression.

Need knowledge to use external econometric software.

- INTERPRETATION OF RESULTS

Significant training required.

DATA REQUIREMENTS

Model has high data requirements.

Land uses are defined with typically 10 or more urban categories, but there is no internal limit on the number of urban or non-urban categories.

Need data on land use, a separate transportation model and information on public policy.

Need travel modeling data.

Needs environmental constraint data or data that can use to impose environmental constraints (such as buffer requirements, air quality regulations or wetlands) on the simulation.

Need local land use parcel data. This data is available in many jurisdictions.

- ACCURACY

Need fairly accurate high quality data.

Need base year data.

Need to use regional economic forecasts.

Need probability of transition data – supply/demand for land and supply/demand for labor.

- RESOLUTION

Must have local land use parcel data.

AVAILABILITY OF DATA

Land use, transportation and public policy data generally exists.

Travel model data generally exists.

In most cases, environmental impact data will have to be determined.

Most likely can generate data from existing sources.

OUTPUT

Behavioral simulation for short or long horizons.

Can be coupled with special situation models.

Provides high degree of spatial resolution.

- **GEOGRAPHICAL/GIS**

- Model provides data that can be imported as a geographical data in a GIS (ArcView).

- Model provides annual and future scenarios.

- Provides for distribution of population scenarios.

The data required by the model can be created using some kind of GIS. Currently, the model has not been integrated with a GIS, but is planned for future releases.

Note: The “What If” Analysis tool considers constraints. UrbanSim is more related to the aggregates.

- **QUANTITATIVE**

- Provides for quantitative data sets.

- Provides for annual and future data sets on an annual basis.

- Dynamic scenarios step the user through the process.

TEMPORAL CAPABILITY

- Provides for adjustments in land-related infrastructure.

- Simulates urban development as a dynamic process over time and space, as opposed to only cross-sectional or equilibrium approach as would be provided by the “What If” Analysis tool.

- Provides annual or long-term analysis.

VERSATILITY

- **EVALUATE**

- Addresses both Greenfield development and redevelopment or intensification.

- **INTEGRATE**

- Can integrate several models into analysis.

- **LINK MULTIPLE VARIABLES**

- Model allows for linking many variables.

COST

Urban Simulation is very costly in terms of human resources needs.

- **HARDWARE**

- Requires a 333 MHZ or higher computer with 128 MB of RAM, 2+ GBs of free hard drive space. It runs on Windows 95/98, Windows NT 4.0/2000, Linux or UNIX, using Java JKD 1.3.

- SOFTWARE

It is a software-based system that can be downloaded for free.

- O&M

Considerable staff time or consultant time.

TRANSFERABILITY

A high learning curve exists.

But, once developed the human resources (human capital) capacity can be used in other locations – model could be applied anywhere in the watershed.