INTEGRATING PLANNING SUPPORT SYSTEM APPLICATIONS IN THE PLANNING
DECISION-MAKING PROCESS: AN EVALUATION OF THE POTENTIAL USEFULNESS
OF THE "WHAT IF?" SOFTWARE

by

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Abstract

Planning Support Systems allow planners to create alternative development scenarios to forecast a more accurate and precise future trend of development in their communities. The software What If?™ has been developed and introduced in the planning profession since its first release in the 1990's. This report evaluates the software What If?™ based on the planning decision-making process. The report provides three aspects of evaluation: technical, empirical, and subjective. In addition, the paper will be also providing an overall understanding of the analytical capability of What If?™, and an overview of its operating procedures.

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CHAPTER 1 - Introduction

Planning is an activity that connects the future and links "scientific and technical knowledge to action in the public domain" (Geertman & Stillwell, 2003). Urban and regional planning consisted of a wide range of activities, many of which are responses to particular societal problems that impacted at different spatial scales (Geertman & Stillwell, 2003). There has often been an uneasy relationship between the selection of the policies and potential profitability of investment. In the planning decision-making process, problems are confronted by the question of "what-if," an alternative approach to the problem had been selected. Both planners and citizens want to know the changing result or likelihood of making another policy choice. What might be the outcome for a community's future development if a different policy were implemented? Most of these what-if questions can be dealt with just based on a planner's past experiences in the field. "Traditionally, decision support theory focuses on how to find a solution for the problem or problems that the decision-maker faces. Problem-solving is conceived as taking some sort of inventory of possible solutions to the problem and deciding which line of action is most likely to be successful" (Vriens & Hendriks, 1997). Consequently, the focus of planners is on comparing alternatives, and making a decision which seems as the best choice of one of the alternatives. Differences between competing theories along these lines occur when comparison functions, choice criteria and methods for establishing them come into play (Vriens & Hendriks, 1997). However, there are some hypothetical questions which will require extensive computer calculations and simulations to achieve the intended results.

It is inevitable that the process of planning will change over time as decision-makers seek to make improvements in their systems on the grounds of efficiency and to confront the pressures of new circumstances, priorities and technology. For land-use professions from every field, such as landscape architecture, urban planning or commercial developers, they are all turning from traditional modes of planning to computer technology. As they do, they are finding extraordinarily detailed visualizations, animated and manipulable 3-D models and vast databases which are available to help them in the decision-making process (Brail & Klosterman, 2001). Among all the Planning Support System software available in the profession in 2009, it is the intent of this research to explore and evaluate the application What If?™ and provide an analysis of its functions and effectiveness for the planning profession.

CHAPTER 2 - Traditional Planning Decision-Making Process and Planning Support Systems

The city planning profession has played an important part in building cities in the United States. One of most important questions in the planning process is "Where can we grow?" The question, in a sense, is about feasibility, but feasibility is sometimes in the eye of beholder. Nevertheless, it is important for planners to distinguish possibility from practicability. There are three techniques for determining what is feasible, they are: 1) opportunities and constraints analysis, 2) strength and weakness analysis; and 3) issue identifcation (Kelly & Becker, 2000).

According to Kelly and Becker (2000), the traditional planning method of determining "where we can grow" is to conduct an opportunities and constraints analysis. The method includes the following categoreis:

- Geography – the opportunities are generally fixed or long term, which is unlikely to change in the planning process. Therefore, geography becomes an important defining parameter in the planning process.

- Environmental – this is closely related with geography. The character of the land defines the type of development that can take place. The environmental category is generally included in the local policies as well.

- Natural Resources – which is also another category that is closely related to geography. However, natural resources depending on the geographic region. Although natural resources are usually an opportunity and not a constraint, the desire to protect certain natural resources (such as prime agricultural land) may be consider a limitation. In some

cases, the natural resources, combined with some public policy choices, can become a self-imposed restraint affecting certain planning choices.

- Infrastructure – also is related to geographic opportunities and constraints. However, infrastructure facilities and capacities are easier to control in some situations, such as roads, bridges, sewage collection and treatment systems, etc.

- Private land and facilities – during the 1990's, the economy in the United States became so strong that most modern factories were operating at full capacities. In that context, empty factories had traditionally symbolized lost jobs and a sagging economy for a community. Therefore, it is important to analyze these private support services and should list them as an opportunity.

- Economy – the economic base of the community is one of the most important categories to analyze. What brings money into the community? The community needs to particularly identify two elements of the local economy, 1) labor force, and 2) industrial input/output.

- Housing – both the availability and the cost of housing are factors that can create opportunities or represent several constraints, depending on the community condition. Communities with higher housing cost will have more trouble attracting new residents or industries than communities with lower or moderate housing costs.

- Local policies towards growth and change – the local policies toward growth and changes create significant opportunities and constraints. In general, antigrowth communities are likely to grow less than similarly situated progrowth communities. These policies can have a significant impact over the long run.

Next, based on the information gather listed above, one of most common planning method is the rational planning. The rational planning process is depicted in the Figure 2.1 for the Rational Planning Diagram, which it consisted of three major key phases, problem formulation, evaluation of conditions, and planning solutions (Pettit, 2002).
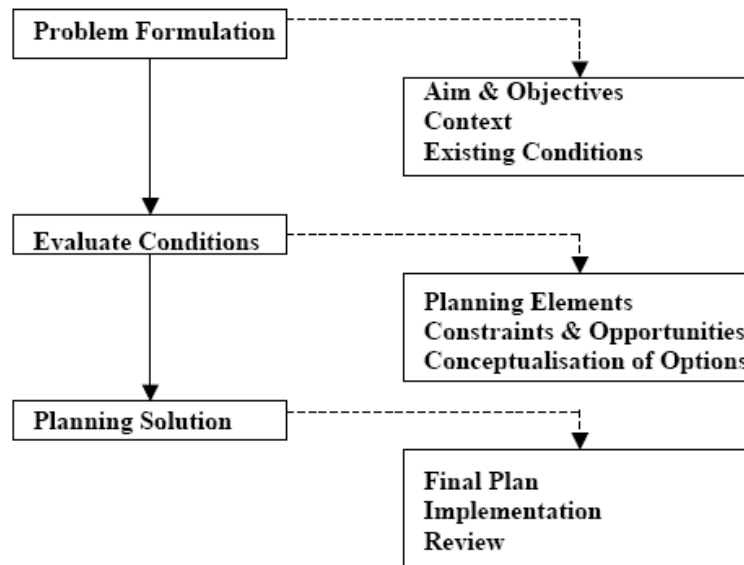
Figure 2.1 Rational Planning Diagram

(Pettit, 2002)

Finally, the last method used in the planning decision-making process is through an issue identification process. The purpose of the procedure is to provide focus for the planning effort and determine a list of issues from the data compiled from the previous two approaches. However, during the last decade of the twentieth century, planning practice has changed significantly in the United States. The planning decision-making process invovlves not only data gathering and analytical procedures, but it has evloved to a more complex process. As for the community planning process, it has become more holistic in scope, more strategic and scenario-

oriented in content and more interactive in nature. In the 1990's, the boundaries between different types of planning were redefined in the profession. In the 1990's, a new type of planning approach emerged. "It was created as a reaction against the more procedural and instrumental orientations that characterized planning during the 70's and 80's. Scenario planning focuses on map representation developed through computer applications and the use of analytical 'what-if' scenario functions and spatial modeling. The approach is closely connected to the view of alternative future, based upon existing planning policy" (Pettit, 2002). In addition, the scenario planning approach is based upon a integrated decision support framework incorporates predictions and tactical planning for land use change based upon (Pettit, 2002):

- Projections from existing trends

- Optimizing socio-economic output

- Decision trade-offs on a variety of factors

At a more technical level, during the last decade, the planning profession has shifted towards the use of scenarios in communicating proposals and concerns. The technique is believed to be more effective and precise in developing the communication between policy-makers and the general public. Spatial scenarios enable the provision of various views of the future, depending on different assumptions or policies. Maps can be a very effective communication tool, as many people prefer to look at a map, because it gives them a visual image of the relationship between places. "The last decade has seen a shift towards the use of scenarios as a means of giving concrete expression to spatial proposals for the future and a move towards communicating these proposals to those concerned in a more effective fashion" (Geertman & Stillwell, 2003).

These scenario models not only helping policy-makers to see what are the future of the community, but also equipped planners the ability to help the public to envision possible future changes, with images that can precisely express the potential future outcomes. Too often, planners or policy-makers make decisions which to over- or under-estimate the outcome, using the traditional planning process. Computer visualization tools, when used properly, can help planners think about, prepare for and maybe even help them make a decision that will benefit the majority of people within a community. "The planning profession also must not abandon science and rationality; rather it should extend them beyond the unnecessary constrained views". Integration of the traditional planning process and planning support systems form a new ideal of planning, creating models, methods and procedures that can help the community achieve their future and visions.

CHAPTER 3 - History of Planning Support Systems

The term 'Planning Support System' was coined around 1987, according to Britton Harris' article 'Beyond Geographic Information systems: Computer and the Planning Professional' published in the Journal of the American Planning Association in 1989. In the article Mr. Harris indicated it started with the Urban and Regional Information Systems Association (URISA) conference in the summer of 1987, someone in the audience who Mr. Harris cannot quite remember, actually coined the term. The term "Planning Support System" was referring to the constellation of digital techniques (like GIS), which were emerging to support the planning process (Geertman & Stillwell, 2003). "In fact, the predecessor term 'decision support systems' (DSS) from which this unknown originator obviously defined PSS by analogy, was coined as far back as the late 1970s in the management literature for a loose assemblage of techniques, usually computer-based, which aided management decision" (Geertman & Stillwell, 2003). As a result, this term slowly entered the geographic word list as 'spatial decision support systems' (SDSS). This is probably attributed to Lew Hopkins and Mark Armstrong who used it in a paper published in AutoCarto in 1985 (Geertman & Stillwell, 2003). To further understand Planning Support Systems (PSS), it is imperative to comprehend its predecessor — Decision Support Systems (DSS).

Beginning in the mid-60s, "there has been an increasing interest in and use of quantitative models of urban and regional systems…. There are many descriptions of the individual models which have been developed in planning and research studies… but invariably these descriptions assume a level of numerate ability which the majority of planners do not possess" (Lee, 1973). Therefore, researchers began to study the use of computerized quantitative models, in order to

assist in the decision-making and planning process (Power, 2007). It was during this era that the development of Decision Support Systems (DSS) started to intensify. As a result, Planning Support Systems (PSS), a subclass of DSS, was later created.

Before 1965, "it was very expensive to build large-scale information systems. At about this time, the developer of IBM System 360 and other powerful mainframe systems made it more practical and cost-effective to develop Management Information Systems (MIS)" (Powers, 2003). "In the late 1960s, a new type of information system becomes practical – model oriented DSS or management decision systems" (Power, 2007). The concept of decision support evolved from the theoretical studies of organizational decision making based on research at the Carnegie Institute of Technology during the late 1950's and early 1960's. The technical work on interactive computer systems was mainly carried out at the Massachusetts Institute of Technology in the 60's (Power, 2007). In the 1970's, articles on management decision systems, strategic planning systems and decision support systems began to appear in business journals and magazines (Power, 2007). During the 80's, research on DSS started to intensify. "In the middle and late 1980's, Executive Information Systems (EIS), Group Decision Support Systems (GDSS), and Organizational Decision Support Systems (ODSS) evolved from the single user and model-oriented DSS (Power, 2007). There are several main features that characterize the DSS in the 80s. First, they are composed of three components: a user interface, a database, and a model base. Together these three components are designed to provide a framework which integrates: all relevant information from a wide variety of sources, with the full range of analytical and statistical modeling tools, and a graphical interface that conveys information in a readily understandable form to decision-makers (Brail & Klosterman, 2001). Above all, these design objectives provide flexibility that is easy to use and that could be adopted by users according to

their needs. Beginning in the 90's, "data warehousing and Online Analytical Processing (OLAP) started broadening the realm of DSS. Prior to the turn of the millennium, new Web-based analytical applications were introduced" (Decision Support System, 2008). This was also the decade of another "revolution in information technology," according to Klosterman (2001). This revolution which led to the creation of Geographic Information System (GIS). As a result, planners now are heavily relying on GIS (Juhl, 1994). Figure 3.1 is a diagram of the DDS history mentioned above.
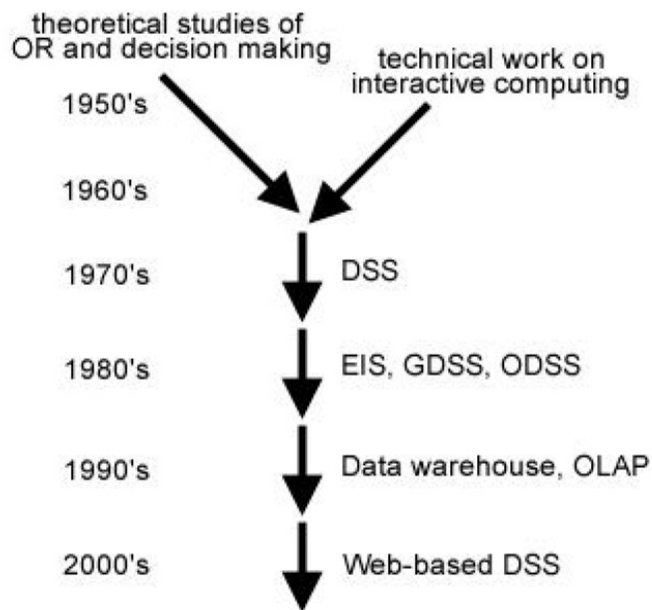

Figure 3.1 Diagram of DSS History
(Geertman & Stillwell, 2003)

The term Decision Support Systems has been defined in various ways, depending on the user's point of view (Power, 2007). Generally, DSS is defined as "a computer-based system that aids the process of decision making," or another way to define DSS is, "an interactive, flexible,

and adaptable computer-based information system, especially developed for supporting the solution of non-structured management problems for improved decision making. It utilizes data, provides an easy-to-use interface, and allows for the decision makers own insights" (Power, 2007). Other definitions for DSS lay in between the above-mentioned two extremes, "a model-based set of procedures for processing data and judgments to assist a manager in his decision making," or "interactive computer-based systems that help decision makers utilize data and models to solve unstructured problems" (Power, 2007). DSS was designed to "help deal with poorly structured decisions by facilitating a decision process which is iterative, integrative, and participative" (Brail & Klosterman, 2001). Since the first model-driven decision support system was developed in 1965, information technologies have been applied to support decision-making (Zhu & Chen, 2008). Regardless of the underlying technology, information visualization has played an essential role in the success of decision support systems (Zhu & Chen, 2008). According to Langendorf, in his 2000 article "… Visualization is a method of computing. It transforms the symbolic into the geometric, enabling researchers to observe their simulation and computations. Visualization offers a method for seeing the unseen. It enriches the process of scientific discovery and fosters profound and unexpected insights". In the professional field of planning, planners need to acquire skills that are necessary to present what exists and what might become reality. What the planner chooses to represent influences others view of reality and very significantly defines the outcome of designs and plans, and thus the future form of cities (Langendorf, 2001). The developments of information technology in the planning fields have been based on the following concerns as shown in Table 3.1 below:

1960s	Data	"Observations which have been cleaned coded, and stored in machine-readable form." The primary concern of electronic data processing (EDP) promoted efficient transaction processing to improve operational tasks.
1970s	Information	"Data which has been organized, analyzed, and summarized into a meaningful form." The primary concern of Management Information Systems (MIS) was the integration of diverse data sets to serve management needs
1980s	Knowledge	"Understanding based on information, experience, and study." The primary concern of decision support systems (DSS) was to facilitate semi-structured decision making in support of executive decision making.
1990s	Intelligence	"Ability to deal with novel situations and new problems, to apply knowledge acquired from experience, and to use the power of reasoning effectively as a guide to behavior." The possible concern of planning support systems (PSS) was to promote discourse and interaction in facilitating collective design decisions.

Table 3.1 Evolving Concerns of Information Technology

(Geertman & Stillwell, 2003)

In the 1960s, the computer was mainly used to handle data. Computer based information systems was mostly used for processing data, procedures, and encoding and digitizing information on paper. The available technology at the time was batch processing of custom-designed, single-purpose, transaction-based information systems on mainframe computers. Public sector applications included the computerization of day-to-day operations such as payroll, accounting, and property tax assessment (Brail & Klosterman, 2001).

In the 1970s, the focus shifted from data to information (data that has been organized and summarized into a meaningful form). The primarily concerns changed from processing data to management information systems (MIS) and use of data in forms that could serve management needs. While the computer technology evolved (including minicomputer development), rational

data management systems (RDBMS) and computer-based mapping also evolved. Public sectors used applications which included the development of urban information systems (UIS), geographic information systems (GIS), and land information systems (LIS) that all together provided the integrated information requirement for the municipal management functions. These tasks included permit processing, code enforcement, infrastructure management and transit operations (Brail & Klosterman, 2001).

Again, in the 1980s, the emphasis changed from information to knowledge (understanding based on information, experience and study). "The change reflected the decision makers' desire for analytical modeling capabilities and for more interaction with solution processes than were provided by management information systems of the 1970s" (Brail & Klosterman, 2001). It was during this period that the new type of systems, Decision Support Systems (DSS) emerged, and created a new set of theories and applications based on DSS.

In the 1990s, the focus was to provide intelligence and the ability to apply knowledge acquired from experience and to use it effectively to solve problems. PSS was designed to provide interactive, integrative and participatory procedures for decision makers. PSS also includes long-range problem solutions and strategic issue development, "as well as explicitly facilitating group interaction and discussion" (Brail & Klosterman, 2001).

In essence, DSS's are designed to help deal with poorly structured decisions by facilitating a decision process which is iterative, integrative, and participative. "They are iterative because they allow decision makers to systematically generate and evaluate a number of alternative solutions, gaining insights which are introduced as inputs to help guide further analyses. They are integrative in that they incorporate decision makers' substantive knowledge along with the quantitative data provided by the models to evaluate alternatives across a broad

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range of pertinent criteria. And they are participatory by permitting decision makers to examine the consequences of employing different information and modeling approaches, and to choose alternative decision criteria, objectives and constraints" (Brail & Klosterman, 2001). A PSS provides an "intelligent digital toolbox" that helps users elect the most appropriate software tools from a range of alternative analyses and forecasting models, and applies these tools to data which have been accessed locally (or via the internet). PSS applications also allow users to quickly view the implications of alternative policy choices in an intuitive graphic, map and interactive display (Brail & Klosterman, 2001).

Over the past few decades, "the development of fast, high resolution, full color display and output devices has spawned spectacular advances in computer-aided design and drafting (CADD), GIS and visualization. Perhaps most important, entirely new kinds of software – most notably electronic spreadsheets, sophisticated database management systems, and graphically oriented, multitasking operating systems – have made possible a flexible and interactive style of computer manipulation unimaginable only ten years ago" (Brail & Klosterman, 2001).

GIS became more widespread in use in the planning profession during the 90's and GIS applications are still being used "primarily for routine operational and management tasks such as permit processing, collecting and maintaining land related information, and preparing thematic maps" (Brail & Klosterman, 2001). There is little information that supports wide use of GIS for planning analysis or evaluation (Brail & Klosterman, 2001). Although given the popularity of GIS both within and outside of the planning profession, GIS remains a "chameleon technology" – which provides the basic functions for collecting, maintaining and analyzing as well as displaying the spatial information that is useful in both private and public sectors (Brail & Klosterman, 2001).

Furthermore, while at the time there are no single applications alone that can provide all of the capabilities planners need to carry out their professional responsibilities, there are a range of different technologies that can be used together to provide capabilities which planners need. While recognizing the limitation, many scholars starting combining a range of computer-based methods and models into integrated systems that are able to support the planning functions (Brail & Klosterman, 2001). In the heart of PSS, undoubtedly is GIS. which not only serves as a display and communications device, it also provides the ability to produce maps and charts to describe past and present conditions, as well as model outputs to suggest alternative futures (Brail & Klosterman, 2001). However, GIS alone cannot serve all the needs of planning. In general, planners are mostly concerned with the question of "what-if" or questions that are asked hypothetically, or results of a changing hypothesis. On the other hand, GIS, "can be broadly regarded as general-purpose systems" (Geertman & Stillwell, 2003). Sometimes also known as Geographical Information Systems or Geospatial Information Systems, "is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the Earth" (GIS.com - The Guide to Geographic Information Systems, 2009). According to ESRI, one of leading GIS applications developer, "GIS is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information" (What is GIS?, 2007). According to Geertman & Stillwell, "typically GIS provides generic solutions where as PSS are specific and focused on the tasks of the application. This implies the handling of aspatial and nonspatial data as well as spatial data, historical data sets as well as projections, qualitative information as well as quantitative, implicit and semi- or even ill-structured knowledge as well as explicit and well-structured knowledge; and the modeling, design, and analysis of dynamic spatial data and

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information as well as the management and orientation of static spatial data or information" (Geertwell & Stillwell, 2003).

However, GIS does not have the capability to serve all the needs of planning decision-making process, "because the current generation of 'general-purpose' systems cannot accommodate the particular informational, computational and display needs of planning… planning requires (1) information that is effectively 'aspatial' at a particular level of analysis… (2) information over time… (3) measures of spatial interaction…" (Brail & Klosterman, 2001). As a result, PSS was developed to provide planners the above-mentioned tools in their decision-making process. Overall, GIS still has limited ability to answer the above mentioned questions. Most "what-if" questions GIS is able to resolve involves physical mapping representations, planning requires:

- Information that is effectively "aspatial at a particular level of analysis (such as regional population and employment levels and trends for the analysis of a city and its components);

- Information over time (such as population employment, and land use data for the past, present and future); and

- Measures of spatial interaction (such as the number of trips between zones).

Currently, none of the points mentioned above can be easily incorporated into existing GIS applications (Brail & Klosterman, 2001). Other computing functions required by planners which GIS is unable to perform efficiently are: compute cross products, manipulate matrices and conduct statistical analyses; estimate system parameters and derive solutions interactively; and

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support analytical and design functions which incorporate goals, objectives, costs, and benefits (Brail & Klosterman, 2001).

The idea of PSS is easy to define but difficult to implement. "The perfect PSS would be a fully integrated, flexible, and "user-friendly" system that allows the user to perform the following tasks:

- Select the appropriate analysis or forecasting tool from an "intelligent digital toolbox" that helps the user to identify the most appropriate methodologies and tools for dealing with a particular task;

- Link the appropriate analytic or projection model to the required local, regional, or national information stored, or accessed through PSS;

- Run the appropriate models to determine the implications of alternative policy choices and different assumptions about the present and the future; and

- Instantaneously view the results graphically in the form of charts, maps and interactive video displays (Brail & Klosterman, 2001).

- Ideally, these processes would be done interactively and in real time, as well as incorporate both qualitative and quantitative decision supports.

Types of Decision Support Systems

There are five broad categories of DSS (What are Decision Support Systems, 2007):

1. Communications Driven DSS (C-D DSS) – this is a type of DSS that enhances decision-making by allowing communication and sharing of information between groups of people. Characteristics of C-D DSS are:

    - Supports coordination and collaboration between two or more people;

- Facilitates information sharing;

- Allows communications shared among groups of people;

- Supports group decisions.

Simple threaded e-mails, web-conferencing applications or interactive video, all are consider part of the C-D DSS.

2. Data-Driven DSS – This is a form of support system that is data-oriented, and focuses on the provision of internal or sometimes external data to help with decision making. Data-Driven DSS mostly will come in the form of a data warehouse, which is a database designed to store data in a way that enables users to query and analyze. Examples of this are Geographic Information Systems (GIS), which allow users to visually represent geographically dependent data using maps.

3. Document-Driven DSS – This is a system that is designed to convert, manage, retrieve and manipulate documents in or to valuable information. There are three primary forms of data used in Document-Driven DSS: oral (i.e. transcribed conversation), written (i.e. reports, memos, and emails), and video (i.e. TV commercials and news reports). A good example of this type of system can be found in internet search engines, which are designed to sift through huge volumes of unsorted data using keyword searches.

4. Knowledge-Driven DSS – This system is designed to recommend actions to users, based on stored problem solving expertise as facts, guidelines and procedures.

5. Model-Driven DSS – The system incorporates the ability to manipulate data to generate statistical and financial reports, as well as simulation models to help decision-makers. Model-Driven DSS uses data and parameters provided by users to assist decision makers

in analyzing a situation, and allows decision-makers to use past data to answer 'what if' questions. This particular type of DSS, which later became the platform for PSS, and Spatial Decision Support Systems (SDSS), which is the basis for GIS.

Spatial Decision Support Systems and Geographic Information Systems

According to the website "Spatial Decision Support System," by Jacek Malczewski, Spatial Decision Support Systems (SDSS) have been mostly used in the public sector. The main characteristics of spatial decision problems include:

- A large number of decision alternatives

- The outcomes or consequences of the decision alternatives are spatially variable

- Each alternative is evaluated on the basis of multiple criteria

- Some of the criteria may be qualitative while others may be quantitative

- The decisions are often surrounded by uncertainty

"SDSS are designed to support decision making related to complex spatial problems such as determining the optimal location for service centers.... As their name implies, they incorporate three spatially related components of a traditional DSS: a database containing a variety of spatial and nonspatial data, spatially related analytic and simulation models, and a user interface that generally includes a GIS…. The models take the required data from the database, uses it to conduct the requisite analysis or simulation, and store model outputs in the database" (Brail & Klosterman, 2001). Since SDSS and Geographic Information Systems (GIS) are both closely related with PSS, it is important to understand how each system works and how those two systems assist the operation of PSS.

As mentioned in the previous section, SDSS was developed in parallel with DSS. SDSS is designed to be an interactive, computer-based system to support user in achieving a higher effectiveness of decision making while assisting users with land use decisions. SDSS typically consists of the three major components (Power, 2007):

1. Database Management System- this system handles the geographical data. A standalone system for this is GIS.

2. Library of potential models – this can be used to forecast possible outcomes of decisions once appropriate models are selected from the library.

3. Interface to aid user – the interaction with the computer system will also assist in the analysis of outcomes.

As previously mentioned, the term planning support system has been defined broadly to encompass a range of technology-based solutions that are useful to planners (Brail, 2008). Listed below is PSS modeling applications that are recognized by the Lincoln Institute conference.

- CommunityViz™ - is a land-use planning SDSS that works as an extension to ArcGIS produced by ESRI. The application uses a scenario planning approach and calculates economic, environmental, social and visual impacts and indicators, as users explore alternatives. CommunityViz includes interactive 3D models and various tools for public participation and collaboration (see Figure 3.2 for application screenshot) (Placeways, 2009).
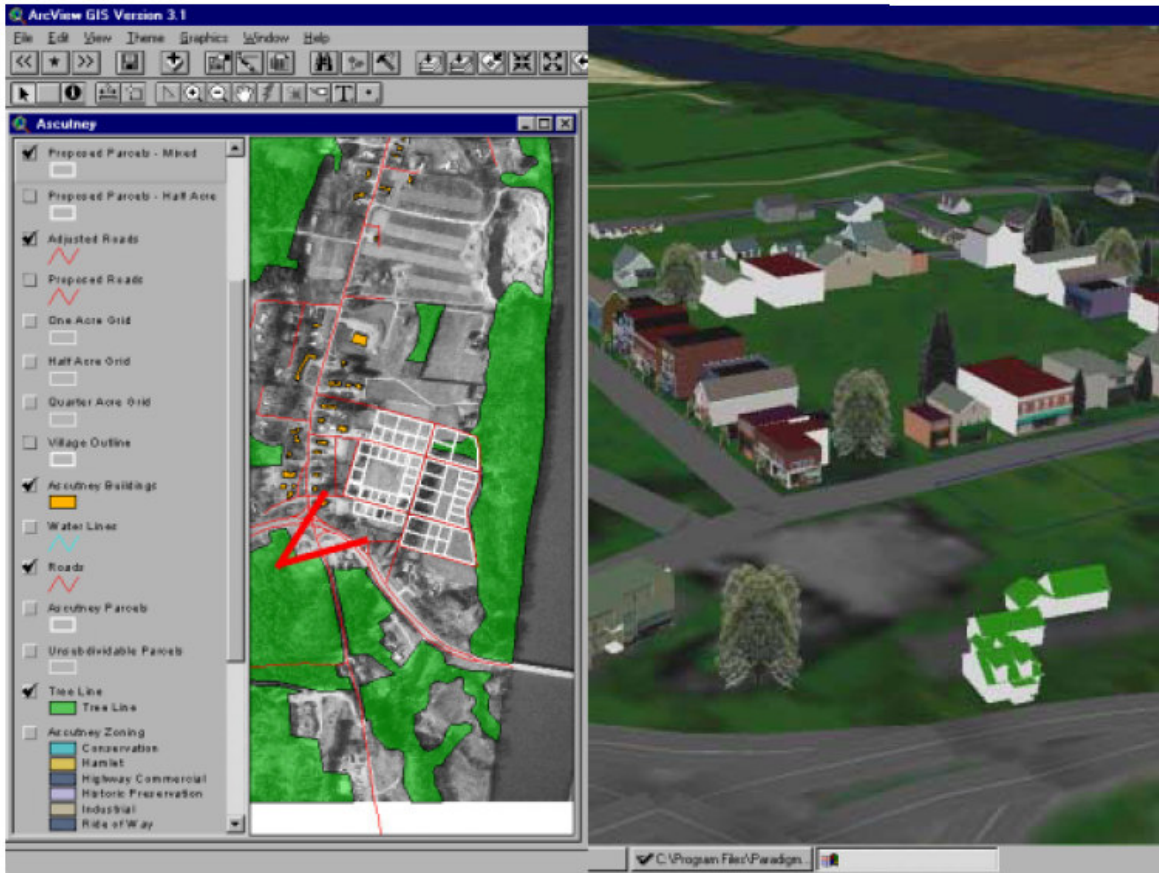
Figure 3.2 Community Viz® Screenshot

(Placeways, 2009)

- Cellular Automaton Land Use Change Model (SLEUTH) – is a model for simulating urban growth and other land use changes that are caused by urbanization. The majority of SLEUTH applications have been for urban forecasting or for integrated modeling of urban growth with some other social or physical process modeling or planning effort. Figure 3.3 and 3.4 indicates SLEUTH coverage both in the U.S. and on world map (Eastern Geographic Science Center, 2008).
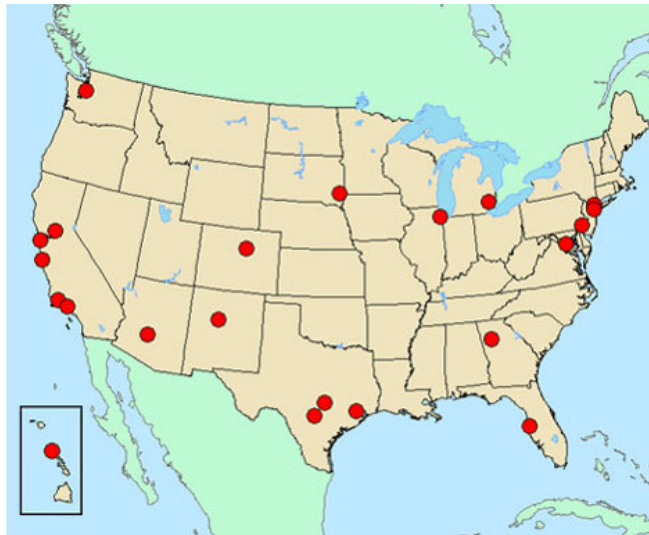
Figure 3.3 SLEUTH Coverage in the U. S.

(Eastern Geographic Science Center, 2008)

Figure 3.4 SLEUTH Coverage on the World Map

(Eastern Geographic Science Center, 2008)

- Land-use Evolution and impact Assessment Model (LEAM) – the application was

  developed by University of Illinois at Urbana-Champaign. LEAM is a process of

modeling, visualization, and testing the impacts of land-use policy decisions. The

program able to simulates land-use change across space and time, see Figure 3.5 below

for application concept diagram (LEAM, 2009).
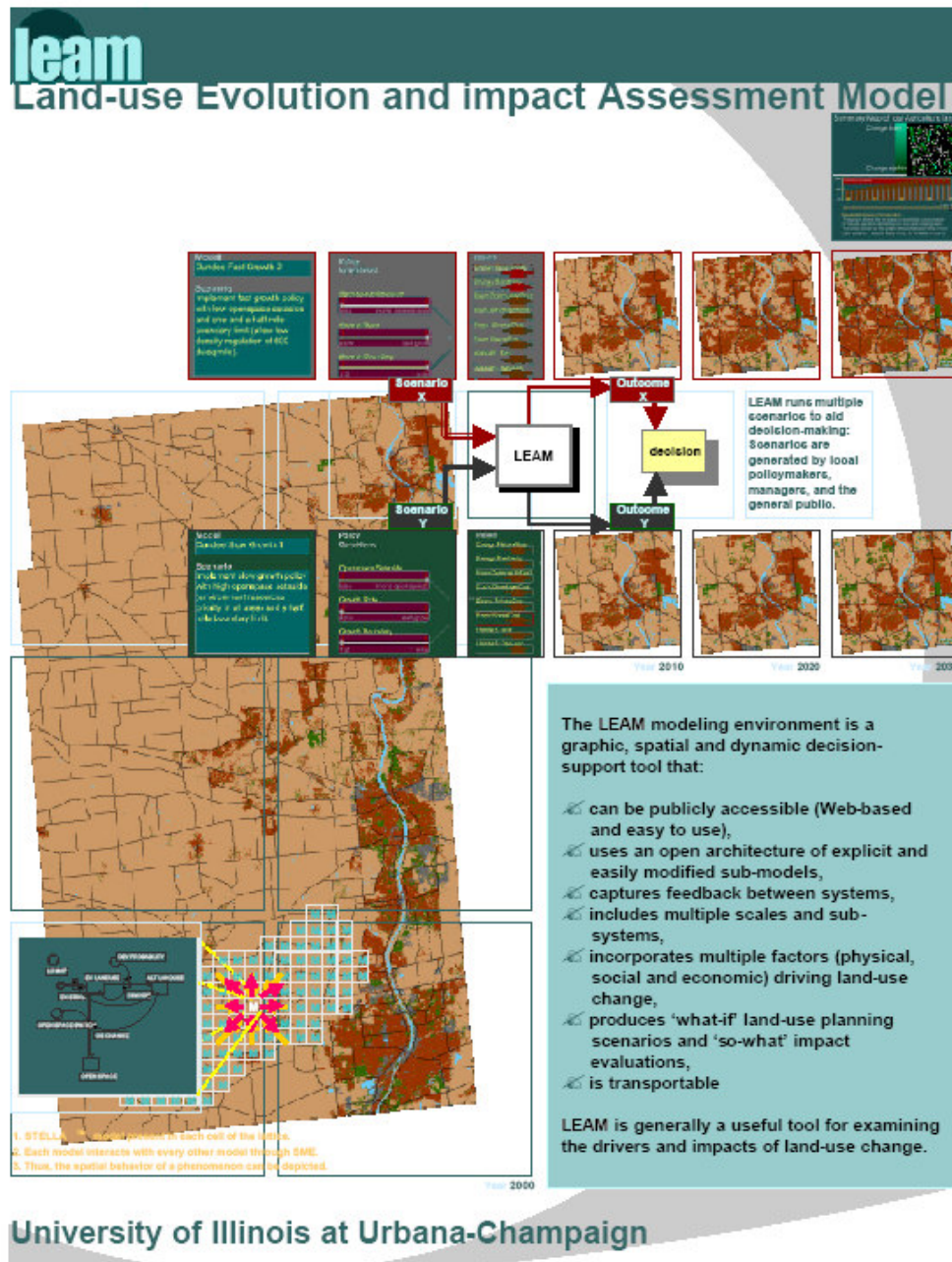
Figure 3.5 LEAM Application Concept Diagram

(LEAM, 2009)

- Environment Explorer or Leef OmegvingsVerkenner (LOV) – is a platform for land use modeling in the Netherlands. The application is a spatial, dynamic model, in which land use and the effects on social, economic and ecological indicator are modeled in an integrated way. The primary goal for the application is to explore future developments, combining autonomous developments with alternative policy options, in relation to the quality of the environment in which inhabitants of the Netherlands residents. The model covers the entire Netherlands, see Figure 3.6 for application modeling concept diagram (LUMOS, 2005).
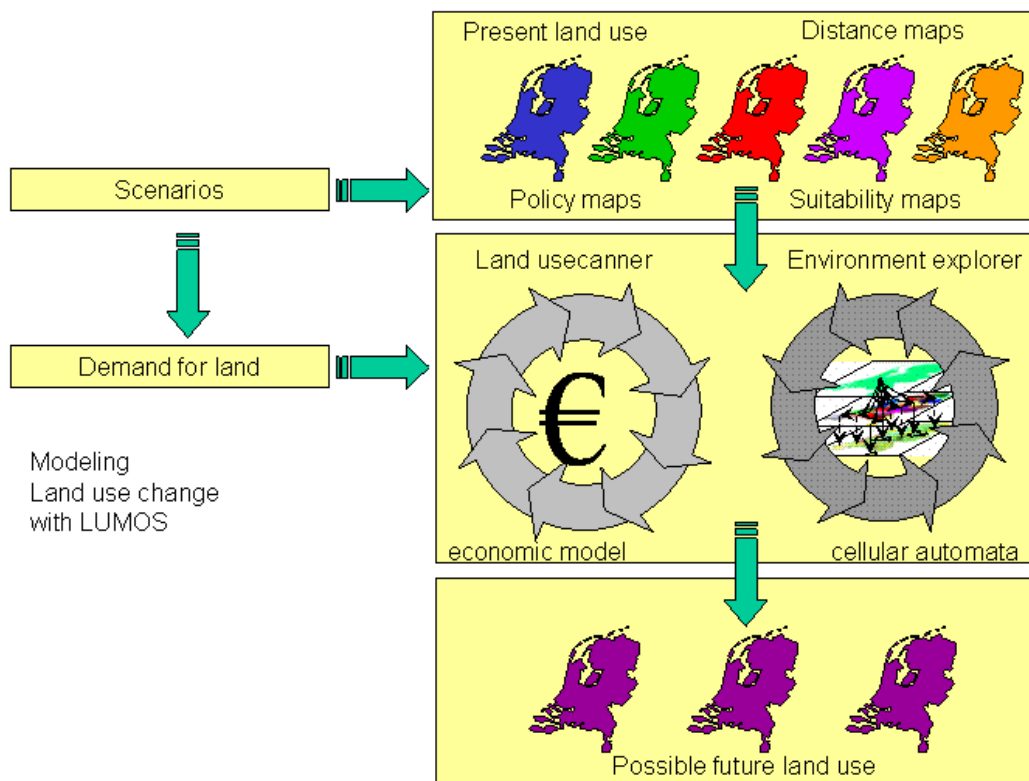
Figure 3.6 Environment Explorer Modeling Diagram

(LUMOS, 2005)

- Monitoring Land Use/Cover Dynamic (MOLAND) – is a spatial planning tool that is used for assessing, monitoring and modeling the development of urban and regional environments. The project was initiated in 1998 (under the name of MURBANDY – Monitoring Urban Dynamics) with the objective to monitor the development of urban areas and identify trends at the European scale. The research includes the computation of indicators and the assessment of the impact of anthropogenic stress factors with a focus on expanding settlements transportation and tourism around urban areas, and along development corridors. The models currently covered approximately 30 European cities. The Figure 3.7 indicates areas the model is covered (MOLAND, n.d.).
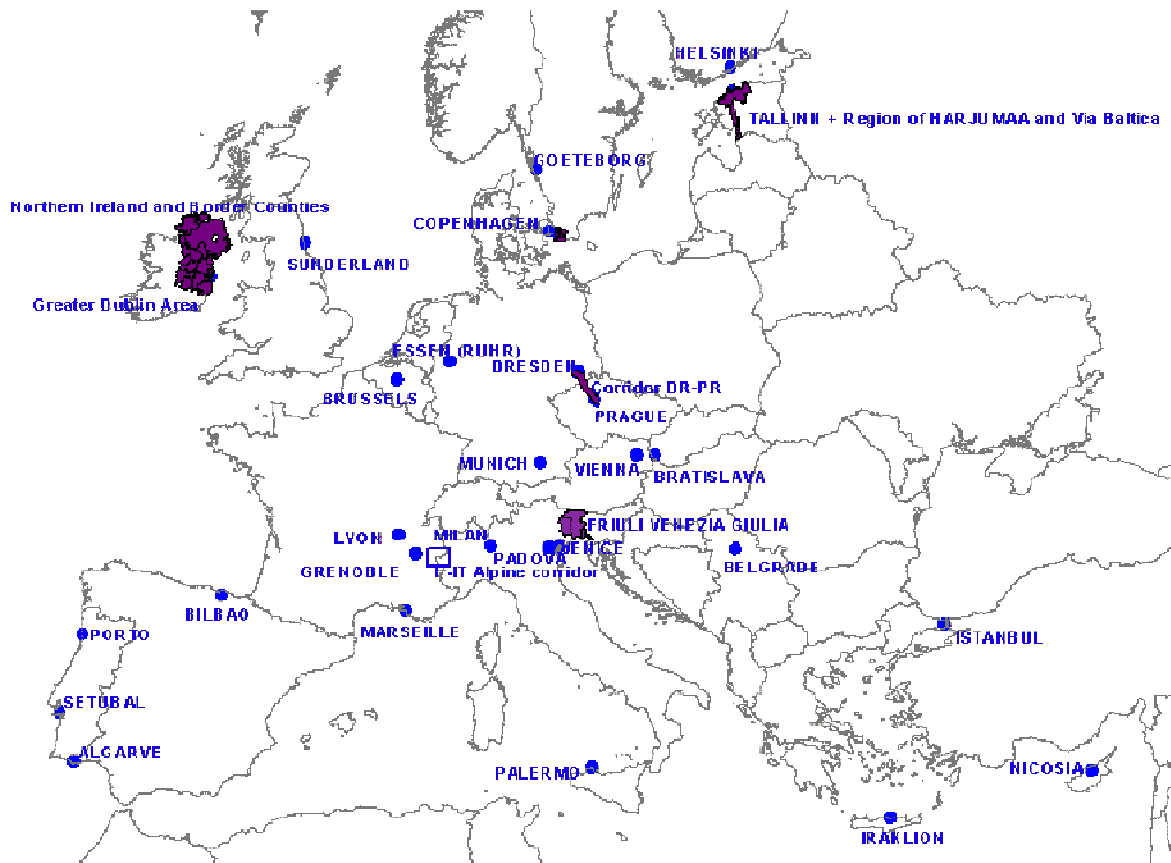
Figure 3.7 Map of MOLAND Coverage

(MOLAND, n.d)

- What if?™ - is a collaborative GIS based Planning Support System developed by Richard Klosterman in 1999. The program is a stand-alone software package, developed using ESRI's MapObjects embeddable mapping and GIS data components. The program has been through two versions (1.0 and 2.0), and has several significant enhancements since version 1.0. The report will focus on the evaluation of this particular program (What if?, Inc. , 2008). The Figure 3.8 is a map showing the location of users of What if?™ located on a world map (What if? , 2008).

What if? Clients

United States

Alabama – Pelham
Arkansas – Conway
California – San Jose, Oakland, San Francisco, Berkeley, Santa Barbara
Florida – Marimar, Clearwater, Tampa
Georgia – Dunwoody, Athens(2), Atlanta(2)
Hawaii – Honolulu
Illinois (2) – Champaign (2)
Iowa – Cedar Rapids
Kansas – Manhattan
Maine – Springvale, Portland
Maryland – College Park
Michigan – Muskegon, Flint
New Jersey – New Brunswick
New York – Ithaca
North Carolina – Charlotte
Ohio – Cleveland, Granville, Cincinnati, Medina, Toledo, Akron(2), Cincinnati(2)
Pennsylvania – Lewisburg, Philadelphia
South Carolina – Columbia(2), Orangeburg
Texas – Austin
Utah – Salt Lake City
Virginia – Richmond
Washington – Port Orchard
Washington DC(2)
Wisconsin – Green Bay, Oshkosh, Madison, Stevens Point, Waupaca

International

Australia – Sydney, Queensland, Melbourne(2)
Botswana – Gaborne
Germany – Bonn
Japan – Kanazawa, Fuhisawa City
Korea – Chungju, Suwon, Gyeongsang, Seoul(2)
Malaysia – Kuala Lumpur, Johor
New Zealand – Tauranga
Poland – Warsaw
Saudi Arabia – Dhahran
Singapore – Singapore
Taiwan – Taipei
The Netherlands – Utrecht
Turkey – Urlaizmir
United Kingdom – Nottingham

Figure 3.8 Map of What If?™ Users

(What if? , 2008)

Although the concept of PSS has been defined in many ways in literature, the term "Planning Support Systems" was actually coined by one of the audiences during a lecture that was given by Britton Harris, father of land use modeling (Geertman & Stillwell, 2003). PSS was created "to support the planning process…. As a consequence of these trends and the shortcoming of the existing geotechnology, a range of new or renewed tools to facilitate 'new' planning practice has materialized under the new generic term, Planning Support Systems (PSS). These systems include geotechnology-related instruments that are primarily developed to support different aspects of the planning process, including: problem diagnosis, data collection, enhancing participation, spatial and trend analysis, data modeling visualization and display, report preparation, collaborative decision-making, et cetera" (Geertman & Stillwell, 2003).

PSS is a combination of community planning GIS and planning model's using computers for a planning support base on communities (Brail & Klosterman, 2001). The PSS structure and information is intended to simulate reality and support the capabilities for analyzing, projecting and planning within the decision-making process. By combining geographical analysis, it can provide a framework that will be able to analyze the integration of aggregated and disaggregated spatial data layers for the efficient planning of future community growth (Pettit, 2002). See Figure 3.9 below for illustration.
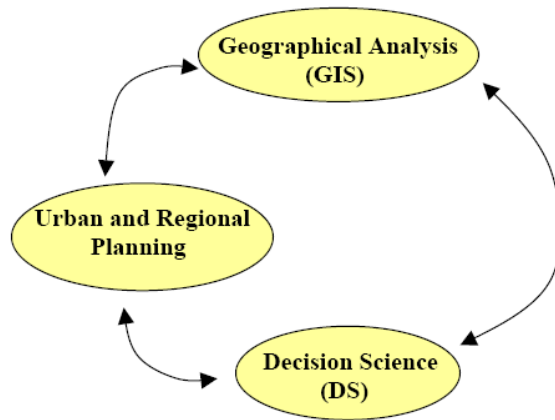
Figure 3.9 Underlying Tools Comparing Planning Support Systems

(Pettit, 2002)

In reality, it is essential for planners to have computer-based applications. According to

Geertman and Stillwell, "There is no denying that planners have always wanted computer-based

tools to enhance their analytical, problem-solving and decision-making capabilities, but it should

also be recognized that planning practice has never effectively embraced many of the methods,

techniques and models developed over time…" (2003). The 1970's was an era of trial and

testing of computer-based applications. The failure of the large-scale urban models, and the

early primitive municipal information systems combined with many attempts to develop policy-

relevant computer-based models severely tested planners confidence in computers (Brail &

Klosterman, 2001). Then, in the 1980s, "planners faith in computer technology was reborn…

with the development of microcomputers that made advanced information technologies and

computer-based methods readily available to professional and academic planners" (Brail &

Klosterman, 2001). As a result, PSS was developed to support both the public and private

planning process. Particularly, PSS are utilized to maintain the derivation and evaluation of

alternative futures (Geertman & Stillwell, 2003). Finally in the 1990s, a revolution in

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information technology changed planners ability to plan. The ideal of PSS is not easy to implement. According to Klosterman (2001), the perfect PSS would be a fully integrated, flexible, and user-friendly system that allows the user to:

1. Select the appropriate analysis or forecasting tool from an "intelligent digital toolbox" that helps the user identify most appropriate methodologies and tools for dealing with a particular task;

2. Link the appropriate analytic or projection model to the required local, regional, or national information stored, or accessed – through the PSS;

3. Run the appropriate models to determine the implications of alternative policy choices and different assumptions about the present and future;

4. Instantaneously view the results graphically in the form of charts, maps, and interactive video/sound displays.

For the purpose of this report, from here on, we will use Decision Support System (DSS) and Planning Support System (PSS) interchangeably for their similarity in nature.

CHAPTER 4 - Methodology

The objective of an evaluation of What if?™ is to assess whether the system satisfied the needs of the user, if the system is suitable for tasks, and would planner's perform better with the new system. These are the basis for the evaluation in this report. However, from a researchers standpoint "the ultimate goal of studying the evaluation of DSS would be to let scholars and practitioners know about the study so they could gain insight for later use. From a practitioners point-of-view, the ultimate goal of evaluation would be to improve the DSS by enhancing decision quality and improving the performance of the decision-making process" (Rhee & Rao, 2008). The purpose of this chapter is to present an approach for evaluating the program What if?™ developed by Richard Klosterman The basic approach to this is to assess how useful the program will be for a planner, and suggest improvements if needed.

The report will focus on the Suitability Analysis offered by What if?™. The land suitability analysis will be based on the limitations established by the FEMA flood zone. The reason for choosing to focus on the Suitability Analysis is because for planners, it is one of the essential factors required in planning for community development. The Suitability Analysis in What if?™ allows the user to input a number of constraints and opportunities that can be represented geographically. A spatial overlay of all the suitability factors is created and enables users to assign ratings and weightings of important to specific factors, such as frequently flooded areas, in order to define the overall land suitability for a particular land use based on the constraint characteristic. The actual evaluation process consisted of finding an appropriate dataset for the analysis, gather GIS data layers from the City of Manhattan, integrate all required layers for the analysis into one, input datasets in What if?™, and based on the conditions

provided, the program will calculate and produce a result which identifies where in Manhattan development would be suitable. Figure 4.1 below illustrates the preparation process, collecting datasets and procedures to complete the Suitability Analysis with What if?™. The process will also be explained in detail later in the report.
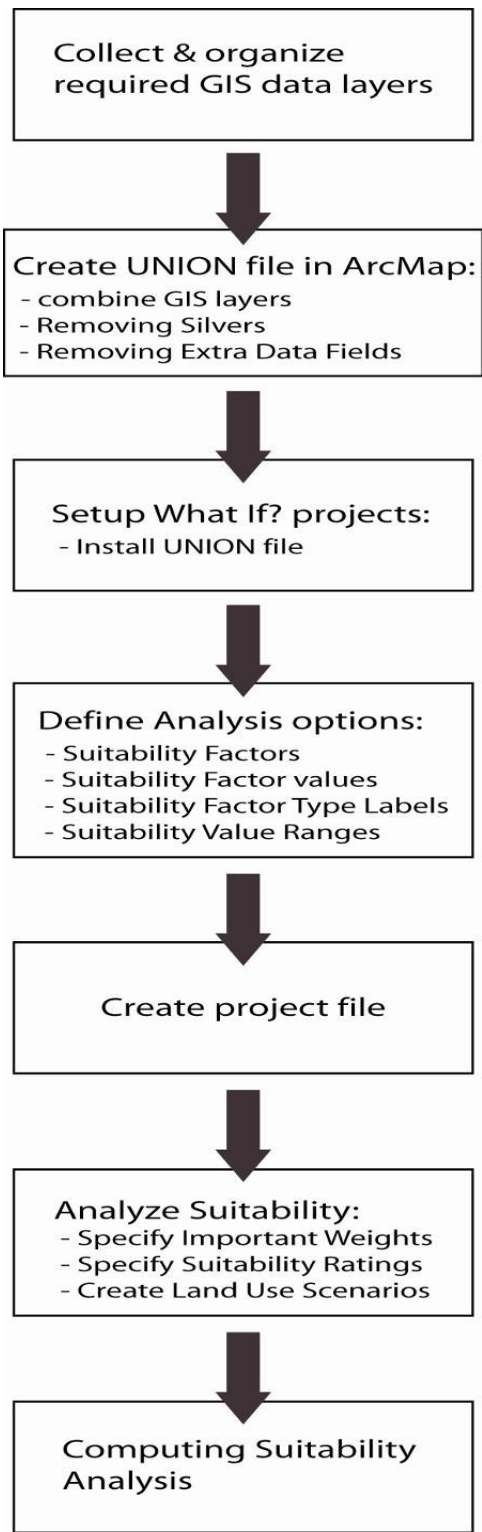
Figure 4.1 Methodology Process

Input Data Layers

All GIS data layers were collected from the City of Manhattan, Kansas FTP website. Some data layers were adjusted to conform to the requirements for What if?™. The following are the data layers that were used to create the Suitability Analysis for What if?™ :

- centerlin.shp [arc feature] City and County streets

- soils.shp [poly feature] Certified digital soils for Riley County

- s_hydroarc.shp [arc feature] FEMA water features streams, rivers, ponds, lakes

- wetlands_all.shp [arc feature] Wetland areas for Riley County

- c_zoning.shp [poly feature] City of Manhattan Zoning

- rileyag.shp [poly feature] Riley County agriculture land use

- boundaryarc.shp [arc feature] Riley County boundary

In defining land suitability analysis requirements, these spatial dataset have been integrated into a UNION file to identify land use and suitability factors. A suitability scenario was created based on these GIS datasets, in relation to constraint layers determined by floodplains, and current land uses in Manhattan.

Principles of Evaluation

In order to evaluate the program What if?™, it is important to be aware of the three-evaluation objects:

1. Technical evaluation – will assess the program's logic, algorithm and data flow. There are various tools to aid the evaluation, such as analysis, models and projections generated by the program. This method will help to judge technical aspects of the system.

2. Empirical evaluation – will only be focused on performance and time taken by the user to utilize the application. Categories in cost benefit analysis and utilization information economics will not be considered in this report.

3. Subjective evaluation – this portion of the evaluation will view how effectively What if?™ affects the interrelationship among the users and environment. A user's perception towards the user interface such as ease of use, understandability, and clarity would be an example of a subjective evaluation (Rhee & Rao, 2008).

Once this has been explained and understood, it is possible to evaluate What if?™ by using several criteria. In this study, the evaluation will focus on the effectiveness of the program within the decision-making process for planners. Figure 4.2 below is showing the evaluation framework for What if?™.

What is Being Evaluated (Evaluation Objects)

	Technical Aspects	Empirical Aspects	Subjective Aspects
OBJECTIVE	– Data flow – Application control	– Cost/Benefit Analysis – Utilization Information Economics – Time Taken	
SUBJECTIVE			– Ease of use – User interface – Understanding

OBJECTIVITY OF CRITERIA

Figure 4.2 Framework of Evaluation

(Rhee & Rao, 2008)

The evaluation of What if?™, will consist of three components:

1. System usage – different organizations have various needs. The program cannot satisfy all the conditions of different organizations in terms of task, users, and organizational context. System restrictiveness is defined based on the program's function and ability to analyze information that is essential for planners, which includes the technical aspect of evaluation described above.

2. Decision guidance – in the next stage of evaluation, the report will be analyzing the ability of the What if?™ program to lead users to the structure and to execute their decision-making process. This includes close examination of the output information generated by the program, to determine its usefulness by creating suitability analysis with What if?™ by using GIS data obtained from City of Manhattan, Kansas. This phase of the evaluation will be partially based on the evaluation object diagram mentioned above.

3. Decision-making effectiveness – this will examines the relationship between what should be done and what has already been done (Evan et al. 1989). In other words, if the expected results in the program are verified through the Manhattan Comprehensive Plan, the system can be deemed effective. This process will include the evaluation of usage of the program, and whether or not it is user friendly? Does the program provide easy to read and understandable output? Is the program interface simple to follow and easy to operate? How long does it take for the program to generate the analysis, was it efficient and of satisfactory quality? These questions will be answered by comparing the data generated for the City of Manhattan comprehensive plan. For this evaluation, the principles will be based on the subjective aspect mentioned above (Rhee & Rao, 2008).

Once What if?™ generates the output analysis for Manhattan, there will be an overall comparison of the quality of the output and the data quality in comparison between two set of different ratings of Suitability Analysis. The scoring for the analysis is solely depends on user preferences.

Summary

This chapter outlined the methodology and criteria that will be used in evaluating the What if?™ software with principles described in Rhee's and Rao's article, which consisted of the proposed decision (outcome) quality, the efficiency of the decision-making process, and the decision-maker's satisfaction. While the approach provided a fundamental evaluation process and guideline for evaluation, it is also expected that the evaluation of the program would be vulnerable to errors. The approach is entirely based on the evaluator's experience and standpoint with similar computer applications and the What if?™ software.

CHAPTER 5 - System Overview of What If?™

The application of What If?™ version 2.0 is categorized as a rule-based, comprehensive project, task-oriented PSS. The program is a stand-along software package, developed using ESRI's MapObjects embeddable mapping and GIS components. According to the ESRI website, developers can use MapObjects "to create applications that include dynamic live maps with GIS capabilities. Developers can also build custom applications using ESRI's latest platform like ArcGIS Engine…. ArcGIS Engine applications can vary from simple map viewers to custom GIS editing programs" (MapObjects-Windows Edition, 2008).

What If?™ is made up of three main components: suitability, demand and allocation. The role that each of these components play in projecting future development patterns are described below:

- Suitability Component - The land suitability analysis (LSA) component enables the user to input a number of constraints and opportunities that can be represented geographically. These spatial constraints and opportunity layers are referred to as "suitability factors" (Klosterman, 2007) The LSA approach is based on the simple mapping overlay approach. A spatial overlay of all the suitability factors are created and enables users to assign ratings and weightings of importance to specific factors (such as distance to bus station) to define the overall land suitability for a particular land use (such as industrial). The Land Suitability Mode enables the user to produce both map and report for a particular land use.

- Demand Component - The land use demand component projects the demand for residential, employment-related, preservation, and local land uses. The demand

assumptions are driven by the available or calculated projection figures and included projected population and employment trends, future population and employment densities, and desired quantities of open space and recreational land. The demand assumptions are converted into the equivalent land use demands and can be viewed in table formats.

- Allocation Component - The What If?™ allocation Component projects future land use patterns using both the inputs from LSA and the land use demand modules. The allocation module also takes into consideration public policies such as farm preservation, zoning ordinances, growth controls, and infrastructure services (roads, sewers and water) to guide the future allocation of land for particular purposes. The allocation engine steadily allocates land required for a particular land use on a user defined time period. Once the required land for a particular land use is satisfied the allocation engine proceeds in assigning land for the next prioritized land use until its demand has been met.

Based on the three components mentioned above, What If?™ provides four options which allow users to customize the program. These four options are: the Sustainability analysis option, the Land Use analysis option, the Population analysis option and the Employment analysis option:

- Suitability Analysis Option – the option allows users to produce suitability maps showing the relative suitability of different areas for accommodating future land uses. The Suitability Analysis Option can be used with only GIS information on the current land uses in the study area and the suitability analysis layers (Klosterman, 2007).

- Land Use Analysis Option - The Land Use analysis option allows you to produce maps showing the projected land uses for up to five projection years. The option also allows users to produce reports and shapefiles reporting the projected land uses for target areas such as census enumeration districts, political jurisdictions and traffic analysis zones (TAZs) (Klosterman, 2007).

- Population Analysis Option - The population analysis option provides the following: all of the information for the land use option and reports and shapefiles reporting the following information for the target areas users defined:

    o Total population;

    o Group quarters population;

    o Number of households;

    o Number of housing units;

    o Number of vacant housing units;

    o Vacancy rate; and

    o Average household size.

    o Employment Analysis Option - the employment analysis option allows users to produce all of the projection information for the population and land use data option provided by the Land Use and analysis option. In addition, it allows users to produce reports and shapefiles reporting the employment, by place of work, for the target areas which are user defined.

What If?™ comprises two applications – Setup and What If?. In What If?™ version 2.0, the application allows users to have:

- The ability to project land use, population and employment figures;

- Flexibility in the number of land use classes and suitability factors that the PSS can handle, and customizable slider bars to capture planning metrics, which are rating and weightings;

- Disaggregated reporting on the projections for target areas and/or total study area; and

- Cartographic and mapping capability.

What If?™ requires pre-processing (such as buffering, union, clip, clean… functions) of input data layers to create a Unified Analysis Zone (UAZ) file. This particular file is referred as the "UNION file" in the user manual. The UNION file is used as the intermediary link between the original GIS data files and the What If?™ program, which allows the installation process to begin by collecting the relevant GIS layers and clean out the ones that are not relevant. To create the UNION file requires two things: GIS shapefile layers and ArcGIS. To convert from GIS layers into a What If?™ UNION file requires the following steps (Klosterman, 2007):

Step 1:

Combining GIS layers – the process started by using the UNION command available on ArcMap to spatially join the different GIS layers that are required for the analysis, and merge them into a single layer that consists of all of the spatial and attribute information.

Step 2:

Removing Silvers – the process of creating the UNION file will cause numerous polygons that are extremely small in size to display in the map. These polygons could affect the accuracy and speed of the analysis, thus should be eliminated from the UNION file to ensure the accuracy of the analysis.

Step 3:

Deleting extra data fields – The process of unioning various GIS data layer will create extra data fields, many of which are not relevant to the analysis. Other than the required fields, the remaining fields that are not needed should be removed.

Step 4:

Creating UNION shapefiles - After completing the steps mentioned above, make sure the file is in the format of a shapefile in order for What If?™ to be able to perform its analysis.

Creating Projects in What If?™

After creating the UNION file in ArcMap, the next step is to create a project file in What If?™ to perform the analysis. The analysis capability is provided by the Setup program. When inputting new areas to analyze, a new project must be defined for the kinds of information that are available for the new study area. This data must be incorporated into What If?™ and new labels and values must be redefined.

What If?™ Setup

The file used in What If?™ setup is an ASCII text file that contains all of the information entered on the Setup program files with an extension of ".wif" which is a unique file name extension for What If?™. For Sustainability analysis, the following are the Setup options to create the project (see Figure 5.1 below for the Setup options dialog box):

- Installing GIS layers

- Running Setup program

- Reviewing UNION file contents

- Defining analysis option

- Defining land uses

- Associating land uses

- Defining suitability factors

- Defining suitability factor types

- Describing suitability value range

- Defining other information

- Creating project files
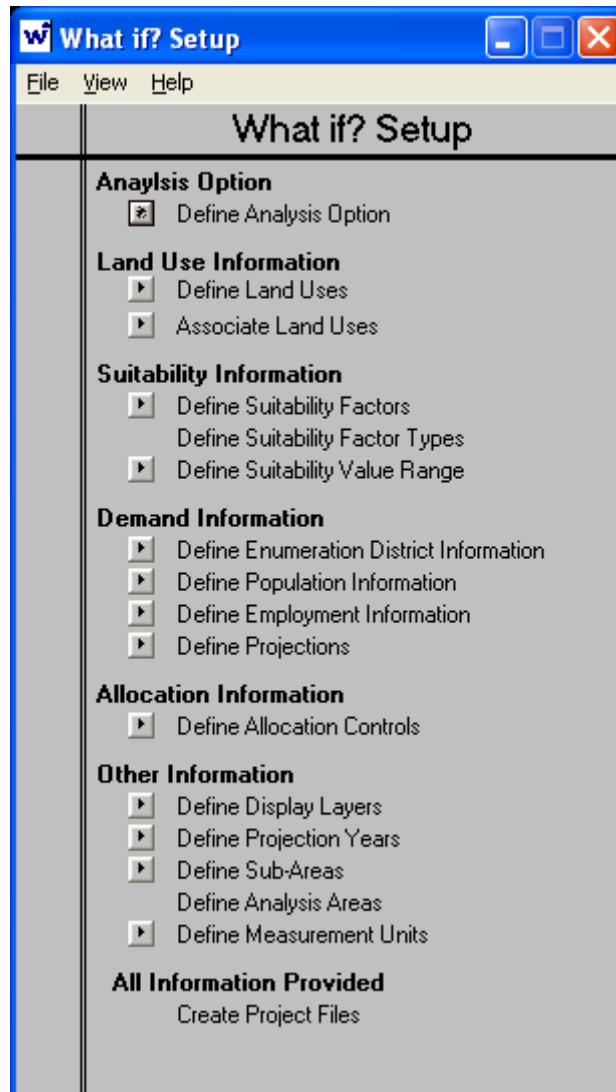
- Reviewing project information

Figure 5.1 What If?™ Setup Dialog Box

The buttons on the left side of the dialog box are used to access the forms and entering required

information. All labels are associated with buttons, and once the user selects Define Analysis

Option, it will specify the information option to be used in the analysis (Klosterman, 2007).

Data Sources

The following section briefly describes sources for GIS, population and employment data which users typically require for their analysis.

- GIS Data – Most of the GIS data required by What If?™ can be obtained either from local or state agencies. There are also GIS data sets users can obtain from the local municipalities or sometime can also be attain from area universities. For the State of Kansas, Kansas Geospatial Community Commons is a great place from which to download GIS data. The website is organized by the University of Kansas, Department of Geological Survey. Universities sometimes published GIS data as well. For Kansas GIS data, a good place to go to is DASC (Data Access & Support Center): Kansas Geospatial Community Commons, which is run by the University of Kansas Geological Survey. Other major web portals for GIS data are (GIS Data - Where to Get It, 2008):

- U.S. Geological Survey – this website includes a wide range of metadata information, and other data such as Digital Raster Graphic files (DRGs, the standard USGS "topo" quads), Digital Elevation Models (DEMs, used to create shaded relief maps such as slope analysis), Digital Line Graphs (DLGs, the individual element of topo quads), and Digital Ortho Quads (DOQs, aerial imagery).

- U.S. Bureau of the Census – Stores demographic information, TIGER data sets, which includes state, country, city, census boundary files, roads, streams and much more.

- CAST (Center for Advanced Spatial Technology) – hosted by the University of Arkansas, an excellent portal to GIS data for each state, particularly natural resources information.

- U.S. Government Geospatial Data Portal – a consolidated framework for all U.S. government GIS data, includes natural resources information, pollution and demographic data.

- Wetlands Data – The National Wetland Inventory (NWI) digital data files, developed by the U.S. Fish and Wildlife Service, provides records of the wetland locations and classifications. The data set is available through the website: http://wetlandsfws.er.usgs.gov/NWI/download.html.

Other data sources:

- Population Data Sources – Depending on the analysis, where to obtain the past or current population data varies. Users could find the population information either from local data sources or at the U.S. Census Bureau American FactFinder website: http://factfinder.census.gov/home/saff/main.html?_lang=en.

- Employment Data Sources – The employment data required depends on the user's analysis. The employment information can be obtained from the U.S. Census, County Business Patterns at the website http://www.census.gov/epcd/cbp/download/cbpdownload.html, from 1998 to 2004.

- Employment data older than 1998 are available in hard copy from most local libraries or universities (Klosterman, 2007).

CHAPTER 6 - Setting Up with What If?™

For the Suitability Analysis, there were only two defined factors entered in the setup: flood zones and land uses for the City of Manhattan. For flood zones, it is based on the information provided by FEMA (Federal Emergency Management Agency) and the land uses of the Manhattan areas based on the information provided by the City of Manhattan. These are the only two factors used for the purpose of the report (see Figure 6.1 below).

Figure 6.1 Screen Shot Showing the Define Suitability Factors Dialog Box

After Define Suitability Factors, the setup continues with the Define Suitability Factor Type option (as illustrated in Figure 6.2 below). For the first iteration of land suitability scenario, the ratings and weighting of the Suitability Factor has been determined by the author.
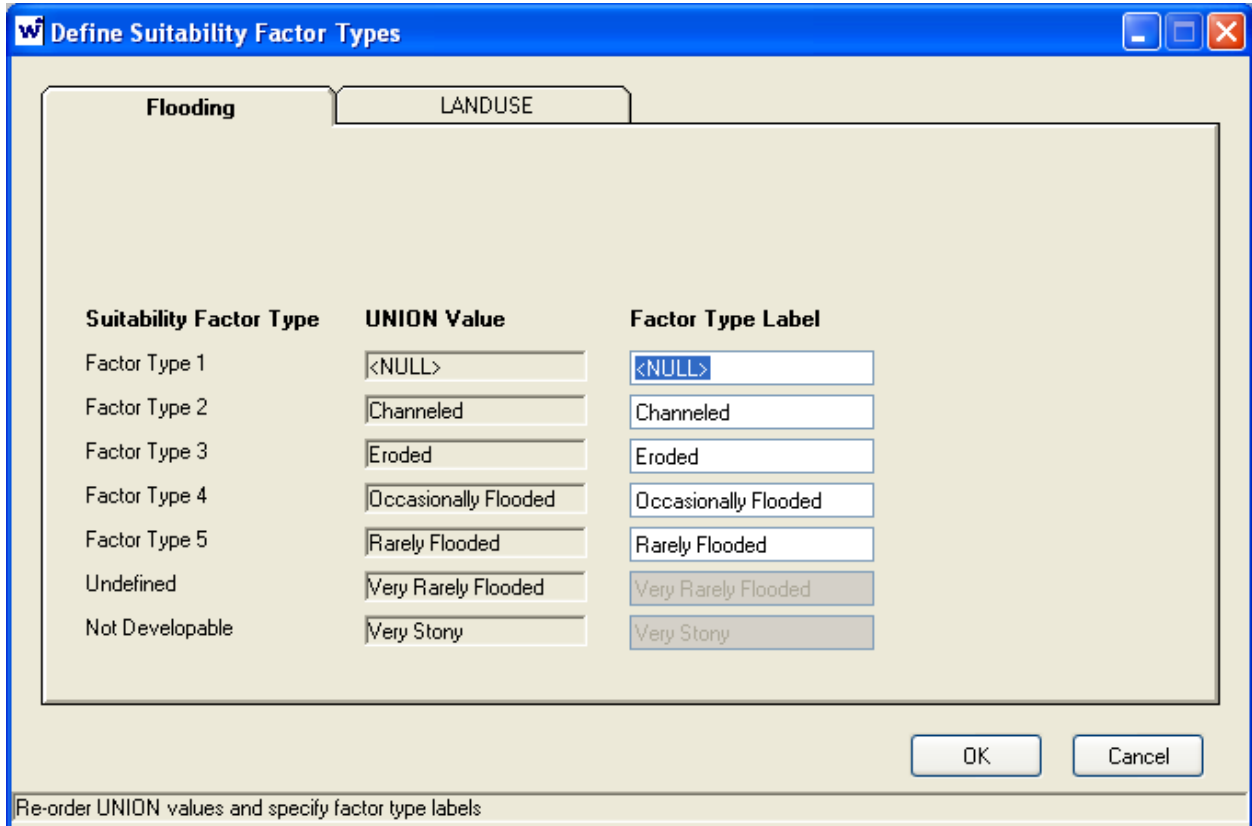
Figure 6.2 Screen Shot of Define Suitability Factor Types

After the setup is completed and the UNION project report is generated, now the system is ready to generate a calculation of Suitability Analysis. For the first iteration of land suitability scenario generation, the rating and weightings have been determined by the author. Figure 6.3 illustrates the screen shot showing the scenario-factor importance rating for the analysis.

"The importance sheet is used to specify the relative importance of different suitability factors for locating the land use selected in a projected future land use scenario" (Klosterman, 2007). The value showing on the right hand side of the dialog box is the specific value that the user can utilize to express assumptions concerning the relative importance of each factor for locating a particular land use. The value indicated the importance of the factors to the user (0 = low importance and 100 = high importance). In addition, zero values also can be used to assign factors that should not be considered or undefined (Klosterman, 2007).

The Suitability sheet also contains a value bar which allows the user to exploit and assign a rating for each Factor. Figure 6.4 below provides a screen shot of the Suitability Scenario Assumption dialog box.
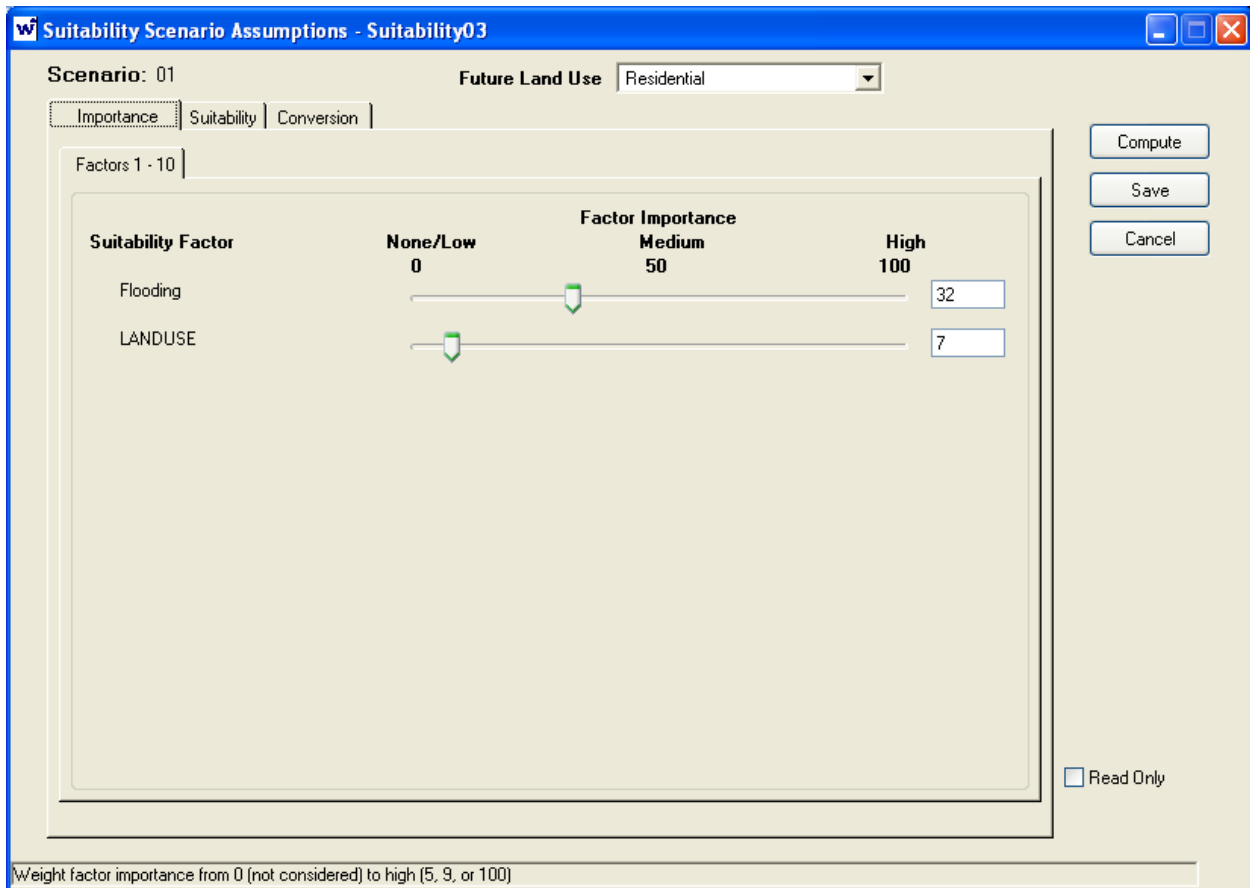
Figure 6.3 Screenshot of Suitability Scenario Assumptions Importance Score Factor

For the Scenario 01 created by the author, the Importance tab score factor provided were based on 0-100 value, so for the Scenario 01 Importance, Flooding Suitaiblity Factor was given a scale of 32 and the Landuse was given a score of seven.
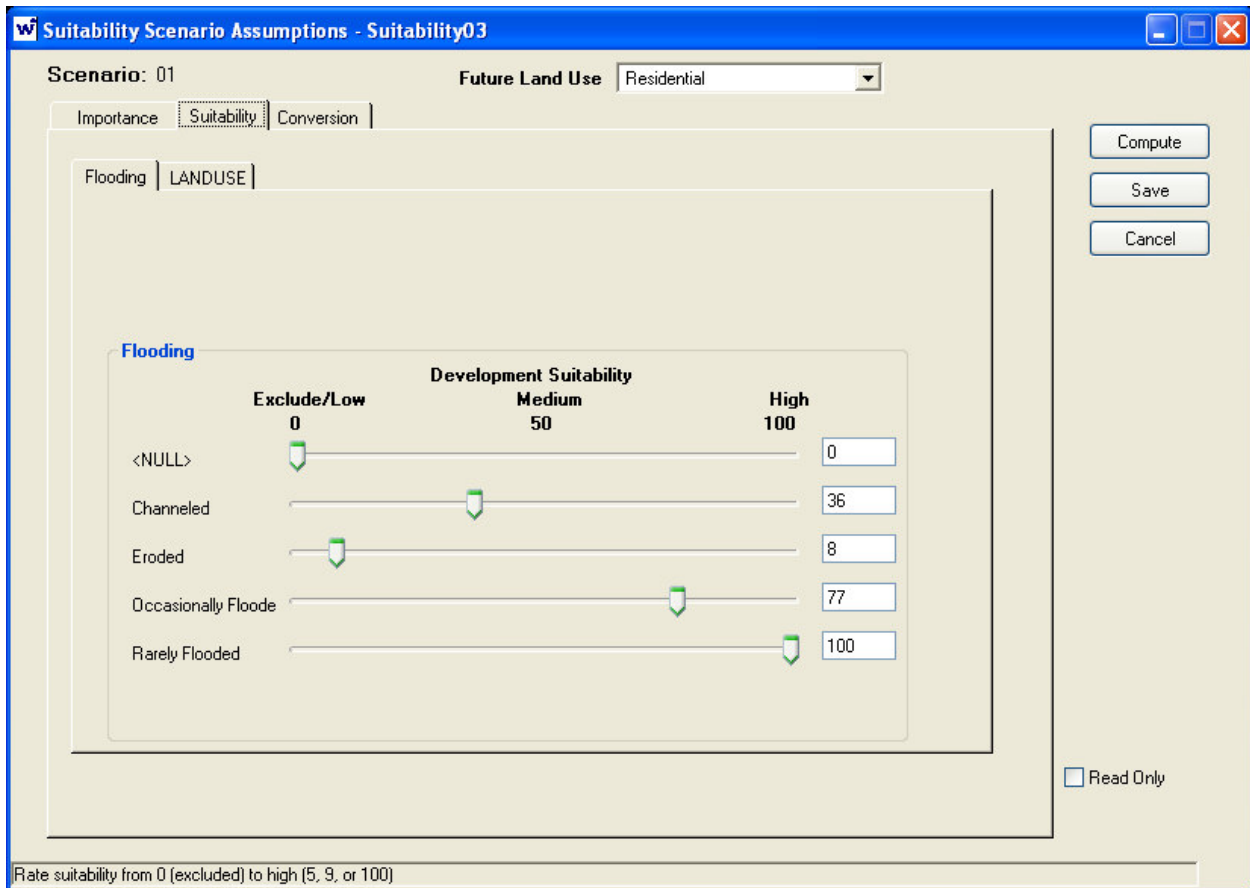
Figure 6.4 Screen Shot of Showing the Scenario Development Flooding Suitability Rating

For the Flooding Suitability tab in the Assumptions dialog box, the score for each factors in the flooding category were given a score as indicated in Figures 6.5. Null recevied no rating, Channeled was given the score of 36; Eroded flooding were given the score of eight; Occassionally Flooded was given 77; and Rarely Flooded was assigned 100.
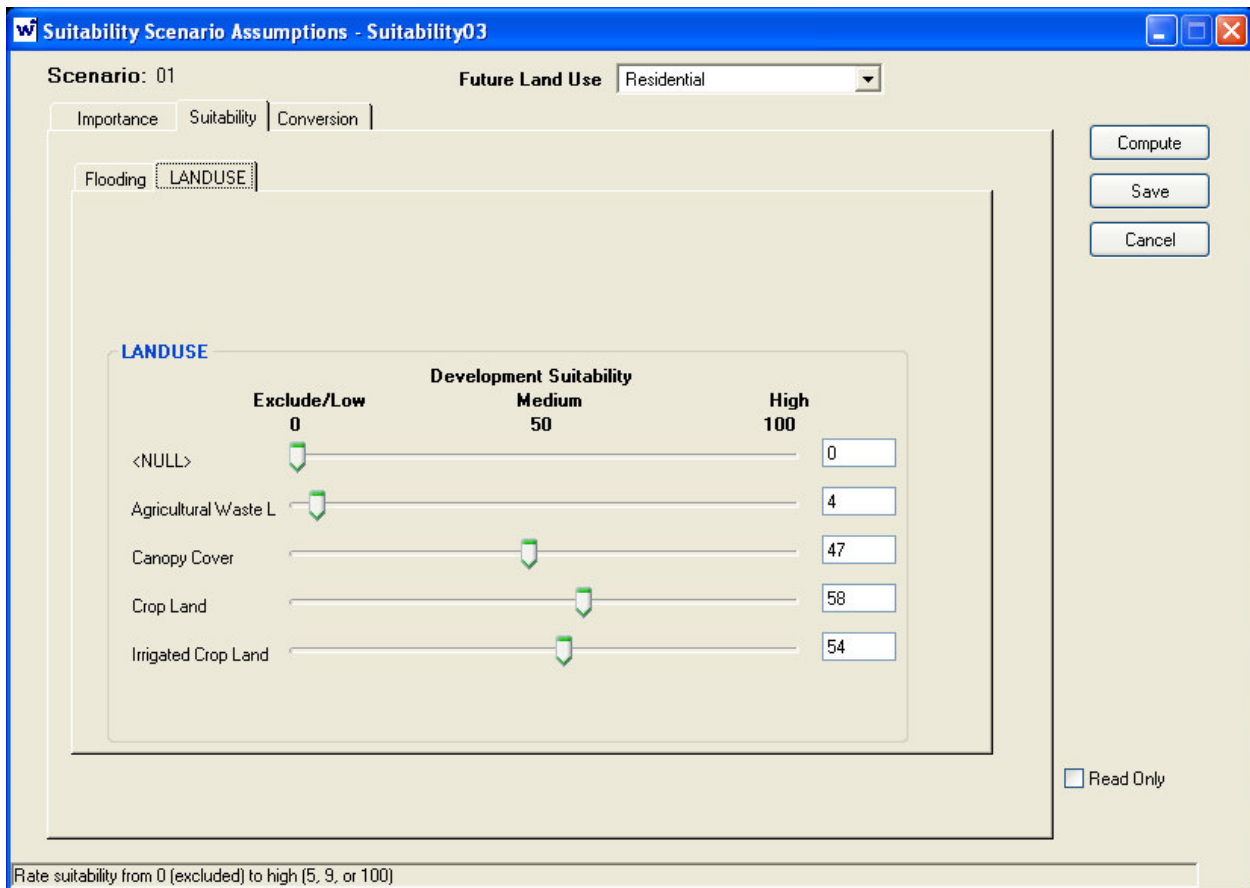
Figure 6.5 Screen Shot of Showing the Scenario Development Land Use Suitability Rating

Next, the user will need to assign score value for Land Use Suitability, as indicated in

Figure 6.6. Each land use factors was provided a score rating based on the assumed importance.

Null received no rating, Agricultural Waste Land was given a 82; Canopy Cover was assigned

the score of 47; Crop Land was 58; and Irrigated Crop Land was given 54.

When assigning importance and suitability ratings, it is very important to give all the

factors a rating. Otherwise, the system will not be able to calculate the analysis or may provide a

false analysis. The next step after assigning ratings for Suitability factors, is to determine the

conversion of specify land uses from their current use. The check boxes in the dialog box

indicate land uses that may be used to convert from their current land use. Figure 6.6 below

shows the screenshot of the Conversion sheet and land uses that are to be convereted, based on

the authro preferences.
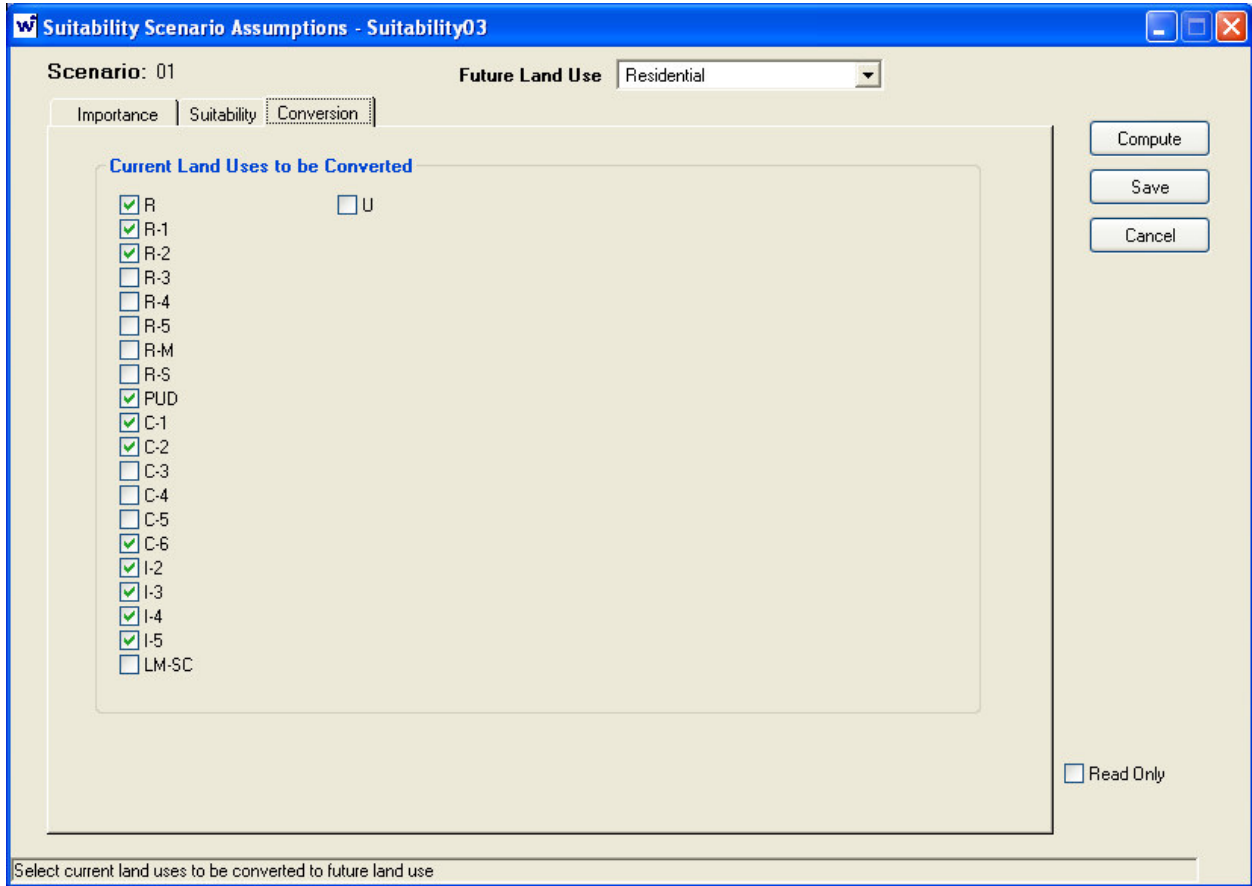
Figure 6.6 Screenshot of Conversion Dialog Box for Scenario 01

After completing the steps indicated above, the user can click Compute on the right side

of the dialgo box to compute the relative suitability of all the UAZs for each suitability land use

(Klosterman, 2007). "The suitability score for a particular UAZ is determined by: 1) multiplying

the UAZ's suitability rating for each factor by the corresponding importance weight; and 2)

summing these products. Suitability scores are computed for all UAZs and all land uses"
(Klosterman, 2007). According to Klosterman (2007) after the system finishes computing, the
following options are available for viewing the suitability analysis results:

- Suitability maps – the system generates a series of maps showing the relative
  suitability of different locations for each of land uses considered in the suitability
  analysis.

- Suitability reports – along with suitability maps, the system will also be able to
  generate reports which identifies the number of acres or hectares within each
  suitability class for all land uses for a specified suitability scenario.

- Comparing suitability reports – The system allows the user to examine the suitability
  maps for more than one suitability scenario or land use at the same time.

- Suitability assumptions report – the system is also able to provide the assumptions
  which underlay a given suitability analysis.

Results Produced For Scenario 01

In the What if?™ file menu selection, in the **C**urrent option→ **M**ap is the illustration of
current condition of the Manhattan, Kansas based on the author's input (See Figure 6.7). The
map is based on the UNION file that was created in ArcMap.
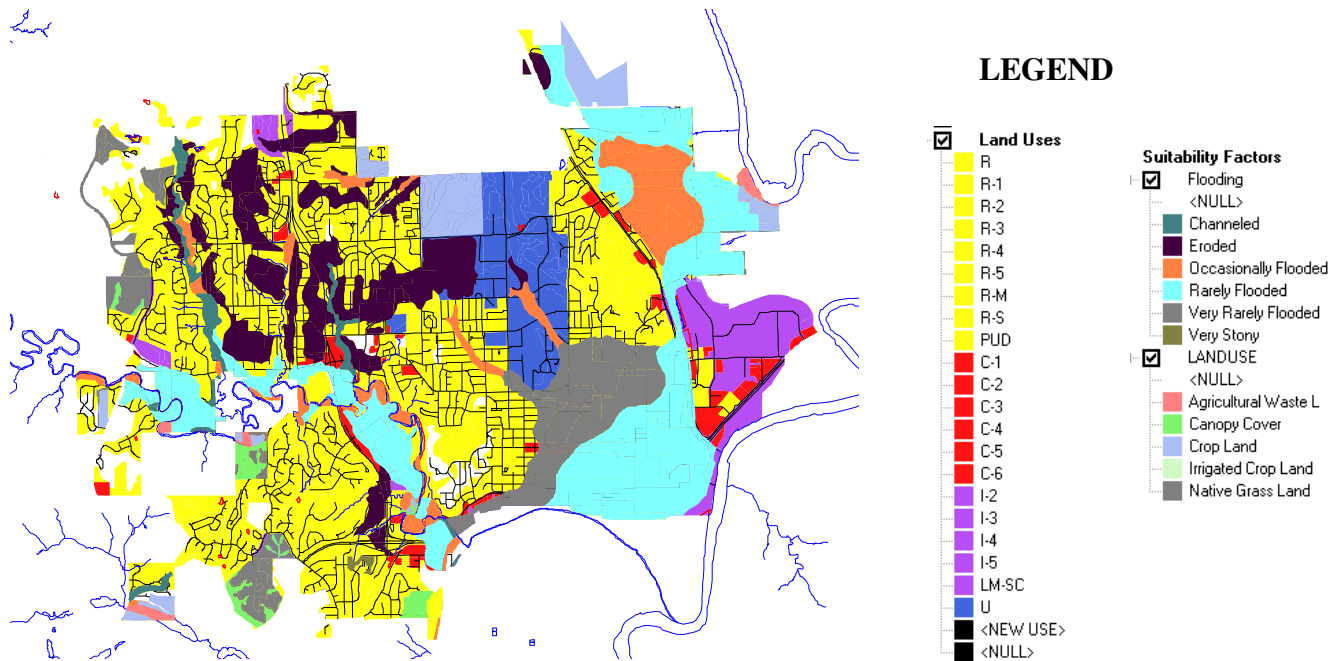
Figure 6.7 Based Map of What if?™ Suitability Analysis Created from UNION File

Based on the existing Manhattan conditions and the criteria that were set by the author, and the Suitability Analysis generated by What if?™ for Manhattan, Kansas. The program indicated about half of the residential areas are not suitable for development, or not convertable for development based on the flood zone and importance assumed for this scenario. Figure 6.8 shows the mapping result of the Suitability Analysis generated by the application.

For commercial businesses, the result shows that the majority of the areas in Manhattan are not convertable, as illustrated in Figure 6.9.
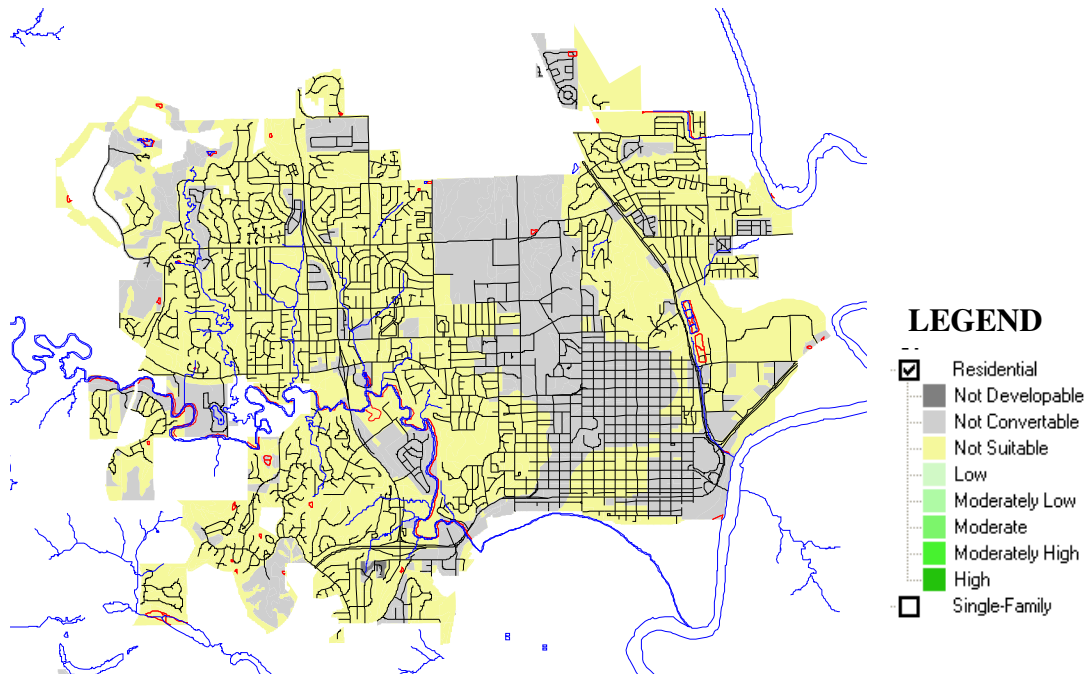
Figure 6.8 Map of Suitability Analysis of Scenario 01 for Residential Area
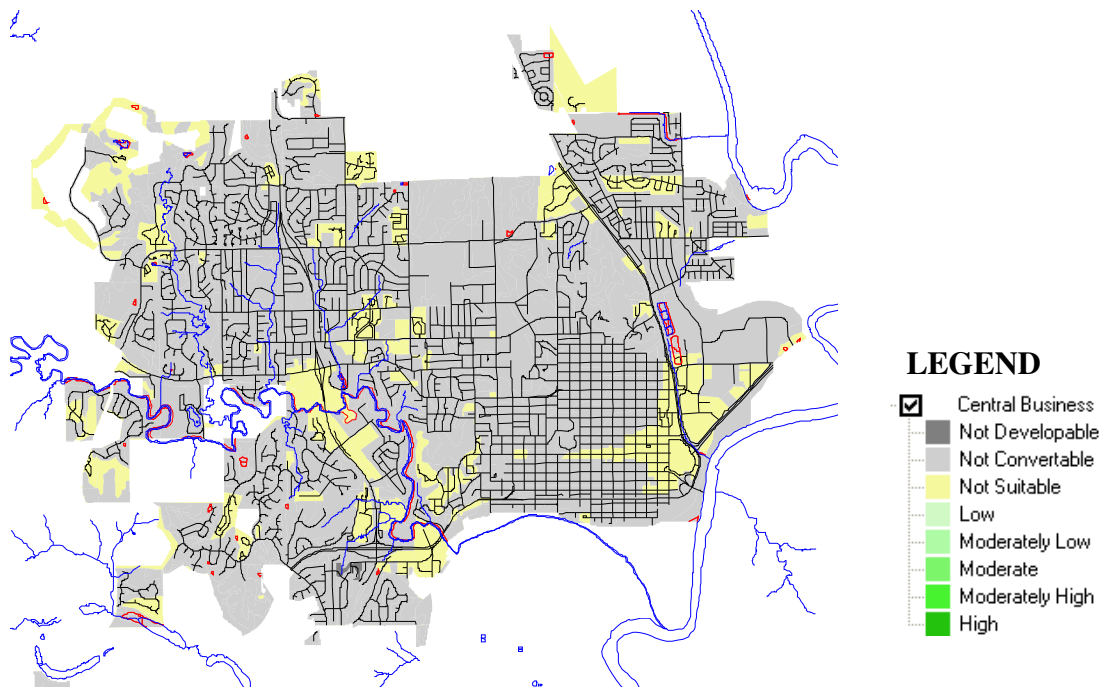
Figure 6.9 Map of Suitability Analysis of Scenario 01 for Commercial Businesses
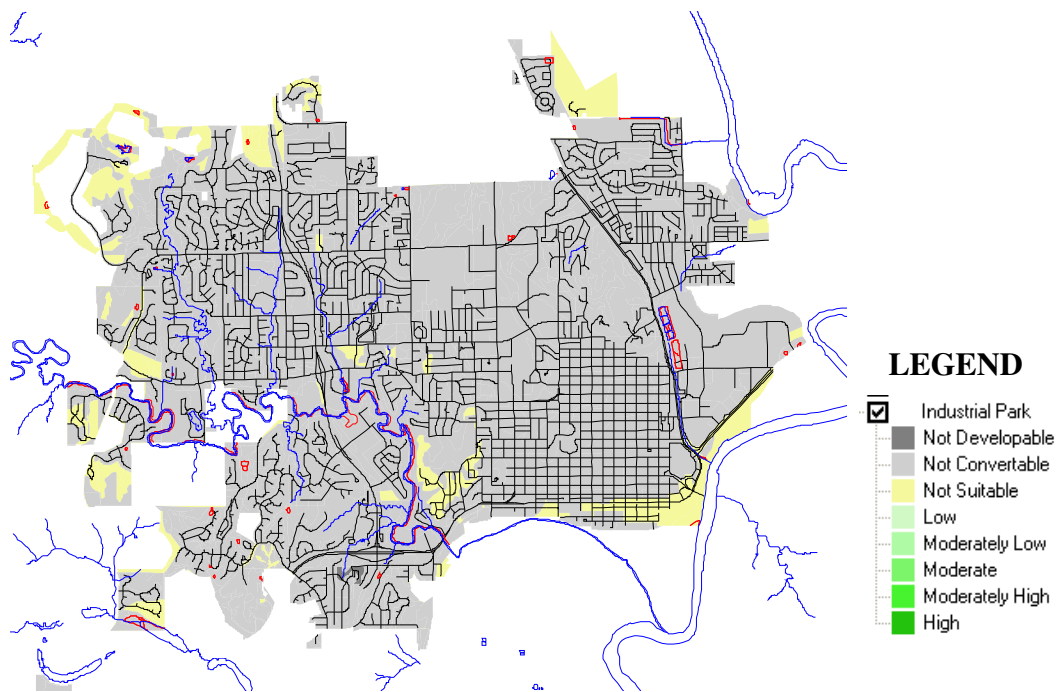
Figure 6.10 Map of Suitability Analysis of Scenario 01 for Industrial Park

For Industrial Park, the result shows that the majority of the areas in Manhattan are not convertable, with some similarity from the map result produced for the Commercial Business (see Figure 6.10).

Result Produced For Scenario 02

For Scenario 02, the author rated the score value for each suitability factor purposely different from the Scenario 01 to provide a comparison between the two analyses generated by What if?™. All criteria and base information still remain identical with Scenario 01. The following are the Suitability Scenario Assumption scores:

- Importance –

  - Flooding = 50

  - Land use = 50

- Suitability –

  - Flooding:

    - Null = 0

    - Channeled = 14

    - Eroded = 2

    - Occasionally Flooded = 100

    - Rarely Flooded = 100

  - Land use

    - Null = 0

    - Agricultural Waste Land = 100

    - Canopy Cover = 8

    - Crop Land = 8

    - Irrigated Crop Land = 8

For Conversion, Figure 6.11 is the screenshot of the dialog box displaying the selected options for Scenario 02:
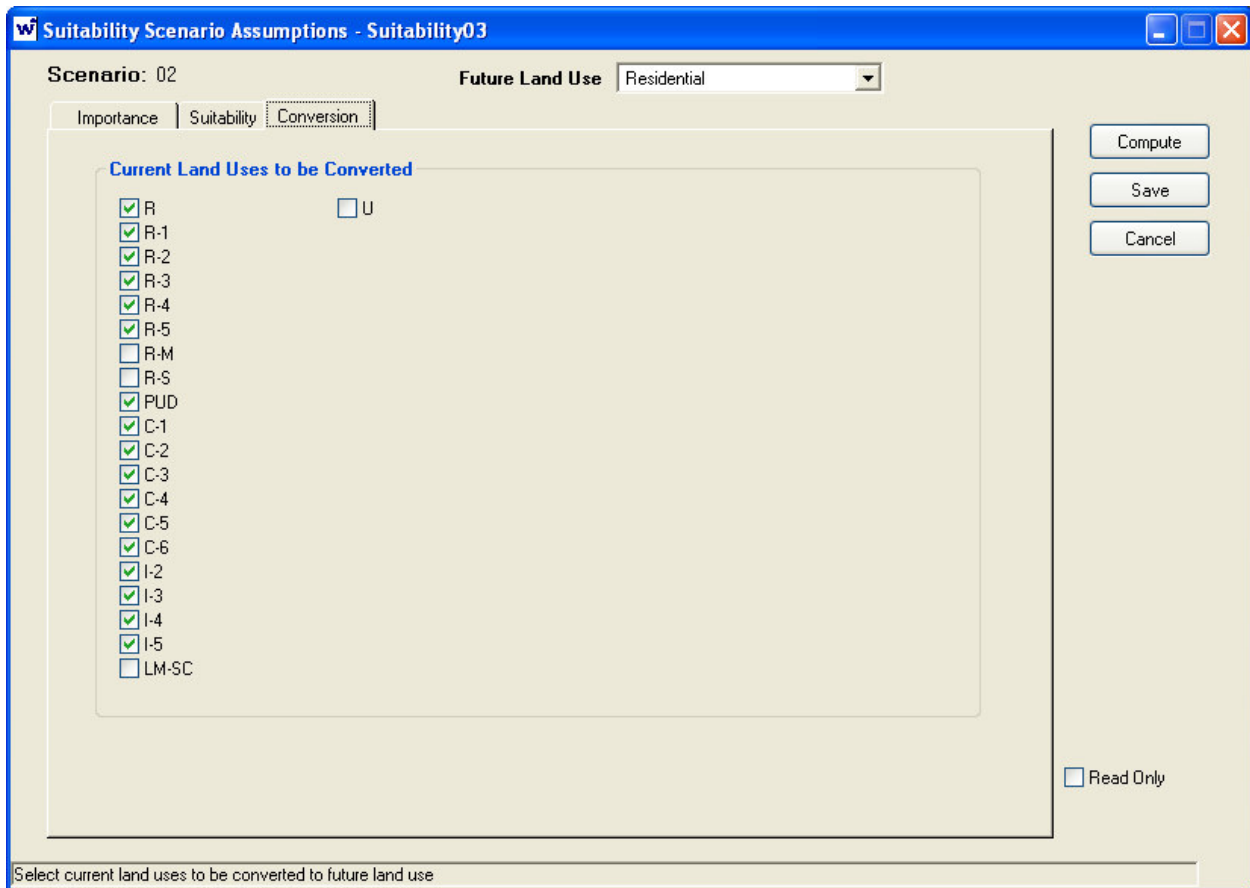
Figure 6.11 Screenshot of Conversion Dialog Box for Scenario 02

For the Residential Suitability Analysis What if?™ performed on the Scenario 02, there are some areas that are moderate high to low suitable for development within the City of Manhattan area. The differences in the analysis results between Scenario 01 and 02 were attributed to the score rating for both scenarios. In the Scenario 01, the weighting of scores for flooding is higher than land use. But for the Scenario 02, all factor scores are the same on the Importance tab. Therefore What if?™ ignored the suitability of development in the flood zone areas and generated a different outcome in the analysis (see Figure 6.12, 6.13, and 6.14 for Residential, Central Business and Industrial Park suitability map).

LEGEND

☑ Residential
■ Not Developable
■ Not Convertable
□ Not Suitable
□ Low
□ Moderately Low
□ Moderate
□ Moderately High
■ High
□ Single-Family
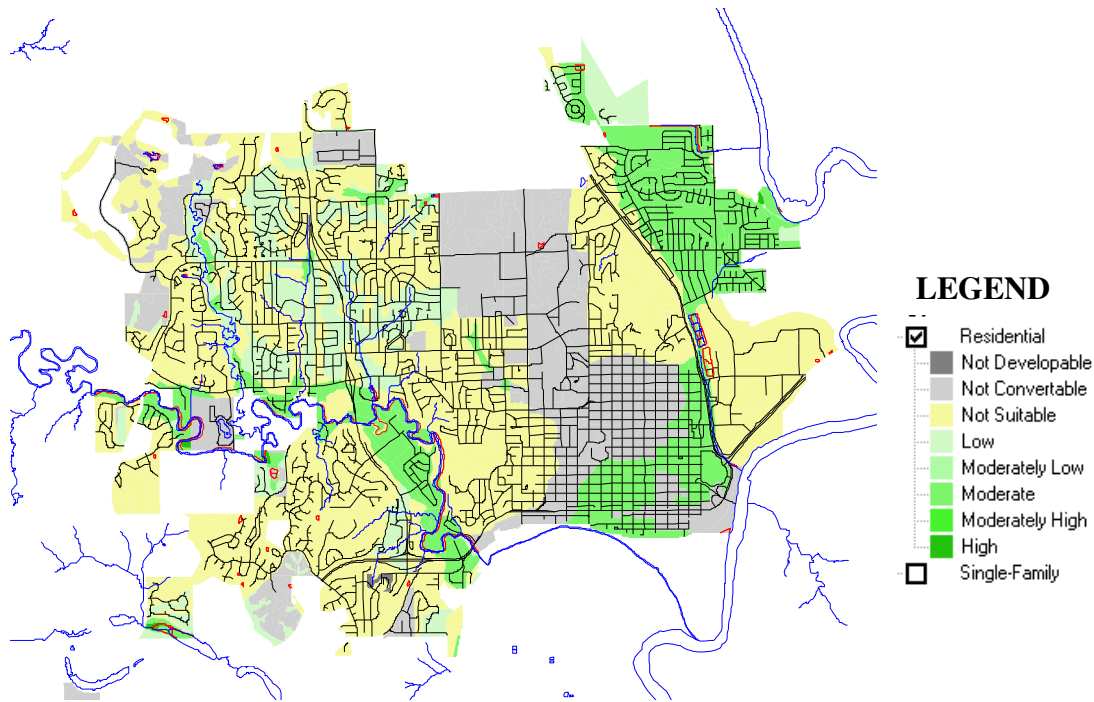
Figure 6.12 Map of Suitability Analysis of Scenario 02 for Residential Area

In comparison to Scenario 01 Residential map from Figure 6.8, Scenario 02 has the northeast, parts of southeast and southwest indicates are moderate for development. The change of the suitability analysis is resulting from changing of Suitability Scenario Assumption scores in the Importance tab (the author rated both floodplain and land use the same). As a result, the What if?™ program analyzed the suitability with both factors using the same importance, which caused the analysis to be different from Scenario 01.

These changes are the same for all the suitability maps of Scenario 02. For Scenario 02, they are all indicating that some parts of the City of Manhattan are suitable for development, which is due to the change in the user input rating scores.
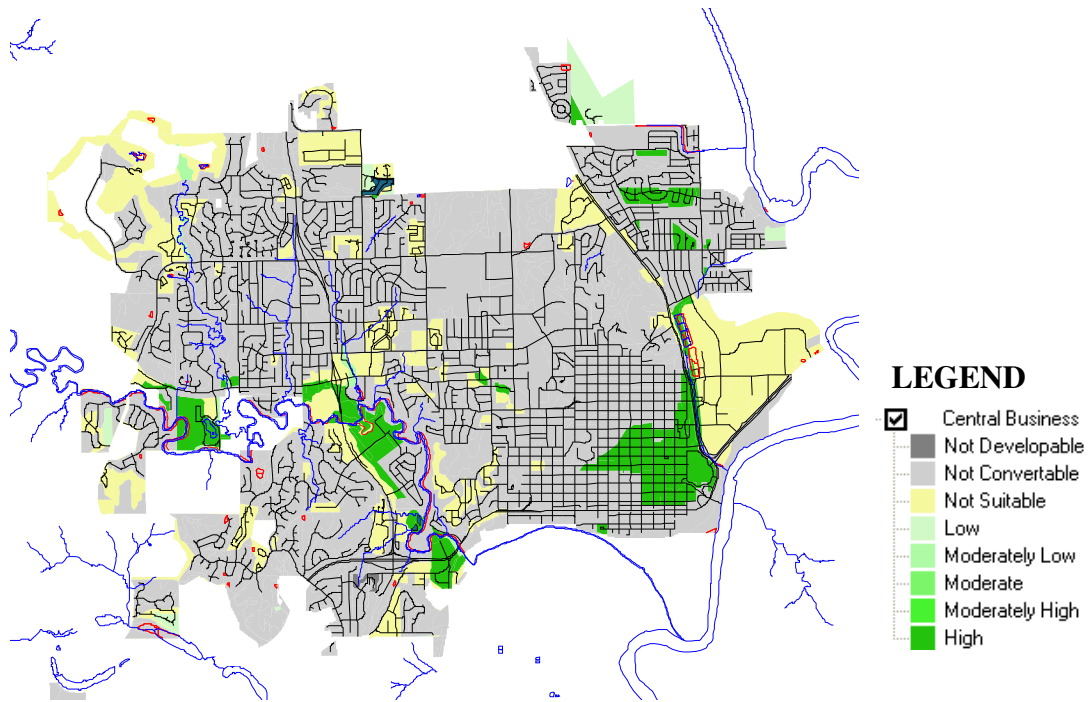
Figure 6.13 Map of Suitability Analysis of Scenario 02 for Commercial Businesses
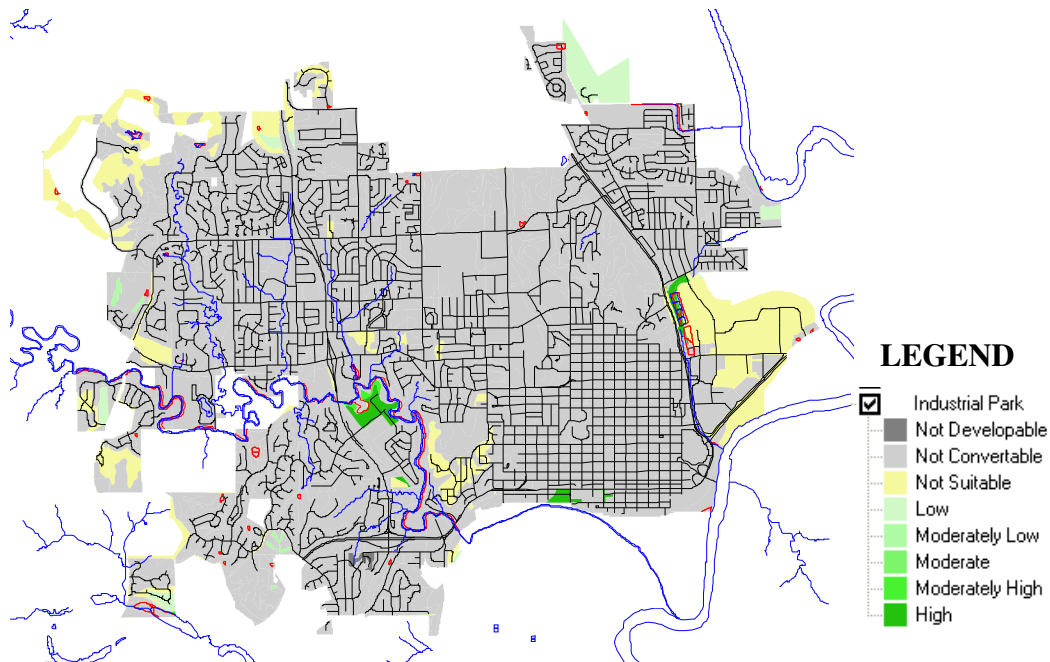
Figure 6.14 Map of Suitability Analysis of Scenario 02 for Industrial Park

Accompanying the visual result of maps generated by What if?™, the application also creates a Suitability Assumption Report. The report is a summary of assumptions, factors, and weighting values the user input into the scenario (see Figure 6.15 shown below).

What if? Suitability Assumptions Report

Scenario:	02
Project:	Suitability03
Report Printed:	May 13, 2009 2:54 PM
Scenario Computed:	May. 13, 2009 12:53 AM

Residential Suitability Assumptions

Factors Considered

Factor	Considered	Weight
Flooding	Yes	50.00
LANDUSE	Yes	50.00

Factors Ratings

Suitability Factor:	Flooding
Category	**Rating**
<NULL>	0
Channeled	14
Eroded	2
Occasionally Floode	100
Rarely Flooded	100

Suitability Factor:	LANDUSE
Category	**Rating**
<NULL>	0
Agricultural Waste I	100
Canopy Cover	8
Crop Land	8
Irrigated Crop Land	8

Figure 6.15 Suitability Assumption Report Generated by What if?™

What if?™ also produces a suitability analysis report based on assumptions entered by the user. The report can be viewed by selecting the Suitability Assumptions Report. Figure 6.16 below illustrates a typical suitability report by What if?™. The report provides all of the information only for the selected suitability scenario (Klosterman, What If? User's Guide, 2007):

- The name of the project and the suitability scenario

- Dates as to when the report is generated and printed

- The factors that were considered for each suitability land use

- Weight values specified by the user for each factor type

- The land use that may or may not be converted from their current use to each suitability land use.

What if? Suitability Report

Scenario: 01
Project: Suitability03
Report Printed: May 13, 2009 2:43 PM
Scenario Computed: May. 13, 2009 12:20 AM

Suitability Land Use	Suitability Category	Suitability Scores	Acres
Residential			
	Undefined	NA	7,880.2
	Not Developable	NA	10.0
	Not Convertible	NA	3,975.4
	Not Suitable	NA	7,544.2
	Low	1.0 to 0.1	0.0
	Medium Low	1.1 to 0.2	0.0
	Medium	1.2 to 0.2	0.0
	Medium High	1.2 to 0.3	0.0
	High	1.3 to 0.4	0.0
Total			**19,409.8**

Figure 6.16 Suitability Report Generated by What if?™

In addition, the application also provides a report allowing users to directly compare the results of two different suitability scenarios (see Figure 6.17 shown below). The report provides all of the information that was specified for the selected suitability scenarios (Klosterman, What If? User's Guide, 2007):

- The name of the project and suitability scenarios
- Dates the report is computed and printed
- The acres (or hectares) of land in each suitability score interval for each of scenarios.

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What if? Suitability Scenario Comparison Report

Project: Suitability03

Scenario #1:   01
Scenario Computed: May. 13, 2009 12:20 AM

Scenario #2:   02
Scenario Computed: May. 13, 2009 12:53 AM

Report Printed: May 13, 2009   2:33 PM

		Scenario 1		Scenario 2	
Suitability Land Use	Suitability Category	Suitability Scores	Acres	Suitability Scores	Acres
Residential					
	Not Developable	NA	10.0	NA	10.0
	Not Convertible	NA	7,880.2	NA	2,465.0
	Not Suitable	NA	7,544.2	NA	8,136.1
	Low	1.0 to 0.1	0.0	1.0 to 2,000.0	2,374.0
	Moderately Low	1.1 to 0.2	0.0	2,001.0 to 4,000.0	0.0
	Moderate	1.2 to 0.2	0.0	4,001.0 to 6,000.0	3,518.7
	Moderately High	1.2 to 0.3	0.0	6,001.0 to 8,000.0	0.0
	High	1.3 to 0.4	0.0	8,001.0 to 10,000.0	347.4
Total			19,409.8		19,409.8

Figure 6.17 Scenario Comparison Report

Overall, the suitability analysis of What if?™ provides the user the ability to determine the relative suitability of different locations for different land uses, while inputting a number of constraints and opportunities that can be represented geographically. These spatial constraints and opportunities are used as suitability factors in the What if?™ program. After input of these layers, a spatial overlay of all the suitability factors is created. This allows the user to assign ratings and weighting of importance to specific factors based on different community policies. In addition, What if?™ can produce both maps or reports of local land suitability for a particular land use (Pettit, Keysers, Bishop, & Klosterman, 2008).

CHAPTER 7 - Evaluation of What If?™

As the previous chapter mentioned, What if?™ has four analysis options, (Suitability, Land Use, Population and Employment). These analysis options enable planners to think in a regional context, while the program provided a major advantage to help planners to visualize the future for their communities. The system also empowers planners to critically examine planning policy through an evidence based science approach. The program is a very powerful tool, only if planners are able to overcome a few obstacles.

In order for one to be able to perform the analysis using What if?™ the first and foremost condition is to collect the GIS data layers that are required for the system to perform the analysis. Fortunately, Manhattan has been developing their GIS data files extensively for the past few years and are still continuing updating their GIS information. Over time, the City of Manhattan has collected a substantial number of GIS data layers that are inclusive and conveniently available for the public to access, which is the deciding factor to continue the research by using Manhattan GIS data.

Technical Evaluation

The category of evaluation consists of two assessments in the following areas: 1) suitability of data sources; 2) Validity and accuracy of the application analysis.

Suitability of Data Sources

According to the User Guide, the only absolute essential GIS layer for using What if?™ "is the one identifying the study area's existing land uses" (Klosterman, 2007). However, in order for What if?™ perform any type of analysis, it is imperative to have "at least three natural

features layers for the Suitability component of the analysis and two or three additional infrastructure or land use control layers for the Allocation components" (Klosterman, 2007). For the most part, it is best to use GIS data layers obtained from trusted sources when conducting the analysis. There were two potentially key issues that can be critical to the success of the What if?™ analysis. The first problem can be the most difficult of the two. For small rural areas, many local municipalities are still trying to establish their GIS data information, and many of these required layers are still in the developing stage, or may not be as complete or coherent as compared to data availability in large metropolitan municipalities. As the previous chapter described, What if?™ is entirely based on the UNION file created from ArcMap to perform its analysis. Without the required GIS data layers and the proper attribute information to create a UNION file, What if?™ is incapable of performing any type of analysis on its own. This can be a major obstacle for small communities trying to use the program. The second problem is found in the Suitability option. When selecting Suitability factors from the UNION field in the setup dialog box for "Define Suitability Factors," the program has limited the selection to allow up to 20 Suitability factors. Furthermore, each factor can have no more than five factor types. For instance, this means that there can be only five soil classification (or types). Otherwise the program will refuse the entered factor. The constraint on the factor type can be a problem in certain areas, such as Manhattan, Kansas. According to the soil map from City of Manhattan, there are over twenty soils types within the city boundaries. For most planners, without proper training in soils identification, a challenge may exist to distinguish each types of soil and reclassify it according to their similarities. Most importantly, there is no other way for What if?™ to adjust the accepted Suitability factor, which means that if the GIS layer attribute consisted of one extra factor, the program will refuse to accept the layer and will not be able

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continue with the setup process. To overcome this restriction, the user must return to the GIS layer attribute in ArcMap, and make the necessary changes to re-classify attributes into five factors. Only then will What if?™ be able to accept the selection and continue with the setup.

Validity and Accuracy of the Application Analysis

Since there were not comparable predecessor studies of the analysis, the determination of the resulting output is largely based on the existing land use data and flood zone information provided by the City of Manhattan and the suitability importance rating chosen by the author. The program put all factors into consideration and created the results in a very short amount of time. The output addresses all the criteria, while efficiently providing an accurate result for the user. Please refer back to Chapter 6 for detail map analysis.

Empirical Evaluation

In this particular category, system performance and time taken to utilize the application are the main focus of the evaluation. The evaluation of the What if?™ system performance is based on the quality and depth of the output produced by What if?™. This portion of the assessment will be solely depending on the researcher's past experiences with other computer applications, as well as the user's adaptation of the system.

System Performance

Although What if?™ is heavily dependent on the pre-process information derived from ArcMap, the overall functions, performance and the time taken to create a comprehensive analysis report of the study area is still excellent. For the study area that is about the size of Manhattan, once the appropriate data layers are setup, it takes less than a minute for the system

to analyze the input data and create a detail What if? Setup Report which consists of land use information for the Suitability analysis option. The report contains all the Suitability options the user defined in the Setup, and other miscellaneous information such as the project name, location of the .wif file, UNION file, and the date and time the report was created and printed. After the analysis is saved on the appropriate driver location and the UNION report is created, the user is now able to select What if? on the menu selection and create maps. Depending on users selection of analysis at the setup and the level of Suitability Scenario Assumptions adjusted, different types of map analysis will be available for viewing. In addition, a map of the original input with the current study area's condition is also available for the user to review. Moreover, the program is also able to generate a Suitability Report based on the levels entered for each analysis. The program provides a convenient overlook for users with their analysis both visually and in text.

Subjective Evaluation

In the subjective evaluation, the assessment is based on the user interface and the user compatibility or understanding of the application in relation with the program interface. For the purpose of the evaluation, planners are the target users.

User Interface and Usability

Only one problem was encountered in the early installation of the program What if?™, which was to get the program installed and running. The problem still remains a mystery, however the installation was finally completed and became fully functioning after a few tries. One possibility which caused the malfunction of What if?™ was that the setup program

somehow was missing a DAT file (data file). The file is typically created by applications to store

data that can only be accessed with the particular application to which it associates. A data file is

especially helpful when debugging a program (.Dat File Extension, 2009).

After the successful installation, there were only two items displayed on the start menu, "what if"

and "what if setup". Both items lead to other dialog boxes that are self-explanatory. The

interface is simple in design, and it is not cluttered with command functions which would

overwhelm the users. The limitation in function selection also helped to ease confusion for new

users. For the most part, there are only a few options available for users to choose from

consistently throughout the entire program. For instance, when first opening the program, a

dialog box appears providing generally only two options from which users can choose: open a

setup or new setup.

Once the user selected the "Define Analysis Option," the file will be able to save under a

special file extension (.wif) which can only be accessed by the program What if™. Any other

changes which the user alters during the session will be saved under the same file (if the user

desires), all except the "Define Analysis Option." In this particular option, once user selected, it

will not be able to revert the choice unless the user starts another new file, and reselects the

option again. Finally, when defining the Suitability Scenario Assumptions, for some reason, if

the user does not rate all the factors, the program could yield an inaccurate analysis or the system

simply would refuse to perform any analysis. Yet the system does not inform the user of all

assumptions needed to be rated. Instead, What if?™ just provide a message indicating the layer

was not suitable for development, which could cause confusion for users not understanding the

exact reason the system will not perform the requested analysis.

As the previous paragraph mentioned, What if?™ was designed with a relatively simple interface. Dr. Klosterman, the creator of What if?™, is aware that planners "must recognize that their models are more likely to be useful in a policy context if policy makers and the public understand and trust them. As a result, planners should attempt to develop models that are simple – rather than as complex – as possible. While the model's detailed computational procedures will inevitably be too complex for nonexperts to understand, their underlying computational procedures should be understandable and clear" (Brail, 2008). Overall, the program interface is uncomplicated and straightforward if the user evaluates only the program itself. However, What if?™ depends on GIS so profoundly that it is very crucial for the user to be able to operate GIS fluently, as well as being computer literate, if one wishes to fully utilize functions available in the What if?™ program.

CHAPTER 8 - Conclusion

The previous chapter provided a detailed evaluation of What if?™. On the whole, the program is a great tool for planners to use and empowers the planners with a visual of the future resulting from chosen policies. What if?™ makes available options that are frequently used by planners in one single software package. The interfaces used in the program are intended to be simple, understandable and easy to use, which Dr. Klosterman had intended as his goal in developing What if?™. The system provided a convenient and quick way for planners to reveal the outcomes of different policy alternatives (Klosterman, n.d.). But since the program is so heavily GIS-based, the pre-process procedures required the user to fully utilize functions in ArcGIS. Although the User Guide published by What if?, Inc. provided some of the instructions regarding what is needed to be done in ArcGIS, for planners who have little or no experience with ArcGIS, these procedures can be a challenge.

One of the objectives of What if?™ is to allow the user to analyze the possible future alternatives in a short, convenient and effective way. The program does seem to forgo the quality of the maps it produces. In comparison to maps that are produced by ArcGIS, the resolution and visual quality of maps and reports that are produced by What if?™ are less attractive and more pixelated. In addition, the mapping and report layout function in What if?™ are also limited in comparison with ArcGIS. However, in order for the system to run more efficiently with less waiting time for users while it is analyzing, these are logical tradeoffs. The program otherwise still generates clear and precise reports and maps based upon each scenario entered into the system.

Furthermore, the constraints set forth by the program are extremely rigorous. All fields need to be defined and sometimes the numbers of factor fields are limited. In reality, especially in large municipal areas, there can be more than just five factors that need to be considered. In the case for users who have more than five factors, there are no other alternatives for them to re-adjust the number of fields they are able to define. The only means for them to resolve the situation is to return to the layer(s) with ArcGIS and reclassify and reduce the number of fields to five or less features.

Finally, one of the most important shortcoming of the program is the setup selection. Under the suitability analysis, all information and values must be fully defined; all available fields subsequently must have something assigned in order for the program to run properly. In some places, the message dialog box that appeared on the screen can be misleading. For a person who is new or not as familiar with What if?™, the confusion can cause unnecessary aggravation to the user. However, "set aside the theoretical issues about the limits of knowledge and assume that PSS models really can predict something useful… most planners are willing to make that assumption, or at least a softer version of it: PSS tools can help planners simulate and describe alternative futures" (Brail, 2008). For many planning agencies, the real obstacles are the cost of start up and the uncertainty about whether start up will be worth the trouble. According to Brail (2008), there are three main reasons for the hesitation of using PSS applications, which is an excellent summary for the report as well:

- Data – some PSS application require large amounts of data that are not readily available or usable form standard sources. Data collection and data cleaning may have taken years for some models,

- Calibration – some models require preparation work before utilizing the actual application.

- Training – learning the software can run up potentially big costs – not just the basic functions, but a comprehensive understanding of the structure of the application and model, its weaknesses and how to interpret results produced by the application. All of these can be more problematic and make the agency more vulnerable to mistakes if the user is not familiar with the software.

In conclusion, What if?™ is an analysis program that is able to provide many analytical services to planners. In the case of contemporary planning practice, too often planners abandoned the pursuit of a better future due to the lacking of projecting or visualizing tools. One of major improvement the What if?™ program need is to make the PSS application flexible, customizable to local circumstances and useful at different level of complexity, and also able to adjust the underlying requirements. The program enables planners to forecast the possible future based on their current public policies. If ones can master the functions of What if?™, the program can be a tremendous help in evaluating the effects or impacts of different planning policies.

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