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I am submitting herewith a thesis written by David Craig Brashier entitled "A Methodology for Evaluating the Role and Impact of Planning Support System Technologies and Scientific Information in a Planning and/or Decision-Making Process." I have examined the final paper copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning, with a major in Planning.

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We have read this thesis and recommend its acceptance:

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A Methodology for Evaluating the Role and Impact of Planning Support System Technologies and Scientific Information in a Planning and/or Decision-Making Process

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U.T. ARCHIVES

Dedication

This thesis is dedicated to Tamara Lindsey Dupwe and my mother, Clara Catherine Brashier, for their continuous love and support during the pursuit of my educational goals. Without both of these strong women, this thesis, and the accomplishments it represents, would not have been possible. I am forever grateful.

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Abstract

This thesis focuses on the application of scientific information and planning support system (PSS) technologies to community planning and decision-making processes. Years of scientific research and recent technological advances have produced a wealth of information and increased accessibility to this information. Technological advances have also enhanced the types of analysis that can be done to support planning and decision-making processes. However, having the capability to access this wealth of information and perform advanced analyses does not necessarily mean it results in incorporation of the data and analysis into the planning or decision-making process.

The main objective of this research is to devise a methodology to evaluate the role and impact of PSS technologies and scientific information on community level planning and decision-making processes. The methodology consists of six areas of focus: (1) issue of concern; (2) characteristics of the planning and decision-making process; (3) relevance of science to the issue; (4) capabilities of the PSS system; (5) roles and capabilities of the planners and decision-makers; and (6) impact of the science.

The methodology is applied to Walden, Tennessee as the town goes through the process of creating a conservation-oriented zoning ordinance.

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List of Abbreviations

3-D:	Three Dimensional
A-1:	Agricultural Zone
C-1:	Commercial Zone
DRC:	Estate Zone
G-1:	Gateway Zone
GIS:	Geographical Information System
LM-1:	Light Manufacturing Zone
NBII:	National Biological Information Infrastructure
OS-1:	Planning Support System
R-1:	Residential Zone
RPA:	Chattanooga-Hamilton County Regional Planning Agency
SAIN:	Southern Appalachian Information Node
SAMAB:	Southern Appalachian Man and Biosphere
UTC:	University of Tennessee at Chattanooga
VC-1:	Village Center Zone
WWW:	World Wide Web

Chapter 1

Introduction

Issue of Concern

This research focuses on the application of scientific information and planning support system (PSS) technologies to community planning and decision-making processes. Years of scientific research and recent technological advances have produced a wealth of information and increased accessibility to this information. Technological advances have also enhanced the types of analysis that can be done to support planning and decision-making processes. However, having the capability to access this wealth of information and perform advanced analyses does not necessarily mean it results in incorporation of the data and analysis into the planning or decision-making process. This research strives to evaluate the effect scientific information and PSS technologies have on community level plans and/or decisions, as well as the overall planning and decision-making process.

Objectives of the Research

The main objective of this research is to devise a methodology to evaluate the role and impact of PSS technologies and scientific information on community level planning and decision-making processes. The methodology described in this research can be applied to any single, community-level planning or decision-making process. Another objective is to apply this methodology, to the fullest extent possible, to a pilot study in the

town of Walden, TN. The town of Walden is going through the process of creating a new, conservation-oriented zoning ordinance.

Research Project

The research presented in this thesis is one component of a larger National Biological Information Infrastructure (NBII) project sponsored by the U. S. Geological Survey. More specifically, it is a part of the work being done for the NBII's pilot project in the Southern Appalachian Information Node (SAIN). After describing the NBII-SAIN and the overall project in greater detail, I discuss the role of the Walden pilot study in this project.

NBII/SAIN Background

The NBII is a collaborative effort to create an electronic network that will enhance access to biological data and information concerning the nation's plants, animals, and ecosystems. Upon completion, the NBII will incorporate interconnected nodes across the country. The development of ten nodes was initiated in 2001, with more planned to begin in 2002. Each node seeks to build partnerships and collect information from all sectors of society. The information will then be made available to researchers, natural resource managers, decision-makers, planners, educators, students, and other private citizens. There are three types of nodes in the NBII: thematic, regional, and infrastructure. Thematic nodes develop, acquire, and manage information on a defined subject, such as bird conservation. Regional nodes handle information based on a

geographical region. Infrastructure nodes focus on knowledge integration, especially geographically referenced information.

The SAIN is one of the nodes established in 2001. The defined region is located in the Eastern United States and within the Sunbelt. The region includes the Great Smoky Mountains National Park and the Tennessee River Gorge. The main functions of this node are to create the integrated access system and clearinghouse to distribute NBII information, and to specialize in ecosystem informatics and biodiversity information analysis and evaluation.

NBII-SAIN Pilot Project

The pilot project created for the NBII-SAIN will enable cooperation between scientific researchers, land managers, and public outreach workers in an area that includes the Tennessee River Gorge and the Town of Walden. The project is a result of partnerships between regional organizations including Oak Ridge National Laboratory, the University of Tennessee at Knoxville, the University of Tennessee at Chattanooga, the Tennessee Valley Authority, the Great Smoky Mountains National Park and the All Taxa Biological Inventory, the Tennessee Aquarium and Southern Aquatic Research Institute, The Nature Conservancy, the Southern Appalachian Man and Biosphere Cooperative, Information International Associates, Inc., and other public and private sector partners.

The pilot project will develop a prototype geographical information systems database that will include topography, hydrology, biology, geology, and human dimension data for the Tennessee River Gorge and surrounding environments. Another

aspect of this project will be to conduct a large scale monitoring effort that will measure the biodiversity and ecological function of the river gorge (Peine 2001). This project also seeks to evaluate the use of the NBII in real decision-making processes. The role of this information will be evaluated in the processes of creating a conservation plan for the Tennessee River Gorge, and in the development of a conservation-oriented zoning ordinance for the Town of Walden, TN.

Role of the Walden, TN Pilot Study

The majority of this project deals with regional-level planning and decision-making issues. The process of creating a conservation-oriented zoning ordinance for the Town of Walden focuses on applying technology and scientific information to a community level decision-making process. This component of the project also provides an opportunity to apply the methodology for evaluating the role and impact of technology and scientific information in a planning or decision-making process.

Chapter 2

Literature Review

Purpose of Literature Review

The purpose of the literature review portion of this thesis is to familiarize the reader with the three main areas of focus in this research: the planning and decision-making process, PSS technologies, and strategies for evaluating the role and impact of technology in a planning or decision-making process. The literature reviewed is divided into these same three categories.

Planning and Decision-Making Process

There are many different theories and models of planning and decision-making processes. There are five dominant approaches to planning theory: comprehensive, incremental, strategic, advocacy, and equity planning (Campbell and Fainstein 1996). This is one way to characterize a planning or decision-making process. Planning and decision-making processes can also be looked at in other terms and characterizations. A process can be described as an elite corps decision-making process, a rational approach, or a collaborative learning process (Campbell and Fainstein 1996).

It is important to understand the planning and/or decision-making process in order to accurately evaluate the technologies involved, because the type of process implemented can have a great effect on the final decision. "Planners may use the best technical data and draw upon the latest theories when they organize planning studies, but they use the concerns of particular officials, interest groups, and other stakeholders to

focus inquiry, select data, organize analysis, and construct the alternatives that shape the comprehensive plan" (Hoch, Dalton, and So 2000: 31).

A simplified model of the planning process can be seen in Figure B-1 (All Figures and Tables in this thesis are located in the Appendices). This illustrates that planning is a circular process, and is never truly completed. First, the goals of the community must be established. This can be done before or after the inventory and analysis. After analysis of the collected information (inventory), the goals may have to be modified. Therefore, links between the analysis step and the goal step are possible. Much of the information gained through the inventory of existing conditions can be displayed in map form. This provides an excellent opportunity for the application of advances in technology, especially geographic information systems (GIS) and three-dimensional (3-D) imaging. This information includes physical data such as soil classifications, topography, vegetation patterns, streams, and floodplains; environmental uses such as land uses, street locations, and building conditions; and public facilities such as parks, schools, firehouses, public utilities, and police stations.

The data collected during the inventory step must now be analyzed. Again, technology can play an important role in this process. Technology can also aid in presenting the information in a way that decision makers and planners can better understand it, and therefore make better decisions based on this information. Not only can technological advances be used to discover problems, but also in finding the cause of these problems. To best determine future needs, this step of the process needs to be revised as soon as new information becomes available.

Another link is possible between implementation and the creation of the plan. Some aspects of the plan may have to be changed before a complete evaluation can be performed, or it may not be possible to implement some parts of the plan at all.

City and regional planning processes are also an attempt to improve the quality of the environment. To best do this, the practice of planning must continue to evolve in order to meet the changes in human desires, technology, and population increases. Planning for natural resources, and planning in general, can be approached in a way to conserve and develop natural resources upon which the future well-being and existence of the community are dependent, and take immediate steps to prevent undue depletion or pollution of these resources (Smith 1971).

The comprehensive approach to planning expands on this basic planning model. This approach is also referred to as the rational model of decision-making. Figure B-2 provides a model of a comprehensive planning approach. This approach to planning requires that planners work closely with residents and other professionals to identify and describe community characteristics, articulate goals, and explore alternative plans for the future (Hoch et al 2000).

The creation of alternatives goes beyond rational analysis. It requires the imaginative consolidation of diverse goals into a more direct plan of action the people might take. This step may lead to revisions of the goal, or its meaning, once certain outcomes and consequences are displayed from following a proposed plan of action (2000). GIS technology, 3D imaging, and photo enhancing technologies can be very useful in this process. These technologies allow the results of certain actions or non-actions to be seen.

Fainstein and Fainstein (1996) point out that the comprehensive planning approach can be expensive and time consuming because each new process begins from scratch, and the plans produced by this process are often difficult to implement.

Another approach to planning is the incremental process. This approach is also referred to as successive limited comparisons (Lindblom 1996). This type of planning and decision-making takes incremental steps to solving a problem. This is the model applied to most governmental processes of creating policy. Past policies are built upon to create new policy. In this theory, policy is considered to be good if it is agreed upon. The policy planning approach is a process that does not focus on land use and site design but on the relationship between goals, policymaking, and social consequences. This approach encourages extensive involvement from a variety of local residents, activists, politicians, administrators, NGOs, and other groups whose absence would undermine the legitimacy of the policies that might ensue (Hoch et al 2000).

The incremental approach to planning and decision-making makes it easy to correct bad decisions or policy in a short amount of time; however, drastic changes and societal reform usually take a long time to occur (Lindblom 1996).

Strategic community planning seeks to incorporate broad participation into the planning process. The goal is to involve the affected community into the decision-making process (Kaufman and Jacobs 1996). Figure B-3 provides a model of the strategic community planning approach. Strategic planning reaches out to explore a wide variety of policies and strategies that benefit the community. One addition to this model is the environmental scan, which includes a "SWOT" analysis. A SWOT analysis addresses the Opportunities and Threats that are most likely to affect the future of the community,

and the strengths and weaknesses the community possesses to deal with them. This process also includes identifying the relevant groups willing to participate in the planning process. This model represents a streamlined approach to rational decision-making that focuses on improving ways to cope with environmental uncertainties that stand in the way of the goals of a community (Hoch et al 2000).

The strategic planning approach has not made significant contributions in communities where planning was already being done very well, but it has proven to be effective in those communities where there was not much planning activity at the time of implementation (Kaufman and Jacobs 1996).

The ideas of advocacy planning and equity planning are very similar in their beliefs. Followers of the advocacy planning theory believe that planners have an explicit responsibility to help the poor and disadvantaged members of society. Advocacy planners believe that the needs of the underpowered members of a community should be placed above all other needs (Davidoff 1996). The equity planning theory does not believe the traditional planning approach can adequately solve the causes of poverty and inequality. The main goal of equity planners is redistribution of benefits (Krumholz 1996).

An elite corps decision-making process is one in which a single individual or a small select group makes decisions for a larger group. In this type of process the decision-makers play the role of experts, and there is no input from members of the larger community for whom the decision is made.

A different approach to decision-making is the collaborative learning process. This process includes early stakeholder involvement and sharing of information among stakeholders and decision-makers.

Hoch, Dalton, and So (2000) describe good planning as "thoughtful problem identification, informed analysis, and fair-minded evaluation and choice of options" (38). Hoch et. al. (2000) also provide four guidelines by which to evaluate a final plan or final decision. A successful plan is one that improves acceptance of an alternative, inspires people to follow its objectives, meets a wider public interest, and meets the expectations of professional colleagues.

One of the most important steps in any planning or decision-making process is the inventory or data collection step. Ehrmann and Stinson (2001) provide a framework for using joint fact-finding techniques and technical experts successfully. In joint fact-finding, stakeholders with different interests and viewpoints work together to develop data and information, analyze facts and forecasts, develop common assumptions and informed opinion, and use this information to reach a decision together.

Joint fact-finding has many potential benefits. This process can address information gaps and scientific uncertainty. The participants in this process also have an opportunity to learn about the scientific underpinnings of various arguments. Joint fact-finding can produce agreements that are more credible, more creative, and more durable. If all stakeholders play a part in gathering and assessing the information on which the decision is based, then they are more likely to stick to that agreement. This process also allows each stakeholder to learn more about the other stakeholders needs and interests, and can form stronger relationships among them.

The first step in this process should be to define the "problem" or issue to be resolved. Then the stakeholders should identify the most crucial information gaps or uncertainties that exist and the issues that could be appropriately pursued in a fact-finding process. It is also very important that all areas of concern are identified at the outset.

The participants should then determine ground rules for information gathering and analysis, who will manage the process, which expert(s) to use, confidentiality needs and reporting requirements, as well as begin discussions on how the information will be used to reach a final decision.

If an expert is used, the stakeholders should decide on how he/she will report back to the group and how often the expert should give an interim report.. Interim reports are important to ensure that the results will be acceptable to the entire group.. Regardless of the method used to obtain information, whether it is through an expert or by other means, the stakeholders should be familiar with limitations of statistical analysis, i.e. margin of error, and how that can invalidate the results.

Once all the information is collected, all the participants should receive the final results at the same time. It may be necessary to develop contingent agreements based on several potential options, if one option does not clearly emerge as the appropriate basis for agreement.

The success of this technique depends on whether the information produced is adequately integrated into the joint decision-making process.

Planning Support System Technologies

The quality of planning and decision-making outcomes depends heavily on the data and information used to make these decisions. Table A-1 summarizes the hierarchy of data used in decision-making processes. Data, at its lowest form, is simply observations that have been recorded and stored. As the level of data increases it becomes more important to the decision-maker and the planning process. At the highest level of utility, this data is referred to as intelligence (Hoch et al 2000). Data used by planners and decision-makers can also be categorized as primary and secondary data. Primary data are that which the planner obtains through direct observation, interviews, surveys, and remotely sensed images from satellites and/or airplanes. Secondary data are data that have been collected by others, i.e. U. S. Census data.

Technological advances have created new ways for planners and decision-makers to collect, analyze, display, and communicate information. These technologies are referred to as PSS technologies. PSS technologies consist of multiple technologies and common interface. GIS have become an integral part of many PSS. Other features of the PSS can include spreadsheets, modeling procedures, expert systems, databases, decision trees, computer aided design, hypertext, mapping, user interfaces for public participation, virtual reality, and the Internet (Nedovic-Budic 2000). The main goal of PSS technologies is to create fully integrated, flexible, and user-friendly systems that combine spatially-based GIS, textual, graphic, and visual information; a broad range of computer-based models and methods for determining the implications of alternative assumptions and policy choices; and a variety of visualization tools for presenting the results of the models, charts, maps, etc. (Hoch et al 2000).

Spreadsheets have long been a part of PSS. Spreadsheets allow decision-makers to evaluate alternative scenarios (Klosterman 1990). Spreadsheets provide a means to analyze any quantitative problem that can be presented in a two-dimensional table, and save time by eliminating the need for repetitive work. This technology allows planners to easily determine certain effects, such as cost, of a few different assumptions and policy decisions in a short time.

The advances in PSS technologies provide many opportunities for improving planning and decision-making processes. Many improvements have already occurred, and many more are highly expected. Campana and Tucci (2001) and Thomas and Hardin (2000) recognize the possibility of identifying the likely effects of urban development scenarios at the early stages of planning as a benefit to the entire process. This would allow many problems to be solved before they become a reality. The highest expectations of PSS technologies include that the technology will lead to improvements in the quality of plans, increase the number of alternatives created, improve the quality of the final decisions (Shiffer 1992), and enhance public participation in the planning and decision-making process (Rybaczuk 2001).

One technological advance in PSS technologies has been the types of images planners can produce. Planners should produce images in order to think, discover and test ideas. A planner should use images that allow him to make connections between ideas and visuals. Images used in this manner can represent beginning thoughts, reactions to sites and programs, and/ or possible solutions (Al-Kodmany 1998).

One PSS technology that assists in creating more effective images is photo-enhancing software. This software allows planners to utilize one form of an overlay

technique. This method allows analyzing spatial and component relationships. This is accomplished by overlaying individual images that contain different details and information about a common geographic area. Overlay analysis has been advanced greatly by scanning technologies. Layers can be created by scanning images into the computer. Scanning allows planners to use actual photos in the overlay analysis, which helps create a greater sense of reality to the final image (Al-Kodmany 1998).

This technology has the ability to produce images that are explicit and easy to understand by both planners and non-planners. This technique also allows planners to convey the reasoning behind certain decisions to the public, such as the case when photo manipulation was used to explain zoning codes that required businesses to use higher quality materials on their facades (1998). Al-Kodmany (1998) expresses the importance of incorporating such imaging techniques throughout the planning process.

At the heart of most PSS is GIS, or some form of geographic information technology. All aspects of the planning process can incorporate geographic information technologies, including data collection and storage, data analysis and presentation, planning and/or policymaking, communication with the public and decision makers, and planning and/or policy implementation and administration (Nedovic-Budic 2000). Zorica Nedovic-Budic (2000) identifies some goals of the planning field she expects to be improved by the advances in GIS. These goals include better quality of urban environments, environmentally and socially sustainable communities, effective spatial organization of urban activities, "smart growth" of urban areas, efficient communication between various urban functions, and democratization of the planning and policy making process. Additional benefits of GIS identified by Jeffery Osleeb and Sami Kahn (1999)

include the presentation of spatial information in a visual manner, accumulation of information from various sources and the representation of all that information in the same geographic scale, allowing one to point to a location on a map and obtain information about that location, and the ability to perform spatial analysis on a site to determine its impact on other locations.

Expectations are high that advances in PSS technologies will enhance community participation in decision-making, and increase input from all facets of a community, especially those community members that do not usually have a voice, by complementing and improving on the traditional means of community input. PSS technologies can help promote community participation by "rendering information more understandable, credible, and usable to different segments of the public, especially those who have not had access to, or experience with more traditional forms of information" (Hoch et al 2000: 55).

Improving community participation is seen as a very important element to improving overall planning and decision-making processes. There are many benefits to increasing public participation. Benefits of broad-based community involvement in planning include creating a stronger sense of commitment in citizens, increasing user satisfaction, creating realistic expectations of outcomes, and building trust between planners and city officials and the public. Public participation also allows planners and designers access to community expertise and local knowledge, which leads to better plans and designs. (Al-Kodmany 1999).

The traditional practice of public meetings or hearings as a means of getting community input creates limitations on the input received. Many times these meetings

take place in an atmosphere of confrontation. This approach discourages some people from participating and may not result in voicing the opinion of the overall community, only those of a few vocal citizens. The traditional format also limits participants to those who have the time to attend, available transportation, and are physically able to participate (Kingston , Carver, Evans, and Turton 2000).

The ability to conduct meetings unconstrained by location or time will greatly enhance the public's access to government information (Hoch et al 2000). A component of PSS that is expected to have the greatest impact on improving public participation is the use of the Internet and the World Wide Web. Web technology can have many positive effects on the planning process. This technology has been used to place draft plans and proposals on a web site for public review and comment. In one case study (Kingston et al 2000) this practice saved time and money by having the public enter comments straight into the system. This allowed for the system to be constantly updated. Information about errors also allowed the system to be corrected immediately by the operators. The Web-based system also allowed the citizens to provide more detailed information about each area of concern than would have been possible on a physical model. Visual images such as photographs and video were not used in this case, but would have provided improved understanding by the public.

Kingston et al (2000) describes another example of using the Internet to enhance public participation. In this case hyperlinks were added to aerial view maps and photos made available via the Internet. This technique helped users orientate themselves on the images. Hyperlinks allow a user to click on a street or building and receive information about the item, i.e. name, address, etc. Using an interactive map allows users to obtain

the information they need, at their own pace, in order to participate to their fullest extent. Planning issues of interest for this case included re-opening the canal that runs through the center of the village, and problems arising from commercial traffic and access to industrial sites. Local citizens were then asked to share their concerns and opinions by placing comment flags on the area of their concern. It provides information that can be of use to both the local community and the wider local authority in terms of future planning and knowledge of local opinion.

A third example of how PSS technologies can be used to increase public participation and improve a planning process is described by Al-Kodmany (1999). GIS, freehand sketching, and photo-manipulation software were used to enhance public participation in the updating of a neighborhood plan. This process allowed citizens to be involved in the development of the plans, rather than just viewing a final plan. These visualization methods helped the citizens reach a consensus on such issues as sidewalks. Once everyone realized the dangers to pedestrians in the areas with no sidewalks, and the potential boost sidewalks could bring to businesses, the community members agreed on the need for sidewalks. This type of communication also informed planners that large trees could not be placed along the street due to the design of the sewer system. This prevented an inaccurate image of what was realistic.

It is important to understand that Web-based systems are meant to enhance the traditional planning process, not replace it. Online systems are a useful means of informing and engaging the public, at least those with access to the Internet and the Web (Kingston et al 2000). With this in mind, accessibility is still a main concern for Web-based systems. Every citizen will not have personal access to the Internet and the World

Wide Web (WWW). The suitability of public access points should be considered before implementing a Web-based system, or else it will not enhance complete community involvement (Kingston et al 2000).

One attempt to solve this problem is the creation of community networks. Community networks provide a forum where neighborhood citizens can communicate and participate in problem solving. This type system also provides citizens with information they would not have had access to otherwise (Hall 1998).

It is obvious that advances in PSS technologies have the ability to enhance public participation, but certain aspects need to be taken into consideration to prevent these same technologies from having a negative, or exclusionary effect. Unequal access to these technologies due to income, education, language, or other barriers will continue to deny certain portions of the population an equal voice (Hall 1998), creating a technocratic elite (Nedovic-Budic 2000). William George Paul (1998) discusses a case study that reveals the limitations of web based planning systems where few people have computer access. Jackson Ward is a minority community with high unemployment and low to moderate education levels. Very few people in this community had computers in their home and public access sites were limited. This project was an attempt to increase awareness of the key issues and needs of Jackson Ward by creating a web site about the community and getting input from the people who live there. Another goal was to give the residents of Jackson Ward an equal voice in the community participation role of the planning process. The web site used a collection of images, databases, and processes to accurately describe the neighborhood, and at the same time test the ability to collect, format, and disseminate information on the Internet. One final goal of the project was to

coordinate and unify community groups and citizens of Jackson Ward. Overall, the project did not meet the desired goals. This can be traced to two major issues: access and computer skills. If you invest in the hardware and software without teaching the intended users how to use it, or without even making sure they will have the opportunity to use the system, you will end up with an underutilized tool.

It is very important to understand what elements of a PSS increase public participation, and discuss how they can be improved. Visualization is key to involving the community in this process, because it allows technical and non-technical participants to relate to the information. Advances in digital visualization techniques have changed and enhanced the way citizens can influence planning and design decisions (Al-Kodmany 1999).

The ability to produce specific images as community members ask questions is an important feature for maximizing citizen input and understanding. It is also important to create and display images of proposed plans within the context of what currently exists (Al-Kodmany 1999). Another suggested technique for maximizing community understanding and participation is to integrate more formal data with mediums such as photographs, stories, and artwork (Rybaczuk 2001).

Extending the method of data collection is another proposed technique to get the community more involved in planning and decision-making processes. This means that local citizens need to be involved in the data collecting, not just outside "experts." This provides an excellent opportunity to involve those citizens who have been excluded, either socially or economically. It is equally as important to make sure a system is in place to distribute the information gained from the research and technology. If this type

of system is not present, then the information gained from the technology and research will remain in the same social circles (Rybaczuk 2001).

Advances in PSS technologies have greatly benefited the planning and decision-making process, and many more benefits are expected. However, research and experience point out that these new technologies do have some drawbacks, and may not fulfill all the expectations discussed earlier. Klosterman (1990) warns that believing new technologies will solve all planning problems is a dangerous way to think. It raises expectations for the new technologies to unrealistic heights, and sets the stage for disappointment, disillusionment, and rejection. Many of the advanced technologies can be expensive and time consuming to implement (Kodmany 1999).

With GIS it is important to remember that planning analysis, projection, and evaluation require that GIS capabilities for storing and manipulating geographic data be combined with planner's models for spatial interaction and prediction. A failure to realize this will cause traditional planning tasks to be neglected for collecting, analyzing, and displaying spatial data on the present (Klosterman 1990). Many times the GIS is not used to its full potential. Reasons for underutilizing GIS include the complexity of the technology, the lack of trained staff, the scarcity of organizational resources, and the fact that generic GIS products do not support many tasks and functions performed by planners (Nedovic-Budic 2000).

There are also many concerns and problem issues associated with the data required for PSS technologies. An obvious concern focuses on the quality of available data to support the PSS technologies and the planning and decision-making process. There are many possible flaws that can affect the quality of data, such as the data may be

out of date, or the history of the data may be weak or not understandable. This has caused some discussion on whether or not to limit the data made available or to make it all available and explain the quality (Tonn, Turner, Mechling, Fletcher, and Barg 1999). How the public might react to faulty or inaccurate data is also a concern of those who work with PSS technologies.

Existing data that are not digitized also poses a challenge for PSS technologies and their users. There may be an abundance of relevant data, but if they are not in digital form, they cannot be used in most advanced PSS. One way to deal with this problem is the time consuming process of digitizing all backlog information. Once data is acquired and/or digitized, it is important to store the data in a way that makes it easily accessible to those needing it. It is also important to be able to collect, store and transmit data from the field. This would reduce the time for producing new information. Consistent and uniform data would reduce the time necessary to perform analysis and increase the accuracy of the analysis (Maier, Landis, Cushing, Frondorf, Silberschatz, Frame, and Schnase 2001).

The creation of metadata has assisted in dealing with some of the problems concerning data and data collection. Metadata identifies the availability of data, the agency source of the data, the format of the data, the cycle of data collection, and the nature of the data in their present form (Osleeb and Kahn 1999). The DUST-2 concept provides another way of addressing problems associated with data. DUST-2 is a first step in developing an interactive, flexible interface and qualifying filter matching several different non-uniformly formatted data resources (Hartman, Noelle, Richards, and Leitinger 2000).

Spatial information technology systems, such as remote sensing and satellite imagery, are beneficial to data collection for GIS and PSS as well. They are helpful because they provide data in a digital format and eliminate the need for manual analysis that can be costly and inaccurate. When integrated with GIS this technology provides timely information to interpret the landscape. The combination has been used to study urban climate, urban environment and quality of life, and housing. One drawback to this source of data is that the data are often at too large of a scale for some planning tasks.

Interagency and interorganizational sharing of information can also solve some of the time and money problems associated with data collection. The lack of information exchange among local, state, and federal government and private sector organizations wastes time and resources and hinders the development and utilization of the full potential of the technology. Certain activities have aided this process. The activities include (a) standardization of geographic data formats and contents; (b) metadata creation and standardization; (c) development of clearinghouse nodes; and (d) surveying the needs for and availability of the common basic data sets that cut across local, regional, state, and federal geographies (Nedovi-Budic and Pinto 2000).

Benefits of this type of information sharing included consistency in formats and map base, enhanced organizational cooperation, and diffusion of information to smaller organizations (2000). The major obstacles to achieving this type of data exchange system are the difficulty of meeting equipment specifications, data standards, implementation time, and financial obligations (Shiffer 1992).

Strategies for Evaluating the Role and Impact of Technology in a Planning or Decision-Making Process

The role of PSS is becoming increasingly important to planning and decision-making processes, and it is accepted that the information produced by scientific research and PSS technologies should be used in making decisions (Maier et al 2001). Since this type of technology and scientific information is expected to lead to better planning and decision-making processes, and ultimately, better decisions, it is important to have a means for accurately evaluating the role this science and technology plays in the decision-making process and the impact they have on final decisions. Zorica Nedovic-Budic (2000) believes that understanding these impacts is one of the most critical areas of future research for urban and regional planning. Nedovic-Budic (1998) also encourages future evaluation research to focus on specific applications in order to conduct a more informed and context-based study, instead of evaluating the GIS technology within the context of an entire organization. To better understand the effects of planning support system technologies and scientific information, we must develop a method for evaluating the role this technology plays in the decision-making process.

The majority of PSS evaluations conducted in the past were based on a cost-benefit analysis of implementation. Attempts to evaluate the effects PSS have on decision-making are rare. However, some work has been done in this area.

The first step in developing a methodology for evaluating the effects of PSS technologies is to define the decision-making process (Dickinson 1990). This is important because the PSS technologies should be evaluated throughout the decision-making process (Nedovic-Budic, 1999), not just at the plan selection stage. After

defining the decision-making process, the next step is to identify the steps of the process that involve the use of the PSS technologies, and define indicators by which to measure the role and impact of the technology and information.

Zorica Nedovic-Budic (1998) has compiled a number of frameworks used in the evaluation of information systems. Of these frameworks, I found the work of DeLone and McLean (1992) to be most applicable in evaluating the impacts of PSS on the decision-making process. DeLone and McLean identify six major categories of information system success and provide measurement indicators for each group. The six categories are: system quality, information quality, information use, user satisfaction, individual impact, and organizational impact. In addition to these six categories, Nedovic-Budic (1999) lists societal impact as a major category for measuring information system impacts. Figure B-4 illustrates the relationship between these seven dimensions of PSS success.

System quality focuses on the contents and integration of PSS databases. Planning requires the use of data from many sources, and a PSS system that can integrate with other information systems, allowing easy access to this variety of data, would greatly enhance the quality of this system. The PSS software and the ease with which it can be learned and used are also very important to the quality of the system (Nedovic-Budic 1999).

Nedovic-Budic (1999) uses data accuracy, availability, collection time, accessibility, currency, and format to determine information quality. In planning and decision making the planning staff, administrators, decision makers, citizens, NGOs, and special interest groups are all affected by the quality of the data.

Information use can be evaluated by examining the specialized areas in which the PSS and scientific information are applied, the planning and decision-making methods aided by the PSS and scientific information, and the various tasks and functions that are replaced by the PSS technologies (Nedovic-Budic 1999).

In order to evaluate user satisfaction, one must consider the different needs of various groups of PSS users in the planning and decision-making process. The planning staff sees the PSS as a means to simplify work tasks, improve their job performance, increase effectiveness and quality of work, and improve their status as an employee and a professional. Administrators and decision-makers are concerned with managing their organization's resources, and improving the decision-making process. Citizens and special interest groups expect the PSS to enhance their role in the planning process. This is usually achieved through better access to information. Ultimately, this should lead to the public becoming more influential in plan and policy development (Nedovic-Budic 1999).

It is important that everyone involved in the decision making process be provided with the appropriate information and understand it. To evaluate the individual effects of the PSS and scientific information, the identification of conflicts, understanding of problems, decision-making time, explicitness of decisions, confidence in analysis, support in finding solutions, and communication of information should be examined (Nedovic-Budic 1999).

Organizational effects focuses on how the PSS assists in organizational tasks such as the storing, retrieving, manipulation, and graphic or non-graphic display of

information; reviewing development proposals; issuing building permits; and answering rezoning questions and requests (Nedovic-Budic 1999).

The societal effects category addresses the issue of equal opportunity. Initial evidence indicates that disadvantaged communities and populations have limited access to information technology, and therefore would not have the same chances to utilize information provided via this medium (Nedovic-Budic 1999).

In an effort to study how GIS affects planning and whether it meets the expectations of the planning agencies using it, Zorica Budic (1994) measured GIS success in two ways: operational effectiveness and decision-making effectiveness. Indicators for operational effectiveness were accuracy of data, amount of relevant data, data collection time, and accessibility of data. Decision-making effectiveness indicators were decision-making time, explicitness of decisions, identification of conflicts, communication of information, and confidence in analysis. These indicators of operational and decision-making effectiveness were then tested in relation to seven GIS implementation factors. The implementation factors could also be interpreted as system quality factors. These indicators included political support, staff support, experience with GIS, database comprehensiveness, system sharing, GIS application, and type of tasks performed with the GIS technology. A significant relationship was found between the following:

- Political support and explicitness of decisions
- Staff support and amount of relevant data
- Experience with GIS and accuracy of data
- GIS sharing and decision-making time

Calkins and Obermeyer (1991) provide 24 questions that are to be used in surveys for evaluating the use and value of geographical information, regardless of the technology used to provide it. These questions are designed to aid in the understanding of how geographic information and analysis are used in decision-making. The questions are divided into six categories:

1. Characteristics of successful uses of geographical information
2. What are the impacts of the geographical information?
3. What are the benefits of the use of geographical information?
4. Measuring the extent of the benefits
5. Characteristics of geographical data and spatial analysis
6. Organizational factors

Holly Dickinson (1990) suggests additional categories for which specific information needs to be obtained in order to evaluate the use of geographical information in a decision-making process. These categories are:

- The overall goals and specific objectives of the decision-making process,
- The steps involved in the decision-making process,
- The steps involving geographic information, and
- The manner of geographic information use (and by whom) in each particular step

Another approach for evaluating the impact of land information systems was presented by Peter Zwart (1991). This technique is beneficial for evaluation at the decision-making or plan selection stage of the process. Zwart describes four impact groups. These groups are based on the type of utilization of the information, and the type of decision for which the information is used. Type of utilization includes whether or not the information changed the mind of the decision-maker, supported the decision-makers' initial beliefs, and whether or not the decision-makers referred to the information. Type of decision refers to the importance of the decision.

The impact groups range from Group I impacts that change the decision-maker's initial opinion of the subject and are used in making important decisions, to Group IV impacts where the information is acknowledged but not used, therefore, it has little or no impact on the decision.

The main ideas and techniques expressed in this collection of previous efforts to evaluate the use and impact of PSS technologies gives researchers a good foundation to create a complete and thorough methodology for advancing research in this field.

Chapter 3

Methodology for Evaluating the Impact of Planning Support System Technologies and Scientific Information in a Planning and/or Decision-Making Process

Based on the literature review in Chapter 2 and conversations with members of the Regional Planning Agency in Chattanooga, TN, researchers, scientists, and information specialists a methodology was created for evaluating PSS and scientific information in community planning and decision-making. Ideally, the evaluator would have a complete understanding of the issue at hand, the decision-making process, the science involved, and the PSS technologies applied in the process. In reality, this will rarely be the circumstance. Therefore, this methodology was created so that the evaluator does not have to be an expert or have extensive knowledge on all these topics. The methodology describes the information that is necessary for the evaluation, and techniques for acquiring this information. This methodology also assumes that every planning and decision-making process is unique. Therefore, the entire methodology must be applied to each process to accurately perform the evaluation.

It is important to discuss the difference between some of the terminology used in this research. Science and scientific information are two separate terms and are not considered interchangeable. Examples of scientific information are topology and wetland

location. An example of science is determining what size stream buffer is required to protect water quality.

Methodology Components

The evaluation methodology consists of six main categories or areas of focus:

1. Issue of concern,
2. Characteristics of the planning and decision-making process,
3. Relevance of science to the issue,
4. Capabilities of the PSS,
5. Roles and capabilities of planners and decision-makers, and
6. Impact of the science.

Figure B-5 shows the relationships between these six categories.

The remainder of this chapter will describe the elements that make up the six categories of this evaluation methodology and a description of the techniques used to collect this information.

Issue of Concern

The first step in this category of the evaluation is to describe the issue of concern. The origin of concern should also be described for the issue. Was it inspired by the public, planning agency, other government agency, etc.? It is also important to discuss the stakeholders' interest in the issue. And finally, it is important to determine how the issue is related to the overall community goals.

Characteristics of the Planning and Decision-Making Process

In order to perform an effective evaluation certain aspects of the planning and decision-making process must be identified and discussed, as well as the role of the PSS and scientific information related to these aspects. The goals of the planning and decision-making process should be described. The type of decision being made is also important. Is the result of the decision-making process focused on producing a plan, regulation, enforcement of regulations, or education? Is the decision a one-time effort or part of a continuum?

It is also important to discuss the role of the PSS and the information in the development of alternatives. It is important to note the number of alternative plans that were generated during the planning process.

The evaluator must also identify the criteria for decision-making, and the complexity of the process within the context of the issue. Creating a model of the decision-making process can assist in understanding and communicating this concept. The evaluator must also pay attention to the role of the stakeholders. A distinction should be made between stakeholders with central influence and stakeholders with marginalized roles.

Another important element of this evaluation category is the added benefits of the PSS and the scientific information. The evaluator should identify the actions that might not be possible in the absence of the PSS and the scientific information, such as the types of analysis, presentation formats, etc.

Relevance of Science to the Issue

This category of the evaluation should include a description of the goals of the science and PSS. The evaluator should describe the relevance of the science to the issue. This includes identifying the science disciplines considered most relevant to the decision-making process. It is important to determine whether or not the persons involved in the decision-making process feel the scientific information is central or peripheral to the issue. The complexity, limitations, assumptions, and the degree of risk associated with the science should also be described. The temporal and spatial scale of the information gained through science should also be considered to determine whether or not the information is applicable to the issue of concern. Factors such as scale and form of the data affect the quality and accuracy of the information produced. For example, a higher resolution of aerial photography is necessary to make accurate parcel-level decisions than is needed for regional decisions. The evaluator needs to be able to identify such an issue and determine if the proper data is available. It is also important to determine the source of the data and information and how current the data and information are that are being used. Outdated data may not be relevant to the issue. It is also necessary to determine the objectivity of the information.

From the above analysis, a judgment can be made as to the suitability of the scientific data and the resulting information to the planning and decision-making process. It is essential to the evaluation process to understand how the planners, decision-makers, and stakeholders interpret the science. This element of the evaluation should determine how the science is readily understood and whether or not the technology improved the

understanding of the information. The evaluator must also look at the relevance of the science to planners and decision-makers. This can be accomplished by asking planners and decision-makers their perception of relevance of the information, as well as their confidence in the science. The role of the scientists must also be considered in this evaluation category.

Capabilities of the Planning Support System

This is a very important category in evaluating the effects of a PSS on a decision-making process because the influence of the PSS depends largely on system quality and information quality (Nedovic-Budic, 1998). The better the system, the greater the potential impact on the decision-making process.

A major element of this category is the capabilities of the system. A system whose purpose is to perform complex spatial analysis is going to have a greater potential impact than a system whose main purpose is data storage. To determine this, the evaluator needs to consider the software and hardware utilized. The system contents can be determined through personal interviews with planners and other users of the PSS. This is important because the contents of the PSS determine the type of analysis that can be performed and the type of information that can be generated. This would include the technologies that make up the PSS, such as GIS or photo-enhancing tools, as well as the number of applications for each of these components. This also includes how the data are stored, retrieved, manipulated, and portrayed. The time frame in which this occurs is also important. Shorter system response times are characteristic of more advanced systems; therefore, it is capable of more complex analysis. Shorter response times also mean that

information can be presented when needed on short notice, and the ability to make changes to the system and its information on the spot can be very important in some decision-making processes. For example, a PSS that can produce requested information on a specific parcel of property when a member of the planning commission asks for it during a meeting would potentially have a greater impact on that decision than a PSS that cannot perform this task. This is the type of characteristic the evaluator needs to identify when determining the capabilities of the PSS. Shorter response times also allow for more tasks to be performed. The system's portability and interface with the Internet are also important factors in establishing the capabilities of the system. One thing an evaluator might need to consider regarding this issue is whether or not the PSS sacrifices any of its performance capabilities when it is used in another location. For instance, will the PSS be able to perform the same steep slope analysis at a meeting held in a rural town's community center as it could in the planning agency's office or in a GIS lab?

The skills and knowledge required to utilize the PSS are also important in determining the system's capabilities. System applications such as GIS can be greatly enhanced when used by those that have more experience with the program. Users with more experience can perform more complex analysis; they will be less likely to commit critical errors; they will better understand the system; and they will be able to perform more tasks in a shorter amount of time than less experienced users. The number of system users can also determine the amount of information that can be produced, and the amount of time necessary to produce it.

Other important factors are the ease of use and learning of the PSS technologies and the skills and knowledge required for interpreting the data and applying it to the

current issue. The clarity and understandability of the information greatly affects its usefulness. If the end user or the decision-maker cannot understand the information, then it will have little impact on the decision. The appearance of the information and how it is displayed also affects the ability of the end user or decision-maker to understand the information.

Access to the system is also an important topic for this evaluation category. The evaluator needs to determine who has access to the data and analysis capabilities of the PSS. Easily accessible data can decrease data collection time. Data accessibility can be improved through a system of sharing information between agencies. It should be determined if planners, decision-makers and/or their support staff, stakeholders, schools and universities, and the general public have access, and if they do, to what extent. The evaluator should determine whether or not the PSS is web-based. Is it possible for the public to perform analyses or view alternatives via the Internet? Determining the level of acceptance, support, and utilization of various institutions is also important to determining the system capabilities. One element that needs to be discussed is the level of support and confidence in the PSS from political figures and decision-makers. Greater political support and decision-maker support increases the impact of the PSS and the scientific information on the decision-making process.

It is also important to determine the amount of support, acceptance, and utilization of the PSS during the planning process, as well as during formulating and enforcing regulations. The acceptance, support, and utilization of educational institutions should also be factored in to the evaluation.

The influence the PSS has on the final decision or outcome is also an indicator of the system capabilities that needs to be addressed in the evaluation. More will be discussed on this in a following category.

Roles and Capabilities of the Planners and Decision-Makers

The roles and capabilities of the decision-makers and planners can have a significant effect on the utilization and understanding of the scientific information generated by the PSS. There are four main elements to this evaluation category. The first is understanding the planners' and decision-makers' appreciation and understanding of the relevance of scientific information to the issue. This affects how this information is applied to the process, and to what extent. Second, the planners' and decision-makers' awareness and understanding of the scientific information and its limitations should be determined. For example, the evaluator should determine if a decision-maker understands that a higher resolution of aerial photos is necessary for performing accurate analysis at a parcel-level than at a regional level. The third element consists of determining the planners' and decision-makers' familiarity with the information and whether or not they directly utilize the PSS. Planners and decision-makers that are familiar with the science and technology will feel more comfortable incorporating the information into the decision-making process. The final element is describing the role of the planner and/or decision-maker. This means describing this person's role as either the primary authority, a member of the support staff, a stakeholder, or a combination of these.

Impact of the Science

This methodology incorporates eight elements for determining the impact of the science on a planning or decision-making process. The first is to describe the impact as perceived by the participants in the planning and decision-making process. Did the scientific information change their initial opinion, support their beliefs, or was it not a factor at all? The second element of this evaluation category is to describe the decision(s) made and the products of the process. Another element is for the evaluator to report the benefits of the PSS and the scientific information to the planning and decision-making process, as he/she perceives them. Another important aspect of this category is to describe the contribution of the organization facilitating the planning and decision-making. One way to evaluate the impact of the science is to note the resolution of conflicts prior to the decision-making stage of the process that are directly accredited to the PSS or the scientific information. The evaluation should also determine whether or not the PSS and the scientific information increased citizen participation in the planning or decision-making process. The decision-making time should also be considered when evaluating the impact of the science and PSS. Reduced decision-making times can be an important indicator for PSS success. A final element of this category is to determine if any additional problems or concerns were identified as a result of the science and technology. For example, threats to water quality might be discovered while using the PSS to perform steep slope analysis.

Methodology Techniques

Two main techniques should be used to evaluate the six areas of focus in this methodology: content analysis and personal interviews.

Content Analysis

Content analyses should be conducted on different types of materials for each separate planning and decision-making process. Planners and decision-makers involved in the process should be contacted about identifying and acquiring the relevant documents. The information reviewed should include documents related to the central issue, such as background information, past plans, or research. A content analysis should also be conducted on information about the PSS used in the process. Information on the decision-making process should also be reviewed. This might include the alternatives considered during the process or the final product of the decision.

Since the content analysis will be different for each planning and decision-making process, the evaluator should become very familiar with the six areas of focus in this methodology and the elements that make up each of them, so that he/she will be able to recognize the important information when it is made available.

Personal Interviews

Personal interviews should include community officials, stakeholders, persons utilizing the PSS, representatives of the planning agency, and participants in the decision-making process. The personal interview aspect of the methodology provides the majority

of information, and the most critical information necessary for evaluating the elements of the planning or decision-making process as described in the six categories discussed earlier in this chapter. This methodology provides questions for the personal interviews. Some questions should be asked to all subjects: planners, decision-makers, PSS specialists, and stakeholders. Other questions are targeted at specific groups. The majority of the questions were designed as open-ended questions in order to obtain as much information as possible from the subjects interviewed.

The questions are grouped based on the six evaluation categories. Following each question is the group or groups of subjects for whom the question is intended.

Issue of Concern Questions

- What was the inspiration for the planning and/or decision-making process related to the issue, and where did it come from? (Planning Agency Representatives and Decision-Makers)
- What was this inspiration based on? Scientific data, personal observations and/or beliefs, community concern, etc? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- How important is the planning and/or decision-making process in meeting the overall community goals? Is it a high priority? (Planning Agency Representatives, Decision-Makers, and Stakeholders)

Characteristics of the Decision-Making Process Questions

- What are the main goals of the planning and/or decision-making process related to the issue? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- What other stakeholders are involved in this process? What type of influence does each of these stakeholders have on the process and final decision? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- In what ways have the general public been involved in this decision-making process? In what ways will the general public be involved in the future? (Planning Agency Representatives and Decision-Makers)

Relevance of Science to the Issue Questions

- What types of scientific disciplines do you consider most important to this decision-making process? Biology, geography, etc.? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- How do you perceive the role of scientific information and PSS technologies in this process? How do you plan to incorporate them into the process? What do you hope to benefit from them? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- Do you feel the scientific information and PSS technologies are necessary for this process? Beneficial to this process, but not necessary? Hinder this

process? Are not at all necessary for this process? (Planning Agency Representatives, Decision-Makers, and Stakeholders)

- Are the available data at the necessary temporal and spatial scale in order to be applied to this decision-making process? (Planning Agency Representatives and PSS Specialist)

Capabilities of the PSS Questions

- Do you support the use of the PSS technologies in this decision-making process? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- What type of analyses and functions will be performed with the PSS for this decision-making process? (Planning Agency Representatives and PSS Specialist)
- What types of computer programs and software will be utilized in the decision-making process (GIS, photo-enhancing software, 3-D modeling, etc.)? (Planning Agency Representatives and PSS Specialist)
- What applications of the GIS will be used in this process? Are these standard applications or were they added to the GIS? (PSS Specialist)
- Is a specialist required to perform the necessary tasks and analyses with the PSS technologies? For all of them? Which ones? (Planning Agency Representatives and PSS Specialist)

- How many PSS users are available to perform tasks and analyses for this project? (Planning Agency Representatives and PSS Specialist)
- What is the source(s) of the data being used? How old are the data? (Planning Agency Representatives and PSS Specialist)
- Are all of the necessary data and information readily available? Are they kept at the same location as the PSS and its users? How long does it take to acquire necessary data that are not readily available? (PSS Specialist)
- Who has access to the data and analysis capabilities of the PSS being used in this decision-making process? Planners, decision-makers, stakeholders, schools and universities, general public? (Planning Agency Representatives and PSS Specialist)
- How difficult is it to understand and interpret the scientific information generated for this decision-making process by the PSS? Is any special training necessary to understand or interpret this information? Do the PSS technologies increase your understanding of the information? Is this information easily applied to this decision-making process? (Planning Agency Representatives and PSS Specialist)
- How confident are you in the information produced by the PSS technologies? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- How will the information generated by the PSS technologies be conveyed to the decision-makers on this issue? Printed maps or photos, computer

projection, written report, etc? (Planning Agency Representatives and PSS Specialist)

- How long will it take to produce the information needed for this decision-making process? How long would it take to make changes to the final products produced by the PSS technologies? Can alterations be made on the spot to answer specific questions? (Planning Agency Representatives and PSS Specialist)
- Will this information be made available to the public via the Internet once it is completed? (Planning Agency Representatives and PSS Specialist)
- How much experience do you have with the PSS technologies used in this process? (PSS Specialist)

Roles and Capabilities of the Planners and Decision-Makers Questions

- Are you aware of relevant scientific information in this decision-making process? (Decision-Makers)
- Do you understand the limitations of the science associated with this decision-making process? (Planning Agency Representatives and Decision-Makers)
- Do you directly use the PSS utilized in this process? Are you familiar with any of the technologies that make up the PSS? Have you personally received any training for any of the technologies that make up the PSS? (Planning Agency Representatives and Decision-Makers)

- Do you feel comfortable interpreting scientific information conveyed through GIS, 3-D models, maps, graphs, charts, etc.? Do these techniques increase your understanding of the scientific information used in the decision-making process? (Decision-Makers and Stakeholders)

Impact of the Science Questions

- How many alternative plans have been produced in this decision-making process? (Planning Agency Representatives, Decision-Makers and PSS Specialists)
- Does the scientific information and/or the PSS technologies used in this decision-making process offer any actions that would not have been possible in their absence? Types of analysis, presentation formats, etc? (Planning Agency Representatives, Decision-Makers, PSS Specialists, and Stakeholders)
- What impact do you believe the scientific information and the PSS technologies had on the final decision? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- Were there any conflicts resolved prior to the final decision-making stage that can be directly attributed to the scientific information and/or the PSS technologies? (Planning Agency Representatives, Decision-Makers, and Stakeholders)
- Will public participation be enhanced by the PSS technologies? (Planning Agency Representatives and Decision-Makers)

- Did the scientific information and/or the PSS technologies reduce the amount of time necessary for the decision-making process? (Planning Agency Representatives and Decision-Makers)
- Were any additional problems identified as a result of the science and technology used throughout this process?

In Chapter Four the methodology components and techniques described in this chapter are applied to a pilot study in Walden, Tennessee. The methodology is used to evaluate the role of PSS technologies and scientific information in the town's process of creating a conservation-oriented zoning ordinance. The pilot study provides an opportunity to test the methodology for its effectiveness. It also provides a chance to evaluate the strength and weaknesses of the methodology itself. The pilot study is critical for fine-tuning the methodology before it is applied to future research on a larger scale.

Chapter 4

Pilot Study: Walden, Tennessee

The previous chapters of this thesis introduced you to the overall project, discussed literature related to evaluating the role and impact of PSS technologies and scientific information in a planning or decision-making process, and described the methodology created for carrying out this evaluation. Chapter Four will now discuss the application of this evaluation methodology to a pilot study in the Town of Walden, Tennessee.

This chapter begins with a brief history and description of the Town of Walden, followed by a discussion of how this community decision-making process of updating the town's zoning ordinance relates to the objectives of the research. Next, the various stages of applying the evaluation methodology will be discussed. As described in Chapter Three, there are six areas of focus in the methodology: the issue of concern, relevance of science to the issue, capabilities of the PSS, characteristics of the decision-making process, roles and capabilities of the planners and decision-makers, and the impact of the science. The techniques used to carry out this evaluation include content analyses of relevant documents and research, and personal interviews.

Town of Walden, Tennessee

The Town of Walden is situated a few miles northwest of Chattanooga, TN atop Walden's Ridge in southeast Tennessee at the end of the Cumberland Plateau (Figure B-6). Walden's Ridge overlooks the city of Chattanooga, which lies below in a deep valley. Walden's Ridge is named after John Walling, who was killed in this area by Cherokee Indians early in the nineteenth century while leading a band of hunters from Virginia (Hamilton County 2000). This area remains heavily forested, and a variety of wildlife can still be found here today, including possum, raccoon, rabbit, squirrels, deer, and an occasional black bear or eagle (St. John 2001).

Walden is considered a "bedroom community" to Chattanooga. The majority of the town's residents work in Chattanooga, or either they are retired (St. John 2001). According to the U. S. Census Bureau (2000), Walden consists of 2,269 acres and has a population of 1,960. The current population represents an increase of 62% from 1980. Despite this growth, the Town of Walden maintains a very rural feel, and this is no accident. The neighboring town of Signal Mountain is somewhat different. Signal Mountain has a more suburban feel, with strip development and subdivisions, and the residents of Walden do not want to see the same thing happen to their community. Table A-2 displays a comparison of U. S. Census Bureau information for Walden and Signal Mountain.

Relation to the Objectives of the Research

The Town of Walden is currently involved in the process of updating their zoning ordinance, and making it more conservation-oriented. This process provides an excellent opportunity to apply the methodology created to evaluate the role and impact of PSS technologies and scientific information in community level planning and decision-making processes. This pilot study provides a simple, small-scale decision-making process that allows for easy application of the evaluation methodology. The Walden pilot study is also important because the community wants to preserve its natural surroundings. This is a prime example of the type of decision-making process that the NBII is hoping to enhance by increasing the access to, and the quality of scientific information.

This pilot study is not perfect, however. The process of revising the zoning ordinance is not complete. Ideally, the evaluation would take place throughout the decision-making process, but due to time restraints, certain parts of this methodology had to be implemented prematurely. Another drawback is that the NBII is still a new, developing concept, and is not yet as effective as it will be in the future.

There is still a lot to be gained from this pilot study. It provides a chance to test the methodology and its effectiveness; it provides a chance to evaluate the techniques used to implement the methodology; and it provides a study for future evaluations to be compared to once the NBII has a chance to play a larger role in the process.

Application of the Evaluation Methodology

The two main techniques used to apply this evaluation methodology are content analyses of relevant documents and personal interviews with persons involved in the decision-making process. For this pilot study, I provide a content analysis on the proposed zoning ordinance document put together by the Community Committee in Walden, as well as the revised version of the ordinance and the changes made by the RPA. I also provide an analysis of the research performed by Jennifer Makosky, an intern for the RPA during the summer of 2001, regarding zoning ordinances dedicated to natural resource conservation and protection.

A subject of one personal interview was Elizabeth Akins, the Mayor of Walden, TN. This is an important piece of the evaluation process because she plays a major role in the zoning ordinance decision-making process, and she is an avid promoter of the new conservation oriented ordinance. A personal interview was conducted with one of the two aldermen of Walden, because they too play an important role in this decision-making process, and Alderman Leo Brown is the chairman of the Community Committee that proposed the new zoning ordinance. Personal communications have already taken place with Jeff Pfitzer and Karen Rennich of the Regional Planning Agency and a formal interview with each was also conducted. Jeff Pfitzer, a graduate of the University of Tennessee's Department of Urban and Regional Planning, was the liaison between the RPA and the town of Walden when this project got off the ground. These interviews were important because the RPA will provide technical and professional support for the town of Walden during the process of updating the zoning ordinance. The RPA, or either the Hamilton County GIS department at the request of the RPA, is responsible for the

GIS analyses. The RPA is also responsible for writing the final draft of the Walden zoning ordinance.

Issue of Concern

The issue was clearly stated in this pilot study. This decision-making process was intended to revise the Walden zoning ordinance and to incorporate methods for environmental conservation. The concerned citizens of Walden initiated this process in 1996. Mayor Elizabeth Akins and the town's aldermen also played a large role in getting this project going.

Decision-Making Process

During the early stages of the evaluation, the evaluator(s) needs to familiarize himself/herself with the decision-making process. This is important for a couple of reasons. The first is that this helps determine the steps of the process that will potentially utilize PSS technologies. Understanding the decision-making process also aids in identifying the decision-makers, stakeholders, and users of the PSS technologies. The second reason is to help define how this process affects final decisions. This should then be incorporated into the evaluation of the impact of PSS technologies and scientific information.

The process of revising Walden's zoning ordinance is best described as a strategic community-planning model with elements from a collaborative learning approach and an elite corp decision-making process. Figure B-7 provides a model of the decision-making process used in Walden. The Walden Community Committee that began this process

included many different stakeholders in the community from the beginning. This is representative of a collaborative learning approach. However, this committee is making decisions for the entire town without wide public participation. This is representative of an elite corp decision-making process.

The first steps to revise the Town of Walden's zoning ordinance began about six years ago in 1996, with the creation of a Community Committee (Brown 2002). This committee was composed of a wide variety of Walden residents. These residents represented different stakeholder positions with in the community. The committee included engineers, architects, business owners, landscapers, investors, developers, and real estate agents, among others.

This committee was created to discuss the need for an updated zoning ordinance, select key issues the ordinance should address, establish goals for this ordinance, research ordinances from around the country that were similar to the ordinance they desired for Walden, and create a draft zoning ordinance. Upon completion of the draft document, it was delivered to the RPA for professional and technical review.

The RPA reviewed and revised the document. The RPA incorporated information gained through the research of Jennifer Makosky, a SAMAB intern during the summer of 2001. Jennifer Makosky conducted research on conservation strategies and techniques for managing growth. The draft ordinance then went through a series of internal reviews to make sure it was in accordance with all professional and legal requirements. The internal review included planners, a Walden city attorney, and a Hamilton County building and zoning inspector. Once the RPA completed its review and revision of the

zoning ordinance, it was returned to the Walden Town Council for review. The town council consists of the mayor and two aldermen.

It was at this point in the process when the methodology was applied and this thesis was written. At this point in the process, only the written portion of the zoning ordinance is complete. Once the written portion of the ordinance meets all the standards of the internal review and Walden's mayor and aldermen approve the document, it will go back to the RPA for the technical analysis necessary for applying the regulations set forth in the ordinance to the landscape and the creation of the corresponding maps.

By law, a public meeting is required before the Walden Town Council takes a final vote on whether or not to approve the new zoning ordinance. This meeting will give everyone in the community a chance to review the final document and maps and make comments. These comments will be heard and taken into consideration by the town council, but the final decision on approving the new zoning ordinance will be made solely by the mayor and the two aldermen.

Following the approval of the zoning ordinance by the mayor and aldermen, the zoning ordinance will be implemented. The results of the zoning ordinance will then be monitored, and updates and amendments will be proposed when necessary to maintain the original purpose of the new zoning ordinance and achieve the goals therein.

Content Analysis of the Document Prepared by the Walden Community Committee

A great deal of time and effort went into the document prepared by the Walden Community Committee (2001). The committee used existing zoning ordinances from communities in Virginia, Vermont, California, Illinois, Minnesota, and Alabama as a

guide for the ordinance's format, as well as incorporating ideas from each of these ordinances into their document. The general form of the final product is similar to that of an official zoning ordinance. It includes the goals and purposes of the ordinance, as well as a statement of a community vision to be achieved through the creation of the ordinance. The document also includes a list of definitions used in the text. The Community Committee included a description and guidelines for a Commercial Design Review Committee (DRC), estate zone (E-1), residential zone (R-1), gateway (commercial) zone (G-1), village center zone (VC-1), light manufacturing zone (LM-1), and an open space overlay zone (OS-1). The document prepared by Walden's Community Committee also included standard sections of a zoning ordinance including: general provisions and exceptions; administration and enforcement; appeals; interpretation and amendments; sanitary wastewater discharge requirements; earth-disturbing activities and clear-cutting of timber; and validity and severability.

The general purpose of the ordinance (2001) drafted by the Community Committee states:

> For the public health, safety morals, convenience, order, prosperity, and general welfare of the citizens of the Town of Walden, and in order to secure the public interest in the orderly development of the Town of Walden by promoting sustainable, long-term economic development, adequate light and air, improved traffic safety, reduced traffic congestion, environmental protection; as well as adequate water drainage, water supply, sanitation and recreational facilities through the regulation by districts and zones of the location, height, bulk, number of stories and size

> of buildings and other structures, the percentage of the population, the uses of buildings, structures and land for trade, industry, residences, recreation, public activities and other purposes, and in connection therewith, the public interest in establishing reasonable design guidelines for all commercial or industrial buildings or structures, there is hereby adopted and established an official Zoning Plan for the Town of Walden consisting of the maps and regulations described herein. In adopting this Ordinance, the Town of Walden recognizes that its natural landscapes and development patterns play an important role in defining the attractiveness, identity, livability, and therefore, the economic health of the community. Currently, the Town enjoys a rural mountain character supported by scenic overlooks, creek gorges, woodlands, and pasturelands. The character of development is predominantly residential and small in scale. (2001: 2)

The committee also created the document to complement the vision established in the Walden's Ridge Plateau Plan (2001). This vision states that the Walden's Ridge area strives "to be a community that attracts families, who can live here through the phases of life, provides for an orderly and cohesive development pattern that maintains a small town atmosphere with rural character and green spaces, and preserves pristine natural areas for the enjoyment of its residents" (2001: 2).

The document contains seven more-specific goals of the ordinance by which the town hopes to achieve the stated purpose and vision. These goals are:

1. To maintain rural character and small scale of development;

2. To protect important natural resources (creek gorges, overlooks, woodlands, steep slopes, wetlands);
3. To protect and enhance property values;
4. To provide a variety of living arrangements;
5. To encourage harmonious and integrated development patterns that are economically feasible and are in harmony with the community with the following development priorities: outdoor gathering places; pedestrian facilities; mixed uses; and landscaping;
6. To discourage commercial strip development; and
7. To promote high quality development that promotes materials and design consistent with maintenance of Walden's character as a rural and residential community. (2001: 2-3)

The DRC consists of five residents from the Town of Walden. The mayor and aldermen will appoint the members of the DRC. The members serve terms of one or two years. The town's mayor and aldermen also determine the length of each member's term. The DRC reviews all plans for new construction and/or exterior remodeling of buildings within the G-1, VC-1, and LM-1 zones. This does not include primary or accessory structures for single-family residences. This section of the document also describes the type of drawings that must be submitted to the DRC, and the standards they must meet.

Next, the document sets forth the general guidelines for each of the six zones considered for use in Walden. For each zone the document describes:

- The purpose of the zone,
- The permitted uses within the zone,
- Special permitted uses; these uses require a conditional permit from the mayor and aldermen, and
- Area regulations, i.e. minimum yard requirements, setbacks, minimum lot areas, height regulations, etc.

The majority of the purposes and guidelines for the zones are fairly standard. The E-1 zone is to guide low-density development and agricultural uses in these designated areas. The R-1 zone encourages low-density residential development. The VC-1 zone is "intended to blend commercial and residential areas into a pedestrian friendly mountain atmosphere where the proximity of residential housing to commercial enterprise does not detract from the quality of life of the residents" (2001: 25). The LM-1 zone is intended for low-impact manufacturing establishments that employ twenty people or less. The G-1 zone provides guidelines for "commercial properties and service uses, which may be orientated to the automobile or pedestrian trade. This district is designed to accommodate such commercial uses as permitted in a manner that will minimize interference with through traffic movements. To insure a high standard site layout, design and landscaping will be site specific" (2001: 22).

The OS-1 zone, however, requires some elaboration. This zone "is intended to provide a voluntary residential development option with R-1 and E-1 Zones that protects open space and natural resources, and retains the predominantly rural character of the

Town of Walden" (2001: 40). The document defines seven specific purposes of the OS-1 zone:

1. To allow development that permanently preserves the open space, pasturelands, woodlands, wetlands, critical views, creeks, and other natural features within the Town of Walden;
2. To connect open space, trails, and recreation sites within the Zone and to integrate the open space and recreation system of the Town of Walden.
3. To allow flexibility in the placement and type of dwelling units within the subdivision;
4. To promote the integration of woodlands, pasturelands, and creeks, into the overall development framework;
5. To promote the use of shared septic, drinking water and stormwater systems that prevent the degradation of water quality;
6. To reduce the amount of new roads and to allow flexibility in road specifications for roads serving residences in the Zone; and
7. To reduce the amount of impervious surfaces in subdivisions, including driveways. (2001: 40)

This section on the OS-1 zone also provides specific guidelines and regulations for minimum size of subdivisions (20 acres), maximum gross density (six dwelling units per 40 acres), open space (40%), ownership and management of open space, lot and building site design, utilities, buffer zones, streets, and the application process in addition to the guidelines and regulations provided for all the other zones.

Content Analysis of Jennifer Makosky's Research

In the summer of 2001, Jennifer Makosky, a SAMAB intern for the Chattanooga-Hamilton County RPA, conducted research on issues related to creating a conservation-oriented zoning ordinance. One product of her research is an annotated bibliography (2001b) of both written and Internet resources for conservation planning. This bibliography includes model ordinances and conservation strategies and planning tools, among other environmental information.

A large portion of Makosky's research focused on the tools and strategies used by planners and decision-makers to create conservation-oriented zoning ordinance. One document identifies 24 of these strategies and tools. This list includes strategies for condensing development, limiting development based on natural features of the land, restricting growth areas, promoting infill and redevelopment, and land acquisition. It describes the typical components of each strategy and discusses the benefits and drawbacks to each. Some of these strategies can be found in Walden's draft zoning ordinance. One tool discussed here that is used in the Walden zoning ordinance is the overlay zone. This type of zone is used to protect a specific geographical area because of environmental, historical, or other specified qualities. Another technique utilized in the draft ordinance is performance zoning. Performance zoning creates regulations based on natural features of the land such as stream buffers, wetland protection, and slope protection. Jennifer Makosky also provides examples of 20 communities throughout the United States that have successfully implemented a number of these same techniques.

Makosky's research provides more detailed information on zoning guidelines and standards for steep slopes and streams. She describes different approaches to creating buffers and filter strips for streams, rivers and watercourses. One method of determining buffer or filter strip width is based on the slope of the land in close proximity to the waterway. The width of the buffer zone should increase as the slope of the land increases. Another method also factors in the use of the stream or waterway. Buffer zones are not as large for waterways that are used for recreational purposes. A third approach uses soil type and slope of adjacent lands to determine the buffer or filter strip width. This approach suggests wider buffer zones where erodible soil is present, and more narrow buffers where the soil is slightly erodible.

Jennifer Makosky (2001) describes the measures five different areas have taken to protect their steep slopes. Abemarle County, Virginia, banned all development in areas with 25% slope or greater. Pacifica, California, created a preservation district with strict development guidelines. However, this approach did not protect all steep slopes. Boise, Idaho, also banned development on slopes greater than 25%, but they also required a hillside permit to be obtained for development on slopes greater than 15%. A slightly different approach is taken in Croton-on-Hudson, New York. Here no more than 25% of the area can be developed on slopes of 15-20%, and only 10% can be developed where the slope is over 20%. Nashville, Tennessee, requires that areas of 25% slope or greater be platted outside the building envelope, but a variance can be obtained.

Content Analysis of the Draft Zoning Ordinance after RPA Review

When the Walden Community Committee completed the draft zoning ordinance, they turned it over to the RPA. At this stage the document was reviewed and updated so that it met legal and professional standards. Some minor changes were made to the original text, but the majority of the original document remains in the RPA updated version. The format of the document has been rearranged to match the format of a typical zoning ordinance. The RPA made several additions to the ordinance including some of the tools and techniques researched by Jennifer Makosky, as well as other standard elements of a zoning ordinance.

An example of the types of minor changes made to the original text is the deletion and addition of some definitions. The RPA also added a category for livestock and fowl to the General Provisions and Exceptions Article. Another minor change was that the RPA changed the name of the Gateway zone (G-1) to Commercial zone (C-1). The guidelines for this zone remained the same, though. Some minor changes were also made within the permitted uses and special uses sections of zones E-1, R-1, and VC-1.

One major addition was the Agriculture zone (A-1). The community committee's draft included agriculture practices in the E-1 zone. The A-1 zone is designated for agricultural land uses, but also allows churches, farm stands, single-family detached dwellings, barns, bed and breakfasts, schools, and a few other uses.

The addition of the Guidelines for Community Design was also a major change. This section is based on a Community Vision public meeting in 1996. The guidelines are intended to "encourage opportunities for more traditional, compact development patterns, often referred to as nodal development, rather than more linear strip commercial

development fostered by encouraging the creation of gateways, public spaces, cross and parallel streets, and a future town center" (Chattanooga-Hamilton County Regional Planning Agency 2001). This added section incorporates the Town Center idea for clustering development. Included are guidelines for parking in these areas of clustered development. This is an attempt to prevent seas of parking lots associated with strip development. The community design guidelines include schematic drawings to help explain the standards for cross street designs and the concepts of building scale and consistent building design.

A couple of key changes were made to the development standards in the OS-1 zone. The maximum gross density was changed from six dwelling units per 40 acres to two dwelling units per acre. The RPA also increased the percentage of land that was to be classified as open space from 40% to 50%. These changes were made to increase both the chance of developers using this overlay and the amount of open space when it is used. Other minor adjustments to the OS-1 zone include additional street requirements and a change to the application process that requires draft concept plans to show all slopes over 25%.

Regulations pertaining to signs and advertisements were added by the RPA. The purpose of these standards is to "protect aesthetic values as well as public health, welfare, and safety by regulating the size, height, design, quality of materials, construction, location, illumination, and maintenance of signs and sign structures within the Town of Walden, Tennessee" (2001: 57). These regulations seek to protect property values and enhance the business activity while at the same time preserving the natural beauty and scenery of Walden.

Sections regulating landscaping, steep slopes and bluffs, wetlands, and hazardous waste were also added to the ordinance. An existing set of landscape requirements was added to the Community Committee's original version of the ordinance. These requirements stress the use of native plant species in small-scale and large-scale landscaping projects.

The steep slopes and bluffs regulations prohibit the construction of buildings on any slope greater than 25%, with the exception of existing homes at the time of adoption of this ordinance. Minimum setbacks of 30 feet from the edge of the bluff face at the top of bluffs and 65 feet at the base of the bluff will be enforced to protect these features of the natural landscape.

The RPA revised ordinance states that no wetland shall be developed, drained, or otherwise altered. Streamside zones are added to protect stream ecosystems. These zones are to remain as "undisturbed native vegetation" (2001: 71). The minimum streamside zone is 25 feet in width. In areas where the streamside zone contains lands with a slope of 15% or greater, the minimum width is 100 feet.

The last major addition is the article on hazardous waste. This article focuses on protecting the health and safety of surrounding communities from the commercial hazardous waste facilities and commercial medical waste facilities. At the same time, these regulations strive to encourage innovations in related technologies, improve collaboration among similar facilities, and reduce the amount of hazardous waste by promoting recycling, reuse, and reclamation (2001).

One of the goals of this process as stated by Walden's Mayor was to make the ordinance more user-friendly. In an attempt to simplify the use and understanding of the ordinance, the RPA also included a matrix, or table, of the basic zoning regulations.

Planning Agency Interviews

I have had the chance to meet and talk with RPA representatives Jeff Pfitzer and Karen Rennich four times about the process of updating the Walden zoning ordinance. The first meeting involved getting background information on the project, discussing the decision-making process, identifying decision-makers and stakeholders, and acquiring documents relevant to this research.

About a month later, I spoke with Karen Rennich (2002) about the progress of the Walden project. At this point the zoning ordinance was still undergoing internal review, but the information was being shared with the decision-makers and stakeholders in Walden. At this stage, it was believed that the zoning ordinance would have a hard time passing. The main problem was with the DRC. There was the idea that these issues would not be supported, and the ordinance would have an easier time getting passed if this portion were removed. There were also some legal issues associated with DRC and the Tennessee enabling legislation. These types of DRC have been challenged in other cities. Based on this, Karen stated they were moving away from design requirements, and they were focusing on a stricter zoning ordinance in the way of steep slopes and water stream protection. This approach would give less power to the town and more power to the county building inspector.

The next day, I discussed the progress of the project with Jeff Pfitzer. Jeff echoed the problems that Karen Rennich had mentioned with the DRC, and that it would probably be eliminated. He also stated that the developers had voiced some resistance about the landscape ordinance, and that some questions had been raised by an attorney representing developers. Jeff also mentioned that the mayor and aldermen of Walden might not be as strong of supporters for this aspect of the zoning ordinance either. He also mentioned that some might have some unfounded concerns about the VC-1 zone. Jeff also discussed the possibility of greater density within the slope ordinance and raised the question of whether or not Walden had the political will to carry this process out.

The purpose of the next meeting with Karen Rennich and Jeff Pfitzer was to conduct a formal interview for the evaluation as described in Chapter 3. The appropriate questions were used to create a guideline for the interview. The questions were designed to create a natural flow of conversation, but in some cases, as in this one, many questions may be answered before they are even asked. However, I have formatted this report to follow the questions as there are listed in Figure B-8.

It was my intention to interview both Karen Rennich and Jeff Pfitzer separately, but due to time constraints that was not entirely possible. The interview began with only Karen Rennich. We covered the first ten questions, and then Jeff Phitzer joined the conversation. After all the questions in the list had been covered, Karen exited. The first ten questions were then covered again with only Jeff Pfitzer.

1. What are the main goals of revising the Walden zoning ordinance?

Karen believed one of the main goals of the new Walden zoning ordinance was to create an ordinance that was tailored more for the Town of Walden. The old ordinance was adapted from the Hamilton County Zoning Ordinance, and they wanted something that would protect the "unique feel" of Walden and protect their specific interests, because the citizens believe they have something special. The Town of Walden also wanted to protect their natural features such as bluffs. Jeff stated that he believed conservation and protecting the resident's quality-of-life were among the main goals for revising the zoning ordinance.

2. What was the inspiration for revising the Walden zoning ordinance, and where did it come from?

Karen's understanding was that this process was greatly the inspiration of Walden's mayor, Elizabeth Akins, and the aldermen, Leo Brown and Peter Hetzler, but mainly the mayor. Past and present town council members have desired a new zoning ordinance for many years, but the current process may have been jump-started by the recent development of a growth plan and thinking about where the town is headed in the future.

3. What was this inspiration based on? Scientific data, personal observations and/or beliefs, community concern, etc?

Karen believes this inspiration was based on the Town Council's desire to properly manage the growth of Walden, and on the citizen's desire to protect the community. Karen also mentioned the rivalry of sorts between the town of Walden and

its neighboring community of Signal Mountain. Many residents of Walden look at Signal Mountain as an example of what they do not want to be like. Signal Mountain has been seen as more development-oriented, and Walden wants to remain more nature oriented. She believes that the residents of Signal Mountain see themselves more as a neighborhood to Chattanooga, and Walden residents want to preserve a rural, small-town feel.

4. How important is the process of revising the Walden zoning ordinance in meeting the overall community goals? Is it a high priority?

Karen stated that a citizen of Walden might not think a new zoning ordinance is that important in-and-of-itself, but she believes it is very important tool for achieving the overall goal of preserving the Town of Walden, which is an important issue among residents. Jeff agreed that this process was very important to achieving overall community goals for Walden. This led to a discussion with Karen about the level of citizen participation in Walden. The citizens of Walden are very active, and are eager to take part in decisions that affect the community. She gave an example of an instance in which citizens met with a developer and worked out a design that everyone could agree on.

5. What other stakeholders are involved in this process? What type of influence does each of these stakeholders have on the process and final decision?

Karen identified the major stakeholders as being the Walden Town Council, members of the Community Committee, developers, and all Walden community

members. Jeff mentioned that the RPA was not a stakeholder. The RPA purpose is to provide technical support to the town of Walden. Karen also stated the role of the RPA was to provide support for Walden. The RPA was doing the "grunt work" to create this tool for the community, but once they accept it, it is up to them to decide how they will use it.

6. In what ways have the general public been involved in this decision-making process? In what ways will the general public be involved in the future?

Karen did not speak on public participation up to the current stage of the process, because she was not involved at the beginning of the process. She did discuss the fact that a public meeting would be held, where the RPA would present the new ordinance, and this meeting would be advertised in the newspaper. There will definitely be an opportunity for public comments at this meeting. She also mentioned that there might be one or two additional meetings with the community prior to this meeting in order to get public input and feedback, and this would depend largely on the interest expressed by the community members of Walden.

7. What types of scientific disciplines do you consider most important to this decision-making process? Biology, geography, etc.?

When asked about which scientific disciplines were most important to this process, Jeff believed that geography and biology were the two most important. Karen stated that these types of science would become more important at the stage of GIS analysis. She also stated that these disciplines have played a large role in the process up

to this point, whether it was intended or not. The citizens are acting on personal observations, but these scientific disciplines play a part in their concerns.

8. Do you support the use of the PSS technologies in the Walden Project? Does the RPA?

Karen supports the use of GIS and feels it is most important in determining steep slope protection, stream and slope protection, and possibly spring protection and for physically applying zoning to a map. The RPA also supports the use of GIS in all projects as well as this one. RPA also supports community involvement, and GIS is often used as an educational tool. The RPA wants to inform citizens so that they can receive more informed input back from them. Maps produced by GIS are taken to community meetings to help the citizens visualize issues such as tree scaping, traffic problems, etc.

9. Do you understand the limitations of the science associated with the Walden zoning ordinance project?

The RPA employees that use GIS understand the limitations of the technology, and they try to convey this to other employers. Karen also stated an understanding of the fact that certain forms of data are more accurate than others, and some data are not accurate at the parcel level.

10. How do you perceive the role of scientific information and PSS technologies in this process? How do you plan to incorporate them into the process? What do you hope to benefit from them?

The primary role of the PSS technologies will be to create the accompanying maps for the zoning ordinance. This includes zoning maps, as well as maps of the steep slope analysis, wetland location, and stream buffers. All current plans are also posted on the RPA website. The Walden ordinance will also be placed on their website once it is completed. However, the draft document will probably not be placed on the Internet. The PSS technologies will also be used to better educate the community and enhance their participation. Karen believes this can be accomplished by using the PSS technologies to better communicate information and by making more information available. In the future the RPA would like to provide a zoning map for the entire county, so that someone could request information on a single address. Another expected benefit of the PSS technologies, especially the Internet, is the time it will save both the RPA and the community by making enhancing access to information such as census data and zoning ordinances.

11. Do you feel the scientific information and PSS technologies are necessary for this process? Beneficial to this process, but not necessary? Hinder this process? Are not at all necessary for this process?

Karen mentioned that other means could be used to perform these analyses, but GIS is more accurate and less time consuming. Jeff felt that GIS is critical for creating the boundaries for zones, and natural areas that are to be preserved. Both felt that GIS creates a defensible analysis because there is a scientific foundation for the zoning. Until now these decisions were made politically in Walden.

12. What type of analyses and functions will be performed with the PSS for the Walden zoning ordinance project?

The main analysis will be locating the steep slopes as defined in the ordinance. The PSS technologies will also be used to identify streams and riparian zones, wetlands, and create the corresponding zoning maps. Upon completion the ordinance will be made available via the Internet at the RPA website.

13. What types of computer programs and software will be utilized in the Walden zoning ordinance project (GIS, photo-enhancing software, 3-D modeling, etc.)?

GIS is the key PSS technology used in this process. Karen mentioned that the RPA has a GIS based program that has been tailored for their use. The RPA currently uses the ArcView 3.2 GIS software.

14. Is a specialist required to perform the necessary tasks and analyses with the PSS technologies? For all of them? Which ones?

Karen will be responsible for conducting the GIS analysis associated with the Walden project. Karen stated she would seek out assistance from the Hamilton County GIS Department from the beginning. She is able to perform a number of analysis tasks, but may need to seek out instruction for tasks she is not familiar with, or ask the Hamilton County GIS Department to entirely perform the task.

15. How many PSS users are available to perform tasks and analyses for this project?

Karen answered that within the Chattanooga-Hamilton County RPA there were two planners that mainly performed GIS analysis, including herself. She added that the Hamilton County GIS Department consists of about 8-11 employees, and they were also available for help.

16. Do you directly use the PSS utilized in this process? Are you familiar with any of technologies that make up the PSS? Have you personally received any training for any of the technologies that make up the PSS?

As mentioned before, Karen regularly used the PSS technologies that will be applied to this project. Jeff is also familiar with this PSS since he once worked for the RPA. Karen has been primarily self-taught on GIS technology, and has received on-the-job experience. However, she has taken an advanced ArcView class that dealt with spatial analysis, modeling, and three-dimensional analysis. She mentioned that she would be attending training classes for ArcInfo 8 in the near future. Jeff is primarily self-taught as well. He did take an introductory course to ArcView3.2 while in graduate school, but gained a good deal of experience with GIS while conducting his thesis work.

17. Are the available data at the necessary temporal and spatial scale in order to be applied to the process of revising the Walden zoning ordinance?

Jeff's understanding is that a higher-resolution data is needed for the slope analysis on a parcel-by-parcel level. What they have is useful, but the RPA is limited in the analysis they can perform with it. Karen believes that Hamilton County GIS will be able to assist the RPA in obtaining this data.

18. What is the source(s) of the data being used? How old is the data?

According to Karen, aerial photographs and topological maps are the main forms of data necessary for this process, and they are up-to-date. The RPA would like to obtain a topological map for the Walden area with two-foot intervals between the contour lines. The majority of data the RPA uses comes from Hamilton County GIS or either they collect it themselves. Parcel level data held by Hamilton County GIS is updated every six months.

19. Who has access to the data and analysis capabilities of the PSS being used in this decision-making process? Planners, decision-makers, stakeholders, schools and universities, general public?

Final analysis would be made available on the Internet. Karen stated that RPA would be willing to distribute data, such as a CD with shapefiles of Walden, to that community free of charge. This information could then be used by the Town Council of Walden to perform their own GIS analysis, if they are capable.

20. How difficult is it to understand and interpret the scientific information generated for the Walden project by the PSS? Is any special training necessary to understand or interpret this information? Do the PSS technologies increase your understanding of the information? Is this information easily applied to the Walden project?

Karen believes the maps will be easy to interpret. She also points out that at community meetings where the RPA presents these maps, a GIS technician will be there to help explain the maps and the techniques used to create them.

21. How confident are you in the information produced by the PSS technologies?

Both Jeff and Karen stated that their confidence level depends on the data used in the analysis, and the source of that data. Therefore, if they are confident in the data, they are confident in the analysis. Karen mentioned that the RPA collects the majority of their own data. She also mentioned that she is very confident when using this data as a basis for performing analyses.

22. How will the information generated by the PSS technologies be conveyed to the decision-makers on this issue? Printed maps or photos, computer projection, written report, etc?

For this project, printed maps will be the primary form of communicating the analysis results to the decision-makers. Upon approval of the ordinance, these maps will also be posted on the RPA web site.

23. How long will it take to produce the information needed for the Walden project?

Both estimated it would take about two to three months to initially produce the necessary information for this project.

24. Would this information be made available to the public via the Internet once it is completed?

As discussed earlier, it is expected that the approved version of the Walden Zoning Ordinance and maps will be made available on the RPA web site.

25. How many alternative plans have been produced in this decision-making process?

Jeff considers the many versions of the zoning ordinance that have been produced to be an evolution of this planning process, and not really alternatives.

26. Does the scientific information and/or the PSS technologies used in this decision-making process offer any actions that would not have been possible in their absence? Types of analysis, presentation formats, etc?

Karen does not believe anyone at the RPA would have the skill or time to perform the slope analysis based on manual methods. Jeff feels that the technology increase the professional quality of the graphic presented. Karen also added that when a community is presented with graphics that are of high quality and appear professional they feel more comfortable accepting that information.

27. What impact do you believe the scientific information and the PSS technologies had on the final decision?

There was no discussion on this question, because the process is not complete and neither Jeff nor Karen could accurately predict the final products or outcome of this process.

28. Were there any conflicts resolved prior to the final decision-making stage that can be directly attributed to the scientific information and/or the PSS technologies?

At the current stage of the process, no conflicts have been resolved as a direct result of the PSS technologies. Mainly because the technologies have not been applied yet.

29. Will public participation be enhanced by the PSS technologies?

It is a goal of the RPA to use PSS technologies to increase public participation. The ability to use the PSS technologies to better educate the public on issues will enhance the quality of public participation. The Internet plays a large role in this because it makes it easy to provide large amounts of information available to the public.

30. Did the scientific information and/or the PSS technologies reduce the amount of time necessary for the decision-making process?

Not in this case. The disagreements and technicalities that are prolonging this decision-making process have occurred before any of the PSS technologies have been applied, therefore the PSS technologies have not even had a chance to resolve any of the conflicts or speed up the process.

31. Were any additional problems identified as a result of the science and technology used throughout this process?

As a result of this project some issues have been raised about the vulnerability of the town's escarpment and how that relates to its water quality. However, this cannot be fully accredited to the use of PSS technologies. Karen pointed out the possibility that additional problems could be identified at the public meetings.

PSS/GIS Specialist Interview

Since Karen will also be performing the majority of the necessary GIS analysis, she was also the subject of the GIS technician interview. Many of the GIS technician questions (Chapter 3) are duplicates of the questions we already covered, so only the new questions were asked to Karen. The question numbers correspond to the location of the question in the complete list of GIS technician questions.

1. What applications of the GIS will be used in this process? Are these standard applications or were they added to the GIS?

Karen speculated that she would use spatial analyst and three-dimensional analysis in the Walden project. These applications were additions to the GIS system, but the can be purchased over-the-counter. Other extensions have also been downloaded from the ESRI website, free-of-charge.

2. Are all of the necessary data and information readily available? Are they kept at the same location as the PSS and its users? How long does it take to acquire necessary data that are not readily available?

All of the data needed for the Walden project are readily available, in some form or another, at the RPA or either available through Hamilton County GIS, which is now located in the same building as the RPA, and would be easy to obtain. She also mentioned that the acquisition time for data not readily available depends on the type of data sought.

3. How long would it take to make changes to the final products produced by the PSS technologies? Can alterations be made on the spot to answer specific questions?

Karen and Jeff both agreed that it would be possible to make changes to the maps on the spot. Jeff also added that the structuring of the presentation and anticipating what questions might be asked would be very important in reducing the amount of time it took to make these changes.

Decision-Maker Interviews

The decision-making body of the Town of Walden consists of Mayor Elizabeth Akins, and two Aldermen, Leo Brown and Peter Hetzler. Interviews were conducted with Mayor Akins and Leo Brown. These interviews were also conducted at the same time. Leo Brown is also the chairman of the community committee that created the initial draft ordinance. His responses are considered to take into account the views of various stakeholders, given their participation in the creation of the initial document, and all stakeholder questions are included in this list (Figure B-10).

1. What are the main goals of revising the Walden zoning ordinance?

Mayor Akins stated that she wanted to protect the fragile, natural environment of Walden. She wanted to see the wetlands and steep slopes protected. The Mayor also wanted to avoid troubles such as septic problems that occur when growth is not planned. She mentioned that she wanted to see guidelines for landscaping and signage, and that Walden did not want strip development. Mr. Brown felt that the goals outlined in the Community Committee's draft ordinance clearly stated what the town wanted to achieve. Another goal was to make the zoning ordinance user friendly.

2. What was the inspiration for revising the Walden zoning ordinance, and where did it come from?

The Mayor believed the Community Committee was the driving force behind this process. She also believes the 2020 Growth Plan may have also created interest in this process. The committee was assembled in 1996, and was composed of various stakeholders in the Walden community. The committee included engineers, architects, business owners, landscapers, investors, developers, landowners, and real estate agents, among other Walden citizens. Mr. Brown, who is chairman of this committee, stated that the Mayor's determination to get a new zoning ordinance passed greatly enhanced the process. Both agreed that this process was inspired by the need to properly manage the growth of Walden, and to prevent strip development.

3. What was this inspiration based on? Scientific data, personal observations and/or beliefs, community concern, etc?

This process was based on community concern and personal observations of how they did not want to become. The citizens wanted to protect their unique environment and preserve the rural atmosphere of their town.

4. How important is the process of revising the Walden zoning ordinance in meeting the overall community goals? Is it a high priority?

Both the Mayor and Mr. Brown considered the creation of a new zoning ordinance a very high priority, and that it was very important to meeting the overall goals of the community. The Mayor also hopes their ordinance can serve as a model ordinance for communities that have similar concerns.

5. What other stakeholders are involved in this process? What type of influence does each of these stakeholders have on the process and final decision?

Mr. Brown stated that all major stakeholder interests were represented in some form or another by the make up of the community committee. It was well stated that the citizens and stakeholders of Walden have a great deal of influence on the decision-making process and the final decision. In a related conversation, Fern Lockhart, the Town Recorder, stated that the citizens of Walden were sometimes too involved in the decision-making (Fern Lockhart was not the subject of a full interview). She said that in the past, they have come together and prevented actions from occurring, even ones that were legitimate and would have otherwise been allowed.

6. In what ways have the general public been involved in this decision-making process? In what ways will they be involved in the future?

Both agreed that the Community Committee had been the main form of community involvement, and this had allowed the community to voice their opinion about the issues in the draft ordinance. They also discussed the fact that Walden citizens were consistently active in community decisions and would continue to be that way in the future. The Mayor mentioned the fact that there would be at least one more public meeting to discuss the zoning ordinance.

7. What types of scientific disciplines do you consider most important to this decision-making process? Biology, geography, etc.?

The Mayor felt that biology, geography, hydrology, soil type, and invasive species were all relevant scientific information to this process. She mentioned that these may not have been stated directly by the citizens of Walden, but it was the underlying themes to their concerns.

8. Are you aware of relevant scientific information in the Walden zoning ordinance project? Do you understand the limitations of this science?

Both the Mayor and the Alderman were aware of scientific information possessed by the RPA and the University of Tennessee at Chattanooga (UTC) that is related to this project. They were also aware that they had access to this information. Mayor Akins also mentioned she was aware of water quality information that may or may not be directly related to this project. Mr. Brown felt that he understood the limitations to this

information and the technologies that produced it. This is aided by the fact that Mr. Brown, and Peter Hetzler, are currently taking a GIS training class at the UTC. The Mayor was not as confident in her understanding of the science and technology, but stated that she was confident in the analysis work done by the RPA and that working with the RPA increased the accuracy of the information produced.

9. Do you support the use of the PSS technologies in the Walden Project?

Both strongly support the use of GIS technology in this process of updating the zoning ordinance. They also expressed excitement about the impacts that GIS and related technologies could possibly have in the future. Mr. Brown was especially enthusiastic about the three dimensional capabilities and being able to visualize the impacts of new structures before they are built.

10. How do you perceive the role of scientific information and PSS technologies in this process? How do you plan to incorporate them into the process? What do you hope to benefit from them?

The Mayor views the PSS technologies as a way to increase the accuracy of the analyses that are required. They mentioned that GIS would be used to perform analyses and create maps, but they did not mention any other uses of PSS technologies. Mr. Brown felt that the GIS would be beneficial in selecting the locations for the overlay zones described in the ordinance. Mayor Akins believes the ability to make the zoning ordinance available via the Internet will greatly benefit residents and developers in Walden, because they will not have to drive all the way to Chattanooga to get a copy of

the zoning ordinance. The Mayor also expressed the need for flexible technology that can answer questions on the spot.

11. Do you feel the scientific information and PSS technologies are necessary for this process? Beneficial to this process, but not necessary? Hinder this process? Are not at all necessary for this process?

Neither the Mayor nor Alderman Brown were sure how the analyses would be done if GIS was not used, even though they were sure it could be done. It was also the opinion of both that the technology did not hinder the process.

12. Do you feel comfortable interpreting scientific information conveyed through GIS, 3-D models, maps, graphs, charts, etc.? Do these techniques increase your understanding of the scientific information used in the decision-making process?

Alderman Brown felt that his understanding of the information generated by GIS has been greatly increased by the classes he is taking at UTC. The Mayor feels comfortable with interpreting information from maps generated by GIS, but is not familiar with other forms of information that may be available in the future. The Mayor also stated that she was a more "hands on" person, she feels more comfortable when she can see the real life situation with her own eyes. The Mayor also hopes that the information created by GIS will help increase the public's understanding of the need for conservation.

13. Do you directly use the PSS utilized in this process? Are you familiar with any of technologies that make up the PSS? Have you personally received any training for any of the technologies that make up the PSS?

All of the analyses required for this project will be conducted by the RPA or the Hamilton County GIS department, so neither the Mayor nor the Alderman directly use the PSS for this project. The Mayor has not received any training with GIS. As mentioned earlier, both aldermen are currently taking a GIS training class at UTC.

14. How confident are you in the information produced by the PSS technologies?

The decision-makers are confident in the PSS technologies. This confidence seems to be tied to their confidence in the RPA and its ability to use the technology in order to conduct accurate analysis and provide accurate information.

15. What impact do you believe the scientific information and the PSS technologies had on the final decision?

Again, there was a link between the impact of the technology and the impact of the RPA. Alderman brown feels that the RPA will have a great impact on the final product produced, and how they use the technology will determine the degree of impact it has on the final decision.

16. Were there any conflicts resolved prior to the final decision-making stage that can be directly attributed to the scientific information and/or the PSS technologies?

The resolved conflicts the Mayor and Alderman mentioned were not related to the PSS technologies, but rather can be attributed to the communication between community members and developers and/or the decision-makers.

17. Will public participation be enhanced by the PSS technologies?

Alderman Brown does not believe that any technology could increase the citizen participation in Walden to any great extent, because the citizens already play a very active role in decision-making processes. The Mayor believes the technology could enhance community participation by better educating them on the issues. She also believes that the PSS technologies will help the community to achieve its goals.

18. Did the scientific information and/or the PSS technologies reduce the amount of time necessary for the decision-making process?

Alderman Brown pointed out that it had not reduced the decision-making time, because this process began before the technologies were implemented.

19. Were any additional problems identified as a result of the science and technology used throughout this process?

At this point no additional problems have been identified, but Mr. Brown mentioned again that none of the technologies have really been implemented up to this point of the process.

Evaluation Conclusions

Now that all the information has been collected, and the interviews have been conducted it is time for the final phase of the evaluation. I now draw conclusions about the role PSS technologies and scientific information have played in this process, up to this point. The information I collected also allows me to describe, with a great deal of confidence, the role PSS technologies and scientific information will have for the remainder of this process.

The issue of concern in this decision-making process was clear and evident. Mayor Akins, the Aldermen, and the concerned citizens of Walden, Tennessee, wanted to create a new, conservation-oriented zoning ordinance for the town. The goals of this process were clearly stated as well. The town of Walden feels it has something special and they want to preserve it as the town grows. This includes protecting their natural environment and their rural setting. Through the various discussions and interviews with people involved in this process, it was evident that this was a community inspired process from the beginning. Scientific data and technological analysis may support the community's decision to create a new zoning ordinance, but this decision was not based on such information. Instead it was based on the citizens' personal observations and the undesired growth patterns of neighboring Signal Mountain.

The recent activity on this project has been greatly influenced by Mayor Elizabeth Akins. She is very determined to get the new zoning ordinance implemented before her current term is up in 2004. It is important to have someone who will keep an issue, and its importance, on the minds of the public, to "champion the cause" (Pfitzer 2002), so the project does not loose support or fade away.

Revising the zoning ordinance is critical to achieving the stated community goals. This process is not a one-time effort; it is part of a continuum. This process will create a tool by which future decisions will be based, and the ordinance itself may be amended in the future.

The role of PSS technologies and scientific information has been non-existent to this decision-making process thus far. When the PSS technologies are applied, they will be used in a supporting role. This means that the PSS will be used to visually display the results of the new zoning ordinance, but they will not be used to determine any of the aspects of the zoning ordinance or as a means of offering alternatives for the public and decision-makers. There are a few reasons for this limited and supporting role of the technology and scientific information. The first reason is that the process began in 1996. At this time there was no NBII project established to increase the amount of scientific information, or to enhance access to this information. Six years ago Internet use and many of the now-common PSS technologies were not an integral part of the planning process either. By the time this decision-making process became a part of the larger NBII project, the community had already completed its draft ordinance. The absence of technology and scientific information in the early phases of decision-making limits the impact they will have on the process as a whole.

Another reason for the minimized role technology and scientific information has played in this decision-making process is that Walden is a very small community, and they do not possess advanced PSS technologies directly. For this type of technical support, they must rely on the RPA. Theoretically, this could be a positive thing. The RPA has greater access to data and employees with more experience utilizing PSS

technologies. The RPA also has a working relationship with the Hamilton County GIS Department that greatly improves their capabilities to perform more complex analysis and obtain accurate, up-to-date data. The RPA is willing to distribute data to towns like Walden, but there is seldom anyone in the town halls that knows how to use it, given the appropriate hardware and software are available (Rennich 2002). The aldermen of Walden are currently taking GIS training courses at UTC, so this situation may be improved in the future, but they do not have the experience needed to have an impact in this decision-making process.

In reality, though, it has not been as effective as it could have been. Based on the interviews with the planners and decision-makers, the conclusion can be made that the Walden project has not been a high priority to the RPA. The RPA has many projects going at one time, and some are of greater importance to the powers-that-be than others, but that is the nature of planning agencies.

While this aspect of political support may not be strong, another type of political support is very strong. The current decision-making body of Walden strongly supports the use of PSS technologies and scientific information in the town's planning and decision-making processes. Mayor Akins and Alderman Brown also expressed a great deal of confidence in PSS technologies and analyses performed by the RPA, past and future. Karen Rennich also stated that she was confident in the analysis performed at the RPA. She also stated that her confidence is higher when the RPA uses data that has been collected by the RPA itself. This is an important dynamic of the support and confidence of PSS technologies and scientific information that needs to be considered by the evaluator. The Mayor and Alderman were also very excited about the future benefits of

technological advances, especially the visualization capabilities and the educational opportunities.

One example of how technology could be used in a more proactive, educational role in this process concerns the DRC. The DRC guidelines will probably be removed from the zoning ordinance due to a perceived lack of support. Visualization tools similar to those described by Al-Kodmany (1998) could be used to show citizens and developers the effects different design types would have on the physical features of the community. This may create more support for this portion of the ordinance.

Even though the PSS technology plays a supporting role in revising Walden's zoning ordinance, it is still very important and critical to the final product. GIS is the key PSS component that will be utilized in this project. GIS will be used to perform the steep slope analysis. This is necessary for determining where these critical areas are located on the physical landscape, as they have been described in the zoning ordinance. Karen Rennich (2002) stated that she was "not sure if anyone at the RPA could manually perform this type of analysis in the absence of GIS." GIS will also be used to locate and map other critical areas such as wetlands and stream buffer zones.

The analysis capabilities of GIS make it a very efficient tool for the RPA, but there are also other benefits. One additional benefit is that it enhances the quality of the maps and other presentation materials. Karen Rennich (2002) believes this is important because it increases the public's confidence in the work when it is presented in a high-quality, professional manner. The increased quality of maps and presentation materials also makes it easier for the public and the decision-makers to interpret the final analyses. In this process the maps will provide an easily understandable interpretation of the

critical areas and zoning boundaries. One key supporting-role the technology plays is that it gives a defensible basis for areas of restricted development (Pfitzer 2002). This is an improvement over past instances where similar decisions were politically based.

The PSS technologies were not used in this decision-making process to increase citizen participation. This is not a major factor in this process because it takes place in a small community that is already very active in the town's decision-making. Jeff Pfitzer (2002) also mentioned that in past experiences, outside of Walden, where the Internet was available as a source of input and communication, it was not widely used. The Internet component of the PSS will offer one noticeable advantage when this process is complete. The zoning ordinance will be made available on the RPA's website. This will simplify access to the guidelines for development in Walden.

The components of the NBII-SAIN project have the potential to enhance the role of PSS technologies and scientific information in decision-making processes similar to the one described in this research. The project not only strives to enhance access to this type of information, but also promotes better understanding through training classes for PSS technologies and efforts to involve the community in data collection. It is also very important that the NBII-SAIN project is targeting decision-makers in addition to school children and the general public. This creates a framework for decision-making where all involved better understand the issues at hand and the scientific and technological information associated with them.

Chapter 5

Conclusions

The end of Chapter Four discussed the conclusions drawn from the pilot study in Walden, TN. This chapter focuses on the strengths and weaknesses of the methodology and provides recommendations for future research in this field.

This methodology for evaluation provides an effective means for determining the role of PSS technologies and scientific information in a specified planning or decision-making process. This methodology assumes that every planning or decision-making process is unique; therefore the entire methodology must be applied to each process to accurately evaluate the role and impact of PSS technologies and scientific information. Applying this methodology can be a time consuming effort, depending on the dynamics of the decision-making process.

The methodology does not require that the evaluator be an expert on all aspects of the involved planning or decision-making process, or the science and technology involved in order to accurately perform the evaluation. The methodology provides the main issues of concern, and provides the techniques for gathering this information. The personal interviews are the key method for gaining the necessary information to perform this evaluation. This allows for detailed answers from the people involved in the decision-making process, which leads to a better understanding of how they perceive the role and impact of PSS technologies and scientific information on the planning and decision-making process, and that is an important part of this methodology. However, it

is very important to verify the information gained through the personal interviews. This can be achieved by comparing the answers from different interviews, through documents included in the content analyses, or through additional efforts on the part of the evaluator. This is important because the methodology relies heavily on the information gained through the personal interviews, and this information should be as accurate as possible.

It should be considered a "good indicator" when decision-makers, planners, and stakeholders give the same responses to the same questions. This strengthens the evaluator's confidence in the accuracy of the answers, and it also displays a common understanding of the decision-making process and the science and information incorporated in the process. This common understanding represents a successful communication of ideas and information among all involved in the decision-making process.

This methodology does require that the evaluator draw conclusions based on the information collected. The necessary information will be provided from the methodology, but all of the answers and conclusions will not be completely spelled out for the evaluators.

Interview questions may need to be tailored to meet the level of understanding of the subject. When interviewing Mayor Akins and Mr. Brown some of the questions related to the relevance of science to the issue required some additional explanation, before they understood how they should answer the question. These questions include numbers 7,8, and 10 in Figure B-10.

The methodology succeeded in providing the necessary information to perform an accurate analysis in this pilot study. The personal interviews and content analysis

produced the necessary information on the issue of concern and characteristics of the decision-making process. The personal interviews provided the necessary information for evaluating the relevance of science to the issue, the capabilities of the PSS, and the roles and capabilities of the planners and decision-makers. This pilot study did not have the chance to evaluate the impacts of the science, due to the fact that a portion of the evaluation had to be implemented prematurely and this category focuses on the results of the decision-making process.

This, however, did display an unexpected strength of the methodology. The methodology proved flexible enough make predictions about the impact the science and technology will have on this decision-making process with a high level of confidence, as well as discuss future roles and expectations of the PSS and scientific information in future decision-making processes for the town of Walden and the RPA. By simply restructuring some of the questions, this information was easily obtained. It is recommended, though, that the methodology be applied in the appropriate time frame whenever it is possible.

The future roles and impacts of the technology are important to this pilot study because the final decision is part of a continuum. The accepted zoning ordinance will be a tool and guide for future development in Walden, TN. Therefore, the future uses of scientific information and PSS technologies will continue to play an important role in this process, assuming they are applied to this issue. For example, it would be a tremendous asset for Walden and the RPA if a landowner or developer could go to the RPA website and obtain detailed information on a select parcel of property that would allow him to see what part of the land was developable and what part was protected by the ordinance.

This methodology also revealed that the framework is in place for an increased role for science and technology in the future. Citizens and decision-makers are getting involved in the data collection processes and learning about the importance of environmental conservation at the same time. Decision-makers are also receiving training on GIS. This creates a better understanding of the technology and the types of information and analysis that are possible, and how to interpret this information.

This pilot study proves that this methodology can be used to evaluate the role and impact of PSS technologies and scientific information on a community planning and/or decision-making process, and report the results with a high level of confidence. However, future research could make contributions to this methodology. Future applications of this methodology might want to expand the scope of the interviews to include scientists involved in the process. It might be beneficial to understand the role they play in the decision-making process, whether or not they are stakeholders, or how they became involved with the issue.

Future research, similar to that of Zorica Budic (1994), on how the evaluation categories interact with each other and the impacts they have on one another would strengthen this methodology.

The pilot study was a "test run" for the methodology. It provided a chance to evaluate the strengths and weaknesses of the methodology, the validity of the questions created for the interviews, and to determine if the methodology provided the information needed to perform an accurate evaluation. Future research should include the formulation of a set of measurable indicators. The measurable indicators would allow for a more stringent evaluation. The evaluation should then be expanded to compare similar

decision-making processes where PSS technologies, science, and scientific information are incorporated into the process, with decision-making processes where these factors are not present.

The methodology and research provided in this thesis builds on past research performed in the field of evaluating technology as it relates to planning and decision-making. However, this thesis represents that this type of evaluation methodology is still a work in progress. It is very important for research to continue in this field, and continue to improve, so that planning and decision-making processes can incorporate science and technology in ways that maximize their potential.

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Appendices

Appendix A: Tables

Table A-1. Data Hierarchy Table. Hoch, Charles J., Dalton, Linda C., and So, Frank S. (2000). *The Practice of Local Government Planning, Third Edition.* International City/County Management Association. Washington D. C. 42.

Level	Definition
Data	Observations about people, places, natural features, or other entities that have been recorded and stored.
Information	Data that have been organized, analyzed, and summarized into a meaningful form.
Knowledge	Understanding based on information, experience, and study
Intelligence	Ability to deal with novel situations, to apply knowledge acquired from experience, and to use reasoning to guide behavior

Table A-2. Walden and Signal Mountain Census Information.

	Population				Households	Land Area In Acres	Building Permits for New Construction	Median Age of Residents
	1980	1990	2000	% Change	2000		1990-2000	2000
Walden, TN	1,293	1,523	1,960	51.6%	728	2,269	94	40.5
Signal Mountain, TN	5,818	7,034	7,429	27.7%	2,924	4,328	201	43.6

Appendix B: Figures

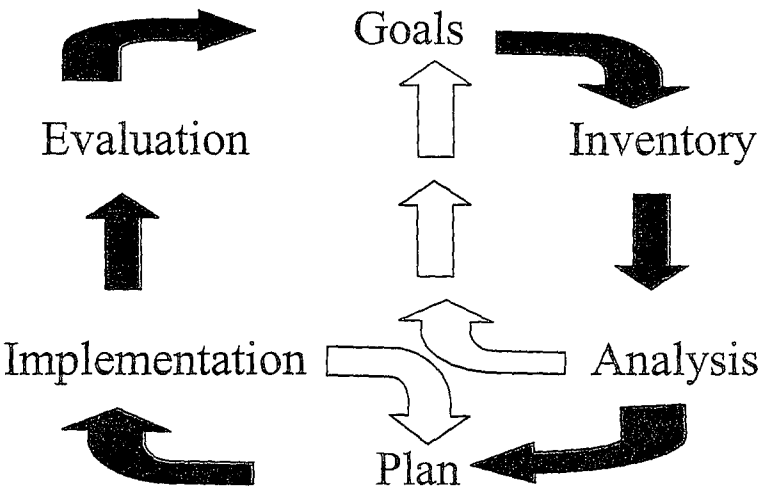

Figure B-1. Simplified planning model. Smith, Guy-Harlod. (1971). *Conservation of Natural Resources, Fourth Edition.* John Wiley and Sons, Inc. 624.

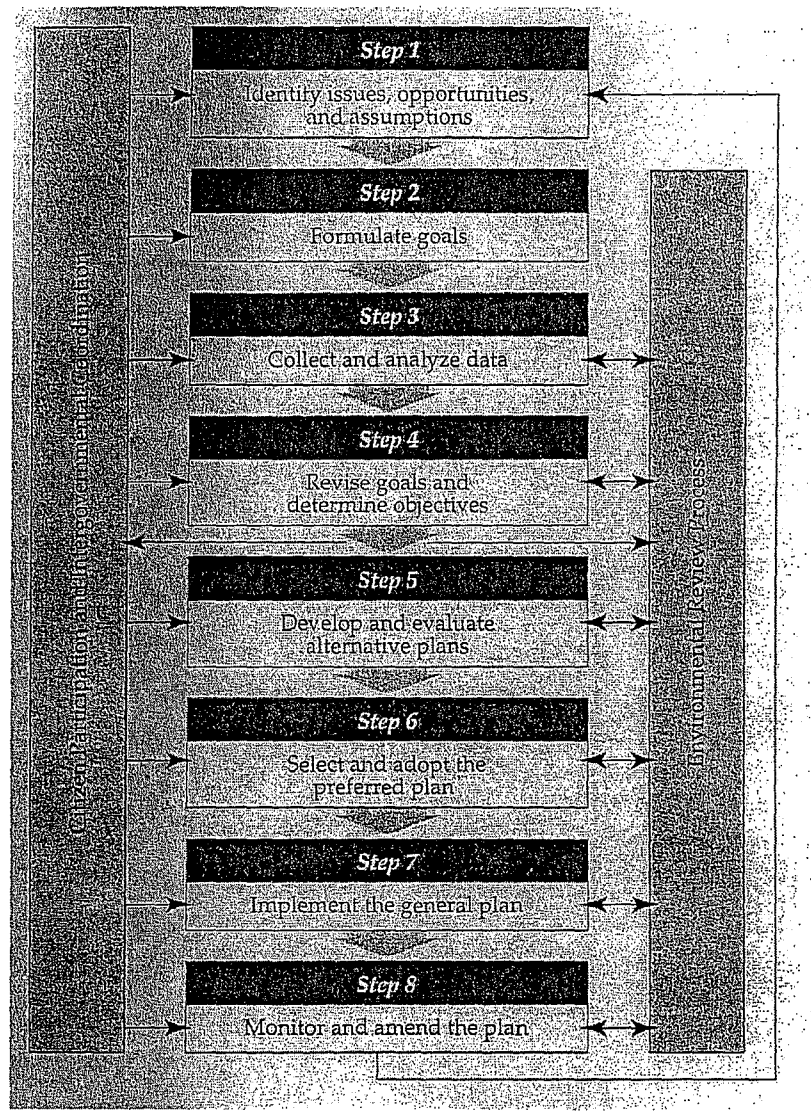

Figure B-2. Comprehensive Planning Model. Hoch, Charles J., Dalton, Linda C., and So, Frank S. (2000). *The Practice of Local Government Planning, Third Edition.* International City/County Management Association. Washington D. C. 25.

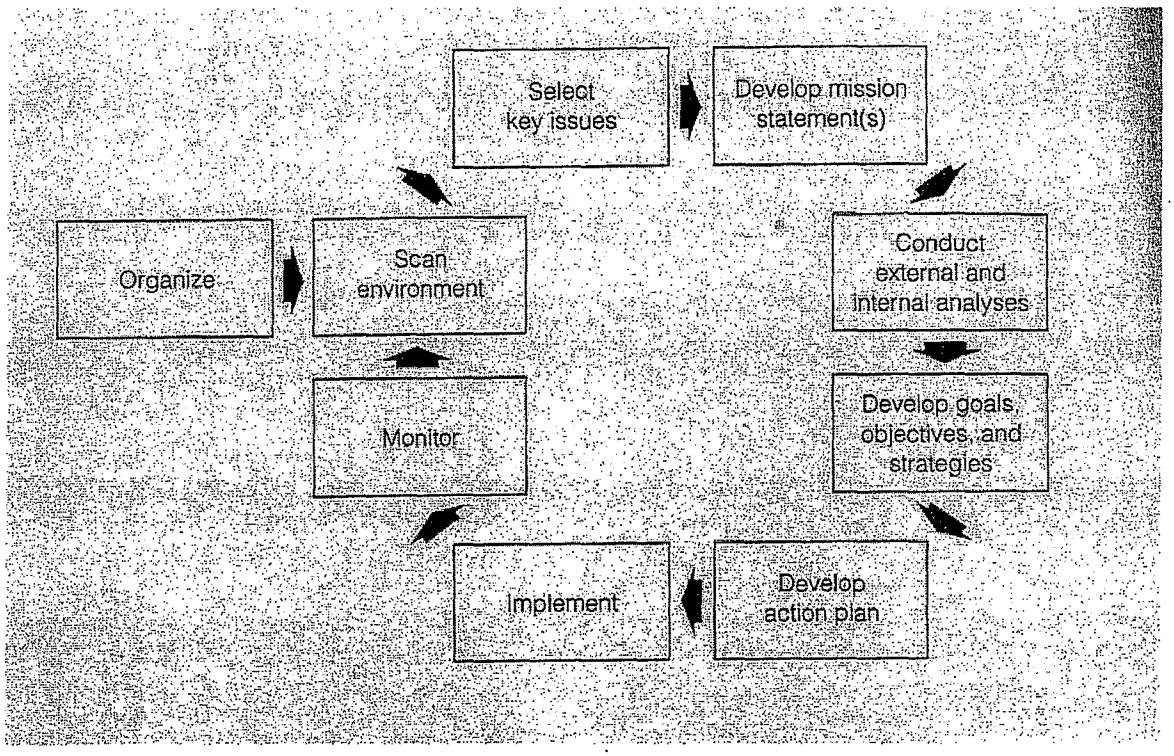

Figure B-3. Strategic Community Planning Model. Hoch, Charles J., Dalton, Linda C., and So, Frank S. (2000). *The Practice of Local Government Planning, Third Edition.* International City/County Management Association. Washington D. C. 28.

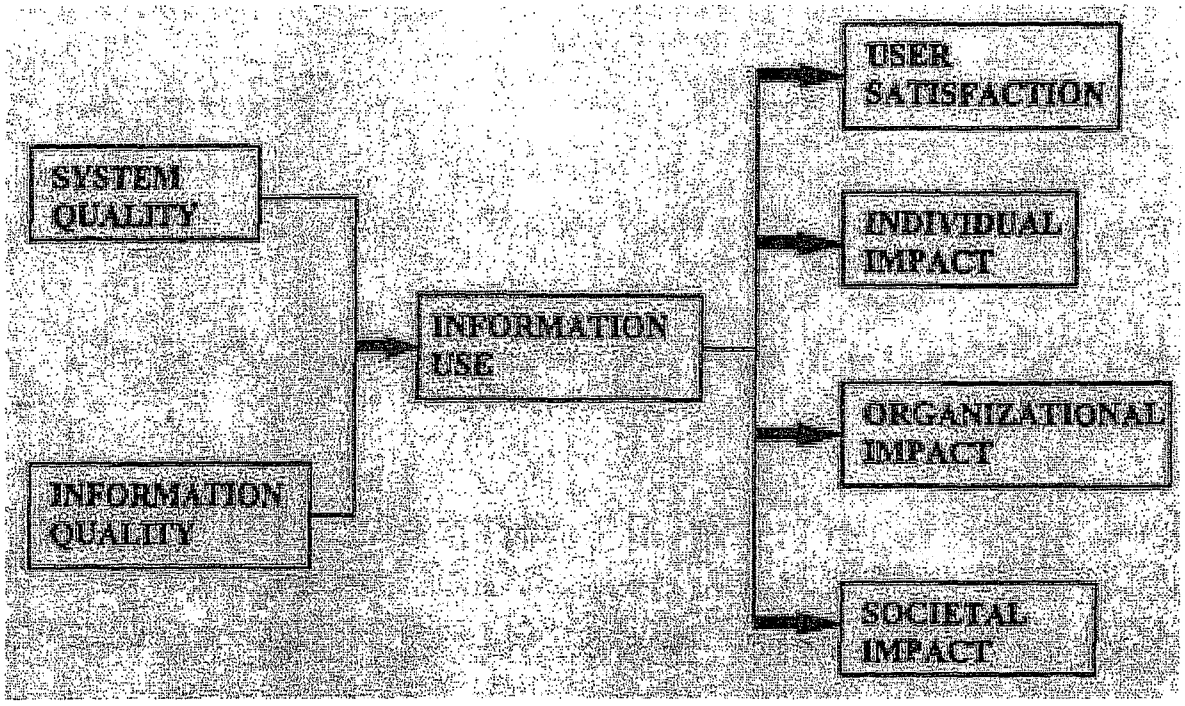

Figure B-4. Relationship between the seven dimensions of PSS success. Nedovic-Budic, Zorica. (1999). Evaluating the effects of GIS technology: Review of methods. *Journal of Planning Literature, 13 (3),* 284-295.

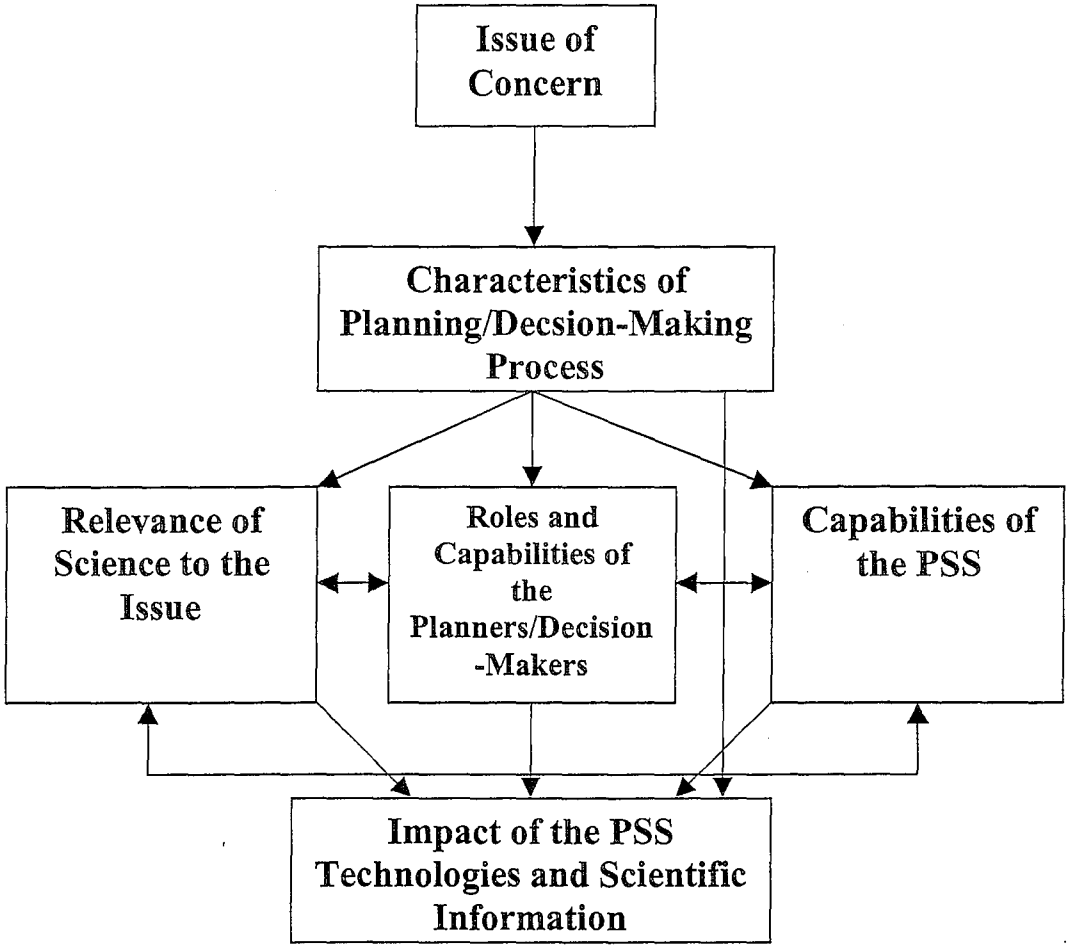

Figure B-5. Relationship of Evaluation Categories.

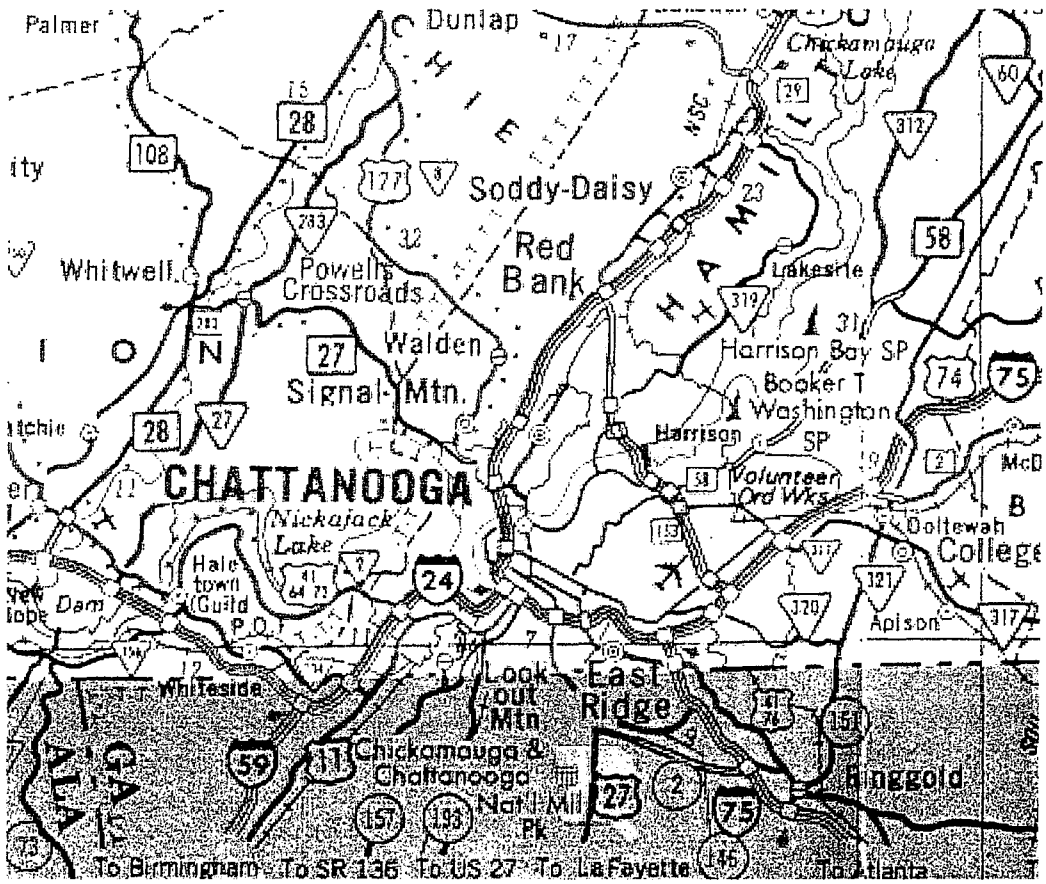

Figure B-6. Location of Walden, TN. Tennessee Department of Transportation. (2001). Tennessee: The official 2001 highway map.

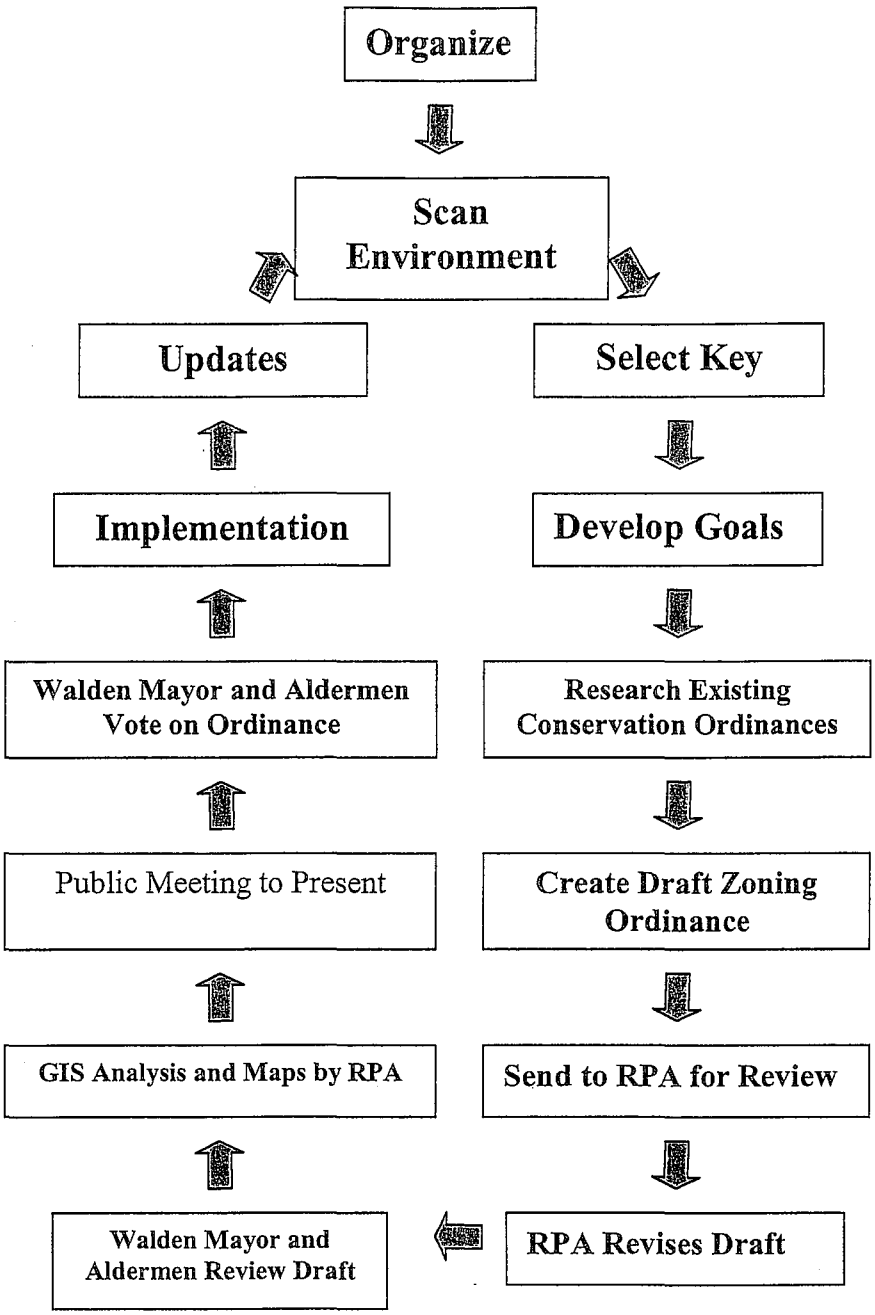

Figure B-7. Model of decision-making process used to revise the Town of Walden's zoning ordinance.

1. What are the main goals of revising the Walden zoning ordinance?
2. What was the inspiration for revising the Walden zoning ordinance, and where did it come from?
3. What was this inspiration based on? Scientific data, personal observations and/or beliefs, community concern, etc?
4. How important is the process of revising the Walden zoning ordinance in meeting the overall community goals? Is it a high priority?
5. What other stakeholders are involved in this process? What type of influence does each of these stakeholders have on the process and final decision?
6. In what ways have the general public been involved in this decision-making process? In what ways will the general public be involved in the future?
7. What types of scientific disciplines do you consider most important to this decision-making process? Biology, geography, etc.?
8. Do you support the use of the PSS technologies in the Walden Project? Does the RPA?
9. Do you understand the limitations of the science associated with the Wladen zoning ordinance project?
10. How do you perceive the role of scientific information and PSS technologies in this process? How do you plan to incorporate them into the process? What do you hope to benefit from them?
11. Do you feel the scientific information and PSS technologies are necessary for this process? Beneficial to this process, but not necessary? Hinder this process? Are not at all necessary for this process?
12. What type of analyses and functions will be performed with the PSS for the Walden zoning ordinance project?
13. What types of computer programs and software will be utilized in the Walden zoning ordinance project (GIS, photo-enhancing software, 3-D modeling, etc.)?
14. Is a specialist required to perform the necessary tasks and analyses with the PSS technologies? For all of them? Which ones?
15. How many PSS users are available to perform tasks and analyses for this project?
16. Do you directly use the PSS utilized in this process? Are you familiar with any of technologies that make up the PSS? Have you personally received any training for any of the technologies that make up the PSS?
17. Is the available data at the necessary temporal and spatial scale in order to be applied to the process of revising the Walden zoning ordinance?
18. What is the source(s) of the data being used? How old is the data?
19. Who has access to the data and analysis capabilities of the PSS being used in this decision-making process? Planners, decision-makers, stakeholders, schools and universities, general public?

Figure B-8. Questions for Karen Rennich and Jeff Pfitzer.

20. How difficult is it to understand and interpret the scientific information generated for the Walden project by the PSS? Is any special training necessary to understand or interpret this information? Do the PSS technologies increase your understanding of the information? Is this information easily applied to the Walden project?
21. How confident are you in the information produced by the PSS technologies?
22. How will the information generated by the PSS technologies be conveyed to the decision-makers on this issue? Printed maps or photos, computer projection, written report, etc?
23. How long will it take to produce the information needed for the Walden project?
24. Would this information be made available to the public via the Internet once it is completed?
25. How many alternative plans have been produced in this decision-making process?
26. Does the scientific information and/or the PSS technologies used in this decision-making process offer any actions that would not have been possible in their absence? Types of analysis, presentation formats, etc?
27. What impact do you believe the scientific information and the PSS technologies had on the final decision?
28. Were there any conflicts resolved prior to the final decision-making stage that can be directly attributed to the scientific information and/or the PSS technologies?
29. Will public participation be enhanced by the PSS technologies?
30. Did the scientific information and/or the PSS technologies reduce the amount of time necessary for the decision-making process?
31. Were any additional problems identified as a result of the science and technology used throughout this process?

Figure B-8. Continued.

1. How do you perceive the role of scientific information and PSS technologies in this process? How do you plan to incorporate them into the process? What do you hope to benefit from them?
2. Do you feel the scientific information and PSS technologies are necessary for this process? Beneficial to this process, but not necessary? Hinder this process? Are not at all necessary for this process?
3. How much experience do you have with the PSS technologies used in this process?
4. What type of analyses and functions will be performed with the PSS for the Walden zoning ordinance project?
5. What types of computer programs and software will be utilized in the Walden zoning ordinance project (GIS, photo-enhancing software, 3-D modeling, etc.)?
6. What applications of the GIS will be used in this process? Are these standard applications or were they added to the GIS?
7. Is a specialist required to perform the necessary tasks and analyses with the PSS technologies? For all of them? Which ones?
8. How many PSS users are available to perform tasks and analyses for this project? How much experience do they have in using the PSS technologies?
9. Is all of the necessary data and information readily available? Is it kept at the same location as the PSS and its users? How long does it take to acquire necessary data that is not readily available?
10. Is the available data at the necessary temporal and spatial scale in order to be applied to the process of revising the Walden zoning ordinance?
11. What is the source(s) of the data being used? How old is the data?
12. Who has access to the data and analysis capabilities of the PSS being used in this decision-making process? Planners, decision-makers, stakeholders, schools and universities, general public?
13. How difficult is it to understand and interpret the scientific information generated for the Walden project by the PSS? Is any special training necessary to understand or interpret this information? Do the PSS technologies increase your understanding of the information? Is this information easily applied to the Walden project? How confident are you in the information produced by the PSS technologies?
14. How long will it take to produce the information needed for the Walden project? How long would it take to make changes to the final products produced by the PSS technologies? Can alterations be made on the spot to answer specific questions?
15. How will the information generated by the PSS technologies be conveyed to the decision-makers on this issue? Printed maps or photos, computer projection, written report, etc?
16. Is it possible to make this information available to the public via the Internet once it is completed?
17. How many alternative plans have been produced in this decision-making process?
18. Does the scientific information and/or the PSS technologies used in this decision-making process offer any actions that would not have been possible in their absence? Types of analysis, presentation formats, etc?

Figure B-9. Questions for the PSS/GIS Specialist.

1. What are the main goals of revising the Walden zoning ordinance?
2. What was the inspiration for revising the Walden zoning ordinance, and where did it come from?
3. What was this inspiration based on? Scientific data, personal observations and/or beliefs, community concern, etc?
4. How important is the process of revising the Walden zoning ordinance in meeting the overall community goals? Is it a high priority?
5. What other stakeholders are involved in this process? What type of influence does each of these stakeholders have on the process and final decision?
6. In what ways have the general public been involved in this decision-making process? In what ways will they be involved in the future?
7. What types of scientific disciplines do you consider most important to this decision-making process? Biology, geography, etc.?
8. Are you aware of relevant scientific information in the Walden zoning ordinance project? Do you understand the limitations of this science?
9. Do you support the use of the PSS technologies in the Walden Project?
10. How do you perceive the role of scientific information and PSS technologies in this process? How do you plan to incorporate them into the process? What do you hope to benefit from them?
11. Do you feel the scientific information and PSS technologies are necessary for this process? Beneficial to this process, but not necessary? Hinder this process? Are not at all necessary for this process?
12. Do you feel comfortable interpreting scientific information conveyed through GIS, 3-D models, maps, graphs, charts, etc.? Do these techniques increase your understanding of the scientific information used in the decision-making process?
13. Do you directly use the PSS utilized in this process? Are you familiar with any of technologies that make up the PSS? Have you personally received any training for any of the technologies that make up the PSS?
14. How confident are you in the information produced by the PSS technologies?
15. What impact do you believe the scientific information and the PSS technologies had on the final decision?
16. Were there any conflicts resolved prior to the final decision-making stage that can be directly attributed to the scientific information and/or the PSS technologies?
17. Will public participation be enhanced by the PSS technologies?
18. Did the scientific information and/or the PSS technologies reduce the amount of time necessary for the decision-making process?
19. Were any additional problems identified as a result of the science and technology used throughout this process?

Figure B-10. Questions for Mayor Akins and Leo Brown.

Vita

David Craig Brashier was born in Memphis, Tennessee, on January 1, 1974. He attended private schools in Memphis, Tennessee, where he graduated from First Assembly Christian School in 1992. In August 2000, he received a Bachelor of Arts from the University of Memphis in Criminology with a minor in Psychology. In August 2000 he moved to Knoxville, Tennessee to attend the University of Tennessee's Department of Urban and Regional Planning. His coursework at the University of Tennessee focused on Environmental Planning. During the time of his graduate studies, David Craig Brashier has worked closely with John Peine, Ph.D., on projects including a Black Bear literature review, and work with the U.S. Geological Survey related to this thesis.