Decision Support:

A Literature Review and Case Studies in the Central Valley of California

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Introduction

This paper provides a review of literature on decision support research. Decision support includes the following: decision support systems (DSS), decision analysis tools, and the application of decision support that is provided to local communities in the form of integrated environments of tools, data, and information. All of the research papers reviewed were studies of the technical support that scientists provided to decisionmakers and land use managers to help them address various land use issues. The support provided in all studies was meant to improve a decisionmaking process. In some of the studies reviewed, support was offered in the form of fully interoperable decision support systems, and in other studies it was a single decision analysis tool, such as a model or a specially designed geographic information system.

This paper also outlines an ongoing U.S. Geological Survey (USGS) research project in the Central Valley of California. In this project, *An Integrated Environment of Decision Support Tools and Scientific Information for Land Managers and Decisionmakers,* decision support is provided to decisionmakers to help them plan for anticipated urban growth that will generate changes to water and land resources. The research questions being considered in this decision support research include the following: (1) How can scientists help planners integrate earth science data and information into planning processes as they address complex growth issues, such as urban growth boundaries, and (2) h ow will complex decisionmaking benefit from the incorporation of scientific data and the use of new decision analysis tools? Decision support in this project is packaged as an integrated environment of data discovery and access mechanisms, decision support tools, spatial land surface data, and scientific understanding. The project is not complete at this time, and results stated here are preliminary. Comprehensive results will be prepared at the completion of the project.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Decision Support

Decision support is the assistance provided to a decisionmaker in the form of technical expertise that enhances the decisionmaking process (Cleaves, David, 1998, unpub. data). According to Katz (2000), there is value in providing decision support to local planning communities, as well as an increasing need for such support. Increasing development rates, tight budgets, hectic daily routines, and limited technical skills make it difficult for local decisionmakers to do the long-term planning required to keep pace with increasing urbanization and its associated pressures. Scientists are responding to the needs of the planners with research focused on decision analysis tools, technique development, integrated systems, and applications. These research efforts are helping to provide an understanding of the technologies that are available today and are also helping planning communities understand how planning decisions affect them over time (Katz, 2000). A review of the current literature in decision support shows that research activities fall into three broad categories: (1) DSSs, (2) decision analysis tools, and (3) integrated environments of tools and information.

Decision Support Systems

When decision support is packaged as an interoperable system with interchangeable parts, it is considered to be a DSS. Cleaves (1998) refers to an integrated collection of tools used in decision support as a “toolbox.” A toolbox can support an entire decisionmaking process. The term toolbox refers to the way the tools are used. Like any toolbox, only one tool may be needed for a small job, or a whole collection of tools may be needed for a big job. Interoperability is what links all of these tools together. The Aurora Partnership consists of government personnel, educators, and private citizens who are working together to support the development and use of DSS in community-based decisionmaking (Aurora Partnership, 2000). Through a series of place-based studies, researchers in the Aurora Partnership are demonstrating new technology to local communities to help them deal with complex land use issues. The Aurora Partnership strongly encourages the use of DSS made up of interoperable decision analysis tools.

Decision Analysis Tools

Decision analysis tools vary and can include analysis software, with or without graphical user interfaces (GUI), geographic information systems (GIS), computer simulation models, and scientific visualization tools. Some tools are used interchangeably in a DSS, and some are used individually. The new tools and technologies now available are providing many benefits to land use decisionmaking. One benefit is their accessibility. For example, many decision analysis tools are accessible through the Internet. Another benefit is that new tools make it possible to evaluate theoretical alternative scenarios for urban development before a large commitment of money or time is made. New planning tools also provide land use planners with the ability to improve interaction among community members through a design that allows all users to participate equally in the planning process. Finally, new tools currently being designed allow replication of the planning process, in a timely fashion, reducing the error that often occurs with manual applications (Batty and Densham, 1996).

Decision Support Research

In the scientific community, two factors are fostering decision support research: (1) Digital technology has become a common tool of everyday life, and (2) a considerable amount of data, tools, and software are available (Arnold and others, 2000). The unprecedented array of choices, along with a more technologically adept public, emphasizes the importance of equipping decisionmakers with the best tools and information available. Birk and Foresman (2000) questioned why decisionmakers and land managers were still operating with out-of-date information, in light of the wealth of digital information and tools now available.

National and international researchers are developing and applying DSSs, as well as providing integrated environments of data, decision analysis tools, and scientific information. A good example is the six community demonstration projects that the National Spatial Data Infrastructure (NSDI) has developed in six different locations throughout the United States, including Maryland, Wisconsin, Montana, Oregon, California, and Pennsylvania (Federal Geographic Data Committee, 2000). An example of international research is the integrated environment of decision support that has been designed to address land use conflicts in the Valencian Mediterranean Region in the east of Spain (Recatala and others 2000). This study in Spain has many similarities to the NSDI community demonstration projects. Each of these research projects focuses on applying decision support in local settings to help make complex land use decisions.

The USGS has a growing interest in decision support research guided by a strategic mission to provide earth science data for the public interest. An initiative, entitled "Decision Support for Resource Management," was recently proposed to develop decision analysis tools and DSSs for public and private resource managers charged with addressing high-priority resource issues. The USGS proposed to work with scientists in academia and private industry to collectively establish standards for predictive models, computer simulations, and scientific visualizations. The derived standards are being established so that the components of decision support will be interoperable and interchangeable (U.S. Geological Survey, 2001). Other USGS research projects in progress where decision support is being applied include the Front Range Infrastructure Resources project (U.S. Geological Survey, 1998), a study of DSS for Management of a Northern Rocky Mountain Wetland to Enhance Amphibian Populations (Goodman, 2000), and the Mid-Continent Ecological Science Center application of adaptive management and decision analysis to issues in the Greater Yellowstone area, as well as watershed projects done in collaboration with the Bureau of Reclamation in the Upper Missouri/Yellowstone ecosystem (Aurora, 2000).

Other Government agencies that are

focusing research efforts on the development of decision support tools and systems include the Bureau of Land Management (BLM) and the Department of Energy (DOE). Both of these agencies recognize that local communities play a critical role in land use planning. Both agencies are encouraging the use of scientific information by generating tools and information that are understandable and easy to access (Aurora, 2000). The DOE has recently developed a public World Wide Web site that provides Internet access to a wide variety of decision analysis tools for sustainable development (Department of Energy, 2000). In addition, the U.S. Bureau of Reclamation (USBR) designed a DSS called the Natural Resources Workstation. This DSS is being applied to wetland management in the San Joaquin Valley of California (Vadas and others, 1995). As a result, many members of the local communities were able to use this DSS, along with data provided by the Mid-Pacific Geographic Information System Group, to review different land use scenarios and explore development alternatives as part of wetland protection. This USBR project blended together DSS theory, GISs, spatial modeling, and mathematical programming into an integrated environment for habitat management.

Educational institutions are providing the basic foundation for decision support with new classes and programs. The University of Pittsburgh is now offering classes in a new Environmental Decision Support Program (Aurora, 2000). The University of Montana offers an educational program that helps to bring decision support technology to local communities (Aurora, 2000).

Applying Decision Support

Studies in which decision support technology has been used for land management are well documented in the literature. For example, Arnold and others (2000) designed specific tools to address urban sprawl. These tools were designed to understand what effect land use change has on water quality. Sanders and Tabuchi (2000) provided local planners in the United Kingdom with an integrated environment of tools and data to analyze flood risk. Vadas and others (2000) brought decision support to the local planning communities in the Central Valley of California to address wetland mitigation. In 1994, Harbor helped local planners estimate the impacts of land use change on ground water recharge with an evaluation tool that he designed (Harbor, 1994). Quattrochi and others (2000) encouraged planners to use scientific data as they investigated the impacts of urban heat islands. Recatala and others (2000) addressed another common land use issue, conflicts between urban/industrial and agrarian uses, their decision support research in Valencia, Spain. Lastly, decision support tools that facilitated data interpretation and decision analysis were used to enhance decisionmaking for wildlife habitat protection in North Dakota (Garcia and Armbruster, 1997).

DSSs and tools are being applied by the scientific community to meet a myriad of challenges facing decisionmakers. These challenges include overworked staff, technological limitations, tight deadlines, and limited budgets. Decision support research addresses these challenges by enhancing the abilities of those individuals who are in a position to change, plan, and design the growth of their communities. Some of these challenges were addressed by Ram and others (2000). The decision support they prepared for planners relied on the World Wide Web as a means of providing access to earth science data, a valuable resource in the planning process. Arnold and others (2000) ensured that their urban sprawl tools were easily accessible to the local planning community. Access to decision support tools, in both of these examples, allowed the communities in question to effectively plan for growth.

Some research activities focus on the use of decision support to minimize the amount of time spent in making decisions. Planning processes are often long because it is important to review and evaluate all options before a final decision is made (Franklin and others, 2000). However, applied research in decision support is seeking ways that enable planners to foresee potential complications with a planned development, saving time and money. For example, in an effort to improve efficiency in decisionmaking, Harbor (1994) developed an evaluation tool that analyzed the effect land use change would have on ground water recharge. This tool was designed to be used in the initial stages of planning to reduce the time spent analyzing the project. Garcia and Armbruster (1997) developed a decision support tool for wildlife management that facilitated data interpretation and decision analysis. This allows managers to formulate and evaluate different scenarios in a timely fashion. Recatala and others (2000) saw their integrated environment of decision support tools as a way to automate the decision process, again saving both time and money.

Other studies found in the literature concentrate on mediating the technical limitations that planning communities now face. Sanders and Tabuchi (2000), as well as Sugumaran and others (2000), developed an integrated environment of tools and data for use in flood risk analysis. Both of these decision support projects developed point-and-click style interfaces for their tools. Decision support tools that are easy to use give those who have limited technical skills the ability to do on-the-spot flood risk analysis.

In a recent special issue of Photogrammetric Engineering and Remote Sensing (PE&RS) dedicated to decision support, many articles focused on the need for spatial data (more specifically, remotely sensed data) to be used in the mainstream of decisionmaking (Birk and Foresman, 2000). The authors of the decision support articles in this special issue emphasized the importance of scientists, providing support to local communities to understand and use decision support technology. A common trend among recent research studies is the practice of forming a partnership or alliance between the planning community and the scientific community. Demonstration projects for the NSDI study how partnerships between Federal agencies and local communities can ensure better long-term planning through technology transfer (Aurora, 2000). Franklin and others (2000) also demonstrate this supportive alliance approach in their work with the National Forest Service. These researchers use new data and methods to improve the U.S. Department of Agriculture vegetation databases. They believe that an improved database will improve the quality of information for intra-agency and multi-agency planning and decisionmaking. Quattrochi and others (2000) cultivate the use of remotely sensed data in decisionmaking through community education programs.

The Central Valley of California

Today, the role of the decisionmaker and land manager, in the wise use of land and natural resources is more challenging than ever owing to the inevitable pressures of urban expansion. In California's Central Valley, the challenge is acute (Vaux, 2000; Medvitz and others, 1999). Vaux states that economic pressures, both regional and global, will make managing California's land and water resources more daunting than ever. One of the biggest challenges facing decisionmakers and land managers in local planning offices throughout the Central Valley is their inability to bring the best available science and technology into the decisionmaking process (Medvitz and others, 1999). Without question, continuous pressures from population increases throughout the Central Valley (Penbera, 1998) on limited water resources and prime agricultural soils warrant the best long-term planning possible. Therefore, we see the logic of assisting the local planning communities in the Central Valley in achieving a new level of planning expertise to meet their new challenges.

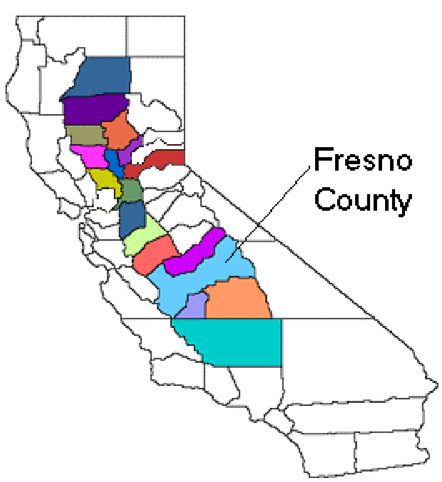

Figure 1: Counties in the Central Valley of California.

The American Farmland Trust considers the Central Valley to be one of the most threatened farming regions in the United States, in part owing to its location and accessibility to the Silicon Valley and to Los Angeles (American Farmland Trust, 1995). In addition, population growth rates for the Central Valley are twice as high as the U.S. rate and one and one-half times as high as the rate of the entire State of California (Penbera, 1998). Fresno County alone has grown 17 percent in the past decade to almost 800,000 people. The California Department of Finance anticipates it will grow another 27 percent by 2020 (table 1) to over a million people. Plans to build a new highway that runs north-south, the entire length of the Valley, parallel to the two existing highways, make urban growth inevitable. Managing the land and water resources and effectively planning for urban growth are necessary to avoid serious declines in the quality of life (Kasler, 1998). As a result, community planners and decisionmakers are rallying their resources to prevent undue harm to the Valley's agricultural viability and natural resources as they determine the best location for urban growth (Oltman, 1996; The Growth Alternatives Alliance, 1998; Vadas and others, 1995). However, local planners in the Central Valley face many impediments to using the best scientific data and technology available. This makes the job of long-term planning very challenging.

Table 1: Fresno County population change over time and projections.

Fresno County, California				
	Year	Population	Change in Population	Rate of Population Change
U.S. Census Bureau total population *	1900	37,862		
	1910	75,657	37,795	50%
	1920	128,779	53,122	41%
	1930	144,379	15,600	11%
	1940	178,565	34,186	19%
	1950	276,515	97,950	35%
	1960	365,945	89,430	24%
	1970	413,053	47,108	11%
	1980	514,621	101,568	20%
	1990	667,490	152,869	23%
	2000	799,407	131,917	17%
California Dept. of Finance Population Projections**	2000	811,179	143,689	18%
	2020	1,114,403	303,224	27%
	2040	1,521,360	406,957	27%

* source: http://factfinder.census.gov/servlet/BasicFactsServlet

** source: http://www.greatvalley.org/research/counties/fresno.htm

Case Study Approach

The approach of this project was to build and demonstrate a decision support environment for three specific decisionmakers working in California's Central Valley. The following research questions were considered: (1) How can scientists help planners integrate Earth science data and information into planning processes as they deal with complex growth issues, such as urban growth boundaries, and (2) how will complex decisionmaking benefit from the incorporation of scientific data and the use of new decision analysis tools? Decision support was packaged as an integrated environment of data discovery and access mechanisms, decision support tools, spatial land surface data, and scientific understanding. Furthermore, the approach in this project was to view the decision support process from a much broader perspective in order to understand and remove the impediments that decisionmakers face in conducting their work. In building an integrated environment of decision support, we considered five categories of impediments: (1) data discovery and data access, (2) land surface data development, (3) modeling and projections, (4) cartographic visualization, and (5) decision support tools. Similar to the decision support projects listed in the literature review section of this paper, it is anticipated that developing an integrated environment will reduce the challenges that decisionmakers encounter as they try to make greater use of earth science data and information in their analyses of complex urban growth planning issues.

Working closely with the decisionmakers in the Central Valley, we selected three land use decisions and treated each as an individual case study. Collaborators from the Fresno Local Agency Formation Commission (LAFCo), Fresno County Planning and Resource Office (County), and Central Valley Habitat Joint Venture with Ducks Unlimited (CVHJV-DU) were selected to work directly with the project team. Each of these collaborators is challenged with managing land and water resources within the Central Valley of California. They are involved in making land use decisions regarding the control of urban sprawl and the protection of agricultural and natural resources while trying to maintain economic prosperity in regions with rapidly expanding populations. Providing an integrated environment of tools, data, and information resources is meant to assist these decisionmakers in generating more informed land use decisions. Additionally, these three case studies, although local in scope, have applicability at regional, State, and even national scales.

Case Study #1: Updating a Sphere of Influence

The first case study focused on the decision of updating a sphere of influence. A sphere of influence outlines the land, outside of a city limit, that is expected to become built up in the near future. A sphere of influence is a State-implied boundary around a city. By 1985, LAFCo had established a sphere of influence for every city in California in an effort to curb urban sprawl. Each sphere was originally drawn with an anticipated 15-year to 25-year window of urban growth. LAFCo was responsible for generating the original spheres and today is the deciding agency for updates to spheres. Today, sphere of influence updates are scheduled on a 5-year interval.

LAFCo, an intermediate level of government between the State and individual local governments, plays a unique role in implementing State growth planning objectives. Since the State considers boundary changes to be a matter of State concern, the sphere of influence becomes the policy plan for urban growth established by LAFCo (Commission on Local Governance, 2000). LAFCo's goals are to provide a statewide perspective on future urban growth and a consistency in broad planning efforts (Fulton, 1999). These are achieved by working together with regional and local governments in this planning process.

LAFCo's executive officer in Fresno County became the collaborator in this case study. Preparing a summary of the decisionmaking process was the first task. A lengthy and complicated explanation of how a sphere of influence boundary is updated was distilled into an executive summary. This decision process was summarized on the basis of interviews with LAFCo's Executive Officer, as well as through the review of published documents (Fulton, 1999; Commission on Local Governance, 2000) The summary was used to guide the development of an integrated environment of tools, data, and information resources.

In the second task of this case study, data discovery and data access were explored. Exploration focused on finding a means by which the collaborator could access earth science data and other land use information, particularly USGS data and information, for the decisionmaking process. The global Internet and the World Wide Web were explored because they are the enabling technology that can deliver data, tools and information for decision support. For this project, a document is being developed that summarizes the data access mechanisms useful to the LAFCo collaborator. The document will describe how each data access mechanism works, the kind of data and information available through each mechanism, the user interface, and any other pertinent information. This document will be a valuable resource for our collaborator because of the limited time available in his daily routine to search for this information on his own (Arnold and others, 2000).

Some of the information found during the exploration of data discovery and data access includes the following Internet sites developed by State and Federal agencies. The USGS has several good Internet sites where earth science information is readily available. The Web site for the USGS geospatial data clearinghouse, http://nsdi.usgs.gov/, provides access to a wide variety of spatially referenced data and information from the four main disciplines of the USGS; biological resources, water resources, national mapping, and geology. A new initiative, based on a multiagency collaboration, Digital Earth, is being tracked as it becomes an access point for a wide variety of natural and cultural information gathered about the Earth. Much of this georeferenced information will be useful for local land use planning projects. Information about this initiative can be found at http://www.digitalearth.gov. The California Environmental Resources Evaluation System (CERES), like a vast library, provides volumes of information about California's natural resources, located at http://ceres.ca.gov/. This State-organized Web site provides access to various electronic data, including maps, satellite imagery, charts, graphs, drawings, and photographs. This information, describing California's rich and diverse environments, is available to a wide variety of users with the goal of improving environmental analysis and planning.

Internet-based academic resources were also explored. At the California State University Stanislaus Web site, http://www.csustan.edu/geography/landuse.htm, GIS shape files of all the city and county general plans for the entire San Joaquin Valley, 67 in total, were accessible (Schmandt, 2000). Another academic data access mechanism can be found at http://ice.ucdavis.edu/. This Web site for the Information Center for the Environment (ICE) is part of the University of California at Davis. The ICE Web server is an easy-to-use access mechanism that provides users with access to data, maps, models, reports, and other related products important to understanding environmental issues that have local, regional, and national significance.

Demonstrating how decision support tools work is often more important than just providing information. This concept is reflected in the literature. For example, a premise behind the NSDI community demonstration projects is that users need to be shown how the tools work. When people see the benefits of these spatial analysis tools, they understand how they can improve their land use planning (Federal Geographic Data Committee, 2000). To illustrate this, the next task in this case study was to demonstrate the use of a decision support tool called Smart Places. Smart Places software was developed to be used as an extension to ArcView GIS software.

For this case study, Smart Places was designed to analyze the decision process that LAFCo, cities, and local communities in Fresno County follow whenever a sphere of influence is updated. Smart Places was chosen for this project because it is easy to use, readily available, low cost, and provides a means to develop several different sphere of influence update alternatives for review. Sanders and Tabuchi (2000) found ease of use to be an important factor in the selection of decision support tools. The key analysis feature of Smart Places software is the radix format. The radix format is similar to a decision tree. In this case study, the decision process for updating a sphere of influence was outlined, and each step in the process was replicated in the radix format. "What-if" questions about land use decisions involved in the update process were also designed in the radix format. When the designed Smart Places radix is run, calculations on the geospatial information are automatically applied, providing answers to the "what-if" questions. Any and all properties and constraints applied to the data or automatic calculations were derived from LAFCo's criteria for this kind of analysis.

This decision support tool was presented to the project collaborator and others in Fresno County to demonstrate its usefulness. Usefulness was based on three things: (1) ease of use, (2) efficiency with regard to the time it took to develop alternative development scenarios, and (3) the level of interest expressed by the collaborator and others. Several local agencies were present at the demonstration of Smart Places, including CalTrans, the Fresno Council of Governments, the Bureau of Reclamation, the Fresno County Information Technology Department, the Housing Authority, and the city of Clovis. Considerable interest was expressed in this tool as a way to improve the ability to automate repetitive procedures when working with geospatial data.

It was made clear during the Smart Places demonstration in Fresno County that this was not the only decision support tool available. The following information about other tools that can be found on the World Wide Web was presented. The DOE's Web site, http://www.sustainable.doe.gov/toolkit/toolkit.shtml, provides numerous descriptions and links to decision analysis tools for sustainable development (DOE, 2000). The Aurora Partnership Web site, http://aurorapartnership.org/tools.htm, provides access to a host of decision analysis tools. Web sites such as these two will become more common as the Federal Geographic Data Committee and

NSDI work to improve the interoperability of geospatial information and tools (Federal Geographic Data Committee, 2000).

The next task in this case study was to understand how higher resolution data needs were being met in the decisionmaking process of updating a sphere of influence. New image sources were introduced to demonstrate how they improve land use planning tasks. A single scene of enhanced thematic mapper (ETM+) data from the Landsat-7 satellite was used in several ways. It was used as a backdrop for the display of vector data. Additionally, by using a remote sensing process, we could combine the 30-meter and the 15-meter data from the ETM+ data to provide a fairly high resolution image of the study area. Combining the higher spatial resolution, 15-meter, panchromatic band with the 30-meter multispectral bands created a sharper image for photointerpretation and analysis. In addition to the Landsat data, high-resolution imagery from the IKONOS satellite is also being used to identify agricultural activity within the study area.

Additionally, efforts were made to understand how land use data needs were being met in the decisionmaking process of updating a sphere of influence in Fresno County. It became apparent that numerous readily available land surface datasets were not being used. The decision support literature indicates that increasing the amount of digital land use data and other information would lead to more informed decisions (Ram and others, 2000). In response, various land use and land cover datasets, historical urban extent representations, general plan maps, soils maps, and other natural resource maps were compiled. In addition, maps were developed illustrating the annexation history for Selma, a rapidly growing city in Fresno County (fig. 2). The annexation map illustrates the progress of urban development over the past six decades by showing how parcels were brought into the city limit incrementally for development. All of these land use datasets were archived as ArcView shape files and made available to LAFCo for review. LAFCo's response to this compilation of land use data and imagery was based primarily on the fact that it requires high-resolution land use datasets that can be used with its parcel base maps.

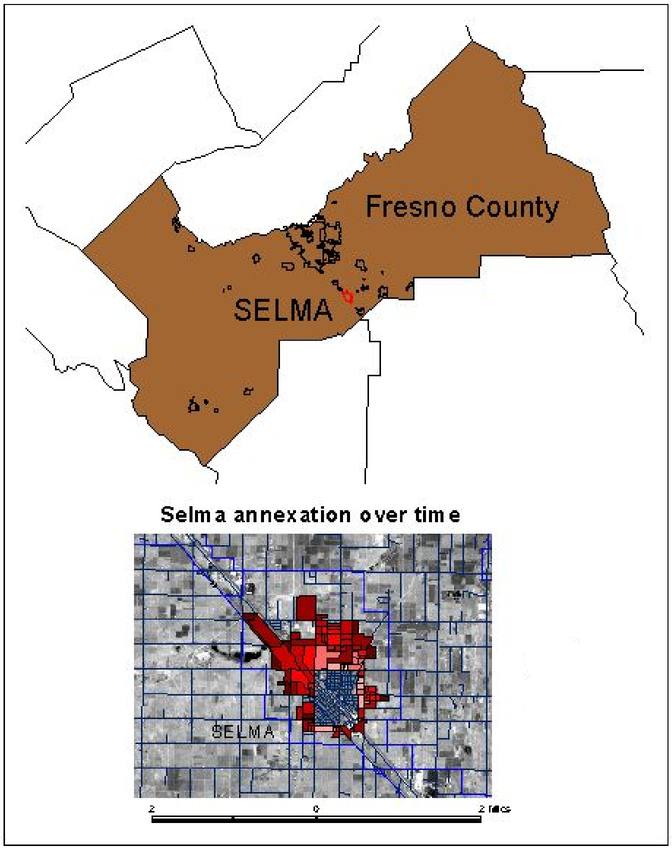

Figure 2: Historical changes in land use, city of Selma, Fresno County.

The final task in this case study is to provide urban growth projections from a land use model. LAFCo and other constituents of Fresno County have consistently expressed a need for urban growth projections and a greater understanding of modeling techniques and capabilities in general. This need is based on questions about the benefits and consequences of urban growth. The approach taken in this case study is to provide urban growth predictions from a selected model and also provide a summary of available urban growth models (Environmental Protection Agnecy, 2000). The summary will assist the local community to determine if another model may be more useful in their planning process.

Case Study #2

The second case study in this project is based on the decisionmaking process involved in identifying ground water recharge basins on the east side of Fresno County in areas that have not previously been developed for ground water recharge. As in case study #1, scientific information and technology that are currently available will be documented on the basis of their use in identifying new locations for ground water recharge development. The need for improvement in this decisionmaking process stems from the fact that existing ground water recharge locations were selected on the basis of convenience and access, not on the best science. Work on this case study has just begun.

The collaborator in this case study is a senior planner with the Fresno County Planning and Resource Management Office. This management office regulates land use in the unincorporated areas within Fresno County where the primary land use is agriculture. Water and transportation issues are the major management concerns. Throughout the Central Valley, decisions regarding ground water recharge are paramount because ground water supplies over 90 percent of the water for all land uses (California Planning Roundtable, 2000). In addition, a significant increase in impervious areas caused by urbanization has dramatically changed ground water recharge and flooding potential throughout the Central Valley (Growth Alternatives Alliance, 1998).

The approach in this case study is similar to the approach taken in case study #1. Their first task is a review of the decisionmaking process for ground water recharge development. A summary of the process will guide the research efforts. The second task is data discovery and a search for data access mechanisms that yield earth science data and other information. We will seek and document data resources and decision support tools that will deliver credible and comprehensive insights into the placement of ground water recharge facilities. The document on data discovery and data access mechanisms developed in case study #1 will be updated with these new sources of information on ground water recharge. The decision support tool, Smart Places, will be used in this case study to analyze all the data. Growth predictions will also be included in the analysis. Much of the data and information and many of the tools compiled in case study #1 will be useful in this case study because they cover the same geographic region, Fresno County.

Case Study #3

The third case study is based on the decisionmaking process involved in the identification of suitable land areas for waterfowl habitat conservation and restoration. Research on this case study has not yet begun. A research scientist with CVHJV-DU will collaborate on this project. The need for research in this area is due to drastic reductions in the natural wetlands throughout the Central Valley. Efforts to restore seasonal wetlands and enhance agricultural land to provide habitat for waterfowl and other wildlife (Gilmer and others,1982) are based on an understanding of urban growth. CVHJV-DU regularly purchases land and/or easements as a mechanism to conserve habitat. These purchases are fiscally and biologically effective only if land use patterns are well understood.

The approach in this case study will be similar to the approach taken in both case studies #1 and #2. The decisionmaking process will be reviewed and summarized to guide the research. An integrated environment of data access and discovery mechanisms, decision support tools, and scientific information will be developed for this collaborator. Data resources and decision support tools for understanding land use patterns will be explored and documented. Currently, CVHJV-DU is attempting to build a risk assessment model to help set priorities on where to conduct conservation activities. In addition, they are interested in overlaying a GIS model predicting probability of urban encroachment to help set priorities for their habitat protection activities. We will support their decision process by finding decision support resources to achieve this goal.

Conclusion

Many references were found in the literature regarding research on the value of providing decision support to local planning communities. In all cases, the literature revealed that decision support technology was helping local planning communities to make more informed decisions regarding complex urban growth issues. This further emphasized the importance of facilitating the use of decision resources through technology transfer. Research included the development and application of decision support, ranging from complete DSSs, to individual decision analysis tools, and integrated environments of tools and information.

The approach used in this decision support research project builds upon the work presented in the literature discussed earlier in this paper. The case study approach illustrates how an integrated environment of data discovery and access mechanisms, decision support tools, spatial land surface data, and scientific understanding can work effectively for local-level decisionmakers in the Central Valley of California. The integrated environment is proving to be an effective means to overcome the impediments that these local decisionmakers face. Each case study in this project, done by working with a local decisionmaker, focuses on a decision that has State or national importance. As a result, the findings of this project can have a far-reaching impact.

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