Beyond City Limits: The Multi-Jurisdictional Applications of GIS

Michael J. Greenwald

Abstract: *Much has been written about specific geographic information systems (GIS) applications, but as cooperative relationships between various levels of government evolve, GIS analysis and systems development will need to adapt. The author suggests multi-jurisdictional GIS development, a system where different levels of government use the same GIS software and databases for completion of their own organizational missions and simultaneously for the purpose of larger regional analysis. This article examines organizational and technological support issues involved in creating multi-jurisdictional GIS through a contrast of a previous attempt by the U.S. Department of Housing and Urban Development and a current project supported by the Southern California Association of Governments.*

Introduction

Discussion of geographic information systems (GIS) has taken professional and academic planning forums by storm within the last decade. Examples of fundamental organizational topics for understanding a GIS include system definition (Leno 1989), improved efficiency (Innes and Simpson 1993; Huxhold 1995), and implementation issues (Budic and Godschalk 1996). These discussions have been supplemented by discussions of GIS in terms of individual systems applied to specific tasks (e.g., land supply monitoring and management [Bollens and Godschalk 1987], facilities location for undesirable land uses [Lober 1995], urban landscaping [Miller 1995], storm water management [Shamsi 1996], and office tenancy [Howland & Lindsay 1997]. What has been lacking is a discussion of GIS in a multi-jurisdictional context, a situation where several vertically organized government institutions (e.g., cities, counties, state, and federal agencies) use the same GIS software and databases for completion of their own organizational missions *and simultaneously* for the purposes of regional analysis and related decision making between various members of the same level of government (e.g., two cities using the same database for the purposes of reconciling incompatible land uses on the border of their respective jurisdictions).

Examination of previous attempts at multi-jurisdictional GIS implementation seeks to answer some of the more daunting questions regarding GIS implementation beyond the realm of a single agency or level of government. Most cooperative GIS implementations have been confined to relatively small geographic areas with participants having the same level of jurisdiction. This paper discusses some of the technological and organizational interactions and assumptions that must be addressed before a cooperative GIS can be executed in the context of multiple jurisdictions with varying levels of political power and responsibility: What is the underlying goal of the system? Who should participate in the development of the system? Why develop such a system now? What type of technical and organizational issues might arise when creating a multiple-user system? After addressing these questions in the context of existing local projects, the focus is shifted to contrast two case studies in cooperative computing beyond the local level.

The first is the attempt of the Urban Information Systems Inter-Agency Committee (USAC), an effort during the 1970s by the federal government to develop large-scale computing capacity at the municipal level for the dual purposes of national policy research and municipal records organization. Although USAC was not a GIS by today's standards (lacking the ability to conduct distance analysis or graphic manipulation/selection of records by selection on a base map), it was one of the first attempts involving multi-jurisdictional computing at the local level, making it historically important. The discussion of USAC demonstrates how the interaction between technical limits and organizational goals must be considered in the development of any multi-jurisdictional computing system.

The second example is an examination of the Southern California Association of Governments (SCAG) Access Project (ACCESS). The discussion of ACCESS serves three purposes. First, it contrasts with USAC the advances in technology and integration of organizational missions under an organizationally consis-

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tent computing system, demonstrating how cooperative computing arrangements can be employed for environmental management purposes (e.g., urban planning, travel forecasting, resource inventories, pollution control, etc.) at several levels simultaneously. Second, because ACCESS is a GIS-based example, it can answer some of the questions based specifically in multi-jurisdictional GIS implementation that USAC begs: How could a GIS be developed, from the beginning, with more than one end user in mind? How will the costs be distributed equitably across participants? What level of detail in the underlying data is needed to make the system work? Third, an analysis of end user sophistication with computers and associated ACCESS usage suggest that although ACCESS does represent significant gains over USAC, it still falls short of achieving its own goals, due to its own technological and organizational impediments. The paper concludes with proposals of what research questions multi-jurisdictional systems raise, and how these questions might be pursued in the future.

Underlying Assumptions and Issues

What Would a Multi-Jurisdictional GIS Do?

A multi-jurisdictional application of GIS attempts to expand the level of detail and range of tasks for which GIS analysis can be useful to individual organizations by facilitating the transmission, disaggregation, and analysis of spatially based information between various levels of government. Howland and Lindsay's research on office tenancy and commuting behavior demonstrates the need for such communication and data disaggregation. (1997) The authors noted that no previous research sufficiently similar to their own work was available for literature review, because data tracking movement of office users below the county level of analysis had not previously been available. Their use of GIS to collect, organize, and analyze their investigation indicates a need for a greater level of detail in data collected, and spanning a wider geographic region; it is a pioneering step in urban planning research.

An important first step in developing a multi-jurisdictional GIS is a justification of why such a system design is necessary. While the case-specific analysis of GIS extols the virtues and exposes the weaknesses of using GIS for their specific purposes, they do not explore how a GIS with different attributes might yield different, or better, results. Such tasks are left to those who would review GIS software (Levine and Landis 1989) or associated software extensions (Levine 1996), and as a result gives the general topic of GIS in the planning profession a short shrift. This lack of discussion comparing GIS capabilities and the tasks to which it will be applied inevitably leads to fragmentation between systems, and the levels of government that use them. Such fragmentation is best avoided by bringing in all parties who have a stake at the inception of the system.

How Would Participants in a Multi-Jurisdictional System Relate?

Of primary concern is how the GIS is viewed and used by the various project participants. Heikkila (1998) draws a distinction between how GIS is used in the planning profession and in the academic environment. The discussion is important because in the pursuit of professional degrees there is an endogenous relationship between the state of the practice and instruction given; what is practiced serves as the basis for academic analysis and instruction, which graduates then take into the field and use to push their profession in new directions. The professional point of view, according to Heikkila, is to use GIS as a reference and storage device for spatially coded information such as property records, building permits, and zoning maps. The academic perspective attempts to broaden the GIS pallet by not only teaching the software mechanics of GIS research for specific bureaucratic goals, but also by taking the information sources listed previously (and others) to use the system as a modeling tool based on the needs of various academic disciplines. Regardless of the outlook adopted, executing large-scale spatial research and analysis on public issues requires massive amounts of staff time and money, and detailed technical knowledge about GIS data collection and forecasting procedures. For these reasons, most municipal planning departments receive regional forecasts from higher levels of government, such as the county, state, or metropolitan planning organization (MPO), with the primary role of lower level agencies being enforcement and compliance. It is only necessary, then, for all but the largest jurisdictions to be able to make projections from data that is given to them. This leaves municipalities and counties in the situation where they simply use the data-analysis tools provided by GIS and do not develop full modeling capabilities, even when they are readily available.

This relationship results in an organizational problem: The variety of GIS used by different governments (or organizations within the same government unit) creates a technological impediment to data exchange and coordination of institutions. In response to these problems, a multi-jurisdictional GIS would use a standardized system of software and map formats to pass information in both directions between levels of government. A multi-jurisdictional GIS could serve as a commonly accepted basis for decision making, because all the information contained within and analysis based on it could be quickly and identically replicated.

The initial development of a multi-jurisdictional GIS project would be in the domain of the branch of government that has primary jurisdiction over the geographic area in question. These initial projects would be delivered to local jurisdictions for review and comparison to their own records. This is done to allow a contrast of a single local jurisdiction to an integrated whole larger than itself, and to correct any errors that may exist in the data sets serving as the project reference. These analyses and corrections will then be submitted to the higher levels of government for inclusion and correction in subsequent GIS projects, and the cycle begins again. Alternatively, local jurisdictions can develop their own project interests, through cooperative arrangements such as councils of governments or public/private partnerships, and submit the project to higher jurisdictions for information purposes or necessary consent, as the case may warrant.

From this arrangement, local jurisdictions can see more clearly how higher levels of government regard their needs in developing regional forecasts, in addition to having the possibility of doing their own forecasting. State and federal agencies, as well as MPOs, would be able to collect more accurate and detailed data. Constant dialogue between system participants would ensure everyone was using the same data and forecast strategies, minimizing inter-jurisdictional conflicts. Ideally, there would be no impediments, technical or otherwise, to having local jurisdictions customize their individual systems with specialized local data so long as they also contained common GIS data between all system participants.

Why Develop a Multi-jurisdictional System?

Just because a framework can be designed doesn't mean that it will, or even should, be implemented. Why attempt developing a multi-jurisdictional GIS now? The answer lies in the technical and organizational advances relating to computing and GIS in the past few years, and the forthcoming opportunities in local planning, which may very well require such cooperation in order to fully take advantage of them. Examples include the U.S. Census in the year 2000 specifically and the proliferation of cooperative government relationships in general.

Technical

Part of past difficulties in developing a multi-jurisdictional GIS was that the costs to distribute the necessary technology widely enough were prohibitive. Most GIS work best on a 32-bit operating system (Huxhold 1991). Prior to the development of 32-bit operating systems, this restricted GIS to the realm of expensive, UNIX-based workstations, requiring large investment in capital and training. In addition, GIS software has become more versatile for the individual user. Spatial analysis capabilities have been steadily incorporated into the mainstream of GIS tasks since the early 1990s. In his review of supplemental spatial statistical modules for GIS, Levine (1996) concluded that there would be an increase in the number of statistical programs interfacing with GIS, and a growth in the ability of GIS to connect with standard statistical packages. Levine was partly correct about the increased connection between statistical analysis and GIS. Rather than establish links to outside application software, developers have included spatial statistical capabilities in software extension packages and later releases of their own systems (Intergraph Corp. 1997). Such developments enhance modeling capabilities for local jurisdictions with each successive upgrade, allowing them to rebut forecasts they consider inaccurate or incomplete. These developments enhancing local GIS capabilities make a multi-jurisdictional context all the more important to ensure that the interests of both large and small organizations are balanced in terms of efficiency and sovereignty.

Organizational

Calkins and Weatherbe (1995) go so far as to say that technological advances such as those described are "removing the technical barriers to spatial data sharing" (Calkins and Weatherbe, in Onsrud and Rushton 1995). They state that the remaining constraints to spatial data sharing (a necessary first step in developing a multi-jurisdictional GIS) are mainly organizational in nature: Does the underlying political and bureaucratic support exist for developing cooperative a GIS? The answer appears to be yes. Current organizational research connected to GIS development suggests that concurrent with this leap in technology is the increased acceptance of GIS in the realm of traditional planning and engineering forums, and the examination of social factors that accelerate or hinder the development of GIS in local governments. Evans and Ferreira (1995) pointed out that the overlap between technological innovation and organizational behavior patterns is a potentially rich area of research, as both impinge on the ability of multiple users to cooperate and maintain cooperative GIS (Evans and Ferreira, in Onsrud and Rushton 1995). On the technical side, Evans and Ferreira suggested future research focus on the "messy transition period when not all the relevant organizations are fully equipped or conforming to new standards and theories for spatial data sharing." As mitigation to the difficulties encountered during this transition, the authors propose that "loosely coupled, cooperating modules of software and hardware" be employed instead of large scale, specially designed systems.

Evans and Ferreira's call was not ignored. Budic and Godschalk (1996) tested the acceptance of GIS among intended users in several departments in Cumberland County, North Carolina (a school district transportation department, the mapping section of a county tax assessor's office, the community assistance and comprehensive planning sections of the county planning department). The results of their investigation are enlightening. The authors found that an "absence of perceived concrete personal benefits" for those who would use GIS was a hindrance in adoption of the system, while the existence of that benefit did not necessarily ensure that the system would be adopted. Three factors greatly enhanced the likelihood that GIS would be accepted in normal operation: a higher degree of computer experience overall (and a greater familiarity with GIS technology specifically), the ability to communicate with one's peers on the use of GIS (closely related to familiarity with the technology), and personal acceptance of work-related change. In addition to the personal factors regarding GIS acceptance, Budic (1994) identified six elements that are critical to developing a local GIS: political support for incorporation of the technology, staff support for its implementation, length of time GIS has been used/experience with the technology, system sharing capabilities, comprehensiveness of the GIS database, and the number and types of applications for which the GIS can be used. Adopting a multi-jurisdictional approach to GIS can generate political support by demonstrating how a GIS can enhance a local jurisdiction's predictive and enforcement capabilities. Database comprehensiveness and systems sharing capabilities are a requirement for a successful multi-jurisdictional GIS, and may be developed at reduced cost through economies of scale, jurisdictional cooperation, and specification of data transfer protocols. Indeed, it is becoming less necessary to devote large amounts of staff time to developing these databases, as external sources for them are beginning to proliferate (e.g., U.S. Bureau of the Census, commercial databases, and public utility CAD network drawings). Thus, the number of tasks for which a multi-jurisdictional GIS can be used is limited only by the amount of information in the database and the technical knowledge and creativity of the GIS user.

Multi-Jurisdictional Opportunities

In order for a multi-jurisdictional effort to succeed, it must be centered on a set of commonly accepted goals. The development of these goals is usually imposed by the existence of requirements or opportunities beyond the local context. This definition is all the more important in terms of a cooperative GIS, because the possibility exists that group resources may end up being co-opted by individual members for their own purposes without any connection to the group effort. This result is particularly likely when different multi-jurisdictional participants are at various stages of developing GIS capabilities in house. These factors will be analyzed in greater detail in the next section, but for the moment they give rise to the question: What set of current circumstances could overcome organizational impediments to a GIS-based cooperative relationship beyond local levels of government?

The first factor that provides the impetus for multi-jurisdictional GIS is the proliferation in recent years of other cooperative efforts between various levels of government. Nunn and Rosentraub (1997) provide examples of *inter-jurisdictional* efforts to provide common services, administer projects, and identify problems beyond immediately local control. Inter-jurisdictional cooperation, as Nunn and Rosentraub have defined it, is restricted to cooperation between similar political entities (i.e., cities with cities, counties with counties). They identify four basic areas of improvement that inter-jurisdictional cooperation can address: economic development, delivery of municipal services, improvement and preservation of physical environmental quality, and socio-political change. The authors suggest that the degree of success inter-jurisdictional cooperative groups attain is linked to the objectives to be achieved (indicating the level of expected political resistance), the institutional format to be used (indicating local autonomy), and the underlying social paradigm to be used (indicating the way issues will be approached, or even acknowledged, by the group).

By itself, Nunn and Rosentraub's argument still begs the question why cooperate using a GIS? The second motivation for a multi-jurisdictional GIS is the interest recently expressed by state and federal organizations in GIS technology and policy. For example, during the current and past two legislative sessions, the California Assembly has repeatedly expressed interest in developing GIS capabilities at the local level through the proposal of a board to manage grant applications written for this purpose. Passage of such a bill into law could represent a new source of funding for additional cities, counties, and special districts to participate in a large multi-jurisdictional GIS. At the federal level, there are two efforts under way to enhance the detail, accuracy and accessibility of spatial data: the National Spatial Data Infrastructure (NSDI) and the Local Update of Census Addresses (LUCA) for the U.S. Census 2000.

NSDI is a project by the Federal Geographic Data Committee (FGDC) to consolidate and assign various tasks of geographic data collection under the jurisdiction of the federal government. The members of the FGDC are the U.S. Departments of Interior, Commerce, Agriculture, and Transportation, respectively. The departments exchange data on their respective jurisdictions consistent with FGDC standards for quality, accuracy, and transmission. As a side task, the FGDC also is intended to "provide guidance and promote cooperation" between the federal government and the state and local governments regarding collection, presentation, and dissemination of spatial data (Office of Management and Budget 1990). As of March 1999, this side task has received greater attention by way of the Community/Federal Information Partnership, a budget item proposed by the Clinton administration in order to expand NSDI's reach to the local level (National States Geographic Information Council 1999).

Under LUCA, the Census Bureau hopes to enlist local jurisdictions in assisting with the year 2000 census by having them correct for geocoding and address database mistakes using the Bureau's Master Address File and Topographically Integrated Geographic Encoded Record (TIGER) files (Williamson 1998). Areas where local jurisdictions may be able to enhance census results include review of subdivisions that should be incorporated in the census tally to allow checking accuracy of municipal boundaries, amending TIGER files with street name or address changes or planned changes, and analysis of multi-family dwelling units and unusual addresses or "atypical" (i.e., illegal) housing units that meet the Bureau's definition of a household. Although LUCA is targeted at municipalities, there is still a role for larger jurisdictions to play. Counties and local area formation commissions can provide the Census Bureau with information on unincorporated county territory not yet under a specific municipal jurisdiction but which will be incorporated before 2010. Both NSDI and LUCA show how a multi-jurisdictional GIS would serve such inter-jurisdictional efforts as a common research resource with information beyond the immediate confines of the participating members, expanding their analytic capabilities without surrendering sovereignty.

Examples of Multi-Jurisdictional GIS

Local Examples

To better understand how multi-jurisdictional systems would work in practice, it helps to examine the organization of existing distributed GIS operations. Because the practice of distributed GIS development is relatively new, much of the following case-specific discussion comes from non-academic resources. Three examples of a multi-jurisdictional system currently in use are the

Indianapolis Mapping and Geographic Infrastructure System (IMAGIS) in Indiana, the Cincinnati Area Geographic Information Systems Consortium (CAGIS) in Ohio, and the Winnebago Geographic System (WINGS) in Winnebago County, Wisconsin. Of these, CAGIS and WINGS have the best historical documentation available, so they are the focus of this section. All of these endeavors have undergone major software and system upgrades within the past seven years specifically for the purpose of securing reliable relationships between project members: WINGS in 1992, CAGIS in 1994, and IMAGIS in 1996 (Elliot 1996; Quinn et al, 1999; Marion County 1999). In each case, the individual participants of each multi-jurisdictional system were using their own GIS since the early to mid-1980s but, seeing the need to develop consistent systems, cooperative forums developed by mutual consent for discussion of issues and opportunities beyond any single level of government. Benefits were realized in reduced staff time to complete tasks and lower maintenance costs due to maintaining only one set of records.

The WINGS and CAGIS examples demonstrate important points. The spark for developing WINGS was the need of both the county and its municipalities to keep pace with its share of increasing regional growth in a cost-effective manner. Designed around a cooperative agreement between the county and six cities within its jurisdiction, the project eventually expanded to all 21 municipalities in the region (Elliot 1996). The operational goal of the new system was to cut costs for municipal and county services by reducing duplicate filings procedures for development, sharing common property databases and computer-generated maps between municipal departments with similar goals, and providing a secure, comprehensive system for maintaining municipal records (American City & County 1995). Analysis of the economic and housing trends of the ten-year period prior to the inception of WINGS bears out this point. Winnebago lost agriculture as an employment base at a proportion 50 percent greater than the rest of the state, while experiencing faster than average growth in managerial and technical service employment (9% and 15% above state norms, respectively). Concurrently, the number of housing units classified as urban grew at a rate 38 percent faster than the state as a whole, while housing units classified as rural increased at a rate less than half (48%) that of the state (U.S. Dept. of Commerce 1980a, U.S. Dept. of Commerce 1980b, U.S. Dept. of Commerce 1990). The case was similar for the CAGIS group: inconsistencies between various municipal and county maps and databases lead to increased delays in processing building permits, infrastructure repair, and public service requests. After CAGIS reached full operational status, the development process was shortened five to seven months on average in the Cincinnati area, while the local sewer district gained six million dollars in reduced maintenance costs and increased revenues. Infrastructure changes made in one department were reflected across the system in near real time, regardless of the jurisdiction (Quinn et al 1999).

In both cases, the driving force for developing the cooperative arrangement was similar: the need for consistency of information and enhanced predictive capabilities across several interdependent organizations. WINGS was built around 20 common critical layers of information for all participants, such as road networks, infrastructure, and parcel data. Individual participants could supplement the system with their own information, and by 1995 the system contained 65 layers of information on all 21 cities and over 85,000 land parcels. Special GIS applications and interfaces were designed for individual departments as needed (American City & County 1995). As the project has grown, it has come to include 200 layers of information and now is being used as a forecasting tool for such tasks as population projection, urban sprawl management, and farmland preservation in a county-wide context. Thus, Winnebago's experience has gone beyond simply enhancing reactive capabilities to the development of new proactive tools. Although primarily designed for information dissemination, analysis of archived CAGIS data could serve the same role for both the city of Cincinnati and Hamilton County, because the system was designed with similar goals in mind.

The expansion the WINGS project experienced is a logical outcome of successful cooperative GIS development. Yet, both WINGS and CAGIS are geographically constrained; neither examines implications beyond the borders of the county. Arguably, concentrated growth has implications beyond the county level. How should other jurisdictions react? A detailed examination of attempts at developing a larger-scale, multi-jurisdictional computing environment, contrasted with a current, similar multi-jurisdictional GIS operations would show how such a systems concept could be improved in this aspect. The USAC program and the SCAG ACCESS project provide those examples.

USAC: A Multi-jurisdictional GIS Collapses

Project Goals. The Urban Information Systems Inter-Agency Committee (USAC) is one of the first coordinated attempts to develop a broad based cooperative prototype municipal information management system. (Eichelberger 1992; Tosta and Croswell 1992). The ultimate goal was to design an integrated system to be used by more than one level of government in their respective decision-making processes (National Academy of Sciences 1976). This was to be achieved through the prototype development of a comprehensive database known as the Integrated Municipal Information System (IMIS), the premise of which was to build "a total municipal information system based on four functional subsystems, representing Public Safety, Public Finance, Physical and Economic Development, and Human Resources Development" (Kraemer and King 1977). USAC identified six related operational goals, including integrated data processing, operations-based automation, prototype development (including system analysis, conceptualization, design, development, implementation, and evaluation), complete project documentation (for project replication), and transfer of developed systems and subsystems.

Project Design and Organization. As described by Kraemer and King, the federal government, through the Department of Housing and Urban Development (HUD), selected six cities (Wichita Falls, TX; Charlotte, NC; Dayton, OH; Long Beach, CA; Reading, PA; and St. Paul, MN) for initial participation. Universities in the participating jurisdictions were included for the purposes of monitoring, technical advising, and evaluating IMIS development. These six sites were chosen from a pool of 79 applicant cities with populations between 50,000 and 500,000. Between 1970 and 1977 (when USAC was formally disbanded) $26 million was spent in pursuit of developing an IMIS for each city: $20 million spent by the federal government, $6 million contributed by the local jurisdictions.

USAC implemented a "consortium approach," which placed most of the responsibility and power for project completion in the hands of municipalities, who were expected to enlist the help of private enterprise for technical expertise and university assets for project evaluation. It was anticipated once IMIS was developed in each city, it subsequently could be connected to state and federal agencies. While initial stages of the project were pursued enthusiastically, it was soon realized that technical complexities were severely underestimated, due at least in part to the fact that IMIS was a prototype. As a result of these technical complexities and associated budget shortages, it was realized that development of IMIS on the desired scale was not possible. Where federal and local goals conflicted, local goals received priority from the primary project implementers. The prime example Kraemer and King give is the desire of the participating municipalities to develop a working system for their own jurisdiction, while federal officials wanted to develop a research tool. This conflict prompted federal review and eventually the imposition of strict adherence to USAC goals. Cities responded by meeting only their official obligations, anticipating the eventual end of the project (Kraemer and King 1977).

Analysis. Kraemer and King note that if the USAC did not develop a fully transferable IMIS, then it at least encouraged the development of large-scale computing at the municipal level. The number of data processing employees in USAC cities increased by 74 percent as compared to 47 percent in the other applicant cities between 1970 and 1975. Computing capacity increased by 2,500 percent and the number of computer terminals increased by 550 percent in USAC project cities over the same time period. For applicant jurisdictions that were not included in USAC, computing capacity jumped 690 percent and the number of computer terminals increased 1,000 percent. In addition to this increased processing power, local jurisdictions took the USAC experience as indicating that large-scale municipal computing projects designed to handle municipal records could at least be conceived, and that smaller subsystems could in fact be built. From the collapse of USAC, then, some of the fundamental requirements for future multi-jurisdictional cooperation in database development were identified. These included the need for greater processing power and computer talent at the local level, the need for project participants to be able to see their work in relation to a larger system, and a realization of both fiscal and staff resource costs involved.

SCAG ACCESS: A Multi-Jurisdictional GIS Under Review

Project Goals. The two major goals of ACCESS are the improvement of communications and coordination between the Southern California Association of Governments (SCAG) and its constituent jurisdictions, and the creation of cooperative subregional planning institutions. The project was envisioned to " . . . give the subregional Associations [i.e., Councils/Associations of Governments] and the constituent local governments the tools they need to engage in a coordinated planning process, and which will allow for all local governments to become more fully involved in subregional and regional planning decision making." To that end, SCAG provided GIS software and computer hardware free of charge to participating member cities within the counties under its jurisdiction (Figure 1).

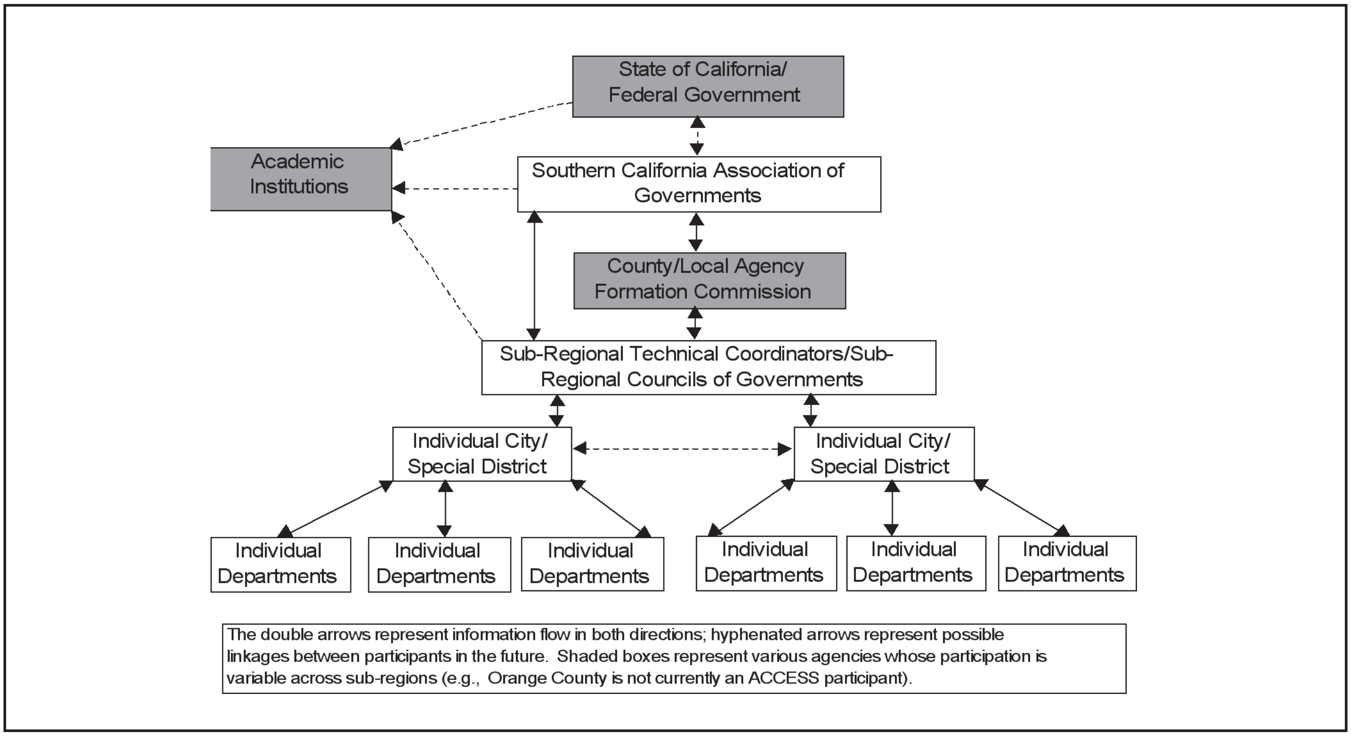
Project Design and Organization. Currently, Orange County participation in ACCESS is facilitated by the Orange County Council of Governments (OCCOG), created to review and comment on regional and sub-regional planning activities and their impacts on such issues as air quality, demographics, transportation modeling, and implementation of new technologies. At the time of this writing, OCCOG membership is comprised of 36 Orange County cities and selected special districts including various water districts, the Orange County Sanitation District, and the Transportation Corridor Agencies (responsible for toll road project management).

Orange County participation in ACCESS is being handled by the OCCOG-Technical Advisory Committee (OCCOG-TAC), a collection of staff from the various OCCOG participating agencies who analyze the opportunities and impacts presented

Figure 1: Jurisdiction of Southern California Association of Governments

Source: http://www.scag.org/bin/scag_map

Figure 2: SCAG ACCESS Organizational Flow Chart

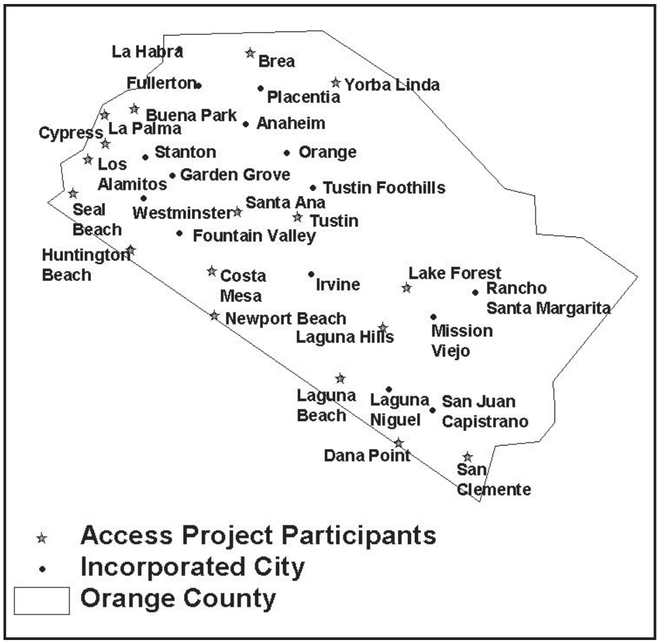


by state, federal, and SCAG programs. The OCCOG-TAC coordinates ACCESS implementation between SCAG staff, participating Orange County cities, and the Center for Demographic Research (CDR, a social science and statistics research organization attached to the California State University at Fullerton) through monthly meetings.

The organizational structure of ACCESS is designed to be simultaneously "top-down" and "bottom-up" (Figure 2). Local jurisdictions and special districts receive initial subregional forecasts from SCAG, acting as the MPO, through the sub-regional councils of governments (e.g., OCCOG for Orange County). Once distributed at the local level, municipalities and special districts can distribute ACCESS information to individual divisions within their organization for review. When this review is complete, the corrections and comments are aggregated and given to the sub-regional Council of Governments and the Sub-Regional Coordinator for the purpose of providing a unified response to SCAG. SCAG then makes what they believe are the appropriate corrections, and the process begins again. After several iterations of this process, the final sub-regional forecasts are distributed, and individual project participants can then use the sub-regional forecasts for their own planning needs. Through this process, counties and cities can ensure that their voice is heard in regional planning decisions, and SCAG has a means of checking and refining their projections, which serve as the basis for meeting their obligations under such federal environmental statutes as the regional MPO. In addition, local users who have common or overlapping borders can use ACCESS as a frame of reference when attempting to resolve conflicts. Academic institutions are considered potential participants because although they participate in OCCOG discussions, they have no voting power and as such cannot directly affect the outcome of the sub-regional review process. Academic institutions can, however, use ACCESS to conduct research, and therefore benefit from project participation.

The technological core of ACCESS is a set of customized GIS project files based around the regional analysis functions for which SCAG holds responsibility, such as the MPO for the Southern California region. Regional project files include growth forecasting for employment and general population growth; demographic analysis at the census tract and census block level; regional employment analysis using Standard Industrial Classification codes; and transportation analysis based on the Regional Transportation Plan developed by SCAG. Local use of ACCESS is supported by: 1) property identification capabilities (useful only when municipalities include their own property records; 2) land-use analysis based on the Anderson Land Use Classification System; 3) a damage assessment routine that allows local jurisdictions to tie their property files to an electronic form which can be submitted electronically to the Federal Emergency Management Agency or the California Governor's Office of Emergency Services; and 4) a general data viewer, containing information on ecologically sensitive areas, political districts, and municipal general plans. In addition, local jurisdictions can supplement ACCESS with any of their own information and combine it with ACCESS project files.

Figure 3: Municipalities Participating in SCAG ACCESS Project as of April 1997



By April 1997, 18 of the original 32 OCCOG member agencies chose to participate in ACCESS (Figure 3).

Participation in ACCESS is free to SCAG member agencies, although there is a $4,000 biannual subscription fee for the project package for non-members. The software component can be leased by itself from SCAG for $2,000. In addition to these fees, there is a lease agreement with Thomas Bros. Maps, Inc. for $500 per year, regardless of whether a project participant is a SCAG member agency. Financing for local participation in ACCESS was derived from three sources in the 1997/98 OCCOG budget. The first two are related to California Assembly Bill 2766 (AB 2766), managed by the Mobile Sources Air Pollution Reduction Review Committee (MSRC). AB 2766 was implemented for the purpose of improving regional air quality through traffic management and the reduction of vehicle trips and harmful vehicle emissions. ACCESS can be used to review how local road projects and land uses tie into regional transportation plans, making AB 2766 discretionary funds available. Second, cities received AB 2766 subvention funding to improve local air quality and participate in projects of regional benefit. It was anticipated that member cities participating in ACCESS would use some of these funds to support the project. Third, funding for ACCESS participation was specifically requested by the OCCOG in their SCAG Overall Work Program (SCAG-OWP) for 1997/98, totaling $50,000/$20,000 for application of GIS studies to the Regional Transportation Plan (RTP) and $30,000 for a demonstration project analyzing building permit data in conjunction with subregional demographic data provided by the CDR.

Analysis. While ACCESS provides local jurisdictions with a new level of analysis, it has substantial problems. The largest difficulties are in the areas of data accuracy and supplementation, basic systems training and management, restrictive licensing agreements, and insufficient exploration of advanced spatial analysis capabilities. These issues are examples of Evans and Ferreira's discussion of the interaction between technological and organizational issues mentioned earlier; they are interconnected in such a way that isolating them is not easily accomplished. First, SCAG does not provide property files for local jurisdictions, meaning that cities have to supply this information on their own. This can be an expensive obstacle to local system implementation. Prices for property information files can range between two and five dollars per parcel, depending on the provider. In cities with thousands of parcels, individual acquisition may become prohibitively expensive.

Currently, OCCOG is negotiating to acquire property files from the private provider authorized by Orange County. Costs of $2 per parcel for initial distribution and $.60 per parcel for yearly updates were originally discussed with the data provider, although using the OCCOG as a collective negotiating forum resulted in a lower unit price ($1 per parcel, $.10 per parcel update fee). Regardless of who eventually does the format changes, a system will have to be developed to ensure that a usable end product is delivered. If there are inconsistencies in database formats across different GIS programs used to convert the property files, costs for corrections will be incurred (both in terms of implementation delays and monetary considerations). The OCCOG is attempting to solve this difficulty of property supplementation by working with the CDR on a pilot project with a subgroup of ACCESS participants. The pilot project would convert and install County parcel files on ACCESS machines in participating cities, for the purpose of determining how such procedures can be streamlined in the future.

Second, for the GIS information provided there is a serious disjunction between what ACCESS displays and what local participants need. Part of this is due to the differences in levels of analysis for the various ACCESS participants. For example, growth forecasts and environmental map coverages have been developed at scales that are adequate for SCAG but useless to the local participants. In some cases, this has led to high levels of spatial error (upwards of 200 feet) that are insignificant to a regional planning organization but of great concern to smaller jurisdictions. In theory, the organizational structure of ACCESS should correct for these errors of scale through the communications process, making SCAG aware of the technical difficulties through the sub-regional coordinator. More fundamentally damaging are the inadequacies of and the restrictions placed on the underlying data. Based on 1990 U.S. Census data, ACCESS files no longer reflect current trends in demographics or employment. Even if this were not the case, ACCESS coverages are not arranged in such a way as to be user friendly. Components of ACCESS cannot be extracted easily for use in other GIS projects, or within sub-projects of ACCESS itself. This inability to reorganize and update data is due to specialized programming code associated with ACCESS, restricting modification or movement of the master data files. In addition, because of the licensing agreements with software and data vendors, ACCESS cannot be placed on a municipal network without renegotiating with the respective companies for a site license. Thus, there is only one terminal per city with full ACCESS capabilities, limiting the number of tasks it can serve at one time. This directly limits the utility of ACCESS as an interdepartmental GIS at the local level, and in fact these data restrictions have driven away many potential participants from this project.

Third, the full abilities of ACCESS to conduct advanced analysis as yet have not been clearly demonstrated to local participants. Training has been sparse and generally off topic, focusing on advanced systems well beyond the logistical capability of project participants or the ACCESS software itself. A few participants have used ACCESS in specific planning functions (e.g., public works management) or as a training device for their staff, but none have fully integrated the system into their planning process. In addition to training difficulties, spatial analysis capabilities of ACCESS are weak and the upgrade capability unknown. ACCESS cannot run spatial statistics or provide three-dimensional analysis; the extensions that exist for this purpose have not been tested for their compatibility with the existing customized programs. It is entirely possible that the specialized code protecting the master data files will conflict with these spatial analysis extensions, yet local jurisdictions will need this ability if they are to participate in future regional modeling endeavors.

Contrast: USAC versus SCAG ACCESS

In order to compare the USAC and ACCESS case studies, a necessary first step is to discuss the evolution of computing environments and examine how that has changed the organizational context of distributed computing efforts. From a feasibility standpoint, technological change has made large-scale computing in general cheaper and easier to comprehend. Kraemer and King (1977) noted that for full implementation of IMIS, 500 *kilobytes* would be necessary for the individual terminal and eight megabytes of total computer storage capacity would be necessary. Such figures now are inadequate for running desktop systems even without GIS. In addition, the command structures for using GIS have shifted from lines of code to graphical interfaces using on-screen "buttons," divorcing the need to have detailed knowledge about computer systems and programming languages from the implementation of GIS. This makes the learning of the day to day operational tasks easier, increasing the likelihood that the system will be adopted at least in part. Relational database software now makes it relatively easier to maintain municipal records of greater detail and number, meaning more task-specific information can be collected, separated, and reported as needed. Desktop modem technology, not even available at the time USAC was implemented, facilitates the transfer of information between jurisdictions. Such advances in capability between the time USAC was concluded and ACCESS was introduced to Orange County substantially lessens the difficulties of participation and coordination burdens placed on those who would design a multi-jurisdictional GIS today.

Still, even if the technology has been made drastically more affordable and understandable to the lay person, learning how to use it remains an obstacle. It was stated in the previous paragraph that relational database software has made it *relatively* easier to manage larger and more detailed municipal records. The nature of this simplification is that database information no longer needs to be part of the original GIS application program itself, meaning that changing municipal records does not require changing the GIS that uses it. This should not be taken to mean that working with a relational database application program is easy. Visualization of the logical relationships between records is difficult, and though all commercial database programs today adhere to a common form of expressing database inquiries, each relational database program in existence can have its own special user interfaces. Each interface can require a new session of training. Similarly, although all GIS can perform many of the same underlying tasks (e.g., property identification, "within distance" location, boundary determination, image overlays), each can have a different user interface, requiring the user to be retrained. More fundamentally, conceptualization of how a GIS works cannot be achieved without at least a concurrent (and preferably prior) exposure to fundamental GIS issues such as data management, graphics, and computer hardware.

The need for both technical and organizational assistance has been a major stumbling block for both USAC and ACCESS. For USAC, part of these problems may have stemmed from the fact that group meetings were scheduled on a semi-annual basis. Infrequency of direct contact may have contributed to a lack of consistent communication and levels of training between the various branches of government and their respective goals (although the criticism of USAC's lack of systems training is somewhat tempered by the fact it was an attempt to develop a prototype). Additionally, Kraemer suggested that the role of the universities in USAC was "a double bind," stating they were supposed to be simultaneously "friendly inside advisors and objective outside critics." The role of critic often prevented the flow of information necessary for a complete analysis of the system, and the role of friendly advisor prevented honest identification of project faults. (Kraemer and King 1977)

By comparison, ACCESS implementation in Orange County has attempted to head off this problem through the recruitment of a technical coordinator already within the project, through the CDR. Because CDR has been involved in providing supplementary data, it is well acquainted with the technical aspects of ACCESS and the problems described in the previous section. Monthly meetings provide a forum in which regular project updates and training issues can be addressed. But without more assistance from SCAG, this input cannot be translated into solutions. Though the CDR technical coordinator may be able to identify problems and perhaps develop temporary solutions, SCAG is responsible for making changes to the underlying system. Realizing this, SCAG is developing new versions of ACCESS in conjunction with sub-regional coordinators to identify and correct problems encountered in previous releases.

This development of ACCESS revisions in response to subregional comments demonstrates a difference in organizational styles between the USAC and ACCESS. HUD's authoritarian management structure and strict adherence to regulations as it became obvious that federal and local goals were diverging generated an indifference, if not outright hostility, toward federal goals at the local level. In contrast, although SCAG did not originally deliver certain necessary components for local implementation of the ACCESS project (namely, the local property identification files), the project was intended to at least accommodate, and hopefully integrate, with local analytic needs. In addition, the more frequent meeting of ACCESS participants provides greater opportunity to address differences in project perspective.

It would appear the ends pursued by USAC and ACCESS are subtly different. The overall goals of IMIS development and ACCESS are identical: Use common information displayed in the same frame of reference for the purposes making local, regional, and eventually federal policy based on increased efficiency of data gathering, greater accuracy of underlying data, and lower redundancy. However, whereas USAC was implemented for the specific purpose of determining whether a prototype system could be built and replicated with the current technology available, ACCESS is designed to involve local jurisdictions more directly into an existing regional planning process using established technologies. Because ACCESS has the benefit of a stable technology base and a broader forum for organizational input, this increases the likelihood that it could succeed where USAC fell short. Critically, though, increased likelihood of success is not an ironclad guarantee. Identification of specific local goals to which ACCESS could be applied had to be conducted by the local jurisdictions; otherwise ACCESS would become just another good idea that failed in the implementation phase.

To that end, a survey was conducted by the OCCOG to identify the general readiness of Orange County cities to participate in a multi-jurisdictional GIS. The results are moderately encouraging. Out of 31 surveys distributed, 23 were returned in various usable forms. ACCESS presents an initial exposure to the benefits of a GIS for 12 of the 23 respondents, 8 of which are below the median size of Orange County cities ranked by population. Although two of those 12 cities are not SCAG members, and thus must pay the project subscription fees, these costs are still substantially less than those incurred if these cities were to attempt to create their own GIS system independently. It is unlikely any of these cities would have a tax base broad enough to develop GIS capabilities without the ACCESS program. In addition to the reduced cost aspect compared to creating a new system, the areas of inquiry proposed as the basis for ACCESS have been well received by the participants. Of five project categories users expressed having included in a regional GIS database (mapping and zoning, infrastructure planning, facilities siting, demographic and transportation analysis, and housing forecasts) all received more than 50 percent popular support, and four received more than 75 percent. Recommendations for future ACCESS projects include regional economic development, business license and crime trends, aerial photographs, and an Internet site where questions regarding ACCESS can be posted and answered.

Where Does ACCESS Go from Here?

Enthusiasm for a cooperative effort is a necessary, but not a sufficient, condition for success. Using Budic's organizational acceptance criteria (1994) as a benchmark, some norms for determining success of GIS environments can be developed: breadth of user base, versatility of data and applications, ease of use, and project tenure. Using these criteria for judging ACCESS, there are serious obstacles to overcome.

Despite the expressed interest in the project, ACCESS execution has not been widespread in Orange County. Training on how to use the system and incorporate it into local jurisdictions has been inadequate and, as a result, interest at the local level has waned. In addition, component failures and data sharing restrictions hampered delivery of initial hardware and software systems to local participants; those machines that have been delivered have been either sidelined or converted to other uses within the cities. Component failures were attributed to reduced hardware quality imposed by budget constraints, while data sharing restrictions were put in place because of agreements with private data providers. Because ACCESS participation is voluntary and executed in a cooperative forum, these issues are known to non-participating OCCOG members, hindering expansion of the system.

In spite of these failures, there is still interest on the part of SCAG to pursue ACCESS in Orange County. The underlying interest in multi-jurisdictional GIS development has been expressed, so the task at hand is to determine whether ACCESS can be salvaged. A good first step is a proposed implementation of pilot projects for ACCESS system upgrades in a few select cities. This gives local participants a chance to see what problems exist with current approaches, test new methods, and resolve difficulties prior to implementing new procedures and system upgrades throughout the sub-region. Technological issues can in part be solved by discussion between new ACCESS participants and the technical coordinator for the OCCOG, but there are certain standardization aspects that can be addressed now that will lessen these problems, which should not necessarily be left up to a committee structure. These should be left to engineers and technical experts to ensure compatibility, accuracy, and efficiency in data collection and use throughout the system, both at higher levels of government as well as the local jurisdiction. Inconsistencies in data can become a costly source of error, and are avoidable if a constant, logical set of procedures is established as a reference point.

Assuming it continues, ACCESS also will face organizational challenges in the coming years. ACCESS can act as the core from which smaller cities build their own GIS, but in a larger sense, the ability to share and revise technical information at several different levels of government simultaneously will influence the way in which all forms of local and regional planning will take place. In order to adapt, ACCESS implementation must be organized in such a way as to facilitate new members beyond the relationship between the cities and SCAG. There already are signs that higher levels of government are interested in pursuing such a relationship in ACCESS specifically and distributed GIS in general, which would greatly expand the project beyond its current relationship. Alternatively, the funds also could be used to upgrade the capabilities of existing multi-jurisdictional GIS participants. To be prepared for this type of policy change, SCAG and OCCOG should anticipate, and in fact promote, new relationships between local, regional, state, and special jurisdictions, so that original goals are not inconsistent with new project requirements.

Conclusions

As recently as 1991, multi-jurisdictional systems could not have existed; the technological base would have been insufficient, the costs astronomical, and the conceptualization of the general capabilities by project participants inadequate. Since then, computer processing power has grown exponentially, GIS have become more refined and user friendly, new sources of funding have been identified, and the literature on the types of problems GIS have been used to solve has grown. The necessary technological and financial support for such a system appear to have caught up with what is a fundamentally sound strategy to further cooperative governance.

Multi-jurisdictional GIS applications also provide direction for academic instruction and research. The pallet of case studies involving GIS must now be broadened to include examinations of how differences of local and regional interests (based in large part on geographic jurisdiction and legal responsibilities) can be reconciled. This will require greater clarification of the role the GIS can play in topics traditionally related to planning such as politics, finance, and law. For those who would teach the application of GIS, instruction must not only include the creation of useful projects, but also how those projects relate to organizations beyond the single client and how analysis must change with the increase of interested and technologically capable parties.

At this point, a warning regarding the investigation and future application of multi-jurisdictional GIS is in order. Levine and Landis (1989) warned against what they called "the false god of comprehensiveness," stating that no single GIS software package can accomplish every conceivable task. Huxhold (1995) further stated that "a successful GIS is built, not bought," arguing an organization should not build a GIS around the specific applications software they choose. Rather, they should choose the software and create necessary database expansions according to the goals they wish to achieve and examine how those choices interact with other organizations with whom they interact on a consistent basis. Those who would attempt to build a multi-jurisdictional GIS must recognize that it cannot be designed at the outset to solve every conceivable multi-jurisdictional planning issue. Instead, the system must be designed to facilitate expansion as new tasks arise.

Aside from these pieces of technical advice, there must be mutual respect between participants of a multi-jurisdictional system and a realization that individual members will use the system to further their own goals as well as group goals. This is the political aspect of any type of cooperative planning. GIS applications will not change that, although they may change the way in which these political issues are framed and resolved. To use a technological analogy, the advent of the pocket calculator in engineering fields was a major advancement in terms of the speed at which analysis could be done. But the calculator *did not* change any of the underlying principles on which engineering is based. The same is true of GIS. Just because the capability exists to run analysis faster and in greater detail does not substitute for the fundamental physical, architectural, environmental, economic, or social principles of the planning process.

Even though USAC collapsed and ACCESS is in need of serious revision, there is still reason to be optimistic about the possibility of using GIS in a federal, state, and local multi-jurisdictional contexts. The first step in successful cooperative planning and conflict mitigation is to get all relevant participants reading from the same page. Multi-jurisdictional systems provide that frame of reference, giving regional jurisdictions the ability to see in greater detail how their plans affect smaller entities, and giving municipalities the ability to use their data in planning processes beyond city limits.

Notes

1. Kaiser, Gerry, Traffic Engineer, City of Neenah, Wisconsin (Personal Communication, 6 July, 1999).
2. Levine, David. Database Administrator for Winnebago Geographic System Project, County of Winnebago, Wisconsin (Personal Communication, 6 July 1999).
3. Bills, T. Principal of Data and GIS, Southern California Association of Governments (Personal Communication, 6 May 1997). The discussion of SCAG ACCESS entails more project specific analysis than the USAC example, due in no small part to the involvement of the author in implementation of ACCESS in Orange County, California from September 1996 to June 1997. The greater detail is in no way meant to minimize the contributions of other research presented here, but rather give as detailed a description as possible to a case study which the author has personal knowledge.
4. Southern California Association of Governments, About Access, http://www.scag.org/public_docs/d62.htm
5. SCAG includes the area between Ventura County and Imperial County as one geographic region. Orange County is one of seven subregions under SCAG jurisdiction.
6. Halls, D.K. Manager of Policy and Legislation, League of California Cities, Orange County Division (Personal Communication, 19 June, 1998).

7. Walsh, D.J, GIS Specialist/Demographer, Center for Demographic Research, California State University at Fullerton (Personal Communication, 14 July 1998).
8. A supplemental source of local information was disaggregated data from Orange County Projections, 1996 (OCP-96) under a Memorandum of Understanding between the CDR, the League of California Cities, the County of Orange, the Orange County Transportation and Fire Authorities, the Orange County Sanitation Districts and the Transportation Corridor Agencies. These data sets were provided at the partial Census Tract level in an ArcView-readable format. Among the deliverable products related to ACCESS, CDR developed the following; 1.) satellite imagery based land use inventory update capabilities; 2.) master polygon files; 3.) multi-stage geocoding, and; 4.) interactive demographics abilities. These CDR project deliverables were to be used in conjunction with the street map database leased from Thomas Bros. Maps to the participating agencies and distributed through SCAG. The Thomas Bros. data sets provide street level and zoning information to be used as reference points for the distribution of OCP-96 data within each city.
9. For example, the city of Huntington Beach was used as a model during an April 1997 training session as an example of how a GIS could be used to connect building permit applications across all the necessary departments simultaneously, reducing the amount of time needed to complete permit reviews. This was a poor example for two reasons. First, this type of system could probably not be designed with ACCESS because of the data and system constraints placed on the project. Second, the Huntington Beach example was developed entirely outside of ACCESS project participation. The Huntington Beach example demonstrated a system which, while technically sophisticated and extremely useful, was beyond the scope of implementation.
10. The survey instrument can be obtained by contacting the author through the Department of Urban and Regional Planning - School of Social Ecology, University of California, Irvine.

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