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Discussion Paper

ITS, LAND USE, AND SUSTAINABLE COMMUNITIES

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The 1991 Intermodal Surface Transportation Act (ISTEA) significantly expanded the range of issues surrounding the transportation planning process. Representing a fundamental shift in the nature of transportation planning, ISTEA formally recognized "that a federal transportation program can be designed explicitly to achieve transportation as well as other social objectives" (Denno 1994: 277). Amid its mandate that transportation planners consider the "overall social, economic, energy, and environmental effects of transportation" [23 CFR 450.316(a)(13)], ISTEA highlighted land use as an area of particular importance.[1]

ISTEA's concern with land use recognizes that land use and transportation are inextricably linked. This link, according to some analysts, makes coordinated land use and transportation planning essential to preserve environmental quality, promote social equity, and to make essential goods, services, and jobs more accessible to residents of both suburbs and inner cities. Replogle, for example, argues that transportation investments often alter land use patterns in ways that reinforce automobile dependence. As a means of relieving congestion, reducing pollution, and making communities more "livable," Replogle and others (Cervero and Landis 1995; Kunstler 1996) argue in favor of coupling transportation demand strategies with compact (often called "neo-traditional") developments. Other analysts, however, contend that the transportation-land use relationship has weakened in recent years, and that this weakened relationship makes it difficult to influence land use patterns through transportation investments (Giuliano 1995; Deakin 1991)

[1] ISTEA's implementing regulations require that planners "explicitly consider...the likely effect of transportation policy decisions on land use and development and the consistency of transportation plans

Given the controversy over the transportation-land use connection, it is not surprising that a major transportation technology initiative such as ITS has entered this debate. Indeed, analysts are not only bringing ITS into this discussion, but some *emphasize the importance of land use issues for exploring the link between ITS and sustainable communities.* In relation to land use and sustainable communities, views on ITS are mixed: some see it as an enabler of sustainable land use patterns (Sperling 1995), while others see ITS as "worsening by orders of magnitude" the problems of 'sprawl' and excessive auto use (Cervero (1995: 93).

This paper explores the debate over the relationship between ITS, land use, and sustainable communities. We examine four salient dimensions of this issue: 1) trends in U.S. land use patterns; 2) the relationship between land use and transportation; 3) debate over the consequences of sprawl; and 4) views on the connection between ITS, land use, and sustainable communities. We then offer suggestions and policy implications for integrating ITS with efforts to promote sustainable communities.

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ad programs with the provisions of all applicable short- and long-term land use and development plans" [23 CFR 450.316(a)].

Trends in U.S. Land Use Patterns

America's metropolitan areas are among the most decentralized, least-densely populated of any in the world (Jackson 1985). Although metropolitan decentralization began occurring during the Industrial Revolution, the trend accelerated during this century, most notably after World War II. Figure 1 illustrates the growth in the nation's suburban population relative to urban and rural areas since 1950. A litany of other statistics further illustrate this trend:

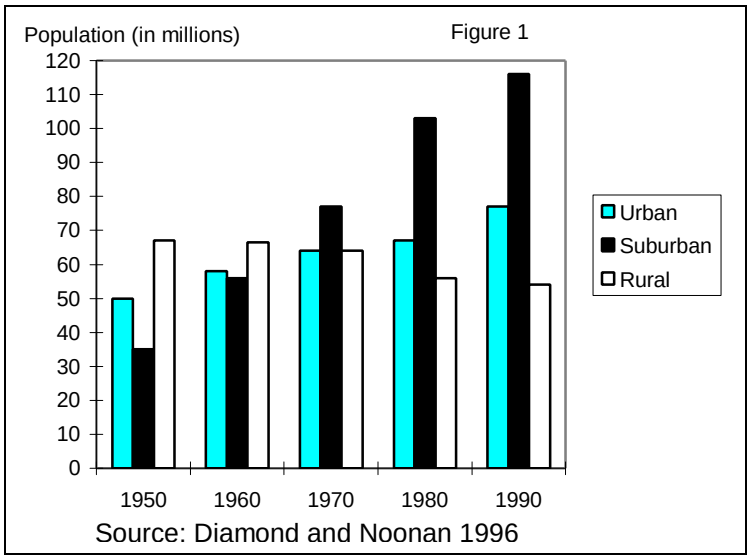

Figure 1
Source: Diamond and Noonan 1996

- The percentage of the U.S. population living in metropolitan areas was 25.5% in 1900 (5.8% in suburbs); 56.1% in 1950 (23.3% in suburbs); and 77.5% in 1990 (46.2% in suburbs)
- Between 1950 and 1970, Washington's urbanized area grew from 181 to 523 square miles
- By 1980, two-thirds of the dwelling units in America consisted of a single family living in a single dwelling surrounding by an ornamental yard
- The population of metropolitan Chicago grew by only four percent from 1970 to 1990, yet residential land consumption increased by 46%, and suburban commercial and industrial land consumption increased by 74%

Metropolitan decentralization, according to Davis *et al* (1994), has taken the form of an explosion in "exurban" development. While there is no single definition of "exurbia," the term generally refers to regions that "span the middle area between the urban/suburban and the rural landscapes, [although] within an exurb there are suburban subdivisions, large farms, small towns, some factories, ranchettes and hobby farms"

(p.46). Exurbs contain nearly 60 million people and constitute the fastest growing portion of the urban landscape. Davis speculates that the consequences of exurban development may be both negative (i.e. diverting resources from inner cities) and positive (i.e. exurban residents may be using excess road capacity in some areas), but concludes that a lack of research on these issues prevents any definitive conclusions.

Accompanying these growth patterns was a radical increase in vehicle miles traveled (VMT) during the 1980s. From 1983 to 1990, VMT per capita in the U.S. increased 40 percent, a rate of growth four times faster than the growth in population (Pisarski 1992). The growth in VMT, and a sharp rise in single occupancy vehicle (SOV) travel, occurred despite extensive (and often expensive) policy efforts to reduce VMT/SOVs through trip-reduction mandates and investments in transit systems. Many factors contributed to this increase in VMT, such as the increasing number of women in the workforce, a growth in employment during the 1980s at twice the rate of population growth (thereby producing more commuting), and an increase in automobile ownership from an average 1.2 per household in 1969 to 1.8 in 1990 (Pisarski 1992). Nevertheless, the continuing dispersion of households and employment undoubtedly played a role as well.

The Relationship Between Land Use and Transportation

The massive highway projects of the Interstate Highway System have had a tremendous impact on land use patterns in America. Highway construction created "an opportunity for millions of urban residents to relocate from central cities to suburban districts" (Rose 1990: 101). The suburbanization enabled by highway systems had a

"snowball" effect, creating demand for still more highways and development in outlying areas. This cycle lead in part to the characteristic "sprawl" of U.S. metropolitan areas. Scholars now debate, however, whether the link between transportation and land use patterns remains significant. While a connection between land use and transportation remains, the controversy revolves around the degree of impact. Do current transportation investments still enhance accessibility -- defined as the "ease of connections between places" (Giuliano 1995: 3) -- and encourage dispersed patterns of urban development? The answer to this question has important ramifications for the relationship of ITS, land use, and sustainable communities. This section examines select research in this area, focusing on both theoretical and empirical studies.

Theories and Evidence on the Transportation-Land Use Connection

Scholars commonly invoke "location theory" to explain the relationship between land use patterns and transportation. Location theories focus on how economic processes (particularly attempts to minimize costs) affect the location decisions of individuals, households, and businesses (Krugman 1996; Deakin 1991). With respect to transportation, location theories posit that as the transportation system improves and transportation "costs" decline, households and businesses will move further away from city centers. Chinitz (1991: 9) reflects the assumptions of location theory in arguing that improvements in transportation "have diminished the urge and the need to be huddled together in high density patterns to facilitate interaction among related economic units and minimize the trip between work and home."

While location theories provide a theoretical link between transportation and land use, empirical studies suggest a far more complex relationship. Giuliano, for example, argues that the extensive transportation networks already in place have weakened the land-use transportation connection. In urban areas, new transportation investments and policies produce only marginal change in accessibility. Deakin (1991) similarly concludes that the evidence indicates that transportation no longer shapes urban form, and that transportation variables are no more important than many other variables in influencing location decisions.

On the other side of this debate are scholars such as Cervero and Landis (1995). Citing evidence from Oregon, Seattle, and the San Francisco Bay Area, they conclude that the transportation-land use connection "still matters" and that coordinated land use and transportation planning should continue:

> While the [land use-transportation] is undoubtedly much weaker today than it was a century ago, or even within the past three decades, the relationship remains important. Investments in transportation systems still strongly affect land use patterns, urban densities, and housing prices. Although new transportation investments no longer shape urban form by themselves, they still play an important role in channeling growth and determining the spatial extent of metropolitan regions by acting in combination with other policies such as supportive zoning and government-assisted land assembly" (p.3).

Given the different interpretations offered by scholars on the relationship between transportation and land use, perhaps a Transportation Research Board (1995) report presents the most defensible conclusion. The report contends that highway expansion projects *may* encourage decentralization if they improve access to developable land in outlying areas. Projects in urban areas, however, are unlikely to produce "structural"

changes in land use patterns. Moreover, the report concludes that "the combination of influences affecting decentralization makes it difficult to isolate the role of any single factor" (p.222). Among the influences listed in the report include:

- Americans' increasing affluence, leading to demand for larger homes and lower density living
- a shift to a more information-based economy that has allowed the dispersion of employment
- suburbs are perceived as safer, cheaper, and generally more desirable places to live
- restrictive local land use polices that shift growth to outlying areas or that "cherry pick" land uses for tax considerations
- zoning and building codes that discourage or prohibit mixed use development
- population growth

The Consequences of Sprawl

While the relationship between transportation and decentralization remains controversial, the *effects* of decentralization are another contested issue. No consensus exists on the degree to which sprawl constitutes a "problem." Some analysts believe sprawl threatens America's environmental, economic, and social well-being. Others view it as a largely benign, rational expression of locational preferences. These competing arguments are presented below.

Among those who view sprawl as a problem are Burchell and Listokin (1995). Reviewing the literature on the costs of unplanned development versus those of managed growth, they conclude that sprawl consumes far more land, leads to higher infrastructure costs, and may result in higher housing costs. Another report, compiled by Bank of America and a coalition of environmental groups, presents sprawl as perhaps California's most pressing issue. The report contends that sprawl imposes severe costs on business, residents in both suburbs and inner cities, and on the natural environment (see Table 2)

Table 2

IMPACT OF "SPRAWL" ON...	*COSTS OF "SPRAWL"*
Business	• higher costs • loss of worker productivity • underutilized investments in older communities • less favorable business climate compared to other states
Residents of suburbs	• heavy taxes (e.g. infrastructure) • automobile expenses
Residents of older suburbs and inner cities	• loss of access to jobs • loss of social stability and political power
The natural environment	• loss of agricultural land, crops and open space • deterioration of ecosystems (e.g. from air pollution and destruction of natural habitat

Source: Bank of America et al. 1995. Table constructed by authors based on source.

To address sprawl, the report recommends greater delineation of where development should occur, more efficient use of developed land, and the use of technology to combat rather than encourage sprawl (e.g. using telecommunications to provide jobs in urban areas). Buttressing the conclusions of the Bank of America report, another report on sprawl in California projected that California may lose 12 percent of its best farmland by 2045 at a cost of $5.3 billion annually to the agricultural economy (American Farmland Trust 1995).

Other analysts express even greater concern about the impact of sprawl, believing it threatens the very fabric of American society. Downs (1994), for example, views the impacts of "unlimited low-density sprawl" as contributing "to unexpected growth-related dilemmas that threaten the long-run viability of American society, something the American public and most leaders have yet to realize" (p.3). According to Downs, the problems associated with sprawl include excessive auto travel, the lack of affordable suburban housing, inadequate funding of infrastructure, costs imposed by suburbanites (such as traffic congestion and air pollution) but borne by others, and the over-consumption of open space. Sprawl may even exacerbate social inequities (Johnson 1995; Chen 1995).

Sprawl, from this perspective, contributes to high unemployment among minorities, the concentration of poverty, and even the disintegration of the family. Sprawl creates "longer distances between jobs, services, shopping, and communities…[which] makes traveling more expensive for everyone, but for the disadvantaged, more expensive often means unaffordable" (Chen 1995: 42).

Yet the view of sprawl as a social and environmental scourge is not universally shared. Landis (1995), for example, argues that California's current development problems stem primarily from tremendous population growth, rather than from low residential densities, from an inability to protect open space, or from under-funded transit. He also challenges the notion that infrastructure costs are higher in suburbs (frequently cited as a cost of sprawl), arguing that many inner cities suffer from infrastructure deficiencies and that higher population densities in these areas would only worsen this problem. Gordon and Richardson (1995) echo this point, arguing that attempts to reverse sprawl through "neo-traditional" compact development may be neither feasible nor desirable, and that the costs of sprawl have never been well demonstrated. Gordon and Richardson even object to the "pejorative use" and increasingly loose definition of the term 'urban sprawl:'

> [The term 'urban sprawl'] conjures up connotations of the general meaning of "sprawl" as an unaesthetic, lazy and undisciplined form of body expression. The original application of this term in the planning context was to describe predominately commercial "ribbon" development along highways (typically both sides) over considerable distances. But the term has been generalized to include almost any kind of low-density suburban development and "leapfrog" development…The argument that suburbanization itself should be the object of attack is amazing, given the expressed preferences of the majority of Americans for suburban lifestyles and the supposed sanctity of the principle of consumer sovereignty. (p.13)

Gordon and Richardson contend that America is in no danger of running out of open space or agricultural land, that higher density development may not reduce VMT or increase transit use, and that road pricing strategies -- not high-density development -- offer the best method of managing the transportation system.

In sum, the debate over sprawl, like that over the land use-transportation relationship, is not easily resolved. Evidence exists that supports the claims of both sides. This ambiguity complicates efforts to understand the relationship between ITS, land use, sustainable communities. Nevertheless, a few analysts have speculated on the "ITS-land use-sustainable communities" connection. We present their ideas, as well as our own, below.

ITS, Land Use, and Sustainable Communities

ITS is part of the broader debate over the effects of land use patterns, the relationship between these patterns, and efforts to promote sustainable communities. And, once again, there is no consensus on the role ITS will (or could) play. Cervero (1995) gives perhaps the least optimistic assessment, believing that an ambitious ITS program is fundamentally inconsistent with a program to promote sustainable communities. The following quote captures Cervero's critique of ITS:

> The past 150 years has been a self-perpetuating cycle of urban transportation advances and decentralization. New transportation technologies have stretched the envelope of urban development, raising per capita fuel consumption, consuming farmlands and open space, and dirtying air basins. White flight to the freeway-laced suburbs and exurbs has left many inner cities in a state of near collapse and divided by race

> and class...By failing to pass on the true social costs to motorists, we encourage excessive auto travel and subsidize sprawl. The so-called Intelligent Transportation System stands to worsen this state of affairs by orders of magnitude (p.93).

In a similar vein, Replogle (1994), though hopeful that ITS investments aimed at reducing transportation demand could prove beneficial, nonetheless argues that the current trajectory of ITS programs are likely to increase highway capacity, reduce commute times, and further encourage unsustainable land use patterns.

Other scholars provide a different perspective on the ITS-land use relationship. This perspective sees sprawl as an environmental and social problem, yet views ITS as a means of addressing it. ITS, they believe, can encourage the development of "neo-traditional" communities: communities in which residential and commercial spaces are intermingled, that support extensive transit systems, and that encourage walking through "pedestrian-friendly" streets and buildings (see Calthorpe 1993). Sperling (1995), for instance, argues that "transit-oriented communities" would be more feasible if combined with publicly accessible real-time traffic and transit information. In addition, the Hunter's Point community in San Francisco and the Fruitvale community in Oakland -- both of which represent conscious attempts at sustainable communities -- propose using ITS together with urban designs to improve air quality, promote economic development and increase housing options (Olsen 1995).

In this debate, as in others, no consensus emerges on the precise relationship between ITS and land use patterns. Some analysts view ITS as a threat to sustainable land use, while others argue that that ITS could contribute to the kind of compact, "transit-oriented" communities they view as model sustainable communities. The weight of the

evidence, however, suggests that neither of these analyses are entirely correct. What appears most likely is ITS investments alone (perhaps excluding the widespread deployment of Automated Highways) will pale in comparison to the other powerful factors affecting future land use, particularly in an era where transportation networks already "make everywhere accessible to everywhere else" (Webber 1992). As we discussed earlier, transportation systems are only one of many factors encouraging decentralization. While ITS could amplify trends already underway (Hempel 1994), ITS systems *per se* are neither all "good" nor all "bad" in relation to land use and sustainable communities. What is clear is that these systems should be integrated into a policy framework guided by the sustainable communities paradigm.

Discussion and Policy Implications

Concluding that ITS deployments, in and of themselves, are unlikely to shape future land use patterns does not mean that a connection between ITS, land use, and sustainable communities does not exist. ITS *can* make a positive contribution to sustainable communities by providing information on the performance of the transportation system. This information can enable greater operational control of the system and a reduction in its negative externalities. ITS applications such as remote sensing, for example, can generate better emissions data and assist in efforts to target "gross polluters." In addition, advanced vehicle identification (AVI) and electronic toll collection (ETC) technologies make road pricing strategies technologically feasible. One such strategy -- congestion pricing -- conveys information (in the form of price signals) to drivers about the true costs of driving (Replogle 1994). And "real time" traffic

information, delivered to drivers via Advanced Traveler Information Systems (ATIS) or to transportation system managers via video cameras at intersections, provides the information necessary to smooth traffic and reduce congestion-related emissions. Secretary of Transportation Federico Pena (1996: vi) perhaps best articulates the importance of information to the future of transportation: " As one examines ITS, it becomes clear that although it appears to be about vehicles on roads, rails, and in the air, in fact it is primarily about information -- and how travelers, shippers, and receivers use it...Many of the improvements to the transportation system will rely on the ability of private firms and public agencies to gather, process, analyze, and disseminate information."

Accurate and plentiful information, then, is the most important contribution ITS can make to building sustainable communities. To make this contribution, ITS's ability to produce transportation-related information must be harnessed within an overarching sustainable transportation strategy. ISTEA provides the framework for such a strategy, but many issues must be addressed before ISTEA's vision becomes a reality. Offered below are policy implications that follow from this discussion.

1) ITS investments should be integrated into the regional planning process

Ensuring that ITS investment decisions reinforce regional transportation and land use planning efforts is the first step toward using ITS to promote sustainable communities. To do this, ITS investments must be formally incorporated into the regional planning process. While ITS investments alone will exert little influence on land use patterns, coordinating these investments with broader growth management policies can channel

growth and limit the spatial extent of metropolitan areas (Cervero and Landis 1995). In the wake of ISTEA, Metropolitan Planning Organizations (MPOs) now shoulder the task of coordinating regional land use and transportation planning. A critical issue, then, is whether MPOs possess the resources to take on these responsibilities. Thus far, the data suggests both strengths and weaknesses in MPO efforts to coordinate ITS activities. Although considerable program coordination occurs among transportation agencies, a Volpe Center study (1994) identified interjurisdictional difficulties as one of the reasons relatively few metropolitan areas have coordinated traffic management systems. In addition, because most early ITS projects were conducted outside of the normal regional transportation planning process, MPOs find it difficult to integrate ITS into existing transportation infrastructure (Dahms 1992). There are also concerns over whether MPOs are adequately staffed: one study, after reviewing several MPOs nationwide, found that many appear unprepared to lead complex ITS initiatives (Booz, Allen and Hamilton 1993). One of the MPOs analyzed in this study had a single employee trained to support a $10 million advanced traffic management system. In light of this data, it appears premature to assume that all MPOs have the necessary staffing and intergovernmental ties to coordinate ITS programs with broader regional efforts.

2) Urban planners should consider how the broader revolution in information technologies will influence land use patterns as well as the prospects for ITS deployments.

ITS deployment is not taking place in a vacuum. These deployments are part of the broader revolution in information technologies. It is likely, then, that parallel advances in information technology may both change the context in which ITS is deployed and

enhance its ability to produce transportation-related information. For example, advances in "clean car" technologies, particularly in both zero/low emission vehicles and fuel efficiency, could reduce concerns over the effects of ITS on air quality. Moreover, information technologies are creating the necessary infrastructure for many ITS systems. The increasing use of computers, the growth of the Internet, and the proliferation of cellular phones all make traffic information increasingly accessible to drivers. By providing such information, these technologies could encourage telecommuting "and also have a synergistic beneficial effect on other transportation strategies that may be required to cope with growing traffic congestion, urban air pollution, and national petroleum dependence" (US DOE 1994: xiii). And finally, Geographic Information Systems (GIS), which computerize spatial data and allow for detailed analysis of regional attributes (i.e. . infrastructure, demographics), is another promising technology for assessing the broad impacts of transportation. GIS "provides one of the most promising tools for integrating complex information about social, environmental, and economic sustainability" (Hempel 1996).

We end this paper with a note of caution. Maximizing mobility -- the movement of people and goods to and from destinations as quickly as possible -- remains a critical concern among both transportation planners and the public, and the promise of facilitating economic growth remains a powerful justification for emphasizing mobility as the primary goal of transportation policy. Moreover, transportation behavior has proven extremely difficult to change. Despite tremendous policy efforts to the contrary, auto use continues to rise, transit use and carpooling keep declining, and metropolitan areas continue to disperse. Any efforts to promote sustainable transportation must consider that "when it

comes to cars, recalcitrant human nature has a way of wreaking havoc with planners' most high-minded intentions" (Wildavsky 1996: 114).