A GIS FOR NEW JERSEY STATE PLAN GROWTH SCENARIO ANALYSIS

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ABSTRACT This paper summarizes the application of a Geographic Information System (GIS) to a comparative evaluation of present growth trend impacts with those of three State Plan growth scenarios in Franklin Township, Gloucester County, New Jersey. An analysis of historical land use changes exposes an increasingly scattered development pattern in the township. Several impacts of this trend are identified. State Plan growth scenarios alter; a) the size of future growth centers; and b) allowable densities of the surrounding area. The degree to which each scenario alters trend impacts is revealed. The intent is to identify the scenario providing the greatest benefit over trend development using a comparison of trend and scenario impacts as a basis. Study conclusions also include discussion regarding the application of GIS as a planning analysis tool.

INTRODUCTION

Growth management has been a topic of concern in New Jersey for many years. When suggested alternatives arise, one must understand the effects of existing development trends. Knowledge of this allows a comparative evaluation of alternative options. Determining the viability of such alternatives for Franklin Township serves as one objective of this study.

A second objective is to draw on project experiences to evaluate GIS as a tool for achieving the planning analysis objective. Many organizations are interested in acquiring capabilities afforded by this emerging technology. Presentation of the techniques applied in this study should be of value to potential users.

The scope of analysis is confined to parameters offered by data which was either acquired from outside sources or created specifically for this project. These include a total of five data sets: land cover for the years 1970, 1985, and 1990, soils, and a road base map. PC Arc/Info GIS software (Environmental Systems Research Institute, Inc.) was used for storage, manipulation, and analysis of these data. Some digitizing was conducted using PC Arc/Info, but it was more effective to employ MicroStation PC (Intergraph, Corp.) for this task. DXF conversion protocols were used to convert spatial data into PC Arc/Info format for further processing.

BACKGROUND

The New Jersey State Development and Redevelopment Plan

In 1985, the State Planning Act was adopted by the New Jersey State Legislature in response to the need for sound and integrated Statewide planning. Under the Act, the State Planning Commission was formed to chart a logical course of growth which would alter present development patterns. The Commission was responsible for creating and adopting The State Development and Redevelopment Plan (State Plan) which would outline this departure. A course was set forth in the Commission's general strategy of:

> ...coordinating public and private actions to guide as much future growth as possible into compact forms of development and redevelopment, located to make the most efficient use of infrastructure systems and to support the maintenance of capacities of natural resource, fiscal and economic systems (New Jersey State Planning Commission, 1991).

These compact forms of development, or growth centers, were of several types ranging in character from highly urban areas to small clusters of habitation. They were to serve as nodes of growth integral to a more efficient overall development pattern. Aside from growth centers, the State Plan proposed that areas outside of centers were to serve as an important component to future development. These were categorized into several Planning Areas intended to accept various levels of development dependent on existing and expected growth. Table 1 lists the center type and planning areas applicable to Franklin Township. Although the State Plan does not set forth specific densities, those appearing below were used to serve as a component of analysis.

Table 1 - State Plan Area Designations

Area	Recommended Density (units/acre)
Village Center	4.000
Suburban Planning Area	1.500
Fringe Planning Area	0.125
Environmentally Sensitive	0.067

(Adapted from: Rutgers University, Center for Urban Policy Research)

Franklin Township, Gloucester County, New Jersey

Franklin township is a rural municipality in the southern portion of New Jersey. It is characterized by large tracts of agricultural and forest land. Approximately one-third of the Township is contained within the Pinelands National Reserve. A relatively subdued topography is found throughout its total area of 55.8 sq. miles. The 1990 Census population count was 14,482 persons with a gross population density of 158.2 persons/sq. mi. This population was clustered to some degree within two growth centers. At that time, the developed land accounted for approximately 12% of the total area. Additional population is projected to bring the Township's total to 20,904 persons by the year 2010.

Geology and groundwater resources are of particular importance when considering development densities in Franklin Township. The headwaters of the Maurice River and numerous lakes are found within its boundaries. These contribute to the Townships rich water resource character. The municipal Natural Resource Inventory (Gershen Associates, 1982) explains that because "the overwhelming proportion of industrial and residential water comes from individual wells, the future population and economic growth will depend on available ground water supplies."

The shallow water table makes groundwater quality a concern, especially in areas lacking public sewerage.

GROWTH TRENDS

Three trends in particular were seen through examination of available data. 1) Diminution of cluster development was found in the decreasing percentage of total Township development within center areas. 2) Outside of center areas, developed lands were are appearing in a radially distributed pattern conforming to the existing road network. 3) An increasing percentage of the Township's prime agricultural soils were supporting this development.

To expose the first trend, diminution of cluster development, boundaries were created for the two existing growth centers within Franklin Township. These boundaries were applied to each of the land use data sets so that the percentage of total township development within center areas for each data year could be obtained. Land use data queries made in conjunction with center delineations revealed that the percentage of Township development within center areas diminished from 27% to 21% between 1970 and 1990.

The second trend, development appearing in a radially distributed pattern conforming to the existing road network, was realized in two ways. One was by simply viewing developed land selected from each of the three land cover data years. This was revealing in itself. However, a second method of buffer analysis was applied. This allowed for quantification of the extent to which development along the existing road network had taken place. A buffer of 400 feet was created for roads intended to provide an arterial highway function. This subset of the Townships road network excludes roads designated as local collectors. Generally, main arterial roads are not intended to provide access to individual lots. This occurrence was seen in the displayed land use. The buffer area, which served as a polygon overlay with the 1990 land cover, revealed that 77% of the Township's development fell within the buffer distance.

The third trend, an increasing percentage of development on prime agricultural soils, was determined by overlaying the soils data with that of the land cover. Each of the thirty-six unique soil types found within Franklin was categorized with respect to an agriculture class (Gloucester County Planning Department, 1977). After combining these with each land cover data set, queries were made for the coincidence of prime agricultural soils and developed land. The extent to which prime agricultural soils were utilized for development is displayed in Table 2. The change from 1970 to 1990 represented a 61.9% increase. It's also worth noting that the 481 developed acres (in 1990) accounted for 13.2% of the total 3,633 acres of prime agricultural soils.

Table 2 - Prime Agricultural Soil Development

Year	Acres	
1970	2971985	415
1990	481	

TREND IMPACTS

The trends discussed above may result in a wide array of future impacts. Creating a comprehensive inventory of these impacts is not feasible given available data. However, three key impacts of particular interest have been identified. These include a reduction in; 1) the sense of place conveyed by the built environment; 2) transportation efficiency and safety; and 3) groundwater quality.

Development appearing away from center areas detracts from the sense of place conveyed by the built environment. As this trend continues, Franklin's growth centers will become less and less distinguishable. Discussion in The Growth Management Handbook (Hamill, 1989) maintains that community focus is a significant quality of life factor. The future development pattern will lack this important characteristic.

The increasing amount of development located along the existing road network will result in reduced transportation efficiency and safety. In most cases, scattered site development requires individual access for each developed parcel. This can present safety hazards and impediment to traffic flow.

The impact of groundwater degradation will result from neglecting to support development with public sewer service. Installation of such infrastructure would allay the burden of effluent purification presently carried by on-site septic systems. Unfortunately, the scattered nature of Franklin's development will make the installation of sewers a costly endeavor.

STATE PLAN GROWTH SCENARIOS

Each of three scenarios were evaluated using the following methodology. The first step involved delineation of growth centers and planning areas. These areas were digitized and subsequently overlaid with environmentally sensitive soil types. These soils were defined as those severely limited for on-site septic disposal and those presenting flood hazards. A second overlay was performed to incorporate the 1990 developed lands. Queries for buildable land (i.e., not environmentally sensitive or already developed) were made for each center and planning area. Allocating population within each area was done by multiplying the buildable acres by the appropriate density (Table 1). This calculation provided the maximum number of dwelling units allowed within each area. The number of these units was then multiplied by the Township's 1990 Census average household size of 3.07 persons, yielding the maximum population for each area. These were summed to obtain the maximum population accommodation.

Scenario I served as a starting point in determining the optimal State Plan delineation. Center delineation was congruent with the Township's proposed sewer plan, which would encompass both existing centers, resulting in a large contiguous Village Center area. Suburban Planning Area would characterize most of the Township under this scenario. The remainder of the township was designated as Fringe Planning Area. Under Scenario I, the Township would be able to accommodate an additional 71,513 persons.

For Scenario II, delineations were altered to accommodate a smaller amount of projected population. This was achieved by reducing Village Center size to that of existing centers. The remainder of what was previously designated as a Village Center in Scenario I, was redesignated as Suburban Planning Area. What previously existed as Suburban Planning Area was converted to Fringe Planning Area. These designations would allow a significantly lower population accommodation of 31,112 persons.

Scenario III exhibited limited application of high density areas and extensive use of low density Environmentally Sensitive designations. This was in recognition of the Township's groundwater sensitivity. As with Scenario II, Village centers would be congruent with existing growth centers. A small Suburban Planning Area would exist. This scenario would accept an additional 20,704 persons.

SCENARIO IMPACTS

Scenario I would permit all three trend impacts: lack of community focus; decreased efficiency and safety of roads; and groundwater degradation. This would be due to continued use of high density development in the Village Center and Suburban Planning Areas. Future development would still have a great deal of flexibility in terms of the location. Therefore, Scenario I would not offer the growth controls necessary to prevent the occurrence of trend impacts.

Scenario II would achieve elimination or partial reduction of trend impacts. The lack of community focus resulting from trend development would be partially reduced. This would be achieved by limiting the use of Suburban Planning Area and by containing Village Center development to existing growth centers. These areas also coincide with the Township's proposed sewer service region. Groundwater degradation would be eliminated assuming sewer installation occurs as planned. Impact to the road network would be partially reduced in degree. It may continue to occur only in the Suburban Planning Area.

Scenario III would eliminate all three trend impacts. This would be achieved by restricting Village Center development to existing centers and limiting the Suburban Planning Area development to a small region connecting the two. As with Scenario II, elimination of groundwater degradation would be dependent on sewer installation in these areas. Designated as low density Environmentally Sensitive, the large remaining areas of the township would escape trend impacts.

Table 3 below summarizes the potential additional population allowance and trend impact reduction under each scenario.

Table 3 - **Scenario Summary**

	Additional Population Accommodation (persons)	**Impact Reduction**
Scenario I	71,512	None
Scenario II	31,112	Partial
Scenario III	20,704	Full

CONCLUSIONS

Optimal State Plan Scenario

A stated objective of this study is to identify the optimal State Plan growth scenario. Using the criteria of greatest trend impact reduction, Scenario III is the most attractive of the three considered. It offers the most beneficial growth management option through a highly clustered development pattern which minimizes the opportunity for urban sprawl. The accommodation of an additional 20,704 persons under Scenario III amply provides for the 6,422 persons projected for year 2010.

Even though Scenario III achieves the greatest impact reduction, further analysis is necessary to identify a definitively optimal growth management option. Growth scenarios are based on proposals set forth during the State Plan development process. Testing variations of these designations should be one consideration for further research. Another should be to increase the depth of analysis by applying an expanded set of data. This would allow for the evaluation of growth options in terms of land consumed by projected population in addition to population accommodation.

Additional data would allow many pertinent factors to be considered but selection of an optimal growth option strictly from an analytical perspective would not account for realistic concerns in plan implementation. Among these are: a proclivity for municipal home rule in making land use decisions; farmland equity loss many landowners may experience; and economic viability supported by market forces. These are just some of the issues that if left unresolved, would prevent successful State Plan implementation.

GIS as a Planning Analysis Tool

As a second project objective, summary statements are in order regarding the application of GIS as a tool for achieving the above planning analysis objective. GIS capabilities are very attractive to those dealing with problems of a spatial nature, but practitioners must proceed with caution. Successful implementation of the technology is analogous to assembling a complex puzzle. A great deal of thought must be given to intended system applications prior to data development investment. Spatial accuracy implications will survive the life of the data, possibly imposing unforeseen limitations on its use. Another potential pitfall is presented by the formidable learning curve of GIS software. This may undermine an ambitious system implementation or project task schedule. Formal training in the use of hardware and software tools must be sought to allay the potential for this problem.

In applying GIS to Franklin Township, analysis of a limited collection of data was conducted by employing several common but powerful GIS techniques. Knowledge of the spatial relationships among these otherwise disassociated data was useful in the land use decision making process. Inclusion of additional data would have likely expanded evaluation criteria, perhaps resulting in the attractiveness of other growth management scenarios. Although it is not possible to tout the selected scenario as the definitive course for future development, a better understanding of all options has been achieved through the use of GIS.

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