Smart Tool

Cape Coral, Florida, uses an interactive growth model to plot its future intelligently.

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Many communities across the nation are facing extreme growth, great pressure for services — and a drop in tax dollars.

To address these realities, a first-of-its-kind interactive growth model was developed for the city of Cape Coral, Florida, that can be adapted for other government agencies to weigh different growth scenarios and the positive and negative impacts of planning decisions.

Typical growth models only allow planners to look at growth in a static way. They don't account for change over time, new trends, or community and regional expansions and contractions. In contrast, Cape Coral's model allows new data to be input over time, thus producing better, more accurate projections.

The city's Interactive Growth Model was developed by planning and population consultant Paul Van Buskirk, AICP, who first used this type of model in the early 1980s to test the effects of developments of regional impact in the state of Florida, and in cities with rapid growth.

Cape Coral is one such city. It has experienced extraordinary growth, increasing in population from 10,930 in 1970 to 102,286 in 2000, a 10-fold jump over 30 years. The ultimate population is projected to exceed 400,000. Moreover, at 114 square miles, Cape Coral is Florida's second largest city in land area. Almost three-quarters of Florida's residents live within 150 miles of the city.

Looking back

Cape Coral is a peninsula that is part of Lee County, and includes the cities of Fort Myers, Fort Myers Beach, Sanibel, Bonita Springs, and several unincorporated areas. Cape Coral and Fort Myers are separated by the Caloosahatchee River.

Cape Coral was pre-platted and incorporated as a city in 1970. The area resulted from one of the largest dredge-and-fill projects in history. When the dredging was completed, what remained was an extraordinary 400-mile network of navigable salt and freshwater canals. The designers then platted residential areas, commercial zones, industrial parks, streets, canals, parks, public areas, and transportation corridors.

About one-third of the city is currently built out; it has one of the largest operating reverse osmosis plants in the country and introduced one of the nation's first and largest residential dual water systems, which reclaims and recycles domestic wastewater for irrigation and fire fighting.

Carleton Ryffel, AICP, the city's recently retired planning director, knew that in a city that approves 200 to 300 building permits per month, there was a critical need to accurately forecast total population. Of equal importance was knowing the short- and long-term distribution of the total population over time. Old methods used to project Cape Coral's population growth could easily over- or underestimate anticipated population at given points in time.

In order to determine the best population projection methodology for Cape Coral, the city retained consultant Paul Van Buskirk in 2001. He was asked to develop and apply a population projection system that could accurately forecast the city's population over the short- and long-term. This initial work led to the development of the Interactive Growth Model, which became a comprehensive tool for planning, and went into full operation in Cape Coral in 2002.

Forecasting methods

Van Buskirk examined four different models: a cohort survival component model, an extrapolation model (simple curve fitting), an exponential model, and a sigmoid model.

The cohort survival component model "ages" the various age groups or cohorts in the population into the future and applies the appropriate birth and death rates, usually found at state vital statistics offices. This model is sophisticated and expensive but does not accurately forecast long-term growth for rapidly growing cities experiencing large immigration.

The extrapolation model plots past population levels in a time series and then extends the line or curve into the future by regression analysis. This method has the weakness of over- or underestimating future population. Another shortcoming is that long-term limits to growth (such as build-out) are not factored in.

The exponential model assumes the population is increasing at a constant rate of change each year. This compounding effect can result in astronomical increases in forecasted population over the long term.

Basically, the sigmoid model is a complex variation of an extrapolation model and is more accurate than other methods for a forecasting short- and long-term growth for cities experiencing extraordinary growth and an estimated build-out population.

Many biological populations, including cities, tend to grow at a rate that simulates the sigmoid curve (or S-shaped curve). Population growth increases at an accelerating rate over time until it reaches an inflection point. Then, the rate of increase slows down until it reaches an upper growth limit.

One of the key variables in this growth equation is its upper limit or build-out. The upper limit for large-scale communities such as Cape Coral can be defined by calculating the total number of housing units that can be built by type and intensity. Then the housing units can be translated to population.

Cape Coral decided to use the sigmoid model for two reasons. First, it incorporates numerous variables that affect growth, and secondly, it has historically proven to be the most accurate growth curve for built-out incorporated cities, including Tampa, St. Petersburg, and Miami.

In 1982, using 1980 census data, Van Buskirk applied a sigmoid model to forecast the future population of Palm Bay, a large, growing community on Florida's east coast. The model predicted a population of 82,331 in 2000. That number was not far off. The U.S. census conducted in 2000 counted 79,413 residents — a mere 3.5 percent lower than the 1982 estimate.

Van Buskirk developed another sigmoid model in Lehigh Acres, Florida, using 1990 data. The model forecasted a 2000 population of 33,098. That year, the U.S. Census Bureau recorded a population of 33,430, a difference of 0.1 percent.

Most recently, the Cape Coral Planning Division used building permits, vacancy rates, and household size to estimate a current population of 117,676. The sigmoid curve had predicted a 2003 population of 117,559 — another difference of only 0.1 percent.

How to use the model

Accurate forecasting is important. Overestimates of population growth may lead to premature expenditure of public funds. Underestimates can have the opposite effect: infrastructure lagging behind needs. The cost to catch up on infrastructure needs far exceeds the cost to meet demands as they occur.

Three basic steps were employed to apply the sigmoid model in Cape Coral: First, an upper limit of growth was set as a key variable in developing Cape Coral's growth curve. The Cape Coral Interactive Growth Model team (Paul Van Buskirk plus staff from various city departments) estimated the permanent population at build-out to be 413,713, based on the city's future land-use map. Next came a sigmoid curve with regression analysis. Finally, the forecasted results for Cape Coral were validated by comparing the values of its regression analysis formula with that of similar cities in Florida that were already, or nearly, built out.

Typically in south Florida, most of the earliest residents are retirees in small households. A service population moves in to provide retail, financial, and medical services. The city then becomes more diverse in age, income, and household size. Next the construction industry grows, and so does the demand for public services. Eventually, the community begins to represent more traditional demographics. The sigmoid growth curve captures these characteristics of growth and incorporates them over time.

On August 26, 2002 the Cape Coral mayor and city council adopted the forecasted population estimates based on the sigmoid curve, and authorized the application of the Interactive Growth Model for planning purposes.

Creating the interactive model

Under the leadership of consultant Paul Van Buskirk, the city of Cape Coral put together a staff team to help with data and geographic information system (GIS) mapping. Team members included a broad cross section of various departments such as planning, GIS, economic development, fire and police, public works, transportation, and utilities. By using this staff team, the city spent less than $50,000 in consultant fees to put together its interactive growth model.

For the next nine months, between October 2001 and July 2002, the team met bimonthly for two hours. At those meetings work assignments from the previous meeting were reviewed and new work was assigned. On average, each staff member worked on parts of the model for about eight hours a month, including the bimonthly meetings. This approach kept the consultant fees low and was educational for the staff because it showed them how to deal with a highly complex issue in an innovative way.

In total, some 50 variables were built into the interactive growth model. These included: the city's comprehensive plan, future land-use map, parks and recreation master plan, transportation plan, fire station plan, utilities master plan, school data, GIS information, and census data.

Here's how the model works. Suppose the location and timing of roads and water and sewer lines are delayed or advanced in a particular location. The result would be overall development of that area as well as other parts of the community. When this happens, community leaders have a better understanding of the implications of their decisions and can get the most from the investment of public and private funds.

Because Cape Coral has a huge land area, the data had to be managed and mapped in smaller segments. When the original developer, Gulf American Corporation, first created Cape Coral in the 1960s, the city was pre-platted into 158 numbered areas called GACs (named for the developer). The GACs became the fundamental unit for the interactive growth model and are also used for comprehensive planning, real estate legal descriptions, and local data generation.

To further manage the data, the staff team created 20 planning districts, which consisted of roughly seven contiguous GACs each. The city's GIS division established the base map for the GACs and planning districts.

April 1 was chosen as the start date of the model to coincide with the release of U.S. census data. That date is also used as a benchmark date to test and validate the model annually and every 10 years when the census is updated. Several sub-models were developed as a regression model of key indices over time. The sub-models were:

- Demand for housing units
- Enrolled school population by grades
- School plants by type of facility, enrollment, and employment
- Demand for acres for parks
- Demand for fire stations and emergency facilities
- Demand for gross leasable area of floor space for retail trade and number of employees
- Demand for office service space and number of employees
- Demand for hotel and motel rooms
- Demand for gross leasable area of floor space for manufacturing and wholesale trade and number of employees.

The building department provided data for the current number of housing units by type for each GAC. City GIS staff then presented data from the current tax rolls on the amount of existing square footage of building area for retail, office-services, manufacturing, and wholesale trade. GIS staff also received data for current areas of developed recreation lands, and the county school system provided current data on school facilities, enrollment, and employees.

The build-out development data for housing, acres of retail trade, office-services, manufacturing, and wholesale trade came from the planning staff and were based on the future land-use map. Information on the location and size of future park and recreation sites also came from the planning staff. Regional research studies, as well as Urban Land Institute guidelines, were used to calculate the number of employees for retail trade, office-service, manufacturing, and wholesale trade.

Current, forecasted, and build-out data were generated for each GAC and put into an Excel spreadsheet. The challenge was to translate the data by GAC so that the information would coincide with U.S. census block groups and traffic analysis zones. This was a job for GIS staff, because they had established the base map for the GACs and planning districts.

GIS to the rescue

Nearly all GIS practitioners require data from multiple sources. It is important to build and share data that can be used by any organization. The city of Cape Coral's GIS division uses the Federal Geographic Data Committee's suggested guidelines, which encourage the use, sharing, and distribution of geospatial data.

One of the goals of the FGDC is to provide standards to help create common definitions for geospatial metadata. GIS data management, by its very nature, is disaggregated, but it fundamentally involves the integration of data from multiple sources. To address the need to build and share geographic information in concert with the interactive growth model, ESRI, of Redlands, California, is helping to develop common content standards (i.e., common data model designs).

The city of Cape Coral's GIS division, headed by Darryl Clare, compiled digital data from various sources, including the U.S. census, Lee County land data, the metropolitan planning organization, traffic analysis zones, and the city's GIS database. These different sources comply with "standards" so data can be referenced to fit together seamlessly.

ArcView was the software package chosen as the building block of the interactive growth model, because it is easy to use. The model had to be more than a conceptual framework; it had to support real GIS work, including the update and maintenance of data.

For starters, data from the Cape Coral database needed to be translated to U.S. census block data. Different layers were combined to make that happen, depending on the particular application and information requirements. Each layer would involve a specific data type, such as tables, relationships, and feature classes.

For example, the street network data used for traffic analysis are contained in the traffic analysis zones within the metropolitan planning organization's database map. These traffic analysis zones contain information about traffic loads. The growth model incorporates information about development into the traffic analysis zones in order to forecast future traffic loading.

Much of the parcel and land-use data were extracted from the city-county parcel database with data attributes of the characteristics of each parcel, in accordance with the state of Florida land-use codes. This base map data set consists of 17 data layers related to the themes of parcel characteristics such as, roads, utilities, drainage, land cover, cultural land marks, and transportation structures. The interactive growth model now had a tool to translate data from the GAC polygons to census blocks and traffic analysis zones for their respective forecast.

A tool for interpretation

Cape Coral's interactive growth model is a systems approach that is population driven. When one variable changes, it proportionately changes the other 50 variables in the model. In the past, this function involved separate software packages not well integrated with GIS.

Fortunately, the linking strategies used in Cape Coral are wholly compatible with one another, so that the interactive growth model, though built for one GIS system, will accept data from another. This tightly coupled system allows modeling information to exist as specially coded modules (objects) within the framework of GIS. Such modules could be written in various languages provided by the GIS (for example, the Avenue Language for ArcView).

The combination of Excel and ArcView enabled GIS staff to produce maps that the public could readily grasp. For example, a particular spreadsheet held data that would help the city decide how much development could occur in each GAC in five-year periods until build-out. That data had to be translated into a graphic — and that is where ArcView's mapping tools came into play.

One series of maps shows the population growth of the city in five-year increments by the progressive darkening of colors on a city map. As the color darkens, the population grows in a given area.

Another series of maps shows commercial development demand over time in square feet. These maps show larger and larger red circles at five-year increments, representing the amount of square feet of commercial floor area needed to serve the projected population in a given area. The larger the red circle in a given year, the greater the commercial demand.

Similarly, this type of map series can be used to show the demand for all land uses and the timing of such facilities as utilities, transportation corridors, fire stations, parklands, and schools through buildout.

Bottom line

Data output from the interactive growth model demonstrated a demand for 6.243 million square feet of gross leasable retail area and a supply of only 4.054 million in the year 2001. The residents of Cape Coral were shopping outside the city.

Judging by the model, Cape Coral would be able to support a regional facility between 2005 and 2010, when the population is expected to reach 150,000. In other words, the interactive growth model has alerted the economic development office when to start recruiting developers for a regional shopping center.

The model can also help ensure that the right parcels are available to meet the current and future demands for neighborhood, community, and regional shopping centers. This is smart growth: People should not have to travel great distances outside their neighborhoods in order to shop. To do otherwise increases demands on roadways, the infrastructure, and travel costs.

School facility planning is greatly enhanced by use of the interactive growth model as well. Output data indicate when and where the school district will run out of school sites. The school board can then identify parcels large enough to support future demands for new school facilities.

Cape Coral's interactive growth model is being used across city department lines. Users include Community Development (comprehensive plan update and commercial corridor studies), Parks and Recreation (timing and location of parks), Public Works (water and sewer timing), Fire (station timing), and Police.

The city is also using the growth model to update its transportation model, a basis of state and federal transportation funding. The public, electricity providers, real estate and the development community, and the county school board have expressed strong interest in the model as well.

With this level of interest, the city established an interactive growth model information function to update the model and provide tailored information to those diverse groups.

We believe the interactive growth model, in combination with GIS, will revolutionize how communities plan and use their resources for the maximum benefit of its citizens.

Paul Van Buskirk is a planning consultant based in Estero, Florida. Carleton Ryffel is the recently retired planning director of Cape Coral. Darryl Clare heads Cape Coral's GIS division. For more information about the Interactive Growth ModelTM, contact Paul Van Buskirk at pvanbuskirk@swfla.rr.com.

Images: Top — The southeast quadrant of Cape Coral to the left, Fort Myers to the right. Between them is the Caloosahatchee River. Photo by Aerials Express. Bottom — Upscale housing is common in Cape Coral; with the issuance of 200-300 building permits per month, this is one of the fastest growing cities in Florida. Photo by Carleton Ryffel, AICP.