SHORT-TERM FOLLOW-UP ASSESSMENT OF A DISAGGREGATE LAND USE MODEL

Corresponding Author: Stewart Berry; Author(s): Srinivasan Sundarum; Howard Slavin

TRB Transportation Planning Applications Conference Presentation, Houston, TX
Topic Area: Transportation and Land Use Integration/Smart Growth
Submission number: 09-165
Max word count: 7,500 including figures etc.
Slides Submission Date: April 6th 2009
Paper Submission Date: Tuesday, May 19th 2009, 8.30am-12.00pm

Abstract

This paper describes the STEP3 household microsimulation model for demographic and land use forecasting that was previously implemented for the Comprehensive Planning Department of Clark County, Nevada, and evaluates its predictions several years later.

The original goal for the model was to produce small area population forecasts for one of the most rapidly growing areas in the United States. The approach to demographic forecasting with STEP3 differs from that used in prior demographic forecasting efforts in many ways. The most fundamental difference is that it is a disaggregate simulation of individual household change. It is also a disaggregate model of land use. The location of each household within Clark County is modeled and new areas are settled in response to population growth and the location of employment and accessibility to jobs and shopping. The disaggregate models are all evaluated using Monte Carlo simulation. Forecasts were generated annually between 2000 and 2025, and the model demonstrates the practicality of microsimulation for these applications.

But how suitable is the model? We now report on the model predictions several years later and describe how well and how poorly the results match up with what has transpired in this region. Lessons for land use modelers and their clients are presented.

Keywords: land use model, demographics

Introduction

The STEP3 household microsimulation model for demographic and land use forecasting (Caliper, 2006) was designed to produce small area population forecasts for Clark County, Nevada. Clark County was one of the most rapidly growing areas in the United States and has proven to be a highly attractive destination for new residents in addition to being a major tourist destination.

The settled land area in Clark County grew enormously over the last decade, but expectations of continued growth have proven to be incorrect. The many planning problems and issues of such rapid growth remain, and are better addressed if forecasts are available to predict in advance where people will live and work in the County. Long range planning for schools and other publicly provided services are greatly aided by better and more detailed forecasts.

However, forecasting any aspect of the future is fraught with danger and may be an impossible task. For this project we implemented a new method to develop demographic forecasts that allows the exploration of alternative future growth scenarios on a micro-scale. This method takes account of organic growth and the evolution of demographics through time. Surprisingly, in many forecasting applications, future year demographics are taken to be identical to base-year or current demographics. This is unsatisfactory as we have every reason to believe that future year population characteristics will be rather different from current ones due to the aging and graying of the population. Attendant to these changes will be implications for the provision of additional services.

Even if we were to become adept in forecasting the future number of residents, planners need to understand where they will live and work, to be able to plan for infrastructure. In some communities there may also be a desire to guide the form and location of new development through zoning and other regulatory means. Therefore, it becomes highly important to predict the spatial pattern of future development.

The problem of small area forecasting is generally considered to be the domain of land-use models. While land-use models have been of academic interest for at least 40 years there are, as far as we are aware, no clear documented empirical forecasting successes. A big part of the problem is the inherently unpredictable nature of private sector developer behavior and decision making. Also, markets are highly impacted by cyclical fluctuations and price considerations, and these too may be beyond our capabilities in modeling. In this effort we aimed to build a model that does not attempt the impossible and therefore we did not treat developer behavior in great detail.

For this project we posited a simple structural model for population growth in Clark County that reflects both economic and demographic principles. We take in-migration to be a key component of future population and can distinguish in-migration of retirees and near-retirees as well in-migration that serves additional population growth through employment in service industries. Specific growth in the gaming and entertainment industry is taken as being exogenous and a vital input to the model. Gaming and entertainment industry expansion creates large numbers of jobs in Clark County through both construction and remodeling and through the need for gaming and entertainment industry workers. There is also a further multiplier effect in that gaming and entertainment industry workers and their households generate additional service employment.

Unfortunately, these various assumptions are not capable of predicting an abrupt change in trends that have been apparent over decades. As a consequence, we expect to see our projections for 2007-2008 deviating from the numbers reported by local, state and federal agencies.

<u>STEP3</u>

Increasing tourism and the consequent growth in the gaming industry and other attractions in Clark County and associated growth in employment in hotel accommodations and other services were used as the primary drivers of the population forecasting approach. Increases in employment through in-migration are necessary to support the activities that serve greater numbers of tourists. Retirees also move to Clark County because of its favorable winter climate, moderate cost of living, and the growing number of attractions and amenities. Additional service employment is needed to serve both retirees and other in-migrants leading to further population increases.

While the precise determinants of tourism levels and in-migration may not be observable, inferences can be made from empirical data and used in forecasting future growth and development. Incorporating these relationships into the forecasting process results in a model that is tailored specifically for Clark County and its unique characteristics.

A forecasting model whose parameters can be adjusted is much more useful than a forecast made at a single point in time. Tuning the parameters can indicate alternative growth futures that could conceivably occur. Also, adjustment of the parameters can help the model track observed population dynamics more closely and lead to more refined forecasts. This can be especially important because of the impacts of unforeseen exogenous shocks or specific major new developments that do not fit with prior development trends as represented in the model. New values for population and employment can be substituted when planned developments are announced.

Using a structural model whose components correspond directly to real world behavior and the characteristics of households and individuals makes the basis for the forecasting process and the forecasts themselves more understandable. Insights from the forecasting effort may be even more valuable in comprehensive planning than the specific forecast population levels themselves as they allow, for example, appreciation of areas that may expand geographically faster than others.

Some of the relationships that are incorporated in the model are either unmeasured, infrequently measured or poorly measured. They may also be poorly understood from a statistical point of view. For example, household formation through marriage is not directly captured in the annual statistics that are typically available. Also, it is hard to create a precise statistical model to predict who will marry whom in Clark County. Nevertheless, use of approximate rates and simple relationships can help forecast demographics of interest such as the number of children who will need schooling in future years.

Developers have found Clark County a favorable location, and housing supply constraints do not appear to have limited population growth. Similarly, infrastructure has been provided so that water, power, and transportation facilities service an increasingly wide area as population settlements expanded. The assumption was that this behavior would continue, and thus we did not model the behavior of home builders or infrastructure providers directly. We did examine whether there are constraints upon land availability that might come into play in the future. While it is not a focus of the project, the forecasting tool could be easily expanded to make it possible to examine transportation implications of future growth and development.

The approach to demographic forecasting with STEP3 differs from that used in prior demographic forecasting effort in many ways. Perhaps the most fundamental difference is that it is a disaggregate simulation of individual household change. By this we mean, that we begin with a population of discrete households in a base year such as the year 2000. Because of data limitations and privacy concerns, we don't actually have data on all or most households. Instead we create a synthetic or virtual data file of households such that when we tabulate their characteristics, we get the aggregate values that were measured in the 2000 Census. To do this we make use of actual Census records that are published as the public use microdata sample. A 5% sample is provided for each PUMA district of which there are eleven in Clark County. The sample obscures the location of each household but in the synthetic population we identify a cell location for each one.

When the sample is built, we do not try to match every single population characteristic for each small area. Rather, we focus on a key subset and then we bring along all the other characteristics associated with the records we draw for that area. By controlling for key demographics, we obtain a more formal and detailed accounting for population characteristics than that provided by aggregate economic growth models and aggregate spatial interaction models.

The synthetic population by itself results in a useful and interesting database which can be used for many applications, but it becomes more useful when we are able to forecast from this base. This is done by evolving the population in a fairly natural way. For example, each person gets one year older each year unless of course they die. This is not the whole story because there are births and marriages and new household formation when children grow up. Migration is the other big factor which in Clark County greatly outstrips emigration. In addition, people retire from the labor force and this has further impacts on the need for additional workers. Models ranging from simple rates to probabilistic explanatory models are used to express these dynamic relationships and generate future forecasts.

An important characteristic of this modeling effort is its use of readily available data. This was one of the more difficult aspects of the project, as there are no ideal data sets for this type of model. These data include the assessor's database and many different types of Census data ranging from time-series at the County level to extensive Year 2000 micro and aggregate data. The fact that the data were available does not, however, mean that they are provided in a form that makes them readily useful. On the contrary, a complex and difficult set of data processing tasks was needed to transform the data so that it is usable for input to the model.

Assembling the data involves adding constructs of the accounting framework that is used in the model. Accordingly, the resulting file contains information on each household, present and future, and the individuals that comprise the household unit. These data are aggregated to 1000 by 1000 meter grid cells (Figures 1) that cover the County for which we keep count of employment and residence land-use by type (Figure 2). Some cells are unavailable for development if the terrain is unsuitable or if they are already fully occupied by stable land uses (Figure 3).

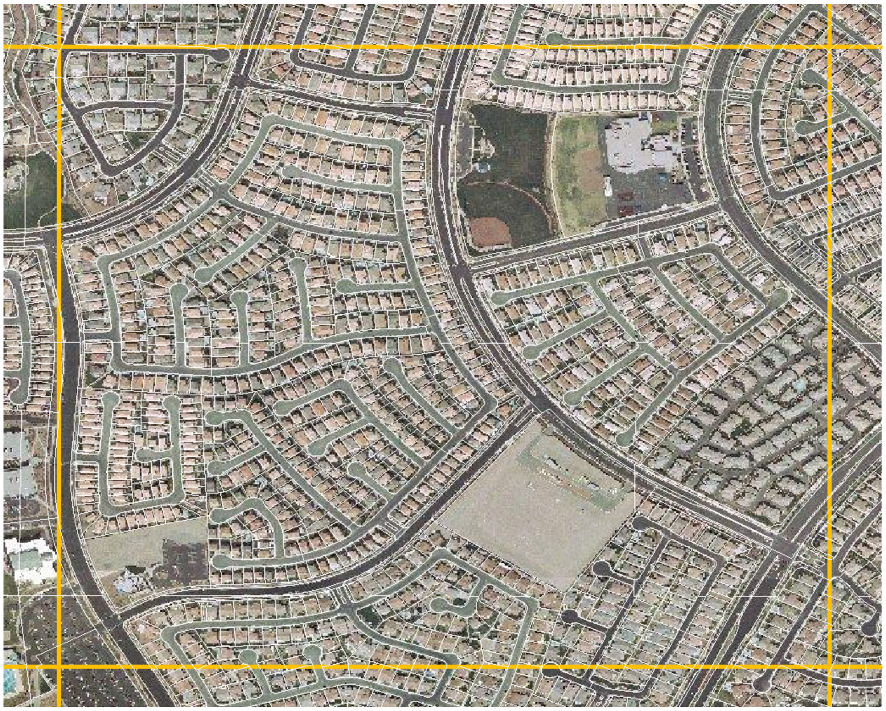

Figure 1: 1km by 1km Grid Cell

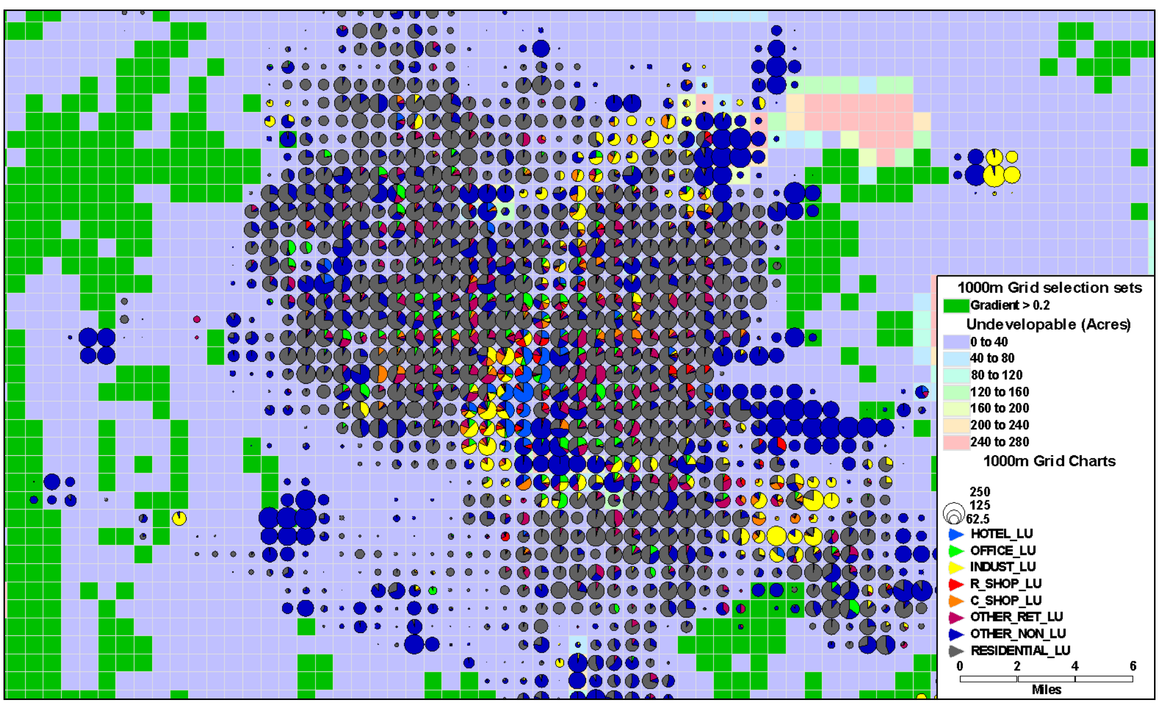

Figure 2: 2000 Las Vegas Land-use Types, Gradients & Undevelopable Land

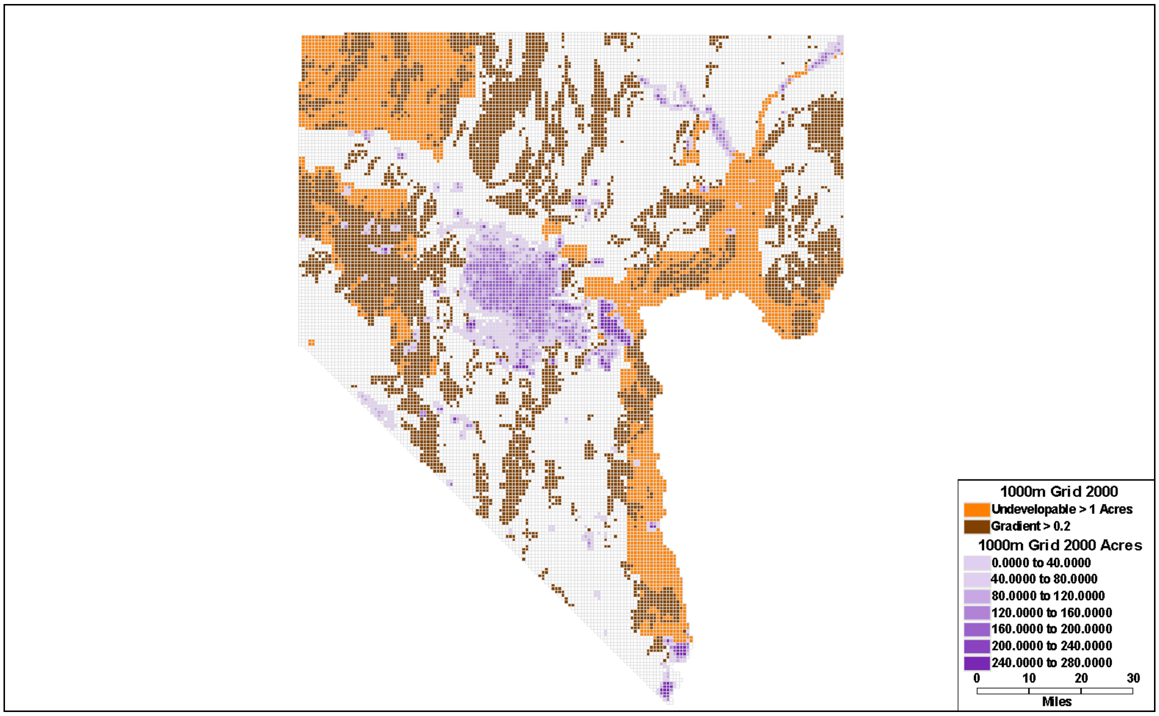

Figure 3: Grid Cells Showing Undevelopable and Developable Land (2000)

Various key trends are embodied in the model, especially those associated with population growth through in-migration which is principally determined by growth in tourism which stimulates growth in tourism-serving employment. This employment in turn causes further growth in service jobs and the population needed to provide this service employment. Using this simple theory, statistical analysis was used to verify these relationships and estimate the magnitude of the effects.

Historically growth rates that average 5 percent per year have been observed and these form the high end of the projections that we developed. With these growth rates a population of 3,591,883 people is reached in 2025. Our predictions described very high growth in the county with the settled area growing significantly. Specifically, high growth was seen in the Las Vegas Valley (North, North-West, West, South, South-East), Searchlight, CAL-NEV-ARI, the Primm-Roach-Borax corridor, Sandy Valley, Moapa, Mesquite and Indian Springs.

The models can be applied in various ways and in different combinations. For example, the population synthesis and progression components can be run by themselves to generate county-wide forecasts. Similarly, the land use spatial distribution models can be run using exogenous or alternative county level forecast numbers. Lastly the whole model sequence can be run including the travel demand model components.

The precursor to STEP3 is STEP2 (Walker, 2005), whose models were innovative in that microsimulation gave more insight and policy sensitivity to travel forecasts. Also, residential and work place choices were incorporated and these have been greatly improved for STEP3. Also, STEP2 did not predict settlement of rural or presently unsettled parts of Clark County.

In the STEP2 modeling effort, we analyzed sustainability from a transportation point of view but with predetermined future demographics. In other words, a separate forecast of future population by traffic analysis zone was an input. This was a significant limitation, and is one important reason why the STEP3 models are much more informative.

Extensive use of GIS technology was made to prepare the datasets used in STEP3. GIS technology is also used to structure the model and present the model outputs in an understandable form.

STEP3 was designed to be easy-to-run, with a custom interface combined with model software that hides the enormous complexity and volume of computations that are attendant to the implementation of this microsimulation approach.

It should be noted that even without the recent global recession, such models have several caveats. In the case of STEP3 there is no explicit modeling of redevelopment, although this might be important to handle in the future. Also, as with any such model, the results are not a guarantee of any specific future situation. More calibration and validation is warranted if the forecasts are to be used for any particularly important purpose.

<u>Demographics, Projections and Estimates</u>

Deterministic population forecasts have several well known flaws:

> "First, no indication is given as to the likelihood of the low and high variants coming true (Lutz and Scherbov 1998). Are the high and low variants quite likely or very unlikely? Will the future population almost certainly be within the high-low range? The variants cannot be meaningfully interpreted. Second, the future trajectories of fertility, mortality, and migration are nearly always assumed to be linear or to change smoothly over time. This simply does not match what is known about past trends. Cyclical behavior and random fluctuations are ruled out (Lee 1999)." (Wilson and Bell, 2007)

Even in a largely stochastic model such as ours, cyclical behavior would have been hard to predict for this region, as:

> "Clark County's population dropped during the past year after decades as one of America's fastest growing counties. Clark County's most recent population estimate in July showed the county lost about 10,000 people since its last estimate in July 2007. Observers, looking back through records for nearly 40 years, said they are not aware of the county having another population loss." (Wargo, 2008)

Probabilistic methods overcome some of the issues of deterministic methods but due to data requirements and the complexity of the implementation, are not commonly applied at the micro-scale. When they are, the predictions at such a small-scale can deviate wildly from the reality. In STEP3 we implemented a variety of probabilistic methods such as those handling the actual migration rates in any given year, plus which households would emigrate and immigrate, or even move within the County. We had hoped that this would result in greater accuracy at the local level if trends continued as expected. Unfortunately, the economic down-turn has for the first time had a direct and severe impact on a region that has otherwise withstood recessionary influences.

These post-bubble effects are apparent in all the variables the model was designed to predict. The Las Vegas Convention and Visitors Authority reports that visitor numbers to the Las Vegas region are down. This obviously has severe reverberations for an economy driven by increasing numbers of tourists.

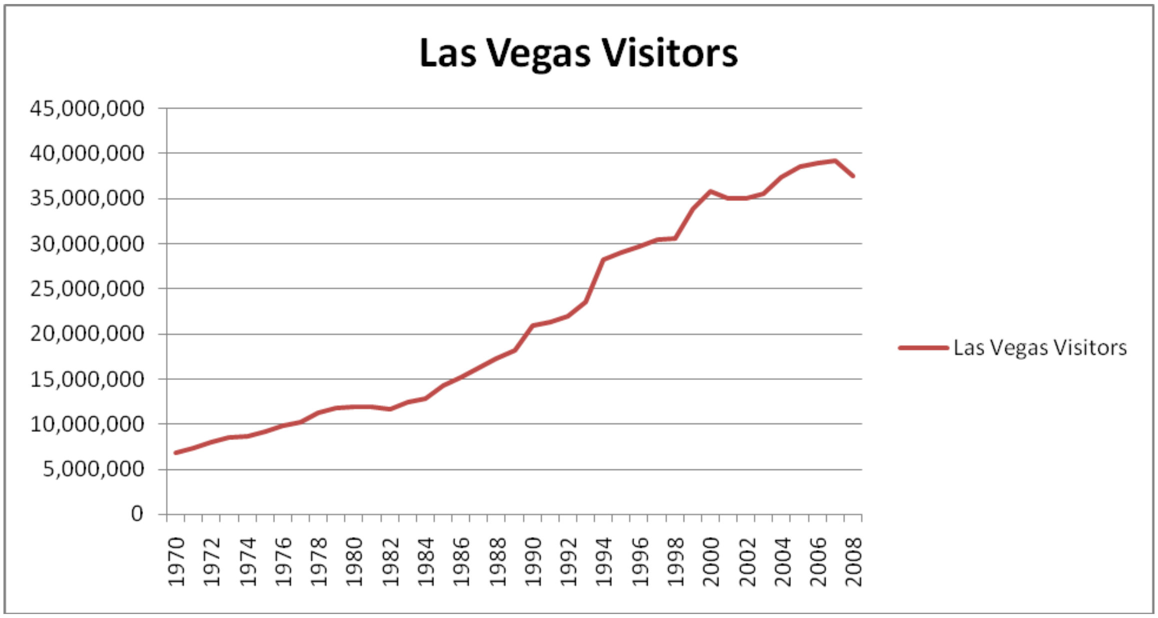

Figure 4: Las Vegas Visitors (LVCVA, 2009)

Using figures from the U.S. Census Bureau, Nevada State Demographer, Clark County Comprehensive Planning, and the Las Vegas Convention and Visitors Authority, it appears that population growth began leveling off in 2007 and then in 2008 actually declined in the Clark County area.

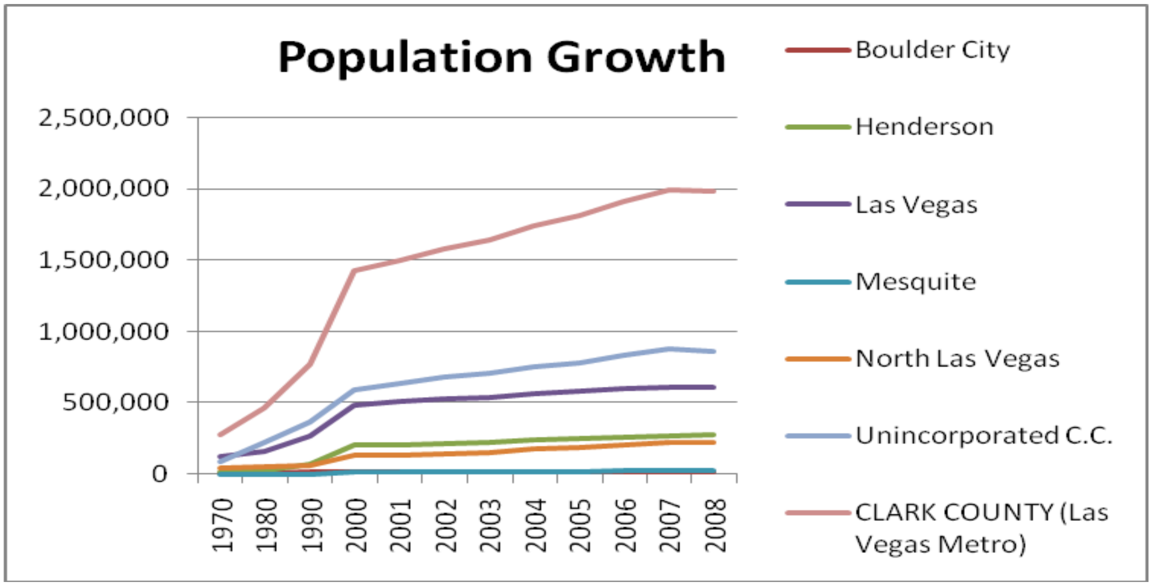

Figure 5: Population Growth (LVCVA, 2008)

The Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages also indicates a drop in employment in the County. The situation appears to be worsening, with the Nevada unemployment rate reaching 9.4% in January 2009 (BLS, 2009) and expectations that it will go higher than 10%. This is despite continuing construction on projects such as the massive CityCenter development.

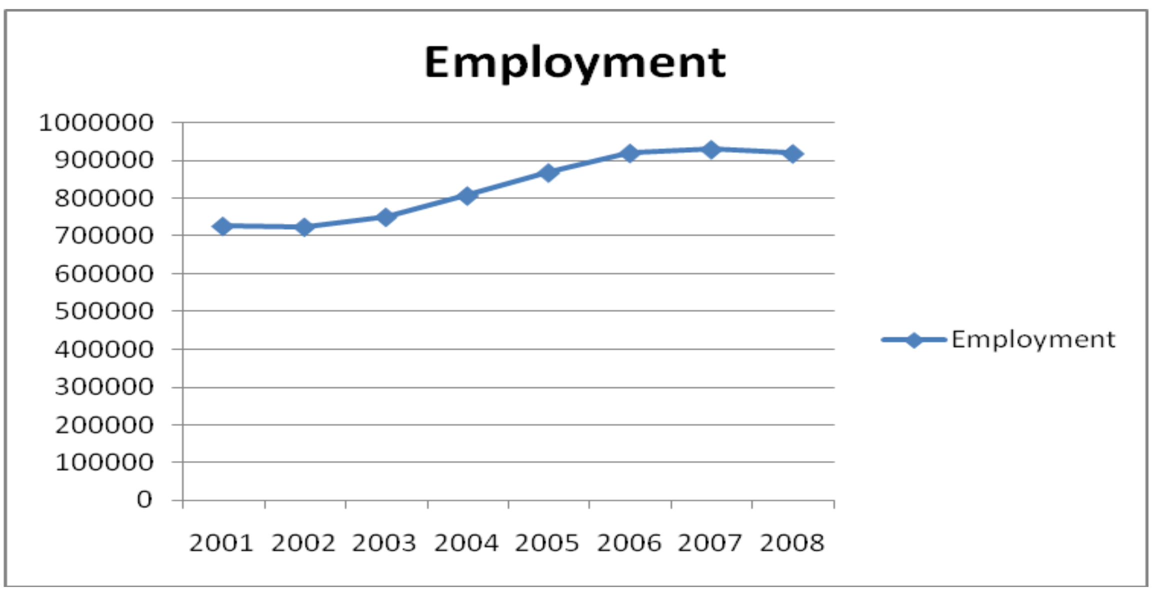

Figure 6: Employment (BLS, 2008)

The STEP3 Population Progression Module creates a demographic projection of individual persons and households for the region by aging the full synthetic population, estimating household formation, and accounting for migration into and out of the study region. This projection is a rich micro-scale description of the general populace that can be expected to be living in the study area given the base-year data and variables that depict the expected changes in the residents of Clark County. The progression is run annually. Consequently, the effects of abruptly declining immigration and population will have a great impact on the validity of the model results. The Census Bureau estimate of the components of population change for Clark County does show a decrease in total net immigration, while the Department of Homeland Security reports that legal immigration of permanent residents to the Las Vegas CBSA has also fallen.

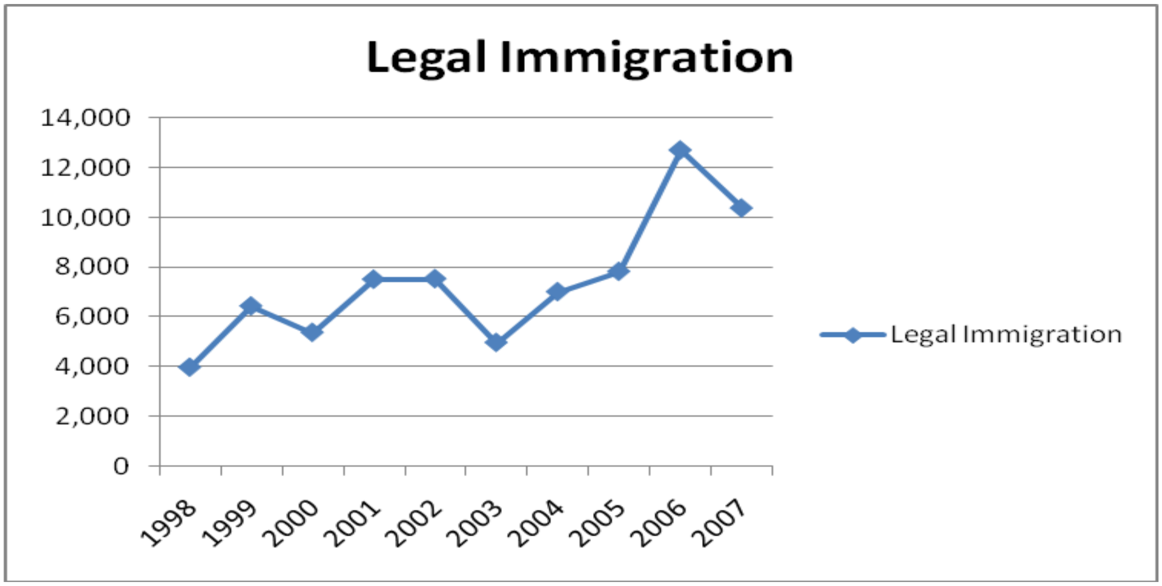

Figure 7: Legal Immigration (DHS, 2007)

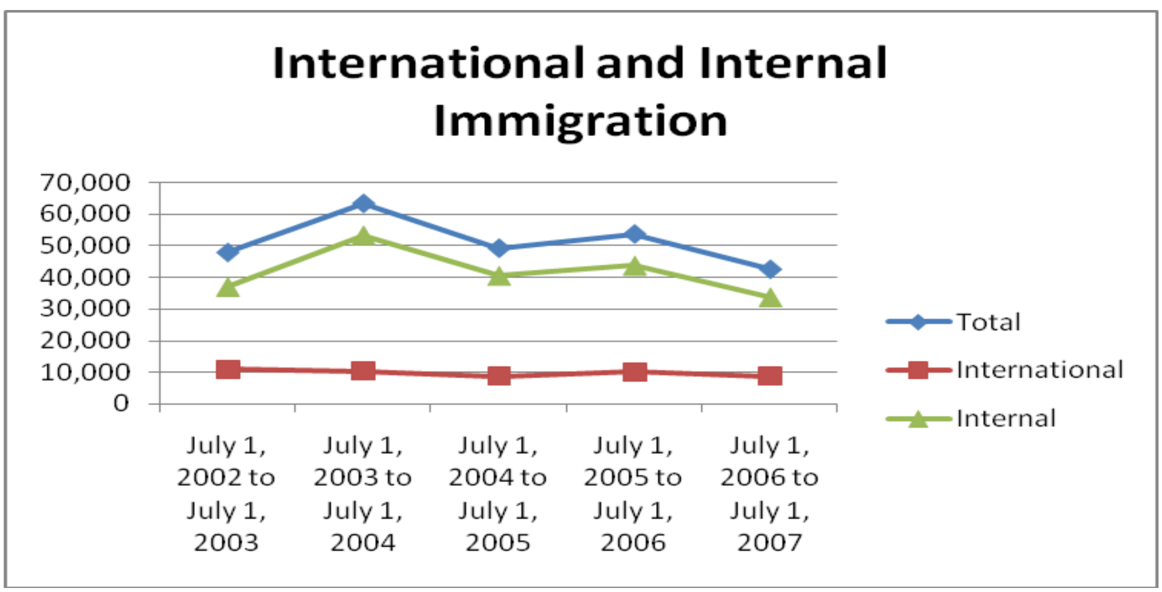

Figure 8: International and Internal Immigration (Census, 2007)

Discussion and Analysis

We will be assessing the expected model deviations using the reality as interpreted from published estimates. We focus on data for the most recent year of 2008, and also explore the 2007 data to better determine any recent trending. This time period is coincident with when the expected trends began to break-down.

To explore population growth we compare total population for Clark County from several sources. We use the original population projections created by Clark County Comprehensive Planning and the Nevada State Demographer for 2007 and 2008. The Planning numbers expected the largest population even when adjusted down, and remain higher than those of the Demographer. Our average population (based on the upper and lower bound STEP3 projections) actually underestimated the 2007 population (Table 1). The Demographer's data falls within the bounds of the Caliper estimates, while the Planning data lies not too far above the Caliper upper bound.

Table 1 Estimates and Projections (2007)

Estimate/Projection	2007 Population
Planning Estimate Original	2,012,215
Planning Estimate	1,996,542
Caliper Upper Bound	1,981,181
Caliper Lower Bound	1,818,892
Caliper Average	1,900,037
State Demographer Estimate Original	1877843
State Demographer Estimate	1,954,319
Difference between Caliper & Planning	96,506 (Caliper underestimate)
Difference between Caliper & Demographer	54,283 (Caliper underestimate)

In 2008, Table 2 shows that the bounds that Caliper predicted actually tally very closely with the numbers being reported by Planning and the Demographer, although we had no way of predicting which of our series would most likely reflect future scenarios. However, there are important local-scale variations that we will discuss below. One important aspect to note is that the Caliper projections have an upward trend 2007-2008 while in reality there has been a decline. If the region continues to exhibit low growth, stagnation or sluggish expansion then our projections will move further and further away from the ground truth because we have forecasted year on year increases (Figure 9).

Table 2 Estimates and Projections (2008)

Estimate/Projection	2008 Population
Planning Estimate Original	2,103,275
Planning Estimate	1,986,145
Caliper Upper Bound	2,067,757
Caliper Lower Bound	1,881,757
Caliper Average	1,974,757
State Demographer Estimate Original	1,939,097
State Demographer Estimate	1,967,716
Difference between Caliper & Planning	11,388 (Caliper underestimate)
Difference between Caliper & Demographer	7,041 (Caliper overestimate)

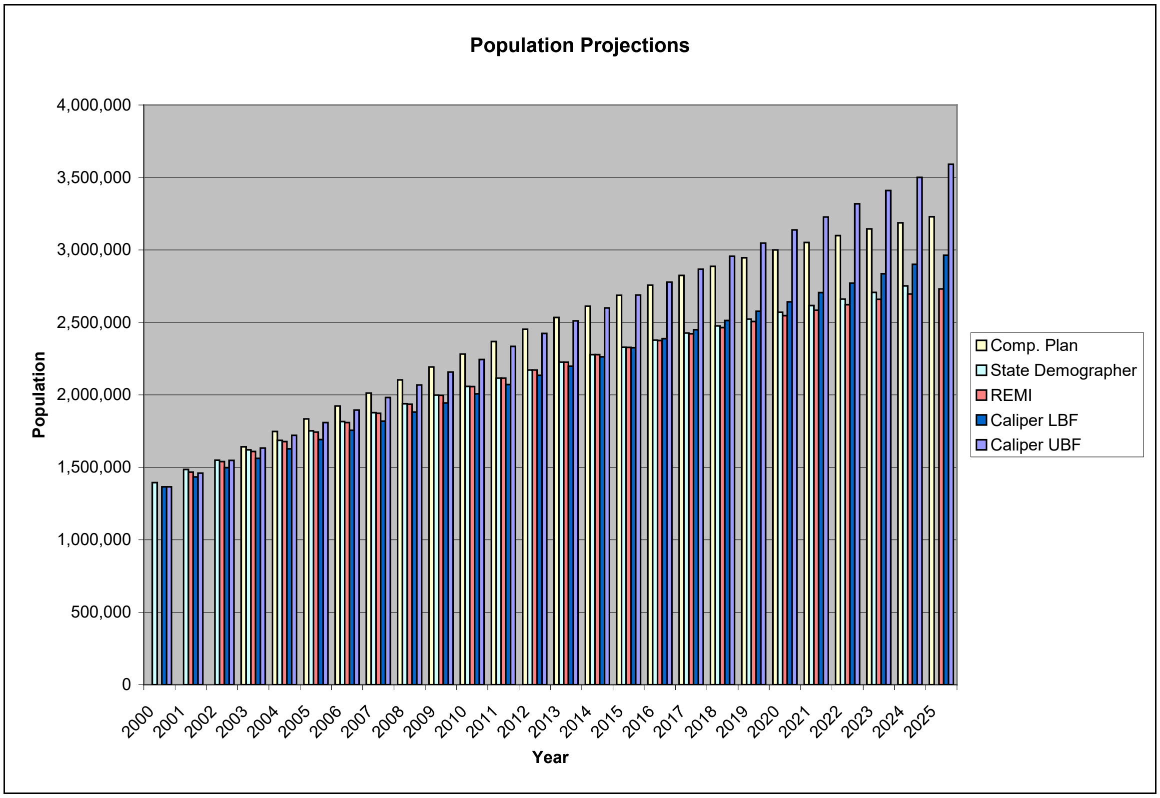

Figure 9: Population Projections

We compared data from several sources at the sub-county level to explore differences in the Las Vegas Valley (Figure 10). We obtained the parcel database for both 2007 and 2008 and these have total population numbers. These were compared with the four STEP3 scenarios for growth in Clark County. These range from high population growth with extensive urban dispersion (upper bound unconstrained: UBU) to lower population growth with constrained dispersion (lower bound constrained: LBC). The average of these 4 trends was calculated as was the average difference from the parcel-based numbers (Tables 3-4).

We also had access to projections that have not been revised since their creation. These zonal based models used the Clark County Comprehensive Planning places and the Regional Transportation Commission of Southern Nevada (RTC) traffic analysis zones (TAZs). Because their projection years are irregularly stepped, their numbers are provided for reference only. As would be expected they generally overestimated the population, but large variations are apparent at this scale.

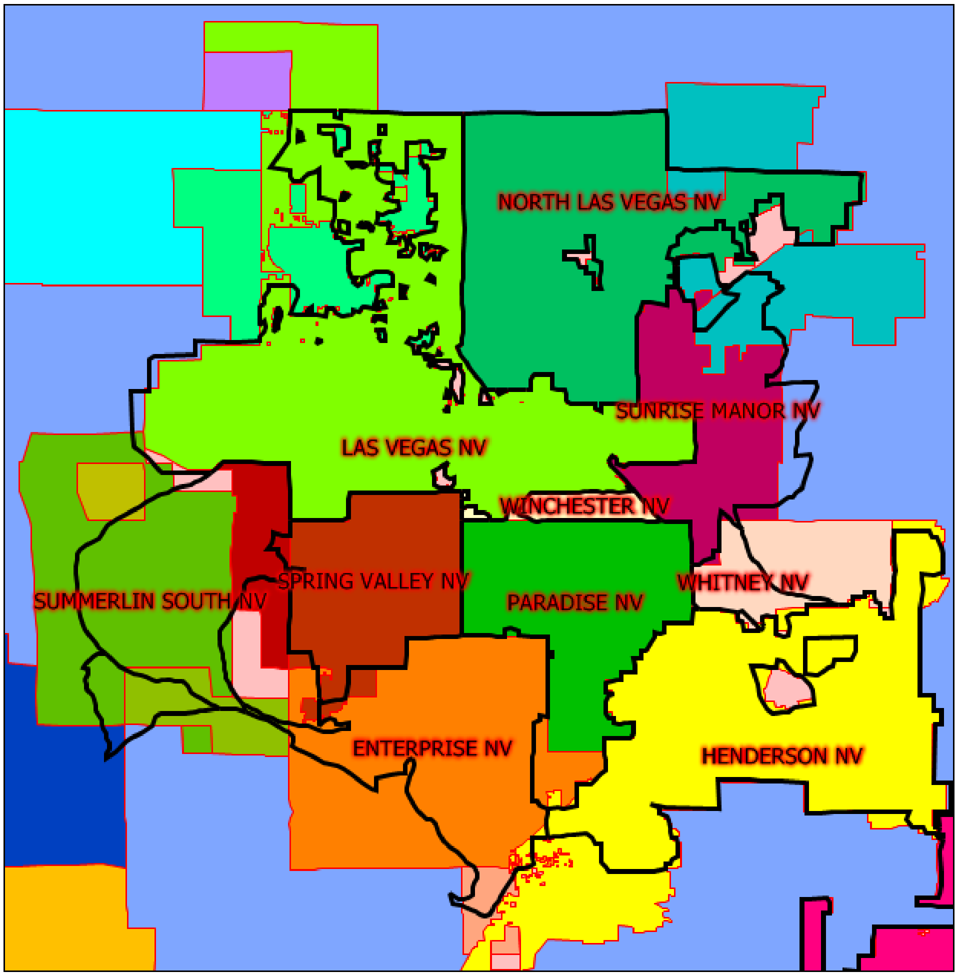

Figure 10: Las Vegas Places

Table 3 Estimates and Projections by Place (2007)

2005 Places	Parcels	UBC	UBU	LBU	LBC	Mean	%	TAZ 06	Places 05/06
LAS VEGAS	574,943	618,359	569,871	518,181	577,089	570875	-1%	564,888	
HENDERSON	245,541	193,988	181,440	167,938	176,922	180072	-27%	241,138	
PARADISE	216,898	311,998	288,397	272,215	288,064	290169	34%	225,481	233,252
NORTH LAS VEGAS	210,485	193,260	235,272	209,176	155,259	198242	-6%	197,737	
SUNRISE MANOR	189,107	189,354	166,540	160,072	182,070	174509	-8%	191,007	190,928
SPRING VALLEY	177,695	128,579	120,584	115,325	121,839	121582	-32%	166,819	171,633
ENTERPRISE	104,891	49,899	55,093	52,254	49,532	51695	-51%	64,245	79,552
WHITNEY	31,928	45,024	34,799	33,712	39,208	38186	20%	26,572	27,167
WINCHESTER	30,795	66,793	62,674	55,056	61,630	61538	100%	34,388	
SUMMERLIN SOUTH	23,856	8,216	9,222	8,398	7,392	8307	-65%	19,311	24,818

Table 4 Estimates and Projections by Place (2008)

2005 Places	Parcels	UBC	UBU	LBU	LBC	Mean	%	TAZ 08	Places 10
LAS VEGAS	568740	633730	575994	524062	591174	581240	-3%	615653	667,065
HENDERSON	248336	197214	186863	169586	178097	182940	-33%	265928	298,424
NORTH LAS VEGAS	211848	201278	260297	219749	158369	209923	-3%	265743	272,402
PARADISE	211009	345719	305030	290574	315197	314130	71%	234098	253,312
SUNRISE MANOR	181699	193274	165874	158789	182278	175054	-7%	196477	204,517
SPRING VALLEY	174922	128983	120548	114799	122618	121737	-32%	183392	230,158
ENTERPRISE	110202	55588	61364	57916	53875	57186	-62%	85838	130,179
WHITNEY	32424	47480	35187	33025	39196	38722	6%	30633	37,085
WINCHESTER	30167	68391	64843	56393	63938	63391	69%	34466	
SUMMERLIN SOUTH	24630	8632	9538	8609	7545	8581	-70%	23735	46,069

**Higher than projected; within projection horizon; lower than projected*

Tables 3-4 show a large overestimation for Paradise/Winchester in the STEP3 results. These areas contain the strip and border the CBD zone, the preferred areas for employment in our model. The remaining places to the south were underestimated while our data was comparable for the north of the urban area (Figures 11-13).

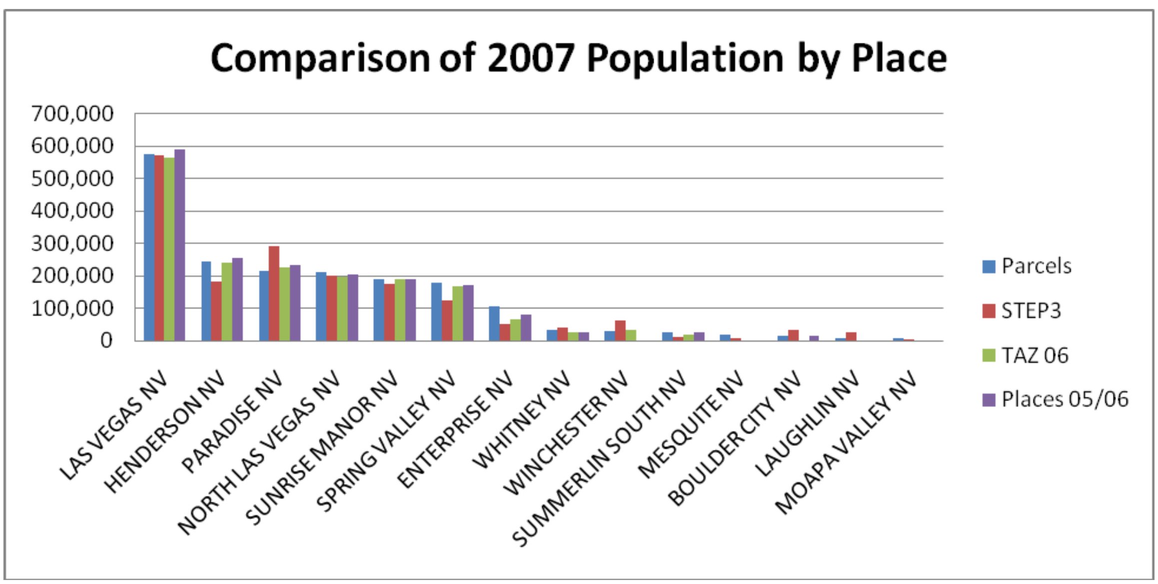

Figure 11: Population by Place (2007)

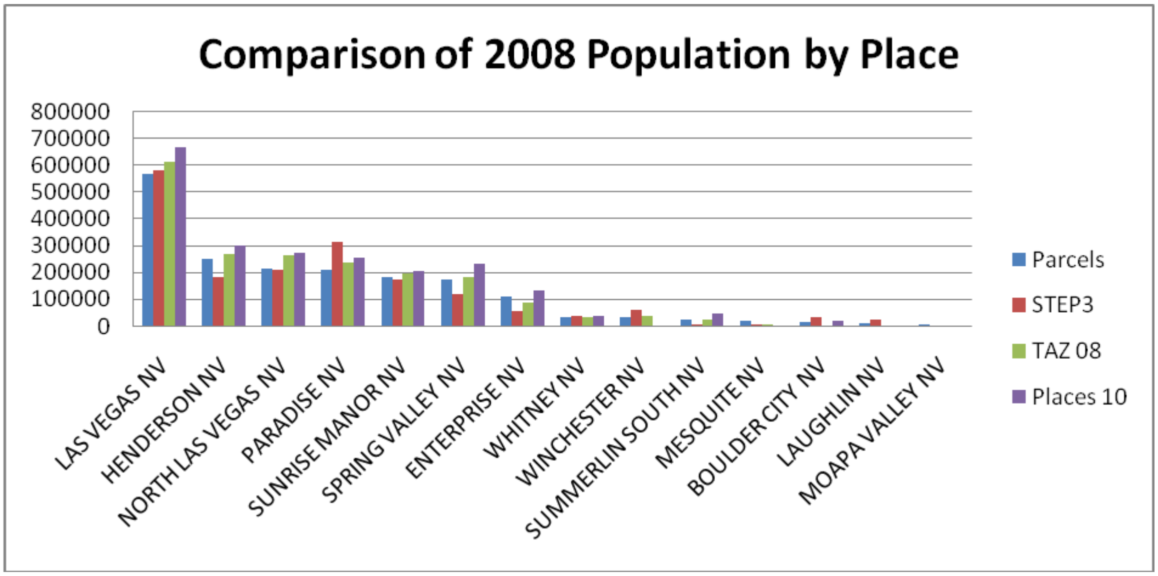

Figure 12: Population by Place (2008)

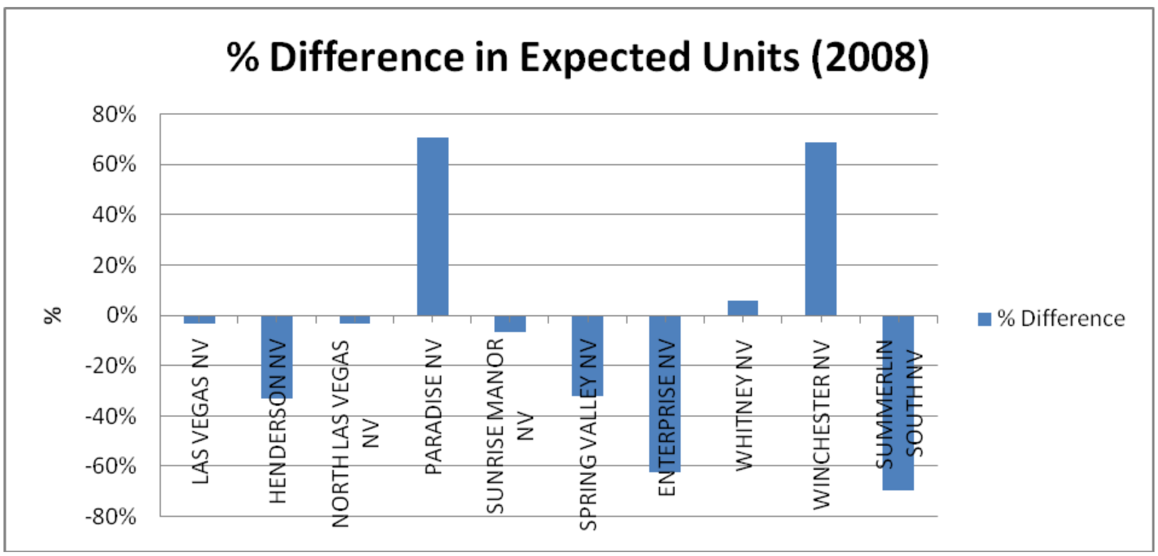

Figure 13: Percentage Difference in the Predicted Number of Residential Units (2008)

Summerlin South, Enterprise, Spring Valley and Henderson all grew much more rapidly than we had anticipated, likely exhibiting accelerated suburbanization as the desire for, and ability to acquire, a new home rose rapidly. The home values in these areas were actually the most expensive (Figure 10). For the Metropolitan Area as a whole, house prices had still shown a 94% increase over 5-years in the 2^{nd} quarter of 2007, but by the end of 2008 the 5-year improvement was only 6% (FHFA, 2009). The area is likely to be subject to continuing shocks as the boom effects normalize, further complicating any attempts to accurately model such trends.

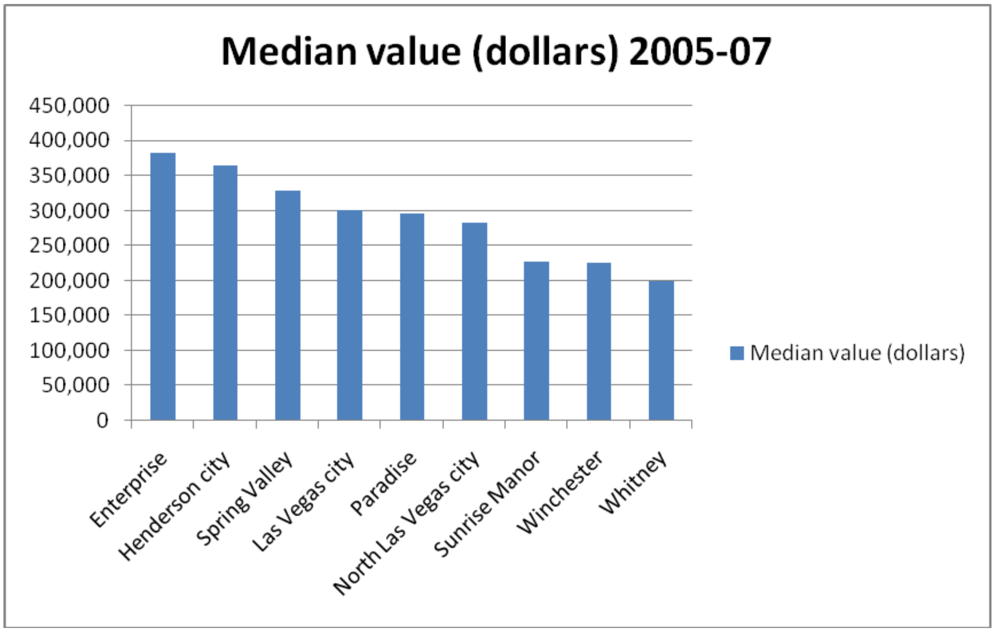

Figure 14: Median value of owner-occupied housing units (Census, 2007)

In terms of hotel parcel construction, we had identified a drift away from the traditional downtown, an increasing size of parcels, and the construction of hotels/casinos away from both the Strip and the old CBD. The latter point highlights the increasing spatial diversification of the gaming industry, with new trends such as locating away from the Strip and the mega-hotel experience. Such hotels typically target mixed markets that include both locals and tourists by providing attractions such as more intimate settings, providing locals with repeat custom "perks" and also through more specifically higher-end gaming experiences for example. Without knowing where these new hubs may be *a priori*, the micro-scale predictions will inevitable be unable to accurate handle them.

However, there is often knowledge of future developments and also the need to assess potential changes and future plans. Such information is incorporated into STEP3 via a land-use layer that allows the user to specify many different characteristics of the proposed developments (Figure 13). STEP3 can also run without any post-2000 land-use inputs.

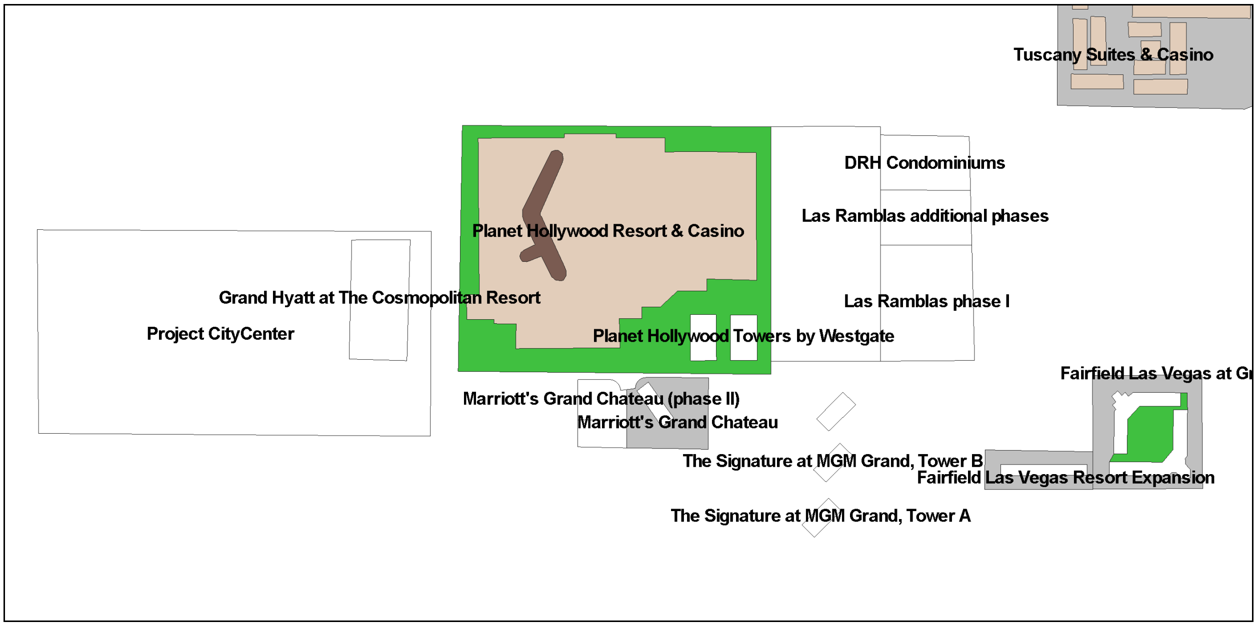

Figure 15: Post-2000 Development Layer

Based on this exogenous information, we expected 8,472 housing units to be built (via major projects) in Paradise by 2008, but which were either cancelled or delayed beyond 2008. For the same city we did not originally account for 878 housing units that were actually built, but the number of cancelled units remained much larger than for any other location. This may go some way to explaining our overestimation for Paradise (Figure 16) and also exemplifies just how difficult it is to control for such events. For example, we had built into our projections the construction of the Las Ramblas Resort which has since been cancelled (Figure 17). This was a proposed hotel, resort, and casino project to be constructed in Paradise by George Clooney with an expected 4,402 condominium residences. The second Trump Tower was also cancelled (Stutz, 2008) and had planned to have 1,283 residential units.

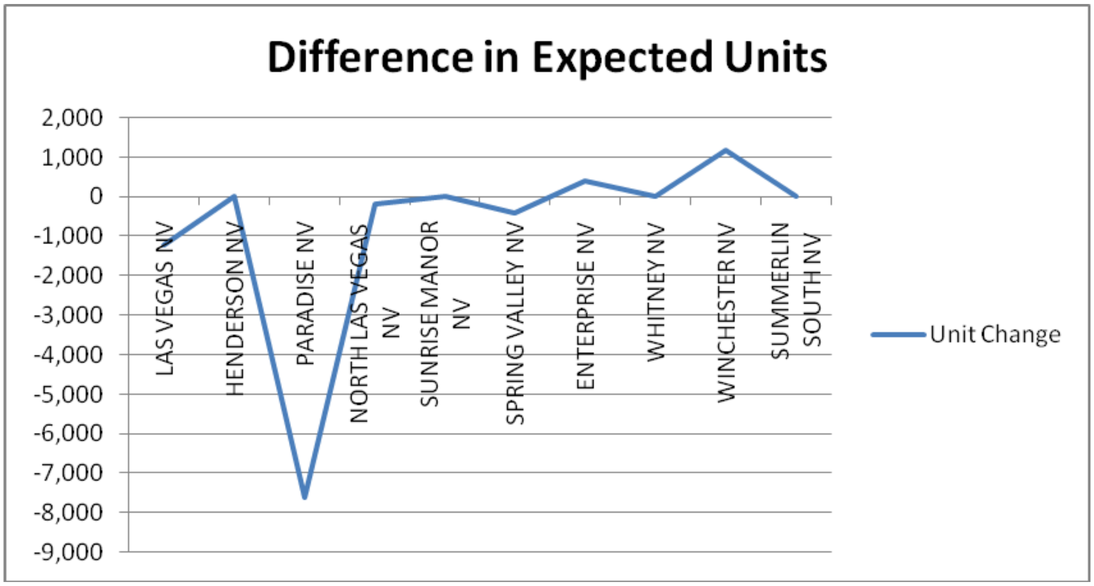

Figure 16: Deviations from projection in the number of residential units (2008)

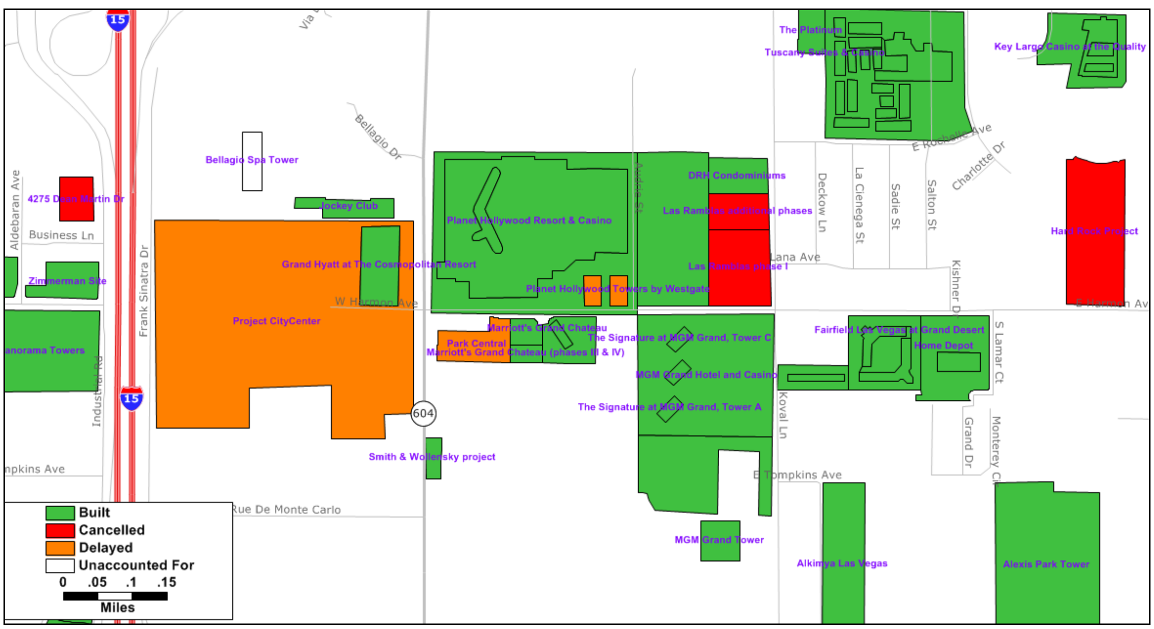

Figure 17: Major Developments by Status

The underestimation exhibited is likely caused by our model attemptting to let people live as close as possible to their jobs. Hotel employment is located largely in Paradise/Winchester and in the north of the city. In addition, the basis of this model is that hotel workers are inclined to obtain jobs in the CBD and the Las Vegas Strip. Residence location for those households where the head of householder is a hotel worker is a function of the travel time to the work zone, prices (in relation to household income), local environment and job availability, and safety. The residential choice model itself is thus conditional on job location. With the growth in demand for more expensive housing located away from the main employment hubs (Figure 14), plus the subsequent impact of construction cancellations, our model became skewed, thus overestimating and underestimating for different areas because they are not exhibiting the expected cause-and-effect. Thus, only 8 years into a 25 year model run, we are seeing local scale problems with our estimates, even while the regional numbers appeared reasonable.

Conclusion

Clark County was one of the primary boom towns in the recent economic cycle. It grew rapidly and was a highly attractive destination for new residents in addition to being a major tourist destination. Consequently, the settled land area in Clark County grew enormously over the last decade. The desire to better address planning problems by predicting in advance where people are likely to live and work resulted in the development of the STEP3 model. As the fall-out of the bust continues to wreak havoc on this region's economy, trends that have continued for decades have halted or even reversed, highlighting the extreme difficulty of creating long-range projections at the local level, and the near-impossibility on a micro-scale.

Because the STEP3 model produces upper and lower bounds for the projections, the regional level forecasts do appear reasonable for Clark County as a whole. However, local-scale numbers are inconsistent with the reality, while the upward growth trend of the model is unlikely to be able to match what we now expect for the region over the next few years. This is true even if Las Vegas experienced a resurgent economy, because interim changes are occurring to the fundamental assumptions that the model is based on, while the distributions of population, jobs, and services are evolving.

The STEP3 Small Area Demographic Forecasting and Land-use Model parameters underlying the forecasting procedure can be modified making it possible to maintain the model and enhance its pertinence and accuracy. Construction projects can be added or removed interactively and output from the model can be easily visualized and understood. In addition, regional trends can be changed to reflect varying factors such as the number of visitors that fuel immigration and the growth of the economy. However, based on the short-term assessment presented here, it would appear that such tools are better employed over shorter time periods given the complexity of the problem that small area disaggregate land use models aim to describe.

References

Berry, S., Sundarum, S. and Slavin, H. (2006), *STEP3: Small Area Demographic Forecasts for Clark County*, Caliper Corporation, Newton, MA.

BLS (2008), *Quarterly Census of Employment & Wages - QCEW*, Bureau of Labor Statistics, Washington, DC (http://www.bls.gov/data/#employment)

BLS (2009), *Local Area Unemployment Statistics*, Bureau of Labor Statistics, Washington, DC (http://www.bls.gov/LAU/)

Census (2007), *American Community Survey*, US Census Bureau, Washington, DC (http://factfinder.census.gov/)

Census (2007), *Population Estimates*, US Census Bureau, Washington, DC (*http://www.census.gov/popest/counties/*)

Comprehensive Planning (2009), *Clark County Annual Population Estimates*, Clark County, NV (http://www.accessclarkcounty.com/depts/comprehensive_planning/demographics/Documents/CCHistoricalPopSummaryWorksheet1990toPresent.pdf)

DHS (2007), *Persons Obtaining Legal Permanent Resident Status*, U.S. Department of Homeland Security, Washington, DC (http://www.dhs.gov/xlibrary/assets/statistics/yearbook/2007/table05.xls)

FHFA (2009), *House Price Index*, Federal Housing Finance Agency, Washington, DC (http://www.ofheo.gov/media/pdf/4q08hpi.pdf)

LVCVA (2008), *Population Trends*, Las Vegas, NV (http://www.lvcva.com/getfile/Population%202008.pdf?fileID=241)

LVCVA (2009), *Historical Las Vegas Visitor Statistics*, Las Vegas, NV (http://www.lvcva.com/getfile/Historical%201970%20to%202008.pdf?fileID=80)

Nevada State Demographer's Office (2009), *Estimates by County*, Reno, NV (http://www.nsbdc.org/what/data_statistics/demographer/pubs/pop_increase/)

Stutz, H. (2008), *Trump staff put on hold: Tower adjusts employee schedules as closings slow*, LVRJ, Las Vegas, NV (http://www.lvrj.com/business/25892124.html)

Walker, J. L. (2005), "Making Household Microsimulation of Travel and Activities Accessible to Planners", in *Transportation Research Record*, 1931, pp. 38-48. (http://sws.bu.edu/joanw/JW_Step2.pdf)

Wargo, B. (2008), *County population drops*, In Business Las Vegas, Henderson, NV (http://www.inbusinesslasvegas.com/2008/11/14/feature1.html)

Wilson, T. and Bell, M. (2007), "Probabilistic regional population forecasts: The example of Queensland, Australia", in *Geographical Analysis*, 39 1:1-25.