APPLICATION OF THE CAMPO DEMOGRAPHIC ALLOCATION TOOL IN THE LONG RANGE TRANSPORTATION PLAN

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Abstract

After the Capital Area Metropolitan Planning Organization (CAMPO) adopted its 2030 Transportation Plan in 2005, the CAMPO Board expressed a strong interest in the integration of Land Use and Transportation for the next long range transportation plan update. In addition to a trend scenario, CAMPO staff developed an alternative growth concept derived from on the Envision Central Texas' preferred compact growth scenario. The concept located high density activity centers where they could be supported by multimodal transportation. These activity centers would make up a significant growth of the regional population and jobs by 2035. This desire for an alternative growth concept required a way to test it along with the trend scenario. CAMPO staff decided to pursue an integrated land use and transportation model. After reviewing UrbanSim, PECAS, TELUM, and other models, CAMPO staff decided to create one of its own. Through this process the CAMPO Demographic Allocation Tool was developed.

The purpose of this paper is to present the newly developed tool and the efforts required to effectively run it. Several topics of this presentation include: a land suitability analysis at the parcel level, incorporation of local land use plans and policies, and input from the travel demand model. At the time of the conference CAMPO staff will be performing dual tracts of demographic scenarios and associated transportation systems for supporting such scenarios. CAMPO staff will report the experience in applying the tool and how it could lead to a better understanding in integration of land use and transportation planning.

Keywords: Land Use and Transportation Modeling, Demographics, Scenario Testing

Introduction

The CAMPO Demographic Allocation Tool was developed to improve the way forecasting was done for the long range transportation plan. The previous forecasting methodology, the modified Delphi process, was better suited for smaller sized MPO's in the absence of a land use model. CAMPO wanted to pursue a land use model but due to its size, budget, and amount of staff, existing land use models were not feasible at this time. Instead the Demographic Allocation Tool was developed as an interim method. The objective of the tool was to be open, replicable, quantitative, based on GIS, integrated with the travel demand model, and allow for multiple scenario development. What was developed was a simple tool that facilitates communication with jurisdictions to see how the region would grow. The following will further explain the background, development, and application of the Demographic Allocation Tool.

Background

In 2005 the Capital Area Metropolitan Planning Organization adopted its 2030 Long Range Transportation Plan, the *CAMPO Mobility 2030 Plan*. In the plan CAMPO forecasted that even after spending $23 billion on roadway, transit, bicycle, and pedestrian improvements by 2030, congestion in the region would continue to get worse. The forecast was based on a trend scenario where much of the new population growth was accommodated in low density single family development on the fringe of the existing urban area. After adopting the plan, the CAMPO Transportation Policy Board called for solicitation of plan amendments in response to concerns that the plan failed to adequately protect future quality of life in the region. The concerns related to the underlying assumptions of the plan, including the future growth pattern.

CAMPO initiated a scope of work and program that would include developing a preferred Regional Growth Concept and a set of implementation strategies. The CAMPO Regional Growth Concept would provide a vision of what the desired future growth pattern is and how CAMPO would work with our partners to implement it over the next 25-50 years. In 2003 Envision Central Texas developed multiple land use scenarios and came up with a preferred scenario that relied heavily on infill in existing town centers. This scenario would result in less consumption of land over the aquifer, a reduction in vehicle miles traveled, a reduction in overall vehicle delay, and a reduction in the cost of local infrastructure. CAMPO used this scenario as a starting point in the Regional Growth Concept process.

CAMPO went through a series of public workshops while working with regional partners to take the Envision Central Texas vision and turn it into the CAMPO Regional Growth Concept. The growth concept recognizes that due to market conditions and other factors, past development trends will likely continue in the region, however, the growth concept proposes that CAMPO, local governments, and other regional partners implement strategies that would encourage the development of "Activity Centers" throughout the region. These Activity Centers would accommodate a greater percentage of future growth supporting the findings that regional land use patterns that incorporate areas of dense residential development, strong mixed use centers, a well connected street network, and a complimentary transit system, would result in a reduction in per capita vehicle miles traveled and a higher level of usage of transit and other alternative modes.

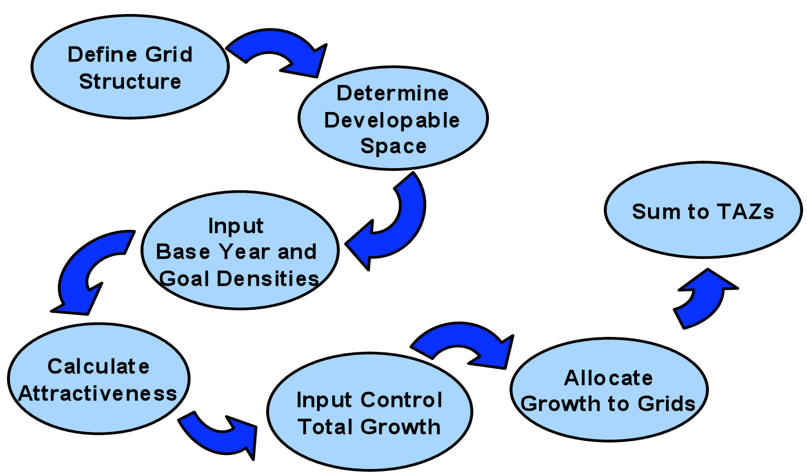
The CAMPO Regional Growth Concept consists of mixed use activity centers that provide additional housing options with employment and retail opportunities closer to where people live. Activity Centers were located based on the Envision Central Texas preferred scenario and a series of criteria defining existing strengths, development potential, accessibility, and development control. These Activity Centers went through a series of workshops where they were either eliminated, added, moved, or made smaller or larger. The scoring resulted in the designation of 1 Large, 12 Medium, and 24 Small activity centers. After establishing the Activity Center locations and sizes the 2005 base year demographics were analyzed and future targets were set for 2035. The Activity Centers made up 34.2% of the regional employment and 10.9% of the regional population, in 2005. Future targets differed by Activity Center type; with Large consisting of 125,000-500,000 people and 200,000-300,000 jobs, Medium with 9,000-75,000 people and 9,000-40,000 jobs, and Small with 2,000-10,000 people and 2,000-10,000 jobs. The Activity Centers at a minimum would make up 21.5% of the regional population, and 36.4% of the regional jobs, in 2035. It is suggested that actual performance may vary by activity center but the overall goal of the Growth Concept is to accommodate a higher percentage of population and employment within the Activity Centers as the region grows.

With the CAMPO Regional Growth Concept developed but not yet adopted, CAMPO needed a way to apply it and test it. In the 2030 Long Range Transportation Plan a single demographic scenario was developed using a modified Delphi process. The modified Delphi process uses a panel of members knowledgeable of the region to come up with a consensus forecast. This process is used primarily by small urban areas to produce reasonable results despite the use of a model. However, the process requires a lot of time and participation from multiple panel members and the results are geared towards making a single future scenario. CAMPO decided to look into various land use modeling platforms to perform the 2035 demographic forecasts. One model CAMPO looked at was UrbanSim, which is being explored by many urban areas. Many of these models, including UrbanSim, are highly data intensive and expensive and resource-intensive to implement. While CAMPO’s long term desire is to pursue a land use forecasting model it was not feasible due to funding and staff constraints for implementation in the 2035 plan update. Instead, CAMPO contracted with Wilbur Smith Associates to develop a GIS-based scenario planning tool to address the immediate need to develop dual tracks of 2035 demographics for planning purposes. This tool is called the CAMPO Demographic Allocation Tool.

Methodology of the Demographic Allocation Tool

The CAMPO Demographic Allocation Tool is a GIS-based computer program for allocating growth to a small geography using control totals from a larger geographic aggregation. (The current applications of the tool are programmed using the GISDK in Version 5.0 of TransCAD.) The growth is allocated in an iterative process from a baseline condition (See Figure 1). The iterative process concludes when the user-defined criteria on growth allocation are met. Throughout the iterative process of allocation, the tool considers the developable land, maximum allowable, and a rating of attractiveness by grid cell. The results are summed to the Traffic Analysis Zone (TAZ) level, the basic unit used in the Travel Demand Model. In the CAMPO application, the tool uses control total demographic input at the county level. The demographics chosen are population, basic employment, retail employment, and service employment. The goals of this tool include a replicable and consistent approach across jurisdictions within the modeled region, and a technical approach based on known objective land characteristic inputs. The tool is intended to be used as part of the regional travel demand model sequence, utilizing travel time output from the travel demand model and providing input for the forecast years. The tool was also developed to allocate growth for multiple growth scenarios. The allocation process is described in the following sections.

Figure 1 Demographic Allocation Tool Process



<u>Suitability Analysis and Allocation Geography</u>

The allocation procedure starts from the estimation of developable land. Performing a suitability analysis, the following factors are used to find the suitability of land to development; a vacant land inventory by parcel, and natural and environmental constraints such as flood plain, parks, preserves, steep slopes, water bodies, etc. A regional vacant land inventory for the entire modeling area conducted for 2005 serves as the basis of available acres to development then the natural and environmental constraints are used as unavailable acres and subtracted from the available acres leaving only developable acres. When allocating households, the unit to derive the population forecast, the allocation is done at a grid cell level. The grid cell starts as a 36 acre cell then is subdivided into 9 acres in more dense areas and then is split along TAZ boundaries in order to sum the household allocation to the TAZ level. The grid cell could range from 0 to 36 acres and is assigned developable acres from joining the results of the suitability analysis. When allocating employees, the allocation is done at the TAZ level. In contrast to the household allocation, developable acres are not necessary to allocate employees and every TAZ is eligible for allocation.

Assumptions for Population and Employment

Once the cells have been determined eligible for development the next step in the sequence is setting up the base year and forecast assumptions. The base year, 2005, was developed outside of the tool and included all of the input necessary to run the CAMPO travel demand model. Estimates of 2005 demographics used in the tool include population, households, household size, basic employment, retail employment, and service employment. The base year population was set at the county level using the Texas State Data Center's county estimates. The population was then disaggregated to the TAZ level utilizing the Emergency 9-1-1 (E 9-1-1) phone database to establish number of households. Several factors were used to account for households without land lines and adjustments were made. From the TAZ level, households were assigned to grid cells using the same E 9-1-1 point data.

After establishing the base year estimates the next step was to develop the forecast assumptions. Since the tool allocates households to get the population the input assumptions are set at households per acre by grid cell. This households-per-acre input is called the Maximum Allowable Density. Several sources of data can be used to determine the future density of a grid cell. Depending on the proximity to the forecast year different data may be used. To determine near term forecasts building permit and septic permit data is used. Mid term forecasts use subdivision site plans to get the total number of households plus the previous maximum allowable data is carried on. Long term forecasts use land use and zoning plans to determine possible densities where nothing has been planned and again the previous maximum allowable data is carried on. Where there aren't data, typical or average densities can be used to establish a maximum allowable. The base year employment was developed using 2005 3rd Quarter Texas Workforce Commission (TWC) data, unemployment insurance estimates (ES-202 data), supplemented by InfoUSA. The TWC data was geocoded by address points and summed to the TAZ level. Since employment is allocated to the TAZ level in forecast years no adjustment is made to the base year employment grid. Similar to the household allocation, the tool allocates employees based on an employees-per-acre forecast assumption. The maximum allowable is set at the TAZ level and also depends on the proximity to the forecast year. Commercial building permits are used to determine near term forecasts by taking the approved building square footage and applying an employees per 1000 square feet conversion. Mid term forecasts use commercial site plans plus the previous commercial building permit data. Long term forecasts use the previous maximum allowable assumptions with land use and zoning being converted by employees per gross acre to account for other possible densities. By documenting every step above the Maximum Allowable Density assumption can be traced back to its source and be transparent and accountable.

Ratings of Attractiveness

The next step after determining the density assumptions is to rate each cell on a level of attractiveness to development. Like other land use models, the purpose of ratings is to determine where the highest potential of development will occur. Many models use economic indicators, migration statistics, land suitability, and other factors to determine development potential. When complicated models have too many submodels, they tend to become less useful for decision-making based on to-be-established policies. It was CAMPO's objective to make the tool to be a direct linkage between growth and transportation policies. The main indicator of attractiveness to development is Accessibility, expressed in travel times. Choosing this parameter also resulted in a tightly integrated system with the travel demand model. The tool reads transit travel times and highway travel times from the model and creates Auto Accessibility and Transit Accessibility measures. The travel times are also weighted by the number of households and employees in each destination zone allowing for a feedback loop to the accessibility measures in each out year. Similarly, when the out year highway and transit networks are updated the accessibility measures reflect that change by showing new accessibility where there wasn't before.

In order to account for other criteria not reflected by accessibility, attractor points are developed to assist in determining attractiveness ratings. In general development is understood to occur around nodes within an urban area. These nodes of influence are usually town centers and major intersections and interchanges. Therefore, since these nodes are understood to be centers of activity, such as shopping or work locations, the more near a household was to a node of influence, the higher its attractiveness rating should be. Nodes of influence also could vary by demographic type; i.e. the nodal influence for households might be very different than the nodes used for allocation of basic employment. These nodes of influence are called Attractor Points in the CAMPO application of the model. Attractor Points can be set for each forecast year depending on where development is expected to occur based on local jurisdiction input. Additionally, if a specific cell needs to be allocated to but does not have a high enough rating based on the previous two parameters, there is an Attractor Constant parameter that will increase the cell's potential for development. This parameter is subject to only rare circumstances and would be documented keeping the process open and transparent. The ratings of accessibility, attractor points and attractor constant, if used, are combined for determining the cell's potential for development in the trend scenario.

To facilitate consideration of implementation of the CAMPO Regional Growth Concept, an additional parameter was created specifically for such alternative growth scenario. The Activity Centers parameter adds an extra value to the attractiveness of an activity center based on designation of large, medium, or small to place them higher in priority for allocation. These parameters used in the trend scenario are then combined with the Activity Center parameter in the alternative growth scenario allocations. The trend and alternative growth scenarios will be developed and analyzed on a parallel track during the alternative analysis phase for developing the 2035 Plan.

Allocation and Aggregation of Forecast Demographics

The allocation of future demographics is based on the county level forecasts for the horizon and interim years approved by the CAMPO Board. This county total policy sets up the frame work for allocating the population and employment by county individually. The allocation of growth is controlled in two ways for any given county totals; 1) by creating Allocation Bins and 2) setting an Allocation Curve.

Allocation Bins are groupings of eligible cells. The number of bins is set by the user and each bin has an equal number of cells. The cells are assigned to bins in rank order with the highest rated cells starting in Bin 1. All of the ineligible cells, those below a certain developable acres threshold, are in bin 0 and not for allocation. After each cell has been assigned to a bin, the amount of growth in each bin is determined by the Allocation Curve. The growth increment is divided among bins using a negative exponential curve. The user may input a specific "beta" value, the exponent to the curve, for each demographic type for each county. The slope of this curve determines the amount of annual growth is set aside in each bin. The higher the beta value the higher the percentage of growth in Bin 1. By setting the beta value lower it allows for more growth to be set aside for the lesser ranked bins. This method would account for a non contiguous pattern of development where growth still occurs outside of the highest ranked cells for reasons not objective in the tool.

Combining all of these steps, the tool then allocates the forecasted growth increment starting with Bin 1, Cell 1 in an iterative process until the increment is depleted. Each cell is allocated to its Maximum Allowable Density provided that growth is still available in its bin. If every cell in a single bin reaches its maximum allowable and there is a remainder, it is added to each successive bin's amount until exhausted. If the successive cells do not use the remainder then the allocation would not be complete. This brings up an important point that cells ranked high in accessibility, such as in Bin 1, do not necessarily coincide with their allowable densities for a large amount of growth. This would leave a remainder for the lower ranked cells and change the Allocation Curve. This occurrence is excusable, however, because the idea is that the highest ranked cells are assured allocation regardless of their density.

Once the growth is fully allocated the grid geographies are summed to the TAZ geography. The household allocation results in a forecasted number of households by TAZ which is then multiplied by the TAZ household size to get population. Since households are allocated and people are not, the initial population calculation does not match the forecast county total. The tool makes an adjustment to the TAZ household size based on a forecast county average household size that the user defines and then recalculates the population to match the forecast county total. The end result is a TAZ with population, number of households, and an adjusted household size. The employment is allocated by number of employees therefore no adjustment is needed at the TAZ level. The newly allocated population and employment serves as the next allocation's base year and the process is continued until the 2035 demographics are allocated. There are a few things to consider procedurally. The basic employment is allocated first based on the base year transportation networks weighted by the base year households. Then households are allocated based on the base year transportation networks weighted by the new basic employment and the base year retail and service employment. Then retail and service employment is allocated using the base year transportation networks weighted by the new households. The allocation follows this stepwise sequence to reflect the idea that people follow jobs then retail and service follow people. The next iteration of allocations uses an updated transportation network based on what is open and operational by that base year. To avoid the fallacy of self-fulfilling prophecy, CAMPO chooses to apply a time-lag for the linkage between travel times and demographic allocations. See example in the table below.

Trend				
2015 Basic Trend	2010 Highway 2010 Transit	2010 HH	NA	NA
2015 Population Trend	2010 Highway 2010 Transit	NA	2010 Retail	2015 Basic + 2010 Retail + 2010 Service
2015 Retail and Service Trend	2010 Highway 2010 Transit	2015 HH	NA	NA
2025 Basic Trend	2015 Highway T 2015 Transit T	2015 HH	NA	NA
2025 Population Trend	2015 Highway T 2015 Transit T	NA	2015 Retail	2025 Basic + 2015 Retail + 2015 Service
2025 Retail and Service Trend	2015 Highway T 2015 Transit T	2025 HH	NA	NA
2035 Basic Trend	2025 Highway T 2025 Transit T	2025 HH	NA	NA
2035 Population Trend	2025 Highway T 2025 Transit T	NA	2025 Retail	2035 Basic + 2025 Retail + 2025 Service
2035 Retail and Service Trend	2025 Highway T 2025 Transit T	2035 HH	NA	NA

T = Trend Network

Status of Application

CAMPO defined three rounds of model runs leading up to the CAMPO 2035 Plan Update. Each round requires a set of demographics and transportation networks. Round 1 was developed in the fall of 2008. The 2015 and 2035 demographics created were based on a 2010 (no-build) transportation network. Before running the tool CAMPO held several meetings to discuss the methodology behind the Demographic Allocation Tool. It was important that our member jurisdictions agreed with the process and knew how it worked. Through out the year subdivision data, site plans, land use and zoning plans were collected through individual meetings with jurisdictions. Many jurisdictions were able to provide some form of future land use. However, some digitization work on the future land use had to be performed prior to this application. Additionally, research over the Internet and other sources was done to develop the region’s maximum allowable densities in absence of available data. Where no data became available, estimation based on typical developments was done to derive the maximum allowable densities. Due to an encroaching deadline the employment goal densities where based off of the 2030 Plan demographics. Once the 2015 and 2035 demographics were allocated reasonableness checks were performed to ensure the allocations were reasonable. The 2015 and 2035 demographics were then run in the travel demand model on the no-build transportation network. These results were used in the first round of public involvement. This was an exercise to depict the congestion levels under the no-build assumptions.

Currently CAMPO is working on Round 2 of the Model Runs. Round 2 consists of dual tracts in demographics and transportation networks. The dual tracts being developed are a trend scenario and an alternative growth scenario. The trend scenario uses a transportation network that is likely to occur under fiscal constraints and demographics that reflect existing and planned conditions. The alternative scenario will reflect the Regional Growth Concept. The transportation network will contain projects that are likely to occur in either scenario along with projects that support the Activity Center locations. The demographics will show a higher percentage of the population and employment in activity centers while still reflecting existing and planned conditions but to a lesser degree. The trend demographic scenario will be used in the travel demand model on the trend transportation network while the alternative demographics will be run on the alternative transportation network. The maximum allowable densities used in Round 1 have been continuously refined for 2010 based on residential and commercial building permits. The 2015 trend will only reflect residential and commercial projects that have been approved or already in development. The 2025 and 2035 trend will rely mainly on approved or planned projects as well as land use and zoning plans. When the alternative scenario is allocated the maximum allowable densities will only change in the activity center locations. The maximum allowable densities will reflect what is required to meet the 2035 targets. The dual track forecast demographics will then be run on CAMPO's travel demand and emissions models for alternative analysis purposes.

In Round 3 the CAMPO Board is expected to decide on a preferred growth scenario which may be the trend, alternative, or a combination of the two. The transportation network will be developed to support the chosen growth pattern. This preferred scenario will be used in the third round of public involvement and run through emissions which will lead into final plan adoption by June 2010.

Conclusion

In Round 1 the tool did what it was supposed to do with the data that was put into it. Simply put; if you put 4 households per acre in a 36 acre grid cell, you will expect to get 144 households. However the difficult part was finding a sufficient amount of data to determine the goal densities for every cell and every jurisdiction. As improvise the estimated maximum allowable densities based on typical developments were created. Another lesion learned was that the forecast household size played an important part in the final TAZ population and should be examined closer. For example; if 500 households allocated to a grid cell that had 3.3 persons per household instead of 1.8, the population is almost doubled. The employment allocation in Round 1 worked out well, even though it was based on previous plan employment assumptions.

The lessons learned in Round 1 helped improve the process for Round 2. Additionally, meetings with CAMPO's Technical Advisory Committee and interested jurisdiction members were hosted to examine the weighting of each Attraction Parameter. These meetings resulted in weighting the Accessibility parameter equal to the Attraction Point parameter. This weighting scheme allows for known projects to receive a higher rating even if they score low in Accessibility. Also, it is important to limit the number of eligible cells to those that only have projects approved or planned. If a project is planned next to land that does not have plans then it shows more development potential than the land next to it. If these cells were not removed they would have the same development potential and could be allocated to before the cells that actually have plans.

Lastly, the Demographic Allocation Tool as a scenario planning tool has reduced the production time of demographic allocations and better equipped CAMPO to consider the land use and transportation connection in the plan development and alternative analysis efforts.

Future Work

Refinements in grid geography to better conform to the actual parcel level data would be an appropriate short term undertaking that can improve the suitability analysis and visualization when presenting such forecast data to the public. The attractiveness parameters are appropriate for the current application; however it is possible to add a value using the Attractor Constant with a rule. A few examples might be adding a value to cells that have utilities or adding a buffer value around the transportation network. The third improvement is to change the allocation from households to people. The tool allocates households, which requires a total number of households per county to be calculated. The number of households could be any combination of households and household sizes to come up with the same population total. Lastly, with continuous efforts in building permits collection, the tool can be potentially refined and evolved from a scenario planning tool to a calibrated model for transportation and land use policy analysis.