Final Report on Year 16 (2003-04) UCTC Research Project

Improved Developer Models for the Sacramento Region
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We successfully completed this project, as planned. There are two deliverables from this project. First, is the paper by Clay and Johnston submitted to TRB, which is summarized below and attached to this transmitting email. Second, Michael Clay, the grad student supported by this grant, was hired to be an Assistant Professor and is now at Auburn University. This paper was the final one of three in his dissertation series.

Summary of Research Paper

Abstract
In the past ten years, integrated land use and transportation modeling has received considerable attention in the scholarly literature. This academic interest is slowly yielding practical applications. Many metropolitan planning organizations (MPOs) and state departments of transportation are beginning to implement these types of models for the first time. While many improvements have been made to these models, and the value of these improvements should not be understated, much work still remains. One of the most challenging problems in land use modeling is how floorspace (buildings) is built and occupied. The purpose of this paper is twofold: first, to draw attention to insufficiencies in the representation of floorspace developer behavior—particularly as it applies to large, urban-edge projects—within current integrated land use and transportation models and, second, to determine the necessity of explicitly accounting for such projects within these models. The Sacramento MEPLAN model will be used together with historical development records to demonstrate and test these assertions. Single large developments are modeled with a common year of development, size, and location. Among the findings, large developments are fairly common in the Sacramento region and make up a considerable amount of floorspace development in absolute terms, large basic sector developments have more of an impact and are therefore more important to explicitly account for than are large non-basic sector developments. A single large basic sector development modeled in a 20 year forecast has a significant impact on zonal outputs. Recommendations are put forward regarding the use of this research in practical modeling exercises.

Background
The current representation of developer processes in integrated models is not behaviorally accurate. In effect, individual zones, grid cells, or parcels make independent decisions as to whether or not to develop, what to develop (type of floorspace), and how much floorspace to build. This representation gives the appearance that the land itself is making the development decision. No true developer or landowner (owning multiple parcels, grid cells, or zones) exists in the models. Among other implications, this

structure means that parcel assembly, for large projects, is not possible and, therefore, these types of development will not be accurately represented in the models.

The current representation of firms and their location choices in integrated models are equally inaccurate. Firms are not represented in these models. Rather, the models locate employees one at a time, with each employee making an independent location decision. There are functions in the models that serve to draw similar types of employees together, thus producing the appearance of firms, but movements are modeled on an employee-by-employee basis.

This current representation is a useful modeling technique that allows the model to "play the averages." If the model develops floorspace one parcel at a time, spatial errors can be assumed to be small. For employee location, these errors may cancel out at the regional level. In other words, error may be fairly evenly distributed throughout the region, thus serving to spatially diffuse errors rather than cluster them in a few locations. One reason for using the current representation of these processes is that it should serve to limit exposure to spatial uncertainty within the model. The concern over putting a regional shopping mall in the wrong part of town has led to the removal of its representation within the model. Testing the validity of this concern is one motivation for this paper.

Part of this concern stems from the idea that there can only be one official forecast. If only one forecast is used then it is reasonable to want to minimize exposure to large spatial errors. But, for policy analysis purposes and scenario testing there is no need to limit the comparisons to a single, official forecast. Uncertainty literature has urged the fields of land use and transportation modeling to move away from the use of point estimates (both as inputs and outputs) and to replace these with distributions obtained from multiple model runs under differing assumptions (*1*, *14 and 15*). This same idea can be applied to spatial uncertainty. Alternative urban futures could be created within these models by varying the size, type, and location of large developments based upon probabilities obtained from observed data. This would allow the robustness of a policy to be tested across multiple urban futures. If combined with representations of input and parameter uncertainty this would produce the most thorough policy testing available with existing models.

Methods

In order to demonstrate the conceptual need to model large real estate developments, several types of data were gathered for this study. First, data on past large developments were gathered from city and county governments in the Sacramento region. In some cases, these data came from both the local building departments (in the form of building permit data) and planning departments for multi-building, large developments. These data were difficult to obtain and are not as robust as anticipated. Local record keeping ranges from meticulous to non-existent. Among those that had readily accessible data, several missing data points and incomplete records were identified.

Second, the Sacramento Business Journal produces an annual publication, the Top 25 Book of Lists (*18*), which, among other things, lists the 25 largest public construction projects and the 25 largest private construction projects for that year. After careful examination of these data they appear to capture all large projects for each year. These data were available for 2001 through 2004. Useful data provided include: the developer, the type of development (from which the use may be obtained), the size (in square feet), the location (by address), and the estimated construction cost in US dollars. In addition, the 2003 publication also included the 25 largest shopping centers in the region with similar data (size, location, year built, etc.) but went as far back as the early 1950s. Taken together, these data provide a reasonably good picture of the recent large development activity in this region.

While the historical development data demonstrate the reality of large real estate developments and the conceptual need to model them, only the model itself can tell us what impact large developments will have on model outputs. To evaluate the effects of explicitly accounting for large projects in integrated land use and transportation modeling and to isolate which types of projects have the largest impacts—and therefore are the most critical to account for—each type of project (or use category) observed in the data was manually input into the Sacramento MEPLAN model. Each project was given a consistent location (northern urban edge), size (one million square feet), and year of development (model year 2002.5). These were run individually and compared against a future base case scenario. By holding size, location, and year constant, impacts can be evaluated more easily and attributed directly to the type of development modeled (e.g. industrial, office, retail, etc.). In all cases, the model was run from a base year of 2000 to the year 2020, a typical planning horizon.

The Base Case represents a relatively unconstrained land use scenario. This land use scenario was derived from the local general plans of the cities and counties in this region. In 2000, over 800,000 vacant acres are zoned for development. By 2050 only roughly 250,000 of these have been developed (leaving more than a half million vacant acres zoned for development). This allows households and employees to locate almost wherever they want. The travel networks consist of the current network (as it was in 2000) with incremental additions in the years 2005 and 2015. These travel networks were obtained directly from the travel demand model currently being employed by SACOG.

Results

The effects of modeling the various types of large developments in North Natomas (the subject zone) can be seen in Table 4. One of the more striking findings is that the secondary growth impacts of the large basic sector office development are larger than its primary impacts. In other words, 5,000 employees were manual input into the model along with the floorspace, by 2020, an additional 6,291 employees (not present in the future base case model run) were drawn to the zone from elsewhere in the region. The drawing effect, or secondary growth impacts from the large office development are actually larger than the development itself. In all other cases, the drawing effect was either equal to or smaller than the size of the initial project, as expected. This is a key finding and demonstrates the differential drawing abilities of different types of large developments, within the MEPLAN model.

Further, the impact appears to be non-linear. The basic sector mixed-use development, which is half retail and half office, had a lower than expected impact on zonal outputs given the magnitude of impacts produced by the basic sector, million square foot office and retail projects. The nature of the non-linearity of these relationships cannot be known from this research. One data point is insufficient to draw conclusions from and further study is needed with multiple sizes of projects to clearly demonstrate this phenomenon.

[Insert Table 4 about here]

The primary and secondary growth impacts of the modeled large developments impacted the distribution of trips. As can be seen in Table 4, the large basic sector office development caused an increase of roughly 32% in trips attracted to the subject zone. This caused the corresponding link volumes (associated with this zone) to increase as well—particularly the arterials, as the major highways were already heavily congested in 2020. This redistribution of trips can be attributed directly to the presence of the manually added large developments, the employees (in the basic sector cases) that were input with them, and the employees that were subsequently drawn to the zone. Trip generation by household income class and by employee type is fixed in MEPLAN. Therefore, the regionwide number and type of trips did not change in the model.

Only modest impacts were expected from this exercise. These large, manually-imposed developments represent only a small portion of the total employment growth in the region for the model year 2002.5 and an even smaller percentage of the total employment growth experienced across all 20 years covered by the model. Further, given the preponderance of million-plus square-foot developments in the historical data it was initially believed that numbers equal to those found in the data would be needed to produce significant differences in the model's outputs. The large shifts in employment and trip activity in the zone caused by a single basic sector development were a bit surprising, especially considering the amount of growth this zone was going to experience anyway (see Table 3).

Two "big picture" findings become evident from Table 4. First, it is clear that within this model, the location of basic sector industry plays a major role in the location decisions of other types of commercial activities. This creates a path dependency within the model. It appears that where basic sector employment goes other types of employment will follow. Care needs to be taken when calibrating the basic sector employee location submodel as this will have a strong influence on model outputs. Second, for the location and size modeled here, basic sector large developments have more of an impact—and are therefore more important to model explicitly—than non-basic sector large developments within the Sacramento MEPLAN framework.

The amount of growth experienced by the subject zone (North Natomas) in the Future Base Case is the most likely reason for why non-basic sector developments did not have a significant impact in 2020. If the zone was going to gain a million or more square feet of a particular development type anyway, then modeling it explicitly in 2002.5 is less critical for final-year analysis. If year-by-year outputs are of interest, then the timing of that growth becomes more vital to model. Also note that while the non-basic projects did not produce large impacts on zonal employment totals, they did impact the number and shares of some employee types within the zone. The large retail project, for example, produced 15% more retail employees in the out year than did the base case.

As discussed earlier, non-basic floorspace is developed in MEPLAN without the ability to explicitly assign employees to it. If zone "x" is unattractive to employees of a certain type, compared with other zones possessing available floorspace, then the floorspace in zone "x" will likely not be occupied. The million-square-foot health project, for example, failed to fill any of its floorspace. This was the only large project modeled that failed to do so. This finding is an artifact of the zonal characteristic for the selected zone.

The small percentage shifts in households caused by the large basic sector developments was a bit puzzling at first. After careful examination of the model it was learned that the increases in employment consumed land and bid up the price of land in the zone. The combination of these together with the marginal increases in congestion (travel time delays) experienced by households in this zone resulting from the large developments are likely what caused the reductions in households observed in Table 4.

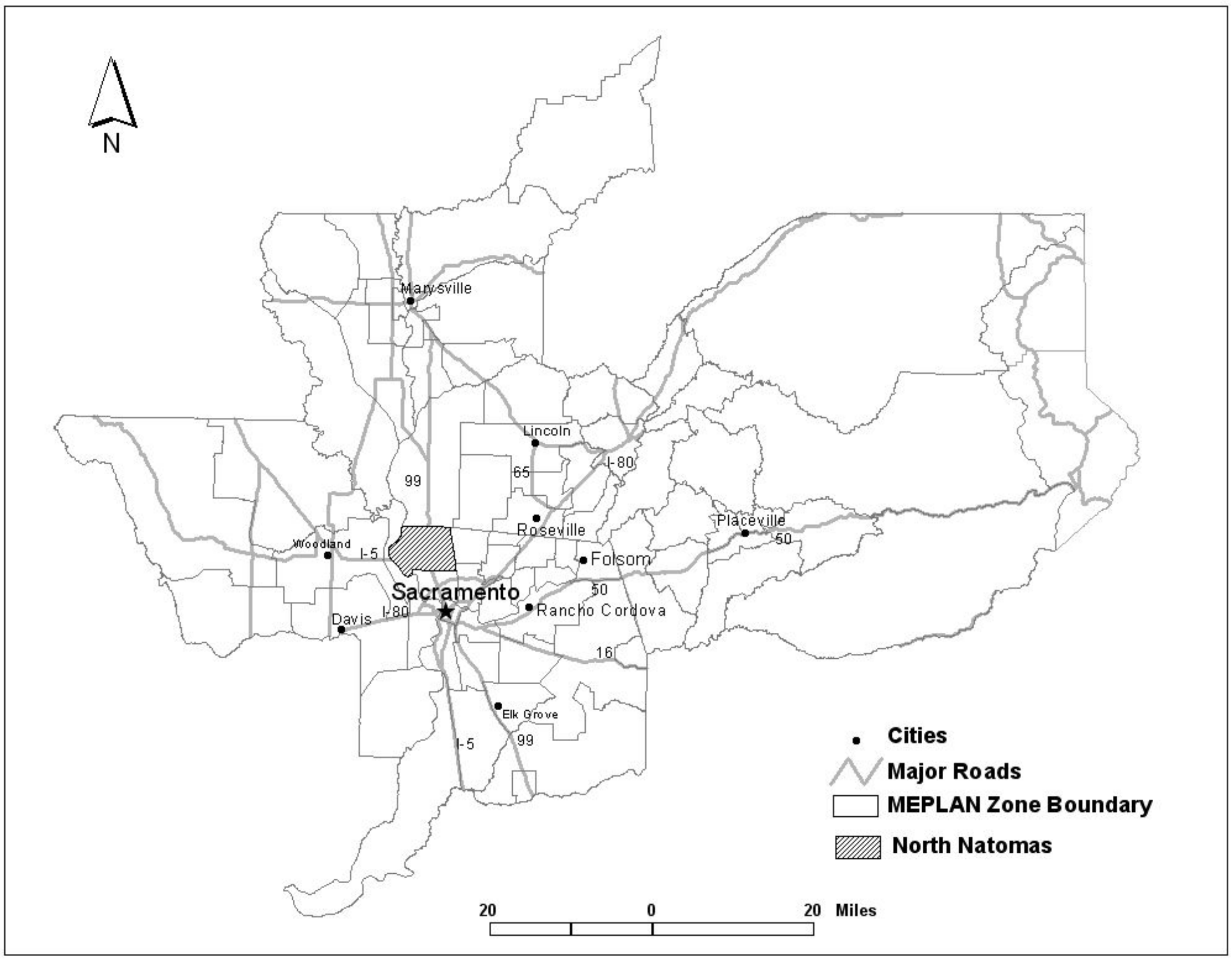

FIGURE 1 The Sacramento Region

TABLE 3: Future Base Case growth in North Natomas Zone from 2000 to 2020

	Year 2000	Year 2020	Percent change
Households	706	36,494	5,069.15
Employees overall	5,549	19,288	247.62
Employees by type:			
Office	862	5,829	576.05
Industry	789	1,462	85.22
Retail	705	5,312	653.34
Health	0	0	.00
Education	123	3,047	2,382.89
Government	3,024	3,594.80	18.88

TABLE 4: Year 2020 Impacts in the North Natomas Zone from Individual Large Developments by Type, Built in 2002.5: Changes from Future Base Case

	Number of employees added manually	Resultant % change in households	Resultant % change in employees	Resultant % change in trips generated	Resultant % change in trips attracted
Basic sector:					
Office	5,000	-2.27	58.54	13.00	32.10
Industrial	3,831	-3.30	49.32	8.09	21.37
Retail	5,000	1.23	36.61	1.89	31.53
Government	5,000	-.85	41.70	3.87	21.47
Mixed-use	5,000	-1.12	28.04	3.96	18.55
Non-basic sector:					
Office	N/A	.23	3.76	1.14	2.31
Retail	N/A	4.43	4.33	3.64	4.52
Health	N/A	.14	-.06	0.10	0.11
Education	N/A	.20	-.09	-0.16	0.30
Government	N/A	.23	3.76	1.14	2.31
Base numbers for 2020:		36,494	19,288	43,451	1,177