

## TELUM Land Use Model Case Study - Des Moines, Iowa

### 1. Introduction

A small sample dataset was used to develop the TELUM Tutorial given in Chapter 3 of this TELUM User Manual. A new user of TELUM can follow through the Tutorial and learn how the system works; using the small dataset provided with the tutorial the user can also test various aspects of TELUM's modeling application. This document presents an abbreviated description of an actual "case study" using TELUM. The case study is based on a project that was initially done by Adam Noelting at the Des Moines Area MPO, and we owe him our thanks for providing the data for the case study analysis. By following the discussion of the model development and analysis provided in this document, the TELUM user can see how an actual MPO dataset was used to proceed through the steps of a model implementation and illustrative scenario testing. It is important to note that these scenarios do not represent official policies of the Des Moines Area MPO, rather they are simple, but we hope realistic, exercises which will serve to show the reader some of the possibilities for the use of TELUM.

### 2. Data Preparation for the Des Moines region

Located in south central Iowa, the Des Moines area is what most people would consider to be a small-to-medium sized MPO, with a year 2000 population of about 394,000 people. The study region selected for the case study covered about 286,000 acres (a bit less than 450 square miles). For the analysis purposes the study region was divided into 103 small areas, or zones.

TELUM guidance recommends users to classify households into 4 to 8 household categories, depending upon data availability and reliability. As recommended, the households were grouped into four categories equivalent to income quartiles. These categories do not have to be exactly equal in numbers of households, but they shouldn't result in grossly disproportionate numbers of households either.

The employment was grouped into eight categories based upon the old SIC codes. The data were prepared and entered into TELUM according to the guidelines given in the manual. On completion of the data entry, the report shown in Figure 1 was prepared by TELUM, and printed for the user.

On completion of the IDEU step, the next tasks involved input of the zone specific data which describe the region. This takes place in the DATAPREP section of TELUM. Once the zonal data are entered in the DATAPREP spreadsheet we can have a quick review of some of the regional totals.

**Initial Data Entry Unit Report**

Name of the Region:  Number of Zones:

Estimated Total Population:  Current Year:  Lag Year:

Employment Data Available

Current Year:  by Type  by Total  None  
 Lag Year:  by Type  by Total  None

Number of Employment Categories:  Employment Categories:

Household Data Available

Current Year:  by Type  by Total  None  
 Lag Year:  by Type  by Total  None

Number of Household Categories:  Household Categories:

Total Land Area of the Region:

Land Use Data Available for Your Project

Usable  Unusable  Basic  Commercial  Residential  Street/Highway  Vacant Developable Land

Forecast Time Periods:

Empl-to-HH Conversion:  PUMS Ratio  Default Ratio  
 Empl per HH by Income:  Empl per HH Ratio  Default Ratio  
 Unemployment Rate:  UR Ratio  Default Ratio  
 Net Commutation Rate:  NCR Ratio  Default Ratio  
 Regional Jobs Per Employee:  RJPE Ratio   Default Ratio

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Figure 1. IDEU Report screen for Des Moines case study

The employment was divided into 8 categories:

- |  |        |
|--|--------|
| 1. Agriculture, Forestry, and Fishing, and Mining – AB | 2,128  |
| 2. Construction – C                                    | 13,029 |
| 3. Manufacturing – D                                   | 19,033 |
| 4. Transportation, Commercial, Utilities – E           | 13,844 |
| 5. Wholesale Trade – F                                 | 18,553 |
| 6. Retail Trade – G                                    | 45,243 |
| 7. Finance, Insurance, Real Estate – H                 | 41,441 |
| 8. Services, Pub. Administration – IJ                  | 94,146 |

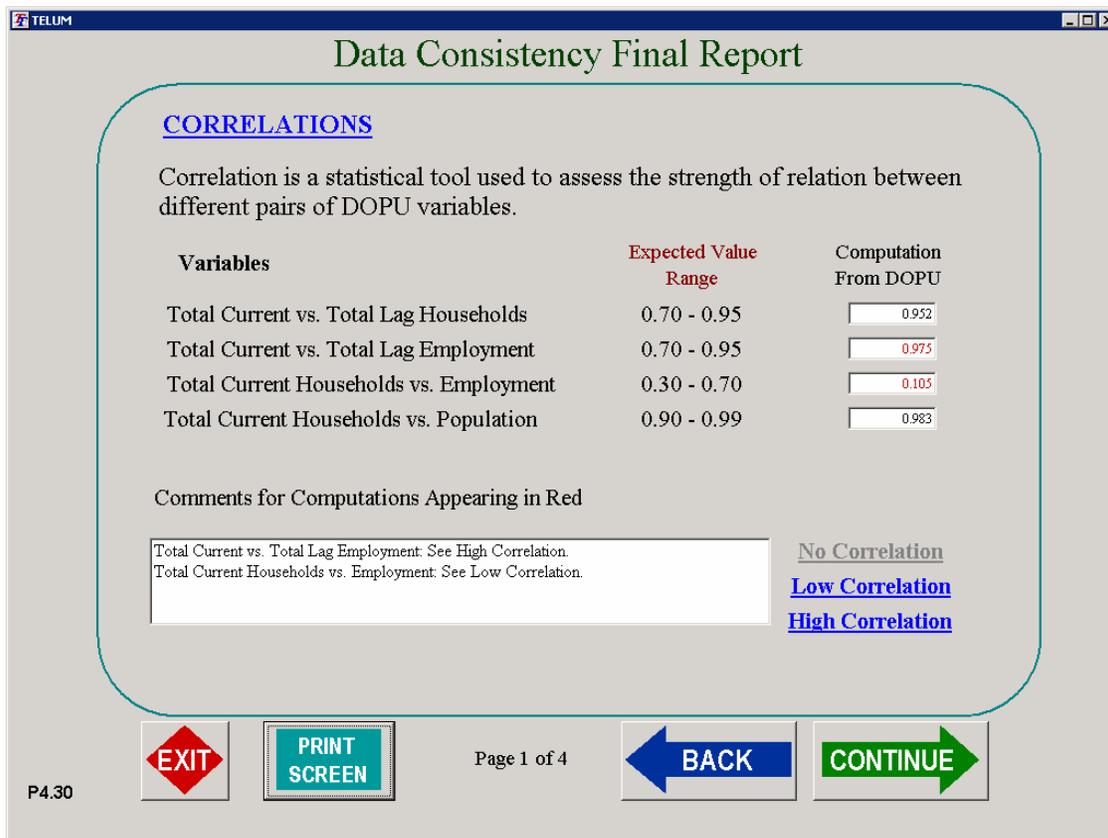
As can be readily seen, there is considerable disparity in the sizes, i.e. the numbers of employees, in each category. If it were possible to do so, it would probably result in better forecasting results, if the IJ category was split so that some of its employees were moved to another category, and if, perhaps, the AB category was combined with other categories to eliminate that rather small group. Of course, the goal of this exercise would be to define groups that are more homogeneous in the location characteristics of the employees, which might or might not be achieved by re-aggregation of the categories. It would be easy enough to construct some alternate data sets and run several different TELUM project installations to test them.

Continuing in this vein, the households were divided into four groups, as per:

1. Low Income – LI	45,724
2. Low Middle Income – LMI	53,840
3. Upper Middle Income – UMI	46,187
4. Upper Income – UI	10,360

Here again, there is considerable size disparity between the UI category and the other three household categories. This should probably be remedied in any future modeling with this data. Either the three lower categories should be revised to put more households in the highest category, or the categories should be revised altogether, by creating perhaps 6 income groups of more even sizes, e.g. about 25,000 households each. Even so, these disparities are not fatal problems, and on the completion of the DATAPREP portion of TELUM a series of checks is performed which are to inform the user of any potential data problems before proceeding into further modeling work. These checks are initiated by the user who is asked to press a Data Check button at the completion of the data entry work. Several reports are prepared, and the first of these reports for the case study dataset is shown in Figure 2.

Here TELUM is checking on possible data problems with, say, current or lagged employment having been calculated by a simple multiple one of the other. Let's assume, for example, that the lagged employment had been produced simply by scaling the current employment up or down. Then, the correlation between current and lag employment would show up as too high. This would cause statistical problems in the model calibrations to be done in the next section of TELUM. The agency would need to invest more time, resources, and effort in obtaining better lagged employment data. If this wasn't done, then the model would calibrate to current employment (and later to projected employment) just being a simple extrapolation of lagged employment (i.e. employment in the previous time period). If, on the other hand, there was very little correlation between current and lagged employment data, then the agency should be concerned that the two data sources were inconsistent, because there should be some moderate correlation between the two, as employment doesn't just jump around a region with no regard for prior employment patterns.



**Figure 2.** DOPU Data Consistency Report – correlations between total current and lag year households and employment in Des Moines dataset

The correlation between total current households and employment should not be too high either. It is quite possible that there will be relatively low correlation between the numbers of households residing in a zone, and the number of employees working there, but in general the correlation should not be very high.

Subsequent Data Check report provides analysis of correlations between the individual employment types. However, the actual problem checking is done only for the current versus lagged employment of each type. Again, it is a matter of checking for what may be simple scaling of data in order to fill in for missing real data. This is followed by a report on what are called “Regional Ratios”. Here, in particular, the regional Population per Household and Population per Employee are checked for consistency. TELUM doesn’t expect to find a regional rate of population per household to exceed 3.00, or a regional rate of population per employee to be greater than 2.00. Note that these are *regional* ratios, not values which might show up for individual zones in the region.

The final of this series of built-in checks is about regional growth or decline, and a land use consistency check (Figure 3). Here the system looks at the change from the lag to the current year for inconsistencies. The user is asked to think about the rates of change implicit in the data which they have input to the system. Again, the purpose is to try to catch problems early in the project, rather than discovering them after the final forecasts have been released to the local news media.

**Data Consistency Final Report**

**PERCENTAGE CHANGE**  
 The percent change observed for DOPU variables between two time periods.  
 Given the short span between time periods, we do not expect dramatic changes between variables.

Computation From DOPU

Regional Percentage Change in Households, Lag to Current Total Households	2.6	%
Regional Percentage Change in Employment Lag to Current Total Employment	5.3	%
Regional Percentage Change in Population, Current to Forecast Year	9.0	%
Regional Percentage Change in Employment, Current to Forecast Year	5.9	%

Comments for Computations Appearing in Red Type Additional Comments

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**LAND USE CHECK**  
 Here we are comparing the Total Land value you entered for your region in IDEU against the Total Land calculated from your DOPU data. Zero indicates there is no difference between the two values.

0

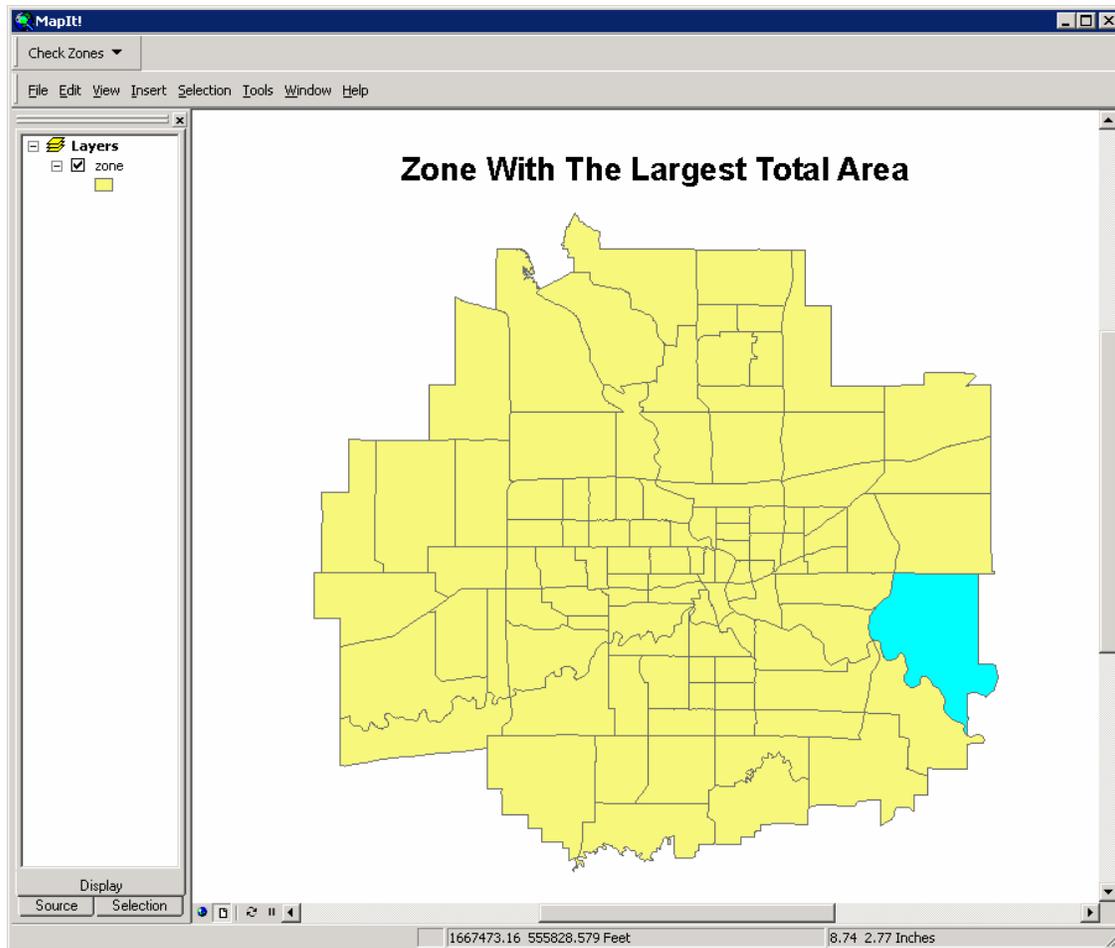
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**Figure 3.** DOPU Data Consistency Report – percentage change between households/ population and employment in current and lag/forecast year for Des Moines dataset

Following these checks on the data, a further set of checks is done on the mapping (GIS) component of the project. In particular, it sometimes happens that inconsistencies between the indexing system of the tabular data and the map *shapefiles* cause erroneous display of data on the map. These checks, performed in TELUM’s MAPIT module, are designed to catch such errors if they exist. One example is to simply check to see that the map ID values match the zone ID values. This is done by mapping what the data file indicates is the zone with the largest geographical area and then to have the user look at the map to see if this is correct. The screenshot of the mapping data

consistency check the for Des Moines case study dataset is presented in Figure 4. Similar consistency check options are provide for the zone with the maximum numbers of employees in the region and the zone with the maximum number of households in the region. In each case, the zone is highlighted on a map of the region’s zones, and the user is asked to check (confirm) if the zone is correctly mapped.



**Figure 4.** Mapping – data consistency check screen for Des Moines case study data and GIS layer

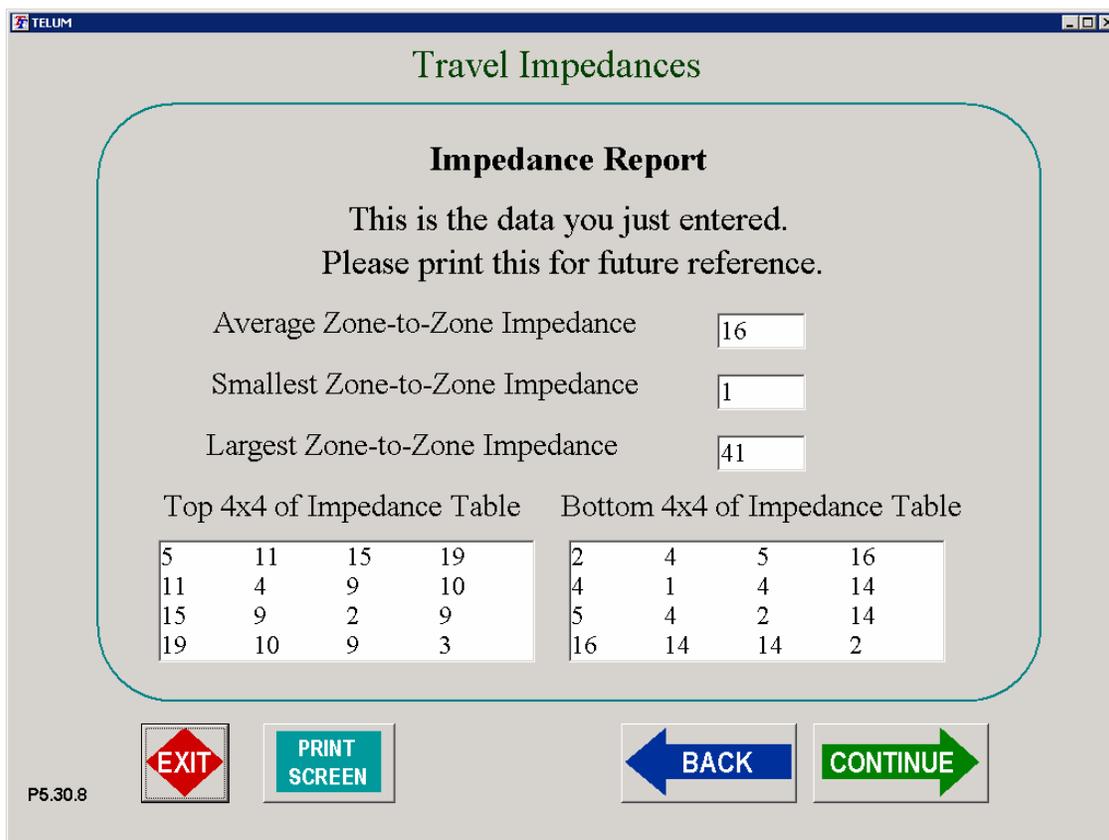
Upon completion of these checks, the user proceeds to the last major data component of the TELUM system where the travel times, costs, or composite measures are inputted to the system. This is done in the section called Travel Impedance Preparation Unit (TIPIU). Every land use model must make use of data which describe the difficulty of physical zone-to-zone interaction. The customary

variables used for this purpose are highway travel times or costs, or composites of time and cost, and in some more complex forms, composites of times, costs, and multiple travel modes such as highway and transit. We refer to these measures in TELUM as *impedances*. All MPO's make use of some form of travel demand models that produce these variables for the underlying transportation network. They are usually reported as matrices or tables listing impedances between each pair of zones in the analysis region (e.g. for a region with 100 zones the table would have  $100 \times 100 = 10,000$  impedance values).

There are, however, several different proprietary software packages in regular use for this purpose. In addition, many agencies have their own customized versions of one of these software packages, or an entirely original travel demand modeling package of local creation. Because of this variety of tools used to produce these measures of zonal transportation interactions, it isn't possible to assume that a specific one or few file formats will be the ones available in any particular agency.

In order to deal with this situation, TELUM requires its transportation network data to be input in a most simple format. This format is not the most efficient in terms of data storage, but it is one which can be created by every transportation software package or by a spreadsheet or database program utility linked to the transportation package. The format for these files is discussed in the TIPU section of the TELUM Manual, and is also illustrated in the Tutorial chapter of the Manual. Basically, the matrices of zone-to-zone impedances are converted to a simple list which begins with the impedance value for zone 1 to zone 1, and proceeds across the matrix row with zone 1 to zone 2, etc. reaching zone 1 to zone n (n is the total number of zones in the data set). The list continues with zone 2 to zone 1, zone 2 to zone 2, and so on to zone 2 to zone n. Again, the list continues with zone 3 to zone 1 and so on, until all rows of the matrix have been input in the list form.

TIPU is designed to both provide a means for entering the impedance data, and to do several simple checks on that data to ensure that it is correct and that input file is the one that was intended. In particular, from the modeling experience it was learned that in the commotion of preparing forecasts and/or regional policy analyses, it is possible that the wrong impedance matrix might wind up being accidentally input to the system. One way to help reduce the likelihood of this error is to ask the user to input some simple numerical checks which can be used by TELUM to confirm that the correct impedance matrix is being used. As such, some specific numerical values are input by the user. Afterwards, TELUM produces a preliminary Impedance Report that looks similar to the one shown in Figure 5.



**Figure 5.** Preliminary impedance report screen (summarizing user input statistics) for the Des Moines case study impedances

Once these values are entered TIPU checks for the availability of the actual impedance file and if it is present it attempts to read it. If it is not present or if it is misnamed TELUM warns the user to repair the problem. If it is able to read the file, TIPU compares the user input statistics to the same statistics as computed from the impedance file it just read. If they match, TIPU proceeds to further checking. If not, it alerts the user to the problem. On completion, a report is printed which can be compared to the initial inputs. In addition, a frequency distribution of the actual impedance values is displayed, as this is a simple way of assessing the sensibility or reasonableness of the overall impedance matrix (Figure 6). The user should be sure to examine these reports before moving on to further work, as unreasonable impedances will result in the entire analysis having to be redone.

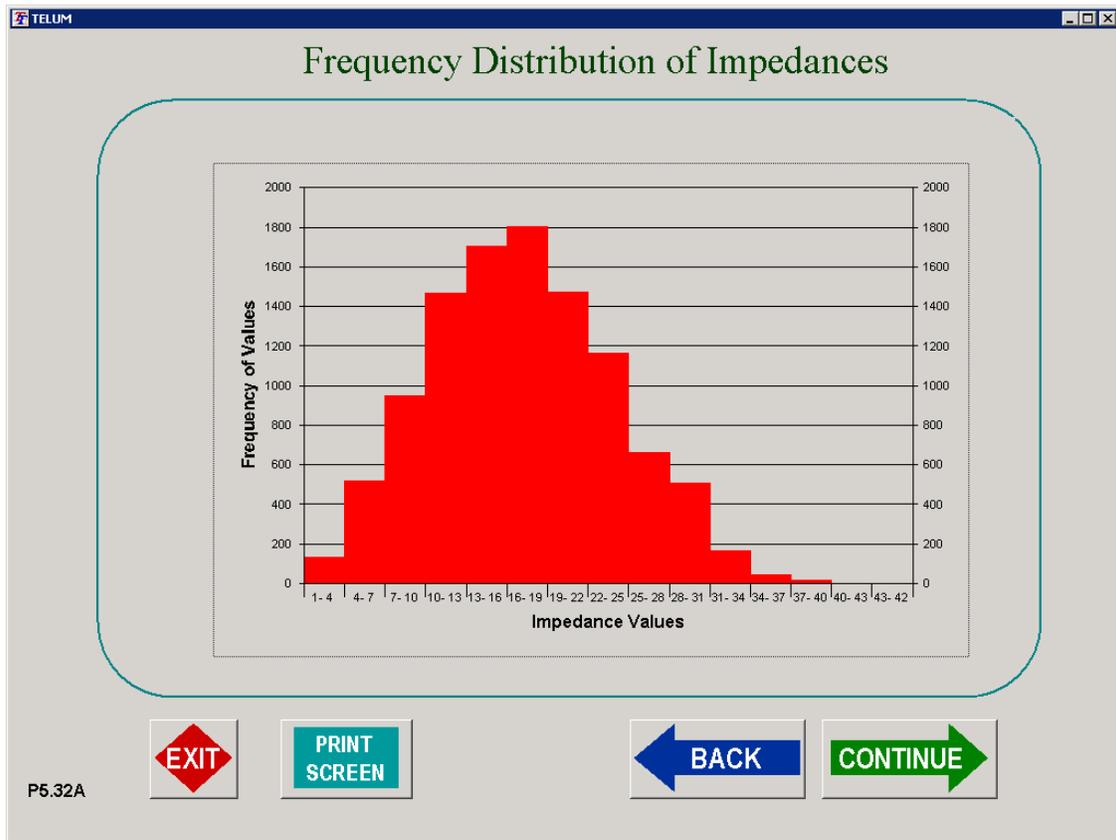
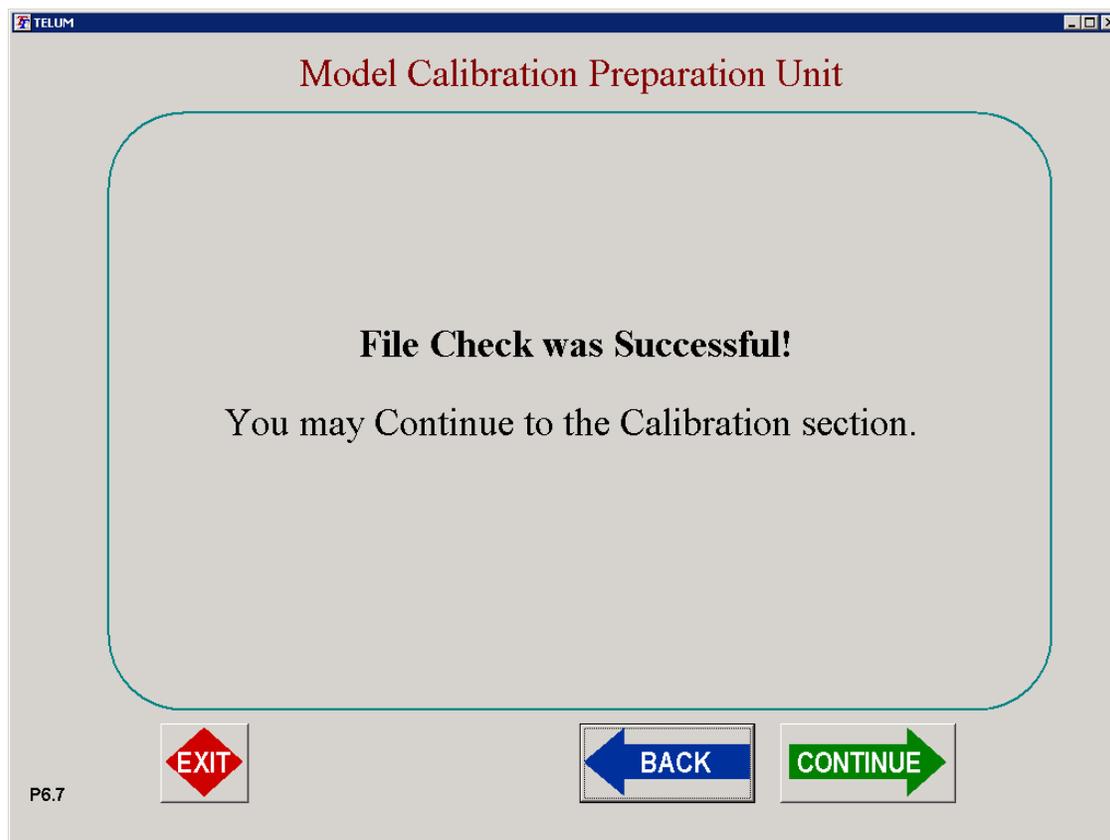


Figure 6. Frequency distribution of impedances for Des Moines region dataset

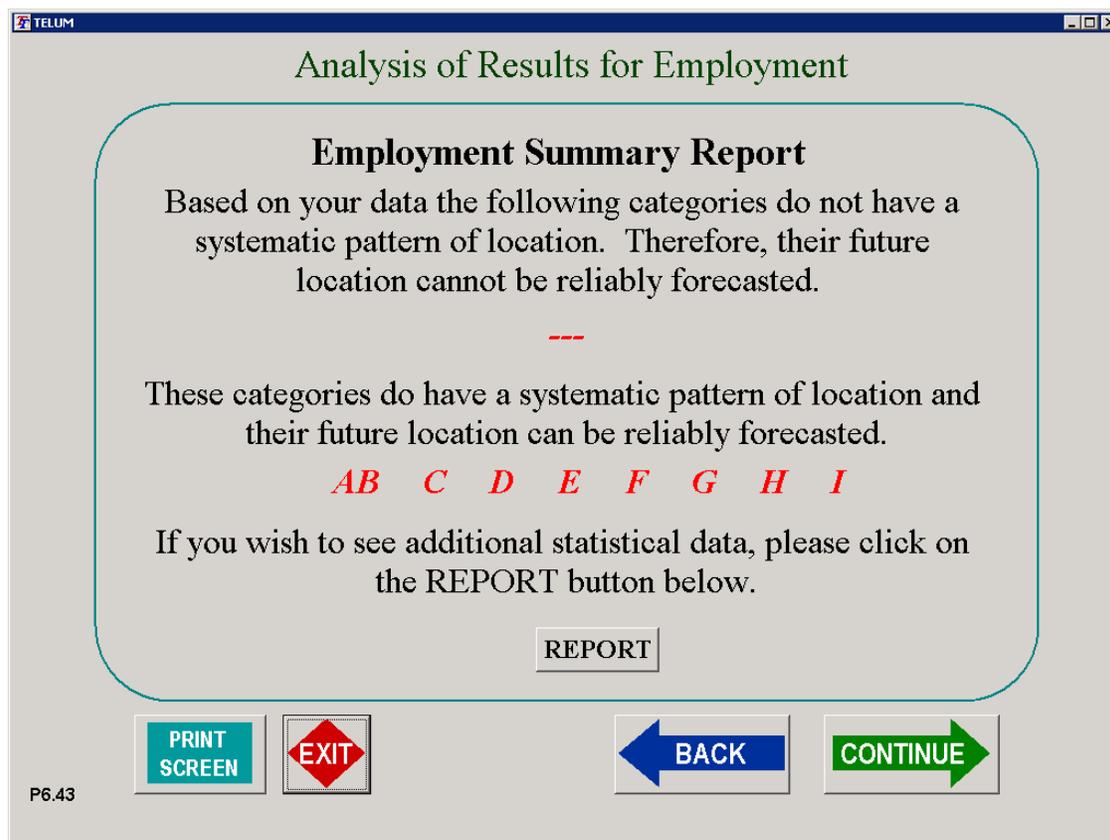
### 3. Model Calibration for the Des Moines region

After completing the data input and verification (data checks) required for the modeling project, the next step is to conduct statistical calculations which will fit the model to the region’s data. This step is called *calibration*. In TELUM the calibration phase begins with checking the availability of necessary data files (Figure 7).



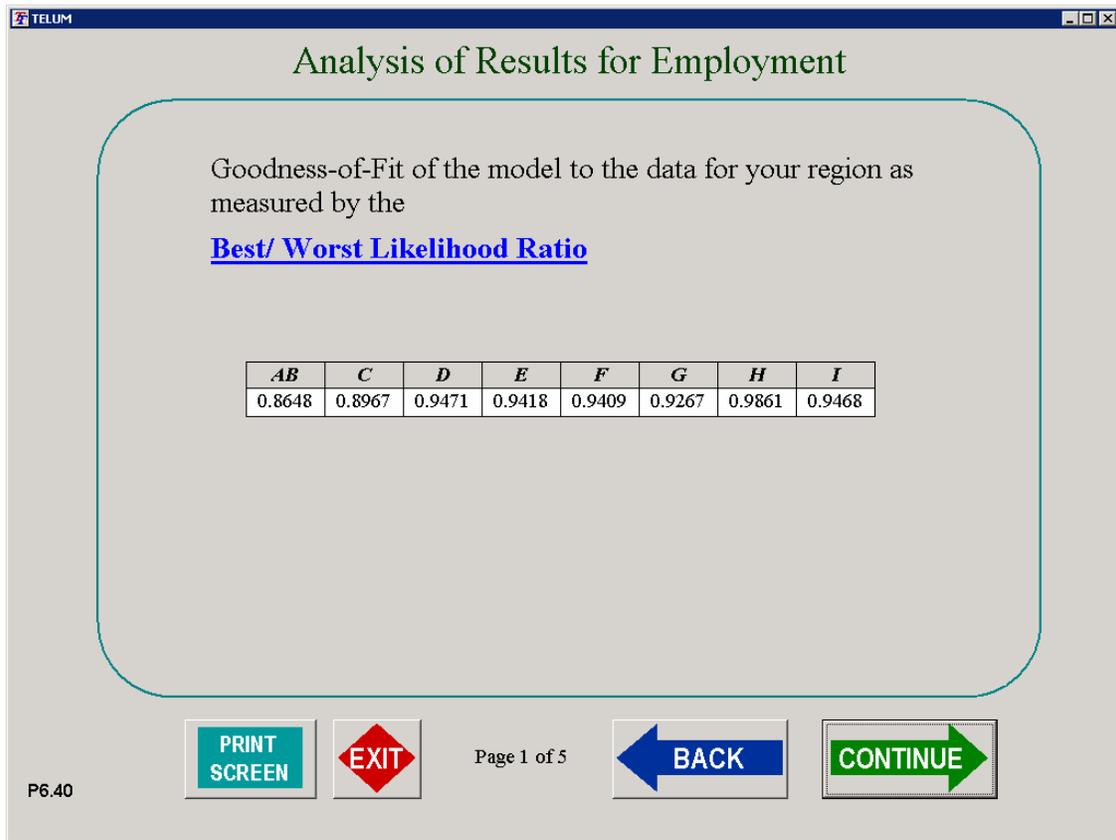
**Figure 7.** The calibration file check report screen (after TELUM confirmed that all necessary files are located)

Once it has been determined that all necessary files are in place, the user is asked to start the calibration process. In calibration each locator type, that is, each employment type and each household type, is calibrated separately. TELUM performs model calibration without user intervention, and it is done in a sequence of individual statistical analyses for each locator type. This analysis is accomplished by a method known as nonlinear multiple regression, using a sophisticated search technique. When completed, a set of summary reports are made available to the user. They begin with a simple summary such as the report presented in Figure 8.



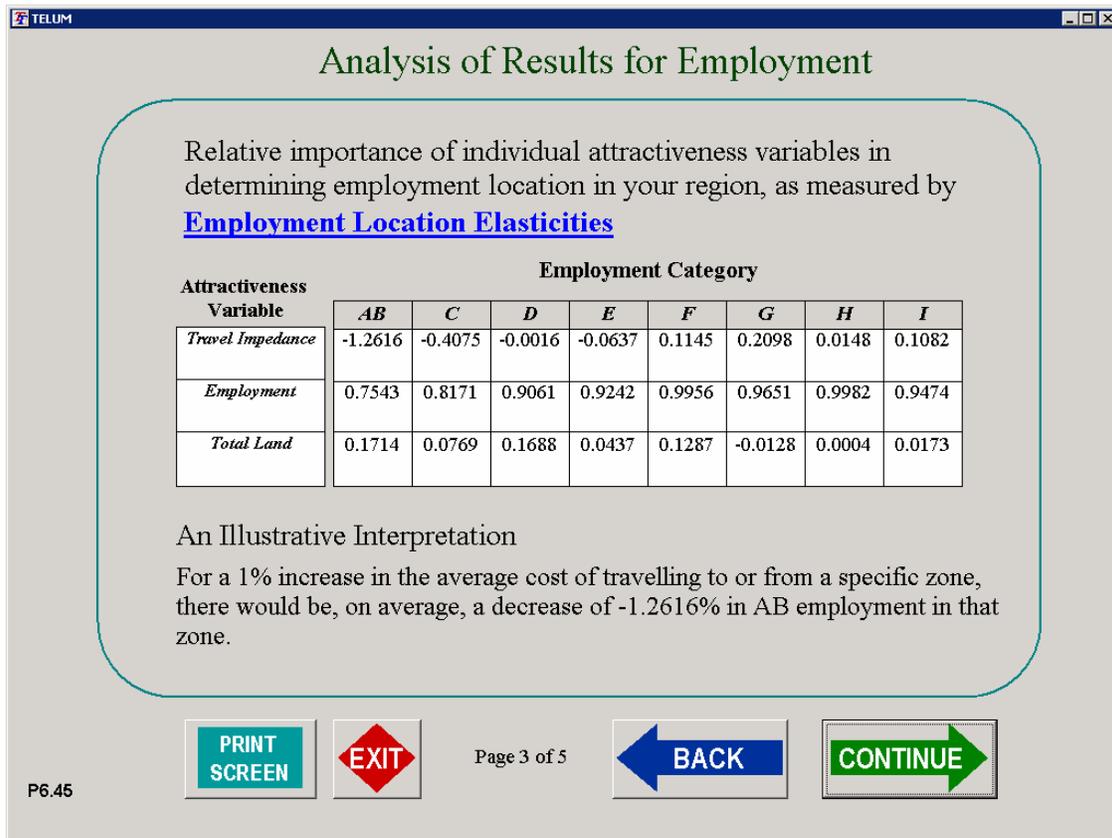
**Figure 8.** Calibration summary – employment summary report screen for the Des Moines case study model

Following the summary, progressively more detailed reports are available to the user: the report shown in Figure 9 summarizes how well the employment model fits the Des Moines region's employment data. The Goodness-of-Fit results are presented in terms of a measure called the Best/Worst Likelihood Ratio, which is equivalent to the more commonly seen  $R^2$  (R-square), or Coefficient of Determination, which measures the portion of variance accounted for by the model. The results shown in Figure 9 indicate a very good fit of the model to the Des Moines employment data, with the range being from 0.8648 to 0.9861.



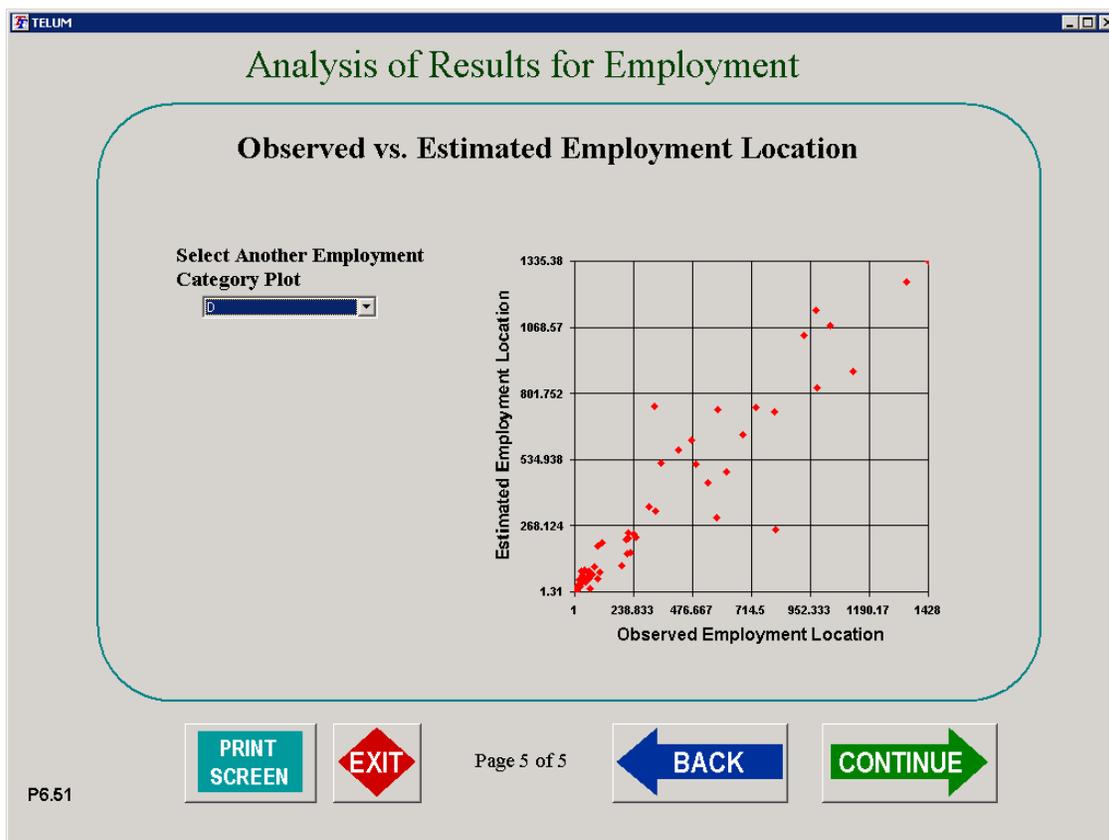
**Figure 9.** Goodness-of-fit summary for the employment model in the Des Moines case study

Additional reports are also available, as calibration is one of the most important steps in the modeling process and the user should be sure that it was done correctly. One such report, on *elasticities*, informs the user as to the relative importance of each of the variables in the model (Figure 10).



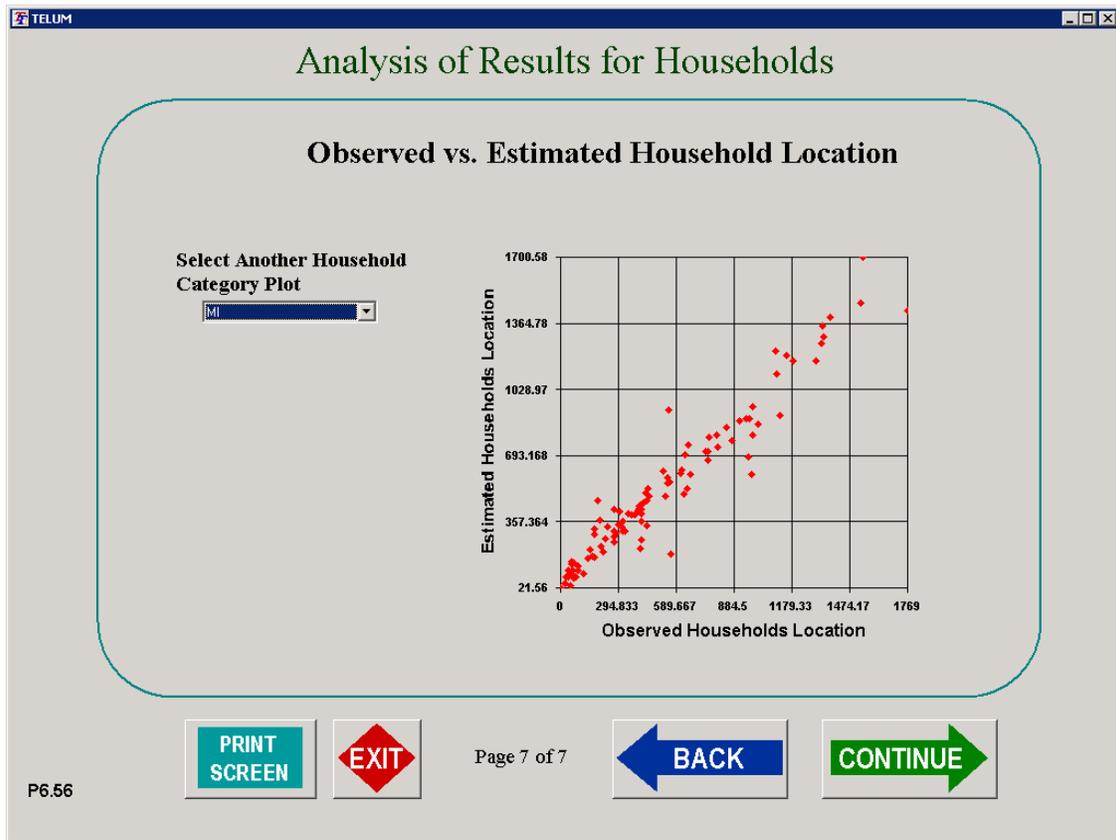
**Figure 10.** Calibration summary – employment location elasticity in Des Moines case study model

In addition to the numerical summaries, TELUM also provides the user with a graphical analysis of how well the model estimates for each of the locator types, employment or households, fit the observed data. These charts are of considerable value to the analyst, as they can be used to point out which zones are not well described by the model equations, and which might bear further examination for possible data anomalies. A chart for employment type D (Manufacturing) for the Des Moines case study model is presented in Figure 11.



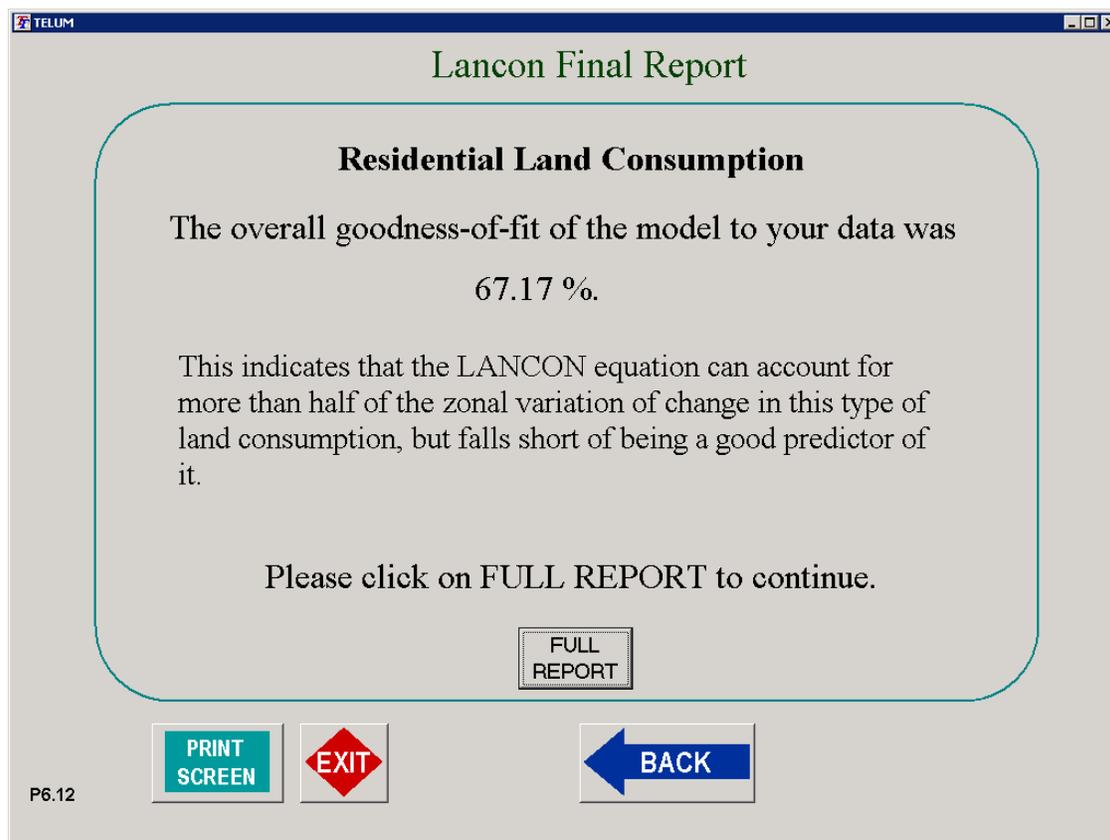
**Figure 11.** Calibration summary – observed vs. estimated employment location for type D – manufacturing in Des Moines case study model

Similar reports are available for the household calibration results as well (Figure 12).



**Figure 12.** Calibration summary – observed vs. estimated household location for type MI – middle income households in Des Moines case study model

The calibration step concludes with the statistical analysis of land consumption, where the average amount of land used by each of the categories of locating activities is calculated. Land consumption calculation is performed by TELUM’s procedure called LANCON. LANCON applies a multiple regression analysis using macros in Microsoft Excel. Results of the LANCON analysis for the Des Moines dataset are presented in figures 13 and 14.



**Figure 13.** LANCON final summary report screen for residential land consumption in Des Moines case study model

Note that the land consumption calibrations almost always show the lowest levels of goodness-of-fit of all the components of the model. This is due to several factors. First, it is very difficult to estimate variations in land consumption by small areas within a region. Second, it is almost always impossible for regional agencies to supply small area land use data for more than one time period. This means that all such models must be built on a cross-sectional basis, thus, in effect, tying one hand behind the modeler's back before even starting. Even so, some portion of the variation can be estimated and this, for the most part, is better than nothing. Perhaps in the near future, with the universal adoption of GIS in agencies, multi-time period land use data will become available. It will still be necessary to cope with differences in data classification and systematic differences in data gathering, but it is possible that it will then become possible to improve the land consumption component of the TELUM model.

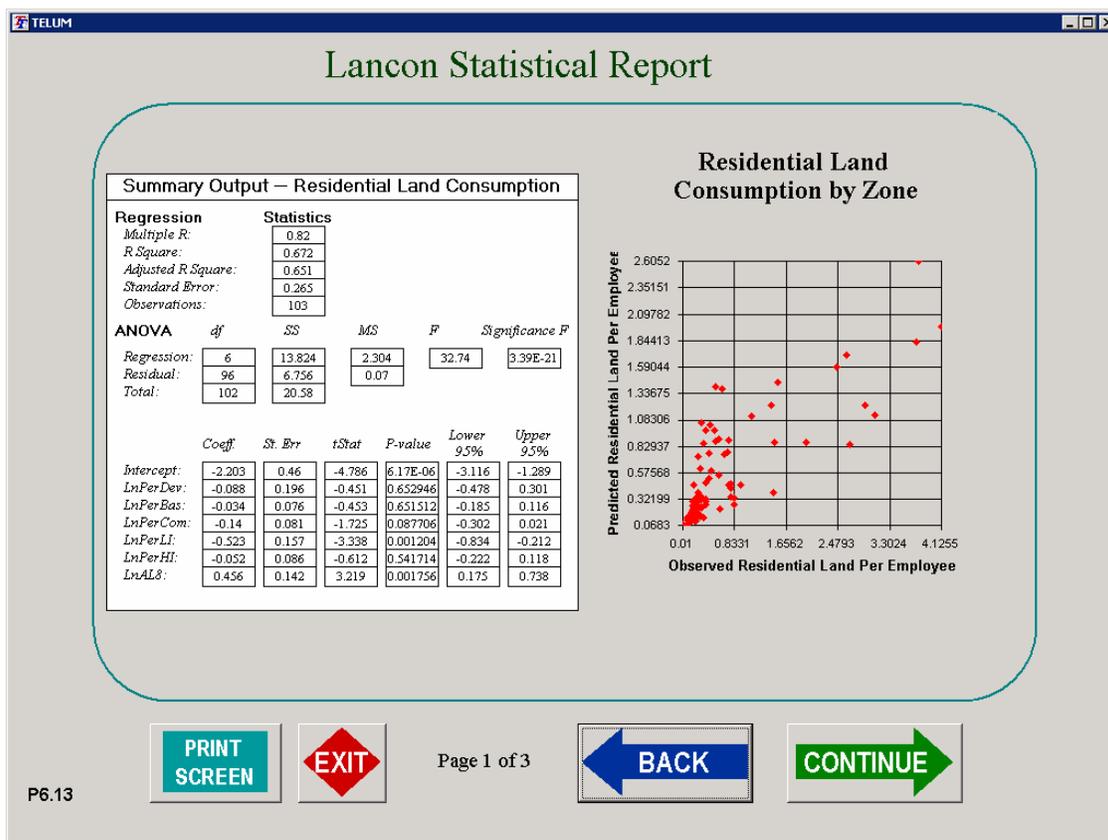


Figure 14. LANCON statistics report featuring a scatter-plot of observed versus estimated residential land consumption in Des Moines case study model

After completing all steps of the calibration process, TELUM system takes the user to the next phase in the process: the actual forecasting of employment and household location in the region.

#### 4. Forecasting for the Des Moines region

Four alternative model forecasts were performed using the provided data for the Des Moines Area MPO:

- 2005-2030 **Baseline Forecast** using constant values of impedance for all time periods;
- 2005-2030 **Policy #1 Forecast** of the region with updated regional travel impedances for the forecast years 2005, 2010, 2020 and 2030;

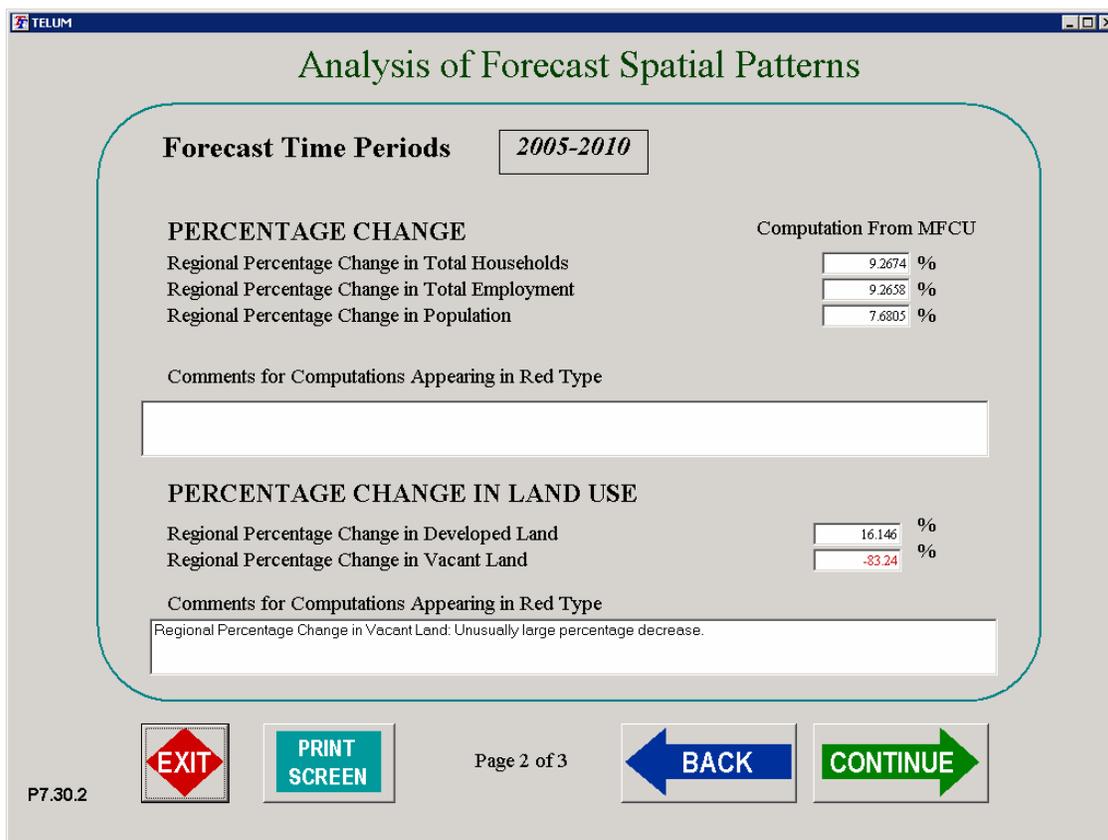
- 2005-2030 *Constraint Forecast* with household and employment growth in outer ring zones *south* and *east* of Des Moines being constrained;
- 2005-2030 *Constraint Forecast* with household and employment growth in outer ring zones *north* and *west* of Des Moines being constrained.

### *a. Forecasting Baseline*

After completing data entry (IDEU, DOPU, TIPU) and calibration (MCPU), we were ready to produce a Baseline set of model forecasts for the Des Moines region by proceeding to the Model Forecast Preparation Unit (MFCU). The MFCU begins a Baseline model forecast by asking the user to press a *File Check* button. During a file-check procedure TELUM quickly scans its project folders to make sure all the data inputs and files necessary for a successful model forecast are available. If TELUM reports an unsatisfactory file check, it is likely that one or more of the steps in IDEU, DOPU, TIPU, and/or MCPU are incomplete. In this case, a user would need to return to IDEU to review the initial data inputs, as well as complete a walk through of DOPU, TIPU, and MCPU to ensure completion of all the steps toward the model forecast.

Upon the return of a successful file-check, TELUM proceeds to the model forecast run, which the system automatically names *BL* for Baseline forecast. Here, TELUM prompts the user to click the “GO” button to begin the BL model forecast for the forecast time periods 2005 through 2030.

On completion of the calculations, the results of the BL forecasts for defined time periods are first presented in a report form, called Analysis of Results (Figure 15). TELUM generates this report for each model forecast year. For Des Moines, six-model forecast reports were generated, one for each 5-year period starting with 2005 and ending with 2030. The user can review reports by selecting a horizon year from the drop down menu.



**Figure 15.** Analysis report for the 2010 horizon year forecast results in Des Moines case study model

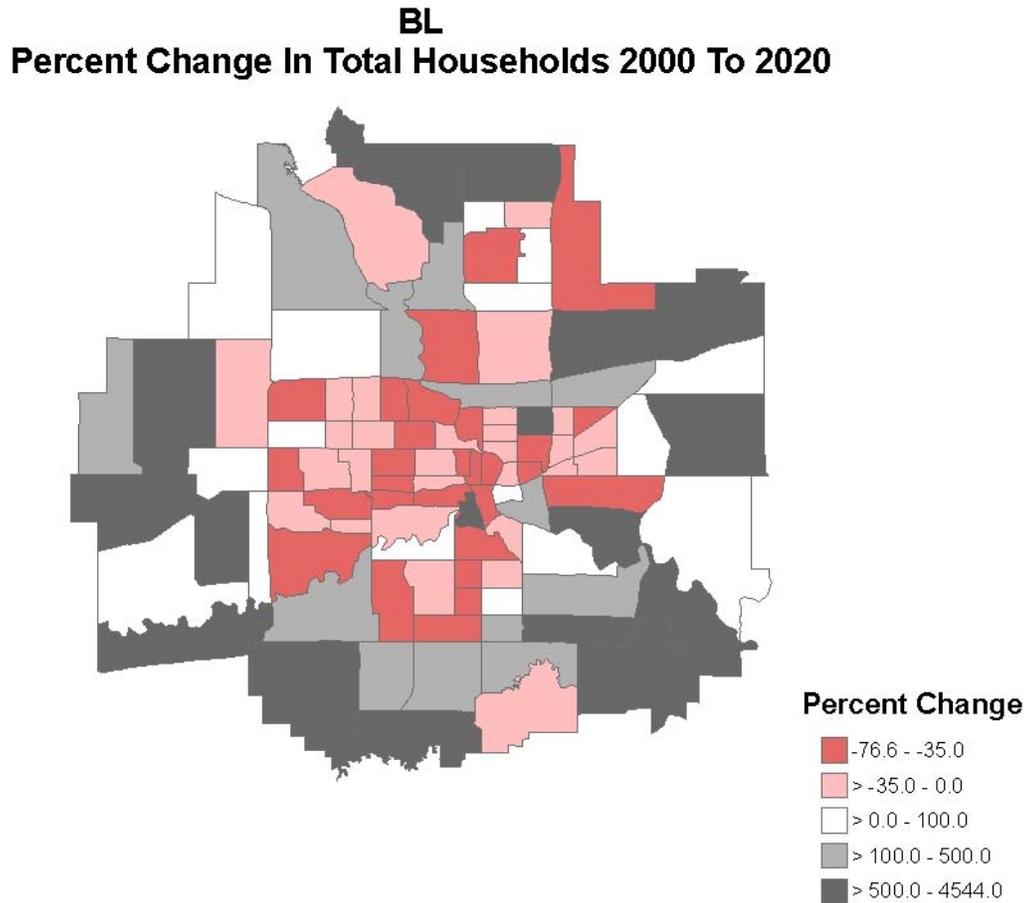
TELUM calculates several descriptive statistics to measure growth or decline in a region, based on the model outputs generated for each forecast year. We can see from the Des Moines MPO forecasts that the regional population is expected to grow between forecast years 2005 and 2010 by over seven percent, and both households and employment are predicted to increase by over nine percent. Furthermore, the TELUM analysis shows that with this additional growth in the region, vacant land in the region is expected to decrease by over 83 percent. While the first two seem reasonable, the latter is most unlikely, and reflects the problems previously alluded to with respect to forecasting land consumption. In practice, it would be necessary for the user(s) to review and revise some of the land consumption forecasts. We found these trends continued through forecast year 2030.

MAPIT module provides a number of maps showing the results of TELUM model forecasts. User can choose to map the following:

- Forecast values of employment and households (totals or by type);

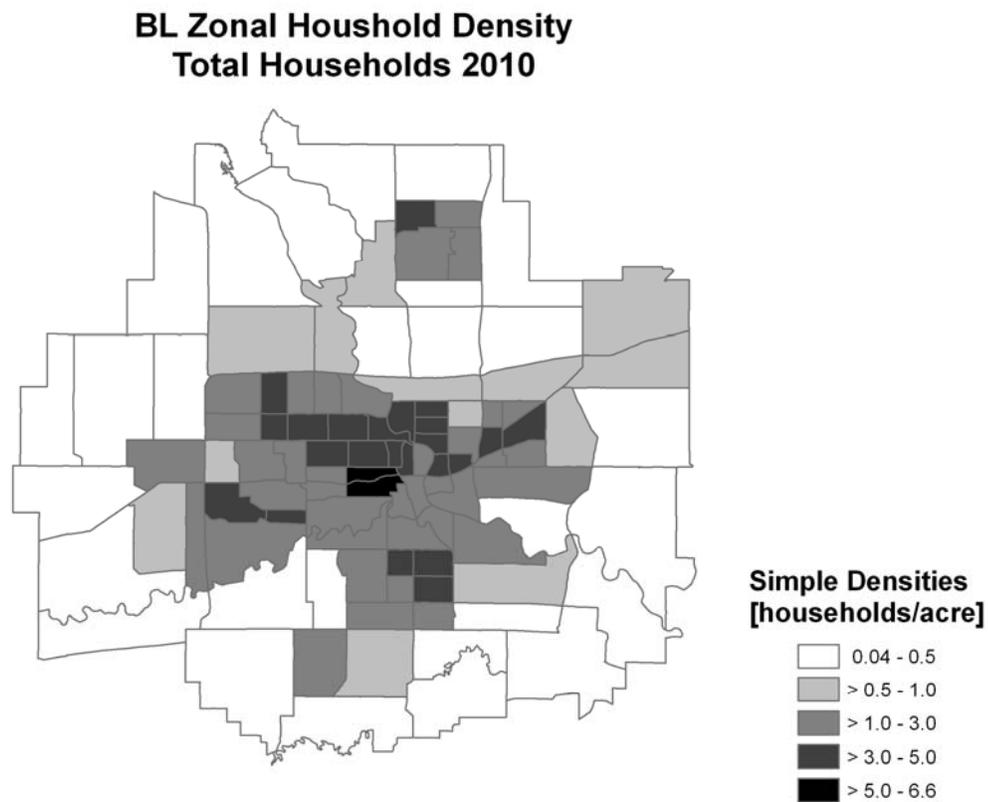
- Differences in employment and households (totals or by type) between two forecast years;
- Percent change in employment and households (totals or by type) between two forecast years;
- Simple employment and household densities (totals or by type);
- Weighted employment and household densities (totals or by type);
- Density gradients.

With MAPIT, we were able to quickly determine where in the Des Moines region the model predicted additional household and employment growth. The map in Figure 16 shows the percentage change in household location between current year 2000 and forecast year 2030 for the baseline (BL) scenario. Immediately, we see that the darker zones, expected to experience growth in number of households, are larger zones located predominately in the outer ring of the region. Note that some of the MAPIT maps will only show completely if they are printed in color.

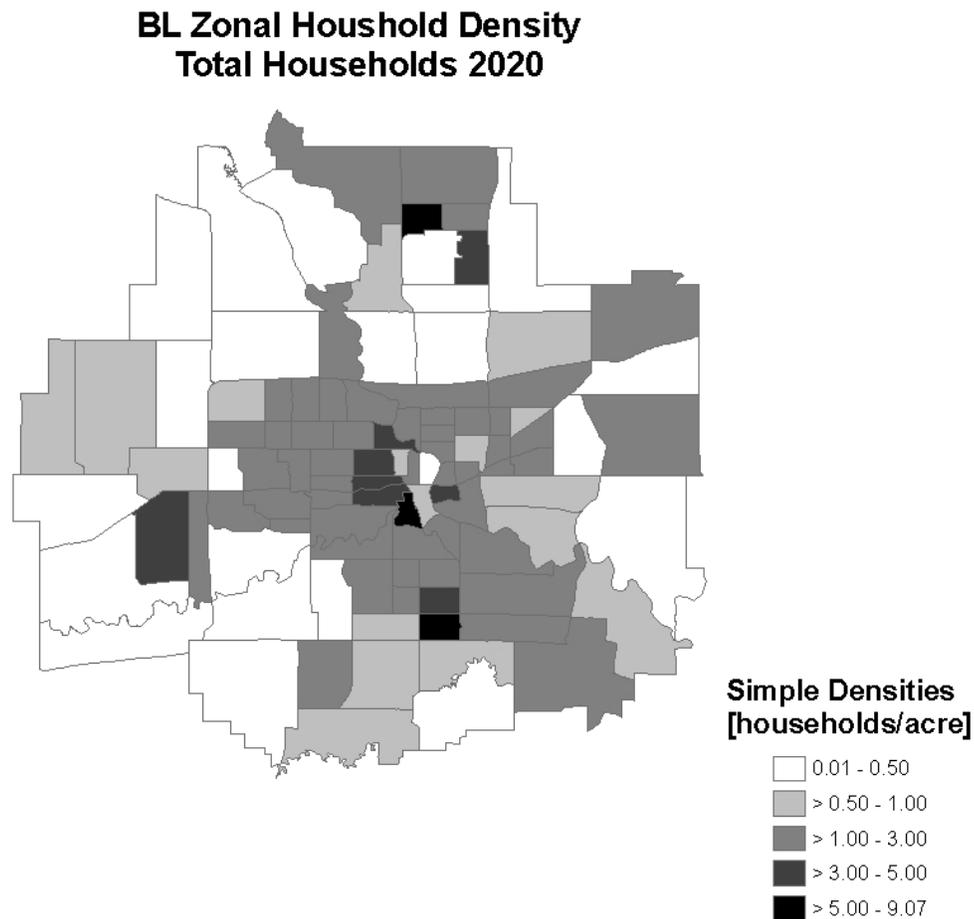


**Figure 16.** Forecast map summary in MAPIT – percent change in total households 2000-2020 for the BL scenario.

Figures 17 and 18 show maps generated from the option *<Map Simple Densities>* for the BL scenario and forecast years 2010 and 2020. The maps indicate the dispersion of zones with dense household population from inside and around the core of the region to zones in the outer ring.



**Figure 17.** Forecast map summary in MAPIT – forecasts of zonal household density for total households in 2010 for the BL scenario.



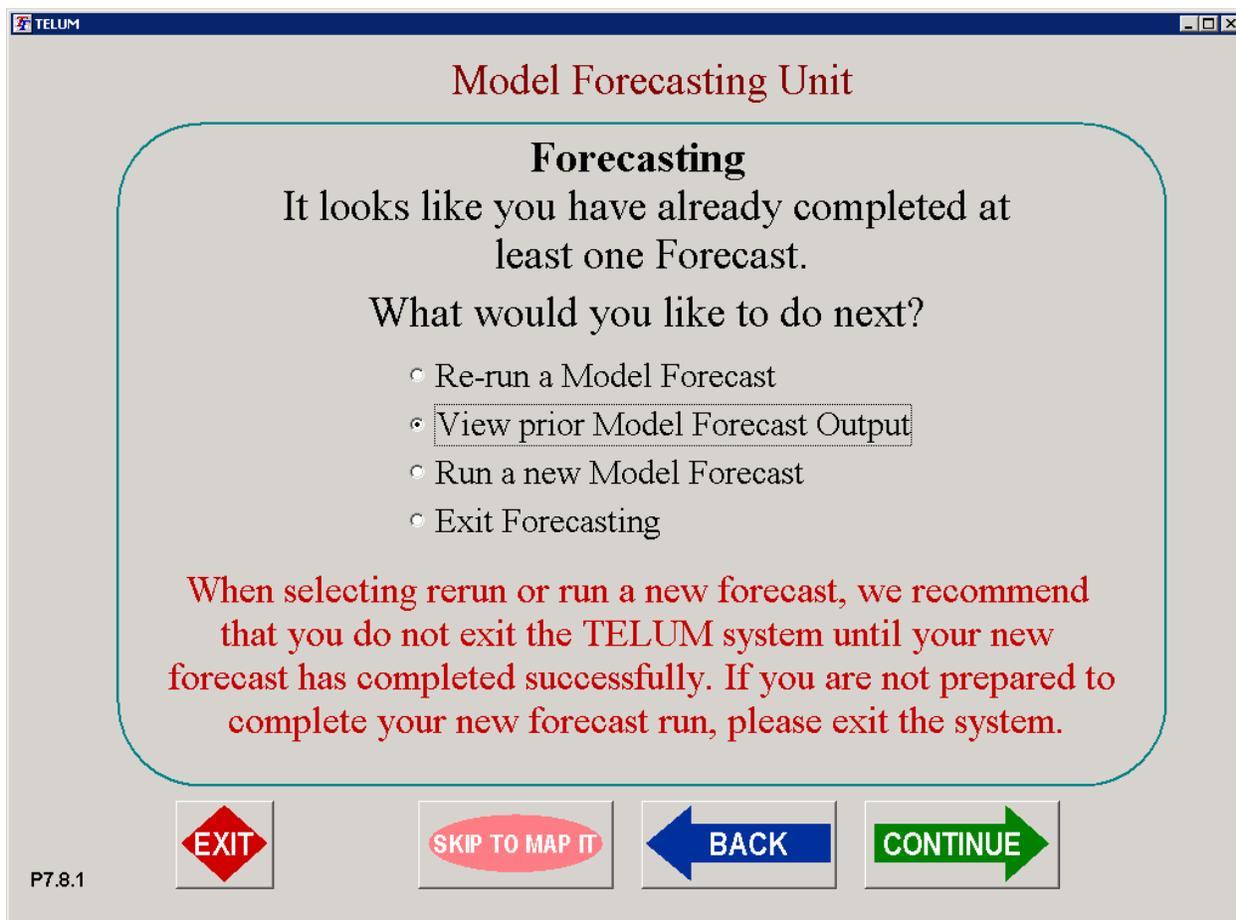
**Figure 18.** Forecast map summary in MAPIT – forecasts of zonal household density for total households in 2020 for the BL scenario.

***b. Policy Forecasts and Comparison with Baseline***

The Des Moines MPO provided additional impedance datasets produced by its 2005 travel demand model that could be used to run TELUM policy model forecasts. These updated impedance files for 2005, 2010, 2020, and 2030 reflect infrastructure investments planned for the region, particularly in the southern and eastern zones. The Des Moines MPO reported in its 2030 Long Range Transportation Plan that infrastructure improvements in the southeast would likely contribute to the development of those zones, outpacing growth in other areas of the region. Using the updated travel impedance files, we returned to the TELUM Model Forecasting Unit (MFCU) to run the first

policy scenario analysis for the Des Moines region. The forecast runs for this scenario were labeled 1P.

Upon return to MFCU, TELUM recognized that a baseline forecast for the region was complete. In these situations the system moves users to a forecasting screen where they need to specify if they wish to repeat or review an old model forecast, or run a new model forecast. In our case study project we selected *<Run a new Model Forecast>* to begin the 1P policy scenario forecast (as shown in Figure 19).



**Figure 19.** MFCU screen that allows user to either go back and review or re-run prior model forecasts, or perform a new (policy scenario) forecast run

Unlike the baseline forecast to which TELUM assigned the name BL, TELUM requires the user to assign names to all new scenario forecasts. The length of a scenario name is limited to three alpha and/or numerical characters.

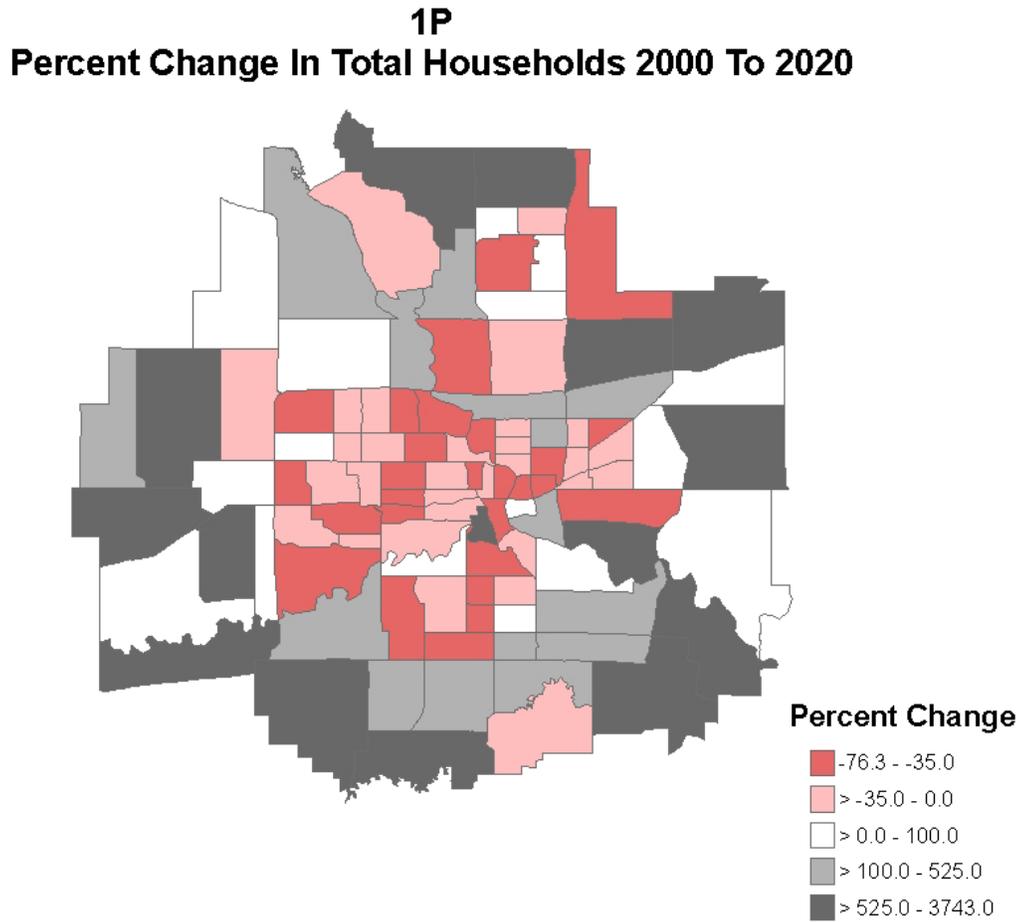
*NOTE: Given that multiple forecasts runs are likely, we recommend users always enter a brief description of the TELUM forecast in the box provided.*

Once the name of the new model forecast is entered, TELUM asks a variety of questions pertaining to the data that the user wants to change or add for the new model forecast. For 1P scenario forecast we indicated that we would add Travel Impedances. Adding impedance files for forecast years 2005, 2010, 2020 and 2030 is done the same way a user enters an impedance file in TIPU, except we began by indicating there were four new impedance files and naming each one as per TELUM instructions.

After each impedance file passed file check, TELUM proceeded to the Model Forecast screen. With the 1P model forecast run completed, we were able to compare 1P regional model forecast outputs to the baseline (BL) forecasts.

### [c. Analysis of 1P Model Forecasts](#)

As we used the same regional growth forecasts for policy scenario 1P as for the baseline (BL) forecast, the review of the 1P analysis reports confirmed that household and employment growth for the Des Moines region would be at the same nine percent rate as in the BL forecasts. Looking at the zonal percentage change in household location for scenario 1P between 2000 and 2030, we found a map very similar to the corresponding BL map. Therefore, the infrastructure improvements considered in scenario 1P overall appear to have little impact on the forecasted development patterns in the region. Without analyzing the regional transportation system, we guessed that there probably was little or no transportation capacity problems in this part of the region to begin with. Thus, the transportation improvements resulted in rather little change in the transportation system's characteristics as perceived by the users. In other words, if there wasn't much congestion in the BL transportation system characteristics, then capacity improvements would not make much of a reduction in the already minor congestion levels. From a modeling perspective, it is also important to note that the transportation modeling process that produced impedances was conducted independently of the land use modeling. This means that if there was any congestion induced by the forecasts of employment and household locations, the transportation models would not have reflected it. All the transportation forecasts, all the way out to 2030, were calculated prior to the running of the employment and household location forecasts. Generally speaking, this is not the best practice, and modeling should be done with a consideration of linking the transportation forecasts and the location/land use forecasts.

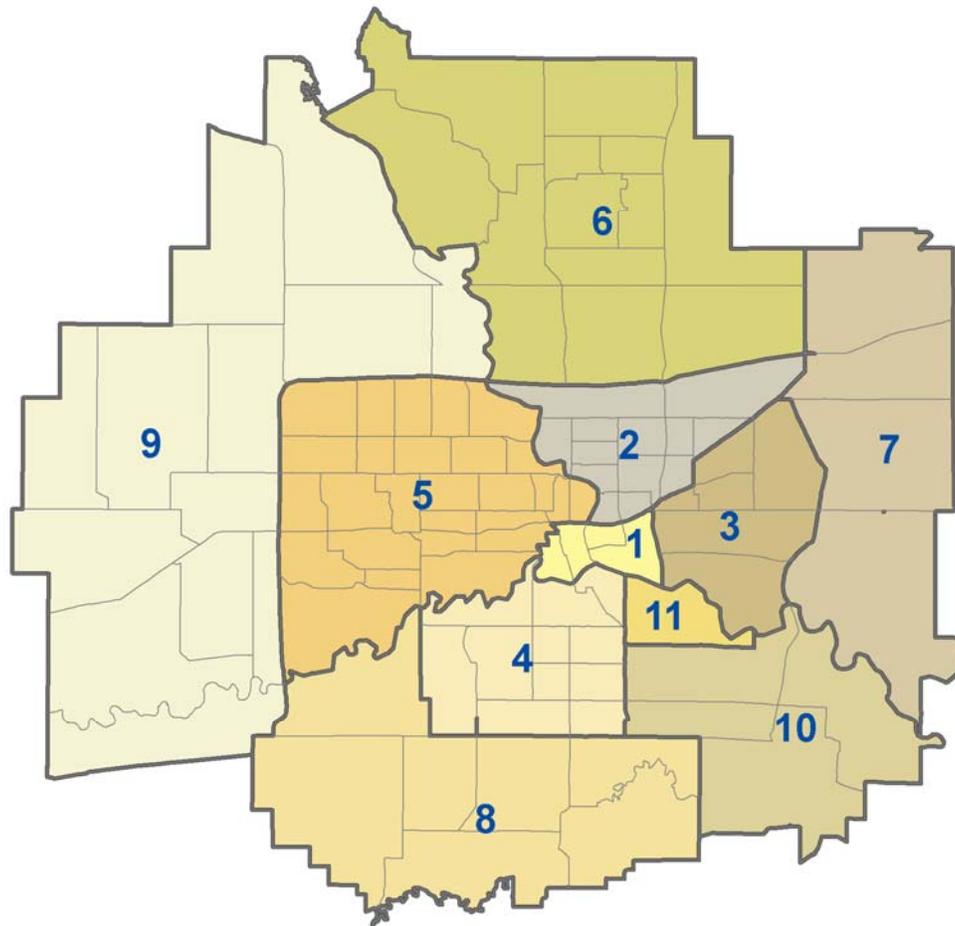


**Figure 20.** Forecast map summary in MAPIT – percent change in total households 2000-2020 for policy scenario 1P

**d. Constrained Policy Forecasts**

The Des Moines MPO expressed some curiosity as to the possible effects of implementing a policy that would increase development in and around the core of the region. The MPO divided the region into 11 sub-areas. Sub-areas # 6, 7, 8, 9 and 10 make up the outer ring of the region in which the MPO would prefer to limit growth in order to stimulate development in and around the core sub-

areas of Des Moines. To follow this up, we did a simple model test run of such a policy. The map of 11 sub-areas defined in Des Moines MPO region is shown in Figure 21.



**Figure 21.** Map of Des Moines Zone Groupings by 11 Sub-areas (each sub-area is labeled by number)

From the BL and 1P model forecasts, we could see that both households and employment were attracted to zones located in the region's outer ring. Therefore, to develop a policy to increase development in the core and inner ring areas of the region we needed to limit location in the outer ring zones. Two policies were developed to constrain total household and employment growth in the outer ring zones using a Type II Forecast Constraint:

1. The first policy constrained total household and employment growth in sub-areas #7, 8, and 10, the southeast corner of the region. The corresponding model forecast was labeled 7C0, which we used as an abbreviation of constraint run in sub-areas 7, 8 and 10.
2. The second policy constrained total households and employment for sub-areas #6 and #9, the northwest corner of the region. The corresponding model forecast was labeled 6C9.

The Type II Constraints were implemented using the [<Run new model Forecast>](#) option in the TELUM MFCU. Just as we had done for the first 1P policy forecast, we began this first constrained model forecast by assigning the name to the scenario (7C0, and then 6C9 in the next scenario run). This time we clicked [<yes>](#) to forecasting constraints and we selected a Type II constraint, meaning we would enter the total number of households and total employment per zone. In both forecasted constraint policies, the total growth of households and employment in each constrained zone was set to 10 percent per forecast year. It is important to mention here, that we calculated the ten percent growth limit of the household and employment totals for each forecast time period using our 2000 zonal totals. The calculations were completed in a separate Excel spreadsheet, printed, and used as inputs for the constrained model policy runs.

Once the user specifies the type of constraint to be used in the model forecast, the system asks for the forecast years that will be constrained, as well as whether there will be constraints placed on employment and/or households, as shown in the screen presented in Figure 22.

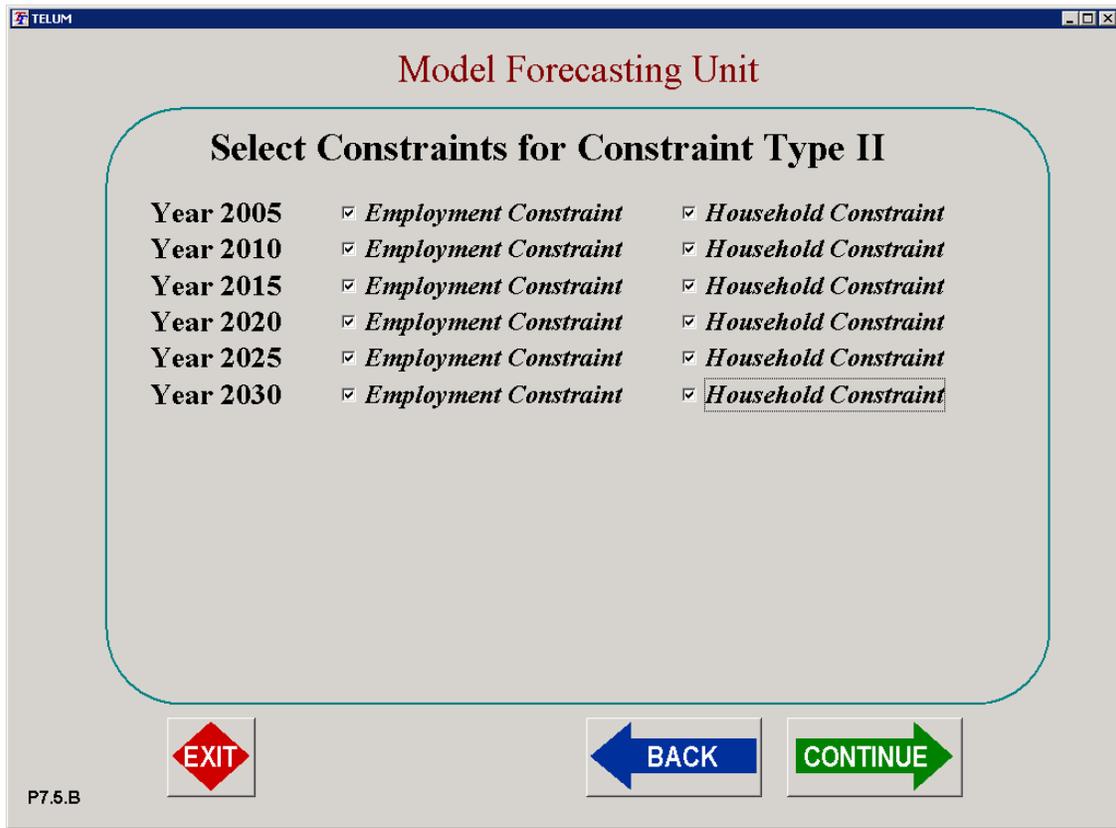
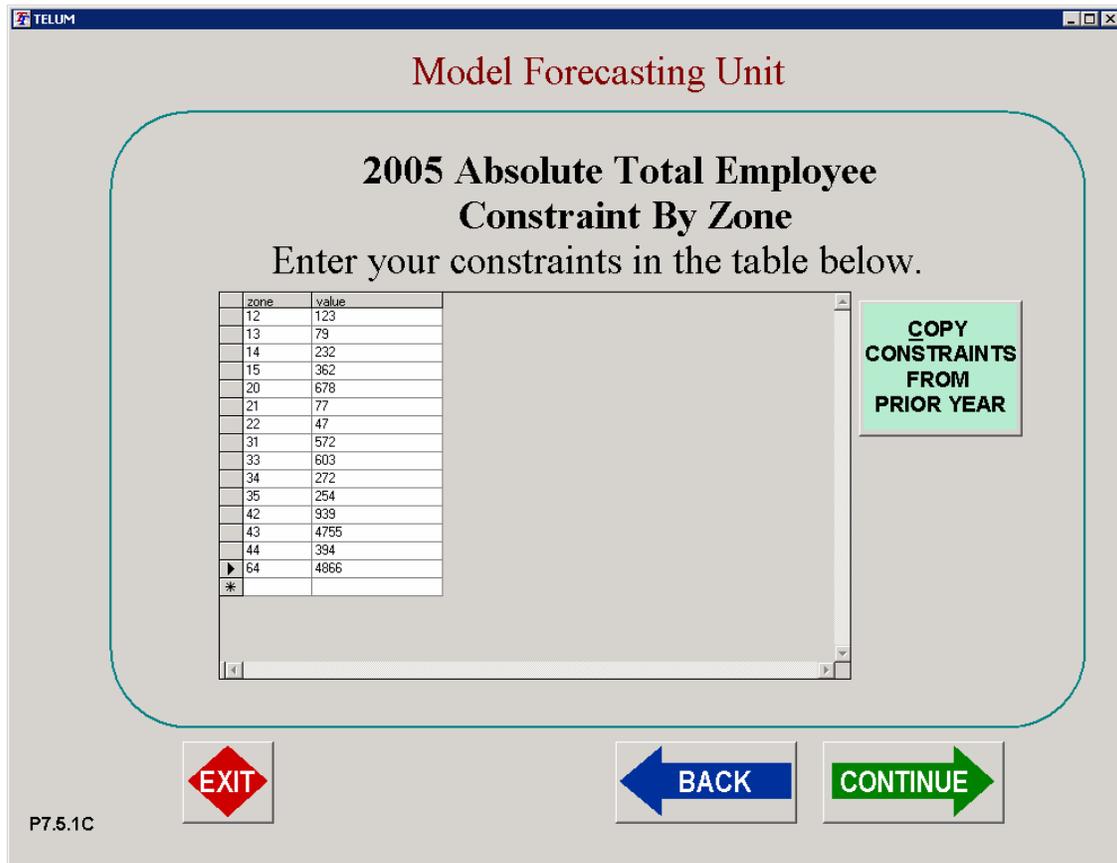


Figure 22. Constraint Type II selection screen in TELUM MFCU

For this policy forecast, we constrained both households and employment for each forecast year, 2005 through 2030.

Each zonal constraint total is entered on a special TELUM MFCU screen shown in Figure 23. After all constraints are entered into the MFCU, TELUM produces a “Constraint Summary”. This summary allows the user to review or print constraint inputs. Once the constraints are entered, TELUM is ready to run the new model forecast.



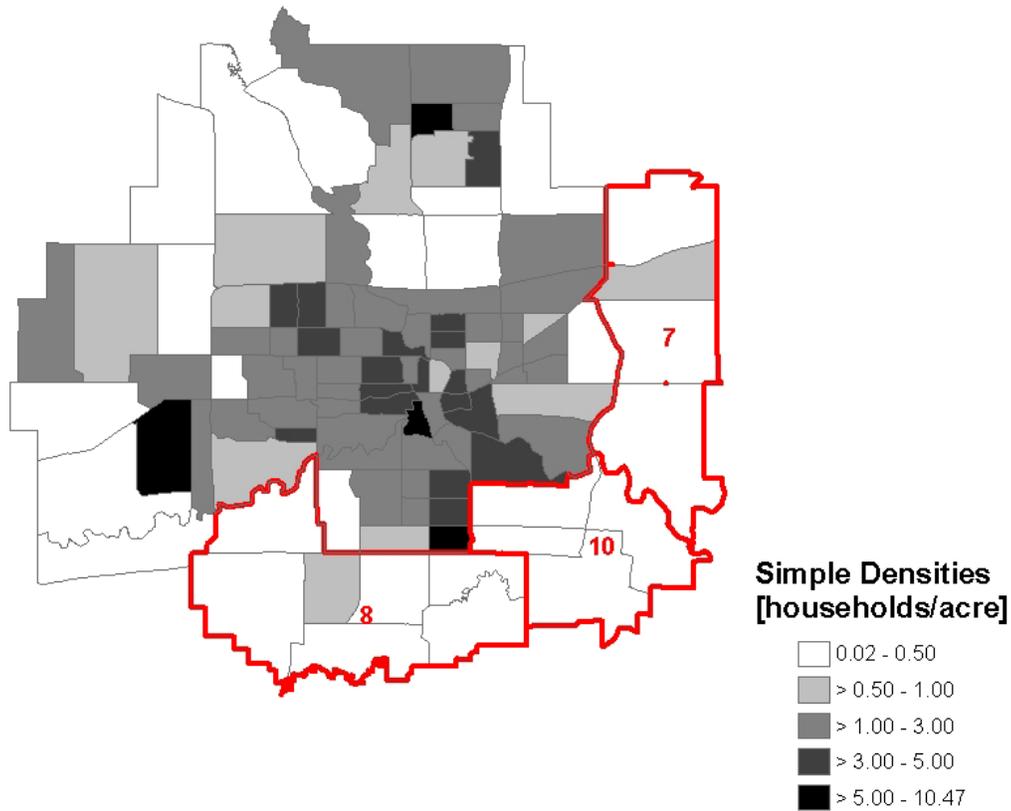
**Figure 23.** TELUM MFCU screen that allows users to enter zonal constraints for the Type II constrained model run (shown are absolute values of the maximum total employment by zone for forecast year 2005 for scenario 7C0)

***e. Analysis of Results from Constraint Policies***

The forecast reports for policies 7C0 and 6C9 each showed the models predicted region-wide household and employment patterns generally similar to the BL and 1P model forecasts. The constraints did, however, produce the expected location changes.

Taking 7C0 first, we could see a difference in the simple zonal densities of total households. In 2020, regional zones with the dense household populations in the core and inner ring zones outnumber the zones showing dense household population in the outer ring zones (Figure 24). Furthermore, the zones in the southern and eastern sub-areas of the outer ring showed significantly lower densities than were forecast in the BL and 1P runs.

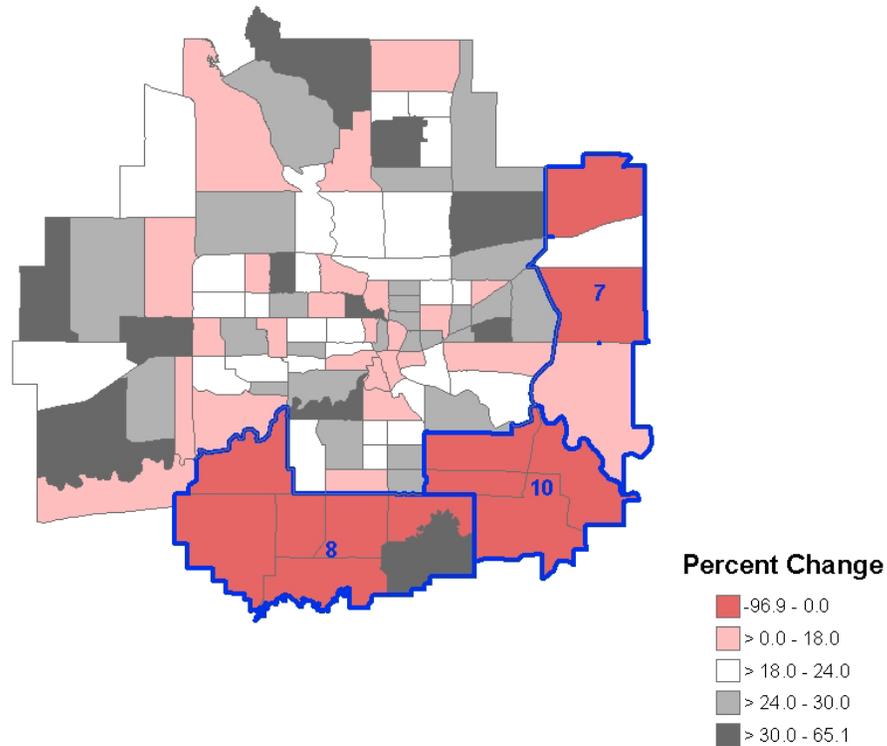
**7C0 Zonal Household Density  
Total Households 2020**



**Figure 24.** Forecast map summary in MAPIT – zonal total household densities in forecast year 2020 for policy scenario 7C0

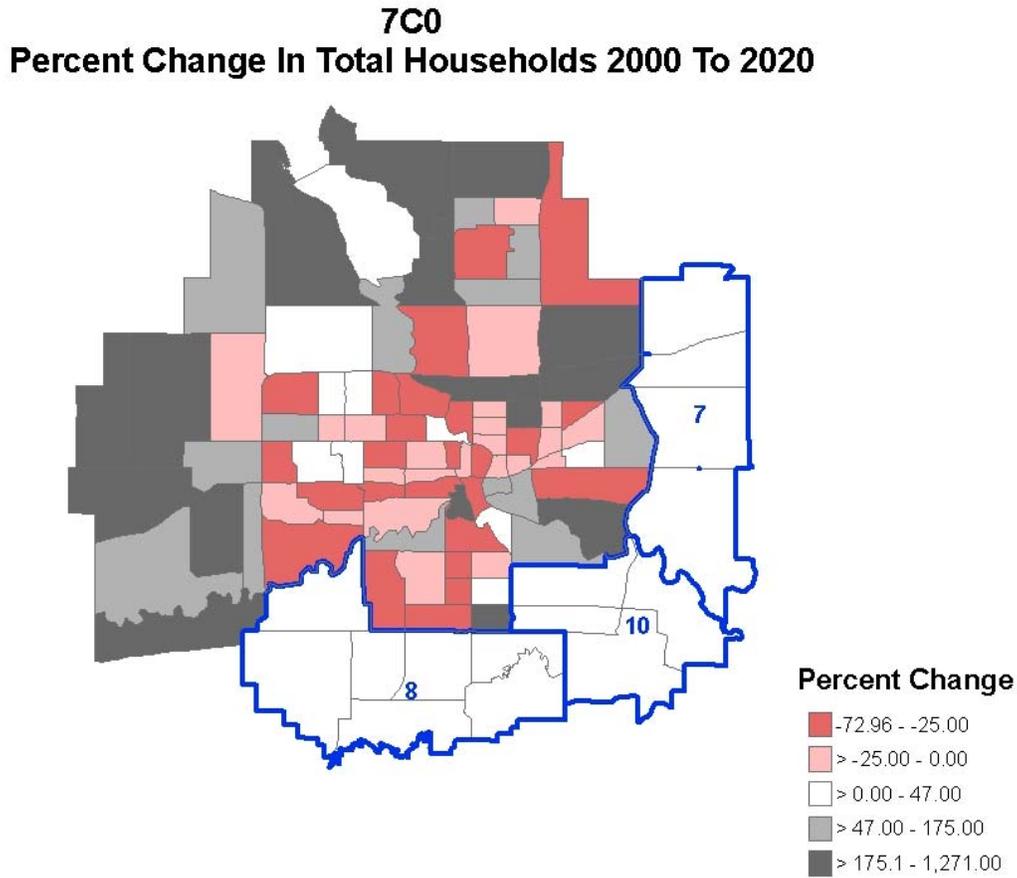
When we compared total household growth between polices BL and 7C0, we could again see that household location southeast of the core decreased. This is evidence that imposing constraints on growth in these zones to 10 percent in fact affected the rate of growth for the southeast portion of the region. This is illustrated on the map in Figure 25 produced by MAPIT. The map shows the differences in forecasted zonal household totals for 2020 between the baseline (BL) and policy scenario 7C0.

**2020**  
**Percent Change In Total Households Between Policies BL And 7C0**



**Figure 25.** Forecast map summary in MAPIT – comparison of total number of households by zone in 2020 between BL forecast and 7C0 scenario forecast

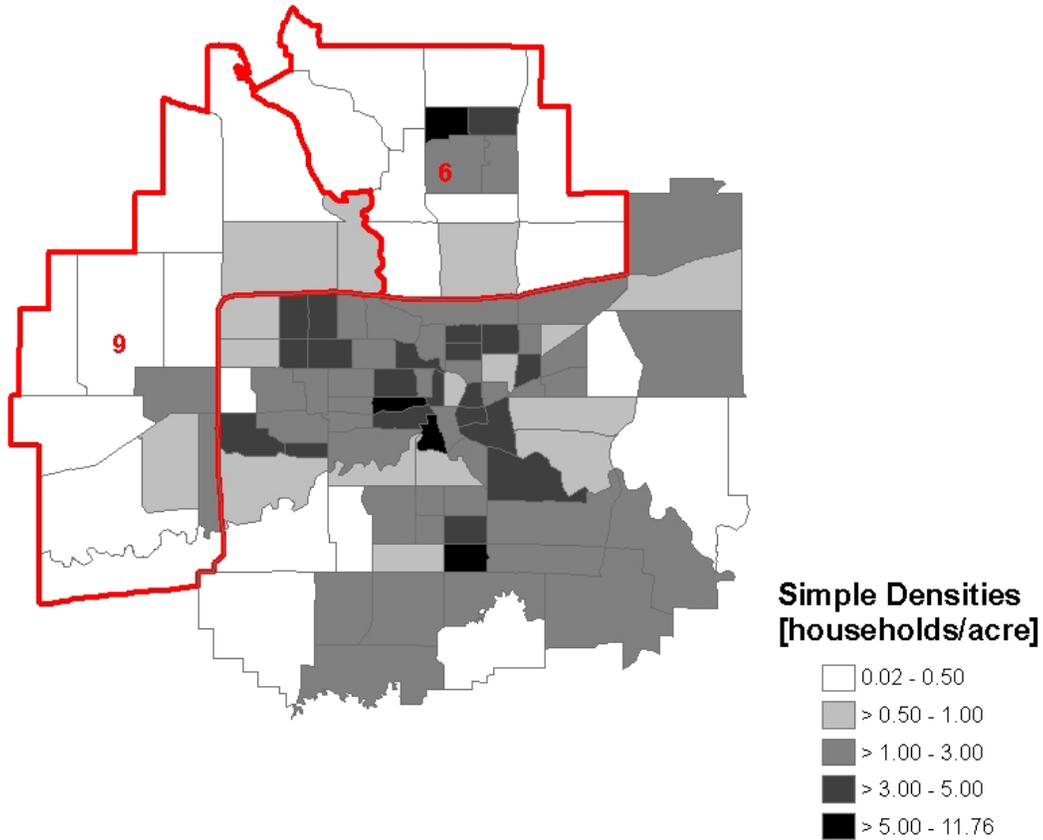
As we looked closely at the impact of the 7C0 zonal growth constraints in the southeast portion of the outer ring, we could see that the household densities in zones north and west, as a result of these growth constraints, also were affected. The region’s entire outer ring remained attractive to households, and since there were growth constraints in the southeast, the northwest, in a relative sense, increased in attractiveness and realized additional growth as compared to the unconstrained forecasts. These effects may be seen more clearly in the map produced by MAPIT shown in Figure 26, observing percent change in number of households between from 2000 to 2020.



**Figure 26.** Forecast map summary in MAPIT – percent change in total households 2000-2020, policy scenario 7C0

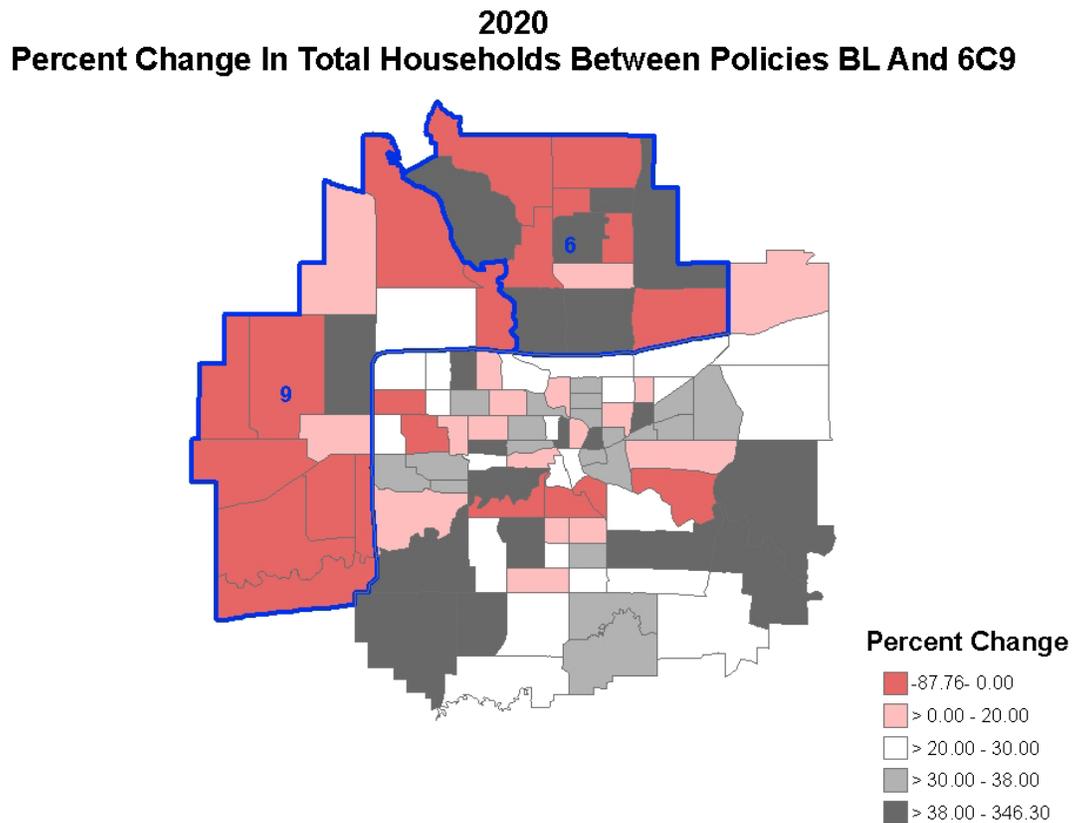
The results of the 6C9 northwestern constraint policy were analogous to those for 7C0. As shown on the map in Figure 27, a few zones in sub-area #6 retained households and thus showed high densities. The majority of densely populated households remained, however, in and around the core Des Moines areas and in outer ring zones southeast of the core. Again, constraining growth in the northwestern sub-areas of the outer ring did reduce densities in the northwest, but at the same time, the unconstrained sub-areas of the outer ring became relatively more attractive and showed increased growth compared to the baseline.

### 6C9 Zonal Household Density Total Households 2020



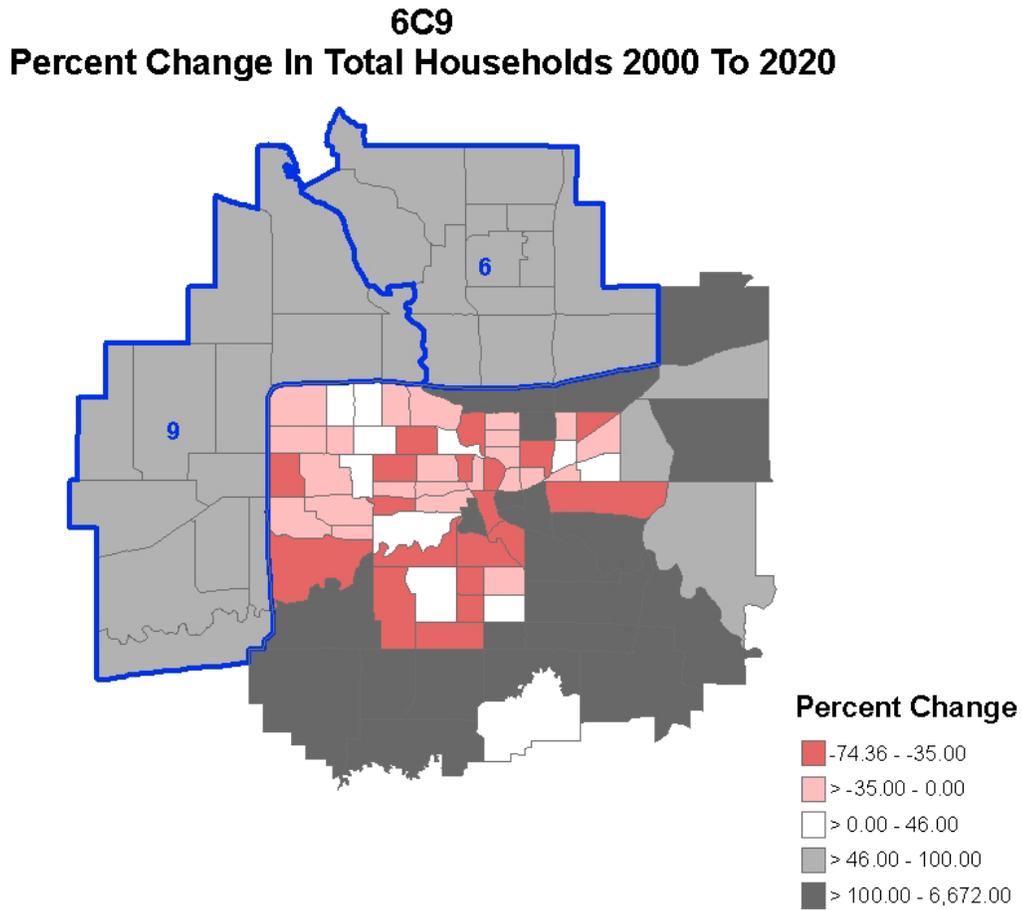
**Figure 27.** Forecast map summary in MAPIT – zonal total household densities in forecast year 2020 for policy scenario 6C9

Similar to what we saw in the analysis of policy scenario 7C0, comparing the total forecasted number of households between polices BL and 6C9 reveals that constraining growth in the northwest (sub-areas 6 and 9) made urban core and southeast areas more attractive. However, it is evident that most of the growth that would otherwise have occurred in the northwest, shifted to southeast, rather than urban core which would have been proffered outcome. Nevertheless, the analysis shows that constraining development in the northeast does have an effect on the overall regional location patterns and zonal growth rates for households. This is illustrated on the map in Figure 28 produced by MAPIT. The map shows the differences in forecasted zonal household totals for 2020 between baseline (BL) and 6C9 policy scenario.



**Figure 28.** Forecast map summary in MAPIT – comparison of total number of households by zone in 2020 between BL forecast and 6C9 scenario forecast

The outer ring of the region remained more attractive than urban core, despite the limited growth in the northwest due to imposed constraints. The map in Figure 29 shows that overall change in number of households in the urban core area was either negative or moderately positive, while areas in the southeast of the Des Moines MPO region experienced high growth. Growth in northwest outer zones (sub-areas 6 and 9) was a direct outcome of imposed constraints. The constraints effectively increased attractiveness of southeast part of the region’s outer ring; some zones in the urban core also saw growth, but majority of densely populated zones there suffered a decline in number of households.



**Figure 29.** Forecast map summary in MAPIT – percent change in total households 2000-2020 for policy scenario 6C9

### 5. Brief summary of Policy Test Results

From the illustrative TELUM policy forecasts completed using the data from the Des Moines MPO, we can conclude the following:

- The Des Moines region is, by virtue of the regional forecasts (control totals) developed by the MPO, expected to see continued growth through 2030.
- Households are attracted to zones located in the outer ring of the region more than they are attracted to zones located in the core of the region.

- Infrastructure improvements that have reduced zonal travel time for the southeast portion of the region contributed to the development of the southeast zones further from the core and inner ring of the region, but overall the proposed infrastructure improvements have rather little effect on regional form. This is most probably because there is not much transportation facility congestion overall, but may also be due to the transportation and location/land use forecasting not being linked and integrated in the modeling process.
- Policy forecasts which constrained household and employment growth in one quadrant of the outer ring zones had the effect of pushing some development toward the region's core, and some other development to zones in other quadrants of the outer ring. A policy forecast constraining household and employment growth in the entire outer ring would likely results in increased development in and around the core Des Moines area.
- A limit on development in outer ring zones with a greater share of vacant developable land decreased the region's loss of vacant land by virtue of focusing development more toward the region's somewhat more densely developed central areas.

## 5. Case Study Conclusion

This case study was undertaken solely for the purpose of showing a prospective TELUM user the steps in a model application using an actual MPO dataset. It is of particular importance to again note that NONE of the policies, analyses, or even comments regarding these materials in any way reflect opinions, plans, or actions of any sort by the Des Moines Area MPO. Their only role was to provide the data and some brief conversations with the authors regarding the region and issues that might be of current interest there.

Overall, the materials presented here are rather like what is seen in most land use model applications in regional agencies. Forecasts made using models such as these are relatively simple to execute. They provide reliable forecasts of future regional patterns, but must be expected to be imperfect in some of their details. It remains more than a little questionable as to how much more reliable forecasts of regional location and land use could be produced. While there has been considerable investment in various incarnations of what are popularly known as micro-simulation models, and models which claim far more complete economic-theory-based underpinnings, there is virtually no evidence to the effect that such approaches can produce any systematic improvement in forecasts. There is, however, abundant evidence to the effect that they require data which are several orders of magnitude more complex, that are significantly more expensive to obtain, and that are often unavailable to agencies regardless of the financial resources they might be willing to invest in data collection. TELUM certainly provides an avenue to useful forecasts for many MPOs, especially ones in

small to middle sized regions, as it relies on data that is readily available to, or can be easily collected or produced by MPOs themselves.

For user support please visit TELUS website at [www.telus-national.org](http://www.telus-national.org) or contact TELUS development team:

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