Passenger Transportation Networks & Urbanization Level:  
A Comparison of Classification Schemes

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ABSTRACT

Planning and operating effective transportation networks rely heavily on the knowledge of current and future transport patterns, which in turn relies on the current and future land use and urbanization levels of an area. However, while various organizations have developed classification schemes to classify areas by urbanization levels, there has been no literature to assess the suitability of such schemes for use in transportation planning and research applications, considering also the status quo of transportation networks and transportation infrastructure systems under a comprehensive approach.

The goal of this study is to compare the well-established classification schemes in the United States and evaluate their ability to capture the key elements of the two-fold relationship between transportation systems and urbanization levels. To achieve this goal, we consider the main passenger transportation networks and other transportation infrastructure systems in a case study of the Midwest region.

The results of this study suggest that each scheme’s classification criteria, as well as the level of aggregation considered, depend on the primary purpose each scheme has been developed to serve. Additionally, the results suggest that all schemes are inadequate for use in transportation research since they do not capture all key elements that affect transportation patterns and needs under a comprehensive framework.

Finally, to address the above issues, we design and evaluate a new classification scheme that focuses on transportation-related aspects, captures key elements, and considers the heterogeneity within rural areas. The ultimate outcome will be a geographic framework suitable for transportation planning and system’s evaluation.
INTRODUCTION

Planning and operating effective transportation networks rely heavily on the knowledge of current and future transport aspects such as transport patterns, needs, and demand. However, several temporal and spatial factors affect these aspects. Key factors among them are: population and population density, terrain and distances, and market and economic structures.

These factors are reflected in the land use and urbanization levels of an area. A broad settlement system based on several criteria (including the above) that has been commonly used in transportation planning, attempting to capture the variation of such factors, is that of rural versus urban communities. Rural communities are smaller in terms of population and have lower population densities, are more isolated (separated by greater distances), oftentimes have rougher terrain, and depend more on primary economic activities (such as agriculture, farming, fishing and mining) and secondary economic activities (such as production and manufacturing).

Much research has been conducted internationally to identify the unique transport challenges and needs in rural areas, investigating the effects of various transport (such as the lack of transit modes) and non-transport (such as the use of advanced technologies) factors, and evaluating possible solutions and alternatives (1, 2, 3, 4).

In the United State (U.S.), even though the research in rural transport had been limited as Nutley (1) recognized, recently there has been an ongoing discussion focusing on rural transport challenges and transport networks by planners and researchers (5, 6, 7, 8, 9, 10). Today, planning and forecasting research acknowledges the uniqueness of rural transport aspects, and attempts both to deepen the understanding how the rural character affects and is affected by various transport aspects, and to design suitable frameworks and models to approach the rural transportation planning (11, 12, 13).

However, a challenge is inherent in any attempt to such research, as well as in any attempt of a large scale system evaluation, operation and planning. Various organizations, such as the U.S. Census Bureau and the U.S. Office of Management and Budget, have developed different classification schemes to classify areas by urbanization levels, with overlapping results at some cases. Today, transportation planners agree that some planning issues may arise from the fact that the term “rural” is vague and without a single definition (5, 13).

Furthermore, the absence of a broadly recognized classification scheme drives researchers to develop new research-oriented schemes. For instance, Chakraborty and Mishra (14) investigate the relationship between transit demand, land use, and various socioeconomic factors, and how this relationship vary between urban, suburban and rural areas. To achieve this, the authors designed a new classification scheme that delineates the statewide modeling zones (subdivided by the authors) into urban, suburban, and rural, using a combination of household and employment densities. Notwithstanding the usefulness of research-oriented schemes, the broad use of such schemes result in incomparable study results and further confusion in the research and planning community on the concept of “rural”.

In addition, in view of the above affect factors and terminology, the effect of urbanization levels and associated land use on various transport aspects is obvious. However, literature focusing on the interactions between transportation systems and land use or urbanization levels, supports that transportation and land use have a two-fold relationship (15). At the same manner, it might be possible that the existing transportation networks and infrastructure systems, as well as the existing transportation aspects previously discussed, could both be affected by the urbanization level of an areas, and affect the future urbanization levels at the same time. Thus, it is of great importance that transportation factors are also considered in the delineation of urban-rural areas, especially for transportation planning and research applications. Nevertheless, classification schemes rarely consider transportation factors in a straightforward manner, and there has been no literature to assess the suitability of the available schemes for transportation and planning research that also considers the status quo of the transportation networks under a comprehensive approach.

The goal of this study is to compare the different classification schemes and evaluate their ability to capture the key elements of the two-fold relationship between transportation systems and urbanization levels. Furthermore, in an attempt to correct for the deficiencies of the compared classification schemes
identified and presented in the following sections, we suggest a new classification scheme which focuses on transportation related aspects, captures all relevant key elements, and considers the heterogeneity within rural areas.

CLASSIFICATION SCHEMES AND TRANSPORTATION NETWORKS

Classification Schemes

In the U.S. a number of classification schemes have been suggested considering various factors such as population, population density, land use and others, to diversify urban from rural communities. Each scheme’s classification criteria, as well as the level of aggregation considered, commonly depend on the primary purpose each scheme has been developed to serve. Herein, we compare five of the most broadly used and recognized schemes, and an additional scheme designed to serve transportation purposes. Following is a brief description of the schemes, and a demonstration of the corresponding delineated areas in the Midwest region (Figure 1). In this paper, we use the Midwest region as a representative case study of the urban-rural variations in the U.S.

Urban and Rural Areas (2010) by the Census Bureau (16)

Urban areas include developed, dense territories, covering residential, commercial, and other “urban” land use, classified based on decennial census and other data by track and block. Urban areas can be of two types: Urbanized Areas (50,000 residents or more, at least 1000 per person square miles, ppsm) and Urban Clusters (2,500-50,000 residents, at least 500 ppsm). Rural areas include all areas outside of urban territories.

Metropolitan and Nonmetropolitan Statistical Areas (2010) by the OMB (17)

Metropolitan (metro) areas include large counties (containing a core urban area with 50,000 residents or more) and adjacent areas that maintain high level interaction with the core, as indicated by commuting ties. Nonmetro areas include micropolitan (micro) areas (counties containing a core urban area with 10,000-50,000 residents, and adjacent), and noncore (counties outside of core statistical areas).


ERS uses the Metro-Nonmetro classification scheme (by OMB) to further partition metro areas into three categories based on the county size, and the nonmetro counties into six categories based on the urbanization level and proximity to a metro area.

Urban-Influence Code (2003, 2000 Census Data) by ERS (19)

Similarly to Continuum Code based on the OMB classification, ERS further partitions metro areas into two categories based on the size, micro areas into three categories based on proximity to a metro area, and noncore areas into seven categories based on proximity to a metro area and whether they include a town of 2,500 residents or greater or not.

Rural-Urban Commuting Areas (RUCA) (2000, 2000 Census Data) by ERS

In this scheme, ERS uses similar to the OMB classification’s criteria to delineate tracks into metro, micro and rural areas. Additionally, in a first level it further partitions these areas into 10 categories based on the largest daily commuting flows, and in a second level it further partitions these 10 categories based on secondary (second largest) commuting flows.


Ripplinger et al. (20) in their study designed a new classification scheme (Urban Population-Rural Density Code) in order to account for some of the deficiencies of the above schemes when used on transportation research. The Urban Population-Rural Density Code scheme is a twofold scheme partitioning counties into a five urbanization levels and five rural levels. Specifically, the scheme uses the
urban population to partitions the urban areas and the rural density to partition the rural areas. To achieve this, the scheme builds on the urban-rural classification scheme, aggregating the urban and rural population from the block to the county level.

FIGURE 1 Midwest Region, Areas by Urbanization Levels, Classified by Different Classification Schemes.
Transportation Networks

Today, the transportation needs and available resources differ significantly between rural and urban areas in the U.S. According to the 2009 National Household Travel survey (NHTS) (21), the average vehicles miles of travel (VMT) for the population between 35-45 years old in rural areas in 2009 was 40.45 VMT/day, while the corresponding VMT was 30.11 VMT/day in urban areas. Additionally, 83% of the transit trips in the U.S. were made in large urbanized areas (22).

In this analysis, we consider the following transportation networks and other infrastructure systems, as shown in Figure 2 for the Midwest region.

- Primary and secondary roadway network, as collected from the TIGER/Line 113th Congressional District Shapefiles (23), corresponding to 2010 data.
- Passenger rail network, as collected from the CTA Transportation Networks database (24), corresponding to 2012 data.
- Amtrak network and stations, as collected by the NTAD 2011 (25).
- Airports, as collected by NTAD 2011 (25) and categorized based on the Federal Aviation Administration (FAA) criteria.
- Alternative fuel stations, as collected by NTAD 2011 (25).

FIGURE 2 Midwest Region, Transportation Networks and Other Infrastructure Systems.
COMPARISON OF CLASSIFICATION SCHEMES

Aggregation Level

The urban-rural classification scheme is based on data aggregated by census tracks and blocks, the rural-urban commuting areas scheme is based on data aggregated by tracks, while all other schemes are based on data aggregated by counties. The chosen level of aggregation is strongly affected by the original purpose the classification scheme has been developed to serve. For instance, the metro-nonmetro classification scheme, aggregated at the county level, was originally developed for data collection and statistical purposes. County is an efficient aggregation unit for this purpose, since the level of details provided by such aggregation is suitable for an efficient analysis.

Urban areas can be considered as the most accurate representation of where urban population is located, since the delineated areas involve territories with tracks and/or blocks that were identified as urban. On the contrary, metropolitan areas are delineated around one or more urban counties (urban cores), and selected adjacent counties. Thus, the aggregation level of metropolitan areas might be inadequate to capture transportation patterns and needs. Aggregation at the track and/or block level provides a more suitable geographic framework for transportation analysis, especially near large urbanized areas. On the contrary, aggregation at the county level does not capture the differences between urban and rural communities within the same county. Figure 3 demonstrates the differences resulted from the two aggregation levels (by tracks/blocks at the left and by counties at the right) in Chicago metropolitan area. As inferred from the position of the passenger rail network within the delineated areas, the tracks/blocks aggregation results in a more precise delineation of the urban area of Chicago.

However, when data collection and manipulation is required at a block level the collection and computational burden is noticeably increased, resulting in unwieldy classification schemes.

FIGURE 3 Chicago Metropolitan Area, Example of Differences in Aggregation Levels.

Number of Classes

The number of classes affects the level of detail depicted in each class. A scheme with a greater number of classes might be more efficient in capturing a higher percentage of the variation in several transport aspects.

Two or three classes of urbanization might not be sufficient to capture the variation of transportation patterns, demand and needs. This idea is demonstrated in Figure 4 where one can see that the highway density variations do not seem to have any correlation with the different classes at the first two schemes (urban-rural scheme, map a; metro-nonmetro scheme, map b), whereas at the next two schemes (rural-urban continuum code, map c; urban influence code, map d) some patterns can be identified. For instance, in the last scheme of urban-influence code it seems that micropolitan areas that are not adjacent to metropolitan areas as well as completely rural noncore adjacent to micropolitan areas have a less dense network.

The urban-rural scheme focuses on a detailed delineation of urban territories but do not capture any variations and diversities in rural communities, which are not negligible among U.S. rural areas. The
The metro-nonmetro scheme might capture some of the variation in rural communities, with the micropolitan areas being territories having both urban and rural characteristics. However, such classification is ambiguous and results in confusion and uncertainties. The OMB scheme itself can be handled in two different ways: that of metro-nonmetro areas (micro and noncore), and that of core based statistical areas or CBSA (metro and micro) and noncore.

![Figure 4: State of Wisconsin, Example of Differences Resulting from Different number of Classes.](image)

**Territorial Boundaries of the Delineated Areas**

Urban territories do not strictly follow municipal boundaries, such as towns, cities or counties, posing issues for the suitability of the scheme on planning and evaluation at a project level analysis. Since the scheme uses track and block, the resulting delineated areas are the combination of the units with the same urbanization level. Thus, a territory delineated as urban can include multiple towns and/or cities and extend to more than one county. At the same manner, one metropolitan area might extend to more than one states, which can also be seen as a disadvantage for the use of the OMB scheme on planning, pertaining to the governance.

**Urban-Rural Population**

The urban-rural scheme, as delineated by the Census Bureau, is probably the most recognized scheme. In addition, as previously noted, urban areas can be considered as the most accurate representation of where urban population is located. Thus, a classification scheme that considers either the urban areas as such, or the urban population, would be of great advantage.

From the compared classification schemes, apart from the urban-rural scheme, the rural-urban continuum code, the rural-urban commuting areas, and the urban population-rural density scheme directly account for the urban population. The OMB scheme, although it considers to some extent the urban-rural classification (using the adjacency with the delineated as core based statistical areas), it does not...
specifically account for urban population. In addition, between these two basic schemes there are significant overlaps. As calculated by ERS from 2000 Census of Population data approximately the 51% of the rural population in the U.S. lives in metropolitan areas. The urban influence code attempts to improve the OMB classification including additional criteria, such as proximity and size, but still it does not separate the urban-rural population.

Additional Transport Related Area Characteristics

Demographic criteria pertaining to population and population densities can be related to several transport aspects such as transport demand. Regarding the population, all schemes consider this as a factor, in one or another way. Turning to the population density, all ERS metro-nonmetro based classification schemes do not directly account for it, which might be considered as a drawback, if one accepts that density plays a significant role to transport aspects such as transport patterns, transport needs, but foremost transport available resources.

The addition of a proximity criterion might be an improvement on the metro-nonmetro classification, since adjacency and proximity to urban cores might affect the transportation patterns between the core and the outside communities, especially for commute to work trips. The same applies for the addition of a commuting flows criterion, which captures the current transport patterns and relationships between the areas in a more straightforward manner.

Complexity and Efficiency

The increase of the classes as well as of the classification criteria can be a trade-off between accuracy and efficiency. Efficiency in this context refers to both the computational and data collection efficiency reflecting the ease of design and replication of the scheme, and the communication efficiency reflecting the minimal effort involved in understanding and using the scheme.

The Influence Code provides a more detailed than the OMB classification, but it might be considered as a less efficient code because of the excess codes and classes. At the same manner, the RUCA scheme improves the OMB classification accounting for similar to this scheme’s criteria with the addition of the commuting links between metro, micro, small town, and rural areas, aggregating at the same time the delineation at the tracks level, but results in a very complex and unwieldy classification scheme.

Finally, the Ripplinger et al. (20) scheme, as the authors identify, result in a 25 (five by five) classes scheme that might be considered inefficient because of the excess classes. At the same time, the scheme is quite complicated and difficult to understand and use, since the two separate parts are overlapping. This is more obvious at the extreme levels, for the counties that are delineated as counties “1e” (with the higher possible urban population and the higher possible rural density). This can be considered as a deficiency resulting both from the twofold nature of the scheme, and the aggregation of the block/track urban/rural population features at the county level.

NEW CLASSIFICATION SCHEME

Overview

In this paper, we focus on improving the main deficiencies identified in established classification schemes. However, it is important for any new classification scheme to consider the wide acceptance and prior use of such classification scheme. A scheme that will be based on one of the Federal rural definitions (such as that of urban-rural or metro-nonmetro scheme) will be of advantage since it could be easily incorporated in future transportation and planning studies, without conflicts with similar past studies, and/or incomparable results.

In view of the above, in this study we design a preliminary, two-part scheme (urban-rural area percent and distance) that attempts to improve the described classification schemes building on the urban-rural classification scheme, focusing on rural areas, and explicitly correcting for the discussed deficiencies.
The urban-rural percent and distance classification scheme is constructed of two parts. The first part is the delineation of the urban areas at the Census Traffic Analysis Zone (TAZ) (26) level into four classes depending on the percent of the surface areas delineated as urbanized area or urban cluster by the Census. The second part is the delineation of the rural areas as defined by the Census (areas outside of urban territories, or TAZ’s with 0% urbanized areas or urban clusters), into two classes based on the size of the surface area of the TAZ and the distance from an urban core (urbanized areas or urban cluster).

Table 1 presents the six classes considered in the urban-rural percent and distance classification scheme. Class 1 includes the completely urban areas; classes 2 to 4 the partially urban, partially rural areas; and classes 5 and 6 the completely rural areas.

<table>
<thead>
<tr>
<th>Classes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100% of the area delineated as urbanized area</td>
</tr>
<tr>
<td>2</td>
<td>65% - 99% of the area delineated as urbanized area or 65%-100% as urban cluster</td>
</tr>
<tr>
<td>3</td>
<td>20% - 64% of the area delineated as urbanized area or urban cluster</td>
</tr>
<tr>
<td>4</td>
<td>1% - 19% of the area delineated as urbanized area or urban cluster</td>
</tr>
<tr>
<td>5</td>
<td>Smaller or equal to the average surface areas with 100% of the area delineated as rural and 16 miles or closer to an urbanized area or urban cluster</td>
</tr>
<tr>
<td>6</td>
<td>Larger than the average surface areas with 100% of the area delineated as rural and 16 miles or further from an urbanized area or urban cluster</td>
</tr>
</tbody>
</table>

Criteria and Considerations

The urban-rural area percent and distance scheme accounts for issues in the aggregation level, the number of classes, the resulting territorial boundaries of the delineated areas, the consideration of the urban population, the consideration of additional transport related area characteristics, and the overall complexity and efficiency of the scheme, as follows.

With respect to the aggregation level, the delineation is conducted at the TAZ level. The use of this Census unit provides various advantages. Firstly, the aggregation level resulted is more efficient than using block/tracks, which would impose a prohibitive computational and data collection burden. Along the same lines, the new scheme is more finely designed than if counties were used, which would result in loss of information, and a less detailed delineation. Secondly, the Census units are more suitable than a custom build unit, such as modeling zones, since they do not present significant overlaps, they are well-established, and the available socio-demographic data aggregated to the units are publicly provided and frequently updated.

Turning to the number of classes, although the urban-rural classification scheme provides a detailed delineation of the urban territories, it does not account for the variations in rural communities. Thus, the delineation of the 100% rural areas into two classes (5-6), as well as the use of four classes at which the percentage of the area delineated as urban varies (1-4) shown in Table 1 provides a more suitable framework, capturing the differences within the rural communities.

Additionally, to correct for the planning issues that might result of delineated territories that do not follow municipal boundaries, we partition all urban territories to the TAZ level. Since each TAZ is strictly assigned under a single county and the units within the same class have not been dissolved, the delineated areas will directly correspond to counties.

Turning to transportation related criteria, the urban-rural area percent and distance scheme directly accounts for the percentage of urban area by TAZ, based on the design criteria presented in Table 1. Additionally, the TAZ partition process has a minimum population requirement (26). Thus, the scheme accounts for the population density through the size of the TAZs. Specifically, in the rural areas one will expect to have larger TAZs to meet the population criterion, because of the lower population densities.
Furthermore, at the second level of the urban-rural area percent and distance scheme, the proximity from an urban core is considered.

Finally, the resulting scheme is fairly simple and efficient. The classes designed are six, the criteria of the delineation are straightforward, and the scheme is overall easy to replicate and use.

**Case Study Results**

Figure 5 presents the resulting delineation under the urban-rural area percent and distance scheme in the Midwest region.

![Figure 5 Urban-Rural Area Percent and Distance Scheme.](image)

As presented in Figure 5, the areas delineated as class 1 are the completely urban areas shaded black, and the areas delineated as classes 5 and 6 are the completely rural shaded light grey and white, respectively. The intermediate classes (2 to 4) include areas with different urbanization levels as described by the delineation criteria in Table 1. The unit used in the urban-rural area percent and distance scheme is the TAZ, which is a less uniformly sized unit than the tracks/blocks or counties are; this can be seen in Figure 5 in comparison to Figure 1, which includes the established schemes compared herein. Another interesting finding of this preliminary study that can be inferred from this map, is that every TAZ in the Midwest is within at least 74 miles to the nearest urbanized area or urban cluster (measured from the center of the TAZ to the border of the urban area).
Comparison to the other classification schemes

The urban-rural percent and distance scheme is based on the Census urban-rural scheme. Thus, a comparison of the resulting delineated areas in terms of the various schemes can be achieved, and it would be of interest.

To begin with, the urban-rural area percent and distance scheme provides a different approach to delineate areas by urbanization levels. As shown in Figure 5, the units chosen (TAZs) behave differently from the units used in the established schemes (either blocks/tracks or counties). The size of the TAZs per se is an indicator of the urbanization level, and using this unit we directly account for the population density.

In addition, a comparison of the surface area delineated under the classes of each scheme could be of value. Table 2 shows the surface area (in square miles) for each class of the Urban-Rural Percent and Distance, the Census urban-rural, and the metro-nonmetro scheme, since these schemes can be easily compared. The units used in each scheme are different, and thus, a comparison of the number of the units delineated in each class would not provide any meaningful information. In addition, a comparison including all schemes would not provide further insights, since there is no straightforward way to compare the classes among the various schemes because of the significantly different delineation criteria used in each scheme.

TABLE 2 Comparison of the Urban-Rural Percent and Distance Scheme to Established Schemes

<table>
<thead>
<tr>
<th>CLASS</th>
<th>AREA (SQ. MI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban-Rural Area Percent and Distance Classification</td>
<td></td>
</tr>
<tr>
<td>Class 1</td>
<td>12,293</td>
</tr>
<tr>
<td>Class 2</td>
<td>5,090</td>
</tr>
<tr>
<td>Class 3</td>
<td>9,416</td>
</tr>
<tr>
<td>Class 4</td>
<td>140,280</td>
</tr>
<tr>
<td>Class 5</td>
<td>124,691</td>
</tr>
<tr>
<td>Class 6</td>
<td>458,756</td>
</tr>
<tr>
<td>Urban and Rural Areas</td>
<td></td>
</tr>
<tr>
<td>Urbanized Area</td>
<td>18,858</td>
</tr>
<tr>
<td>Urban Cluster</td>
<td>5,215</td>
</tr>
<tr>
<td>Rural Area</td>
<td>741,951</td>
</tr>
<tr>
<td>Metropolitan and Nonmetropolitan Statistical Areas</td>
<td></td>
</tr>
<tr>
<td>Metropolitan</td>
<td>194,997</td>
</tr>
<tr>
<td>Micropolitan</td>
<td>171,375</td>
</tr>
<tr>
<td>Rural Area</td>
<td>399,653</td>
</tr>
</tbody>
</table>

As shown in Table 2, the metro-nonmetro scheme classifies less area as rural comparing to the urban-rural scheme. However, this difference probably relies more on the different units used (tracks/blocks and counties respectively) and consequently the level of details pertaining to the delineation of the urban cores, and less on other aspects of the schemes that would capture variations among the rural areas (delineation criteria, number of classes, etc.). This is not the case for the urban-rural percent and distance scheme for which—in urban areas—the size of the units used is comparable to tracks/blocks.

The higher number of classes, together with the units used, improves the level of detail of the delineation. As Table 2 presents, the sum of the area included in class 4 (TAZ with a low percent of urban areas), and classes 5 and 6 (completely rural areas) is comparable to the delineated as rural area in the
urban-rural scheme. However, based on the criteria used on the new scheme, it is safe to assume that the
740 thousand sq. miles of rural area are not homogenous, and that further partitioning them into three
classes is an improvement.

Additionally, for planning purposes, it is reasonable to design uniformly sized classes. From this
perspective, the metro-nonmetro scheme results in a fair delineation; the average area per class is 255
thousand sq. miles with a standard deviation of 156 thousand sq. miles. However, the sizes of the urban-
rural scheme’s classes are significantly different. As seen in Table 2, the classes include areas from five to
742 thousand sq. miles; the average area is approximately 255 thousand sq. miles, with a standard
deviation of 421 thousand sq. miles. Finally, the urban-rural area percent and distance scheme presents
the most uniformly sized classes with 125 thousand sq. miles average area per class, and a standard
deviation of 174 thousand sq. miles.

CONCLUSIONS

The main deficiencies of the schemes compared in this paper pertain to the aggregation level, the
number of classes, the resulting territorial boundaries of the delineated areas, the consideration of the
urban population, the consideration of additional transport related area characteristics, and the overall
complexity and efficiency of the scheme.

The use of each scheme for transportation research has its advantages and disadvantages. Each
scheme captures different spatial characteristics relevant to transportation (such as population density, or
urban land use). However, the schemes that have been included in this comparison have been found
inadequate for use in transportation research, since they do not capture all key elements that affect
transportation patterns and needs in a comprehensive framework. Furthermore, while urban areas are—in
general—well described, a critical shortcoming that has been determined by this study is the absence of a
detailed categorization of rural areas.

The development of a new classification scheme that will focus on transportation related aspects,
capture all relevant key elements, and consider the heterogeneity within rural areas will provide a
geographic framework suitable for transportation planning and system’s evaluation. This would be of
great importance and would substantially benefit the transportation research in general, and especially the
transportation planning and policy focusing on a state or greater level.

In this paper, we introduce a new scheme (urban-rural percent and distance) based on TAZs, a
unit designed for transportation planning purposes, which captures the variations in population and
population densities through the TAZ’s size. Additionally, via the delineation criteria, we account for the
proximity to urban cores, as well as for the percentage of the areas delineated as urban. Both aspects are
expected to play a significant role in the commuting choices of the population, and thus can be considered
relevant to the goal of this study.

However, this paper presents a preliminary analysis, and further investigation focusing on
additional criteria that will directly account for all key transportation aspects, for instance the commuting
flows among regions, is required. Furthermore, the addition of a criterion pertaining to a measurement of
the temporal availability of transportation networks, (such as the highway and/or rail network) could
provide further insights in the analysis. Since transport and urbanization levels have a twofold
relationship, it can be argued that a measurement of the existing transport infrastructure systems could be
an indicator of the urbanization levels. Finally, other key aspects that would affect transport patterns,
needs and demand, such as the terrain, or market and economic structures, should be investigated.
REFERENCES


