INTRODUCTION

Traffic volume information is indispensable in road management systems including congestion, safety, and pavement. This information is also important for road design, maintenance and planning. National and state Departments of Transportation (DOT) have been traditionally collecting traffic volume data on major state-administered roads using permanent and temporary counting stations. During the past few years, a need for traffic information on local roads at acceptable quality has become evident. Knowledge of the Annual Average Daily Traffic (AADT) on local roads is necessary for efficiently managing local infrastructure to wisely use existing transportation assets, improving traffic safety and programming road improvements. Reasonably complete AADT information allows estimating VMT for counties and townships.

Currently, there is no state-supported program of systematic volume data collection on local roads. The two obvious reasons are: (1) Until recently, this need was not obvious or at least not identified, (2) Applying the state system of permanent and coverage counting stations seem to be prohibitively expensive and ineffective given the vast mileage of local roads and typically low volumes.

Some local agencies perform vehicles counting in a more or less systematic manner, while other agencies limit their vehicle counting to short term and geographically constrained operations as dictated by current needs of these agencies. The past and current efforts, somewhat uncoordinated and incidental, have generated a wealth of data which although insufficient for systemic analysis of local roads, may perhaps be sufficient for investigating the relationships between traffic volumes, land use, and network characteristics. Such relationships, once known, could become the basis for practical methods of estimating traffic volumes on local roads that had not been included in traffic counting programs.

Several methods have been employed to collect and estimate traffic data for local roads. With respect to traffic data collection, in-situ technologies (pneumatic road tubes, piezoelectric sensors, magnetic loops, etc.) and non-intrusive techniques (manual counts, passive and active infra-red, passive magnetic, microwave radar, ultrasonic and passive acoustic, etc.) have been utilized or tested (Leduc, 2008; Bennett et al., 2005; FHWA, 1998; IMAGINE, 2006; Martin et al., 2003; Schmidt, 2005; USDOT, 2006).

With respect to traffic data estimation for local roads, several methodologies have been utilized, such as correlation coefficients (Talvitie et al., 1980), linear and non-linear regression (Memmott, 1983; Xia et al., 1999), regression clustering (Seaver et al., 2000; Saha
and Fricker, 1988), and fixed effect cross-sectional time series (Noland, 2001). These (and other) studies have identified a number of factors that play in the forecasting of ADT or VMT, such as, traffic (historical traffic patterns, traffic districts and zones, changes in road capacity, etc.), roadway characteristics (number of lanes, road functional classification, etc.), socioeconomics (population demographics, education, income, vehicle ownership, employment characteristics, school enrollment, etc.), and geographic characteristics (agriculture, urbanization, housing, commercial and industrial land development, etc.).

None of these methods use the network-based routing vehicles. Our method will use network demand modeling principles which is more reliable than the purely statistical estimation. Model calibration will included fitting trip generation parameters by minimizing the prediction error of AADTs. The next section describes the concept of the model with simplifying assumptions that allow one-step calibration. Then, detailed descriptions of the model and of the efficient estimation procedure follow. Implementation discussion of the model to Indian road network concludes the presentation.

CONCEPT

This paper presents a new method of estimating AADTs on local roads: rural and urban based on three major inputs: (1) Known AADTs on major non-local roads, (2) Land use including residential, industrial, and commercial development, and (3) Local network of roads and its connection with other roads with known AADTs. This database must be supplemented with past traffic counts on local roads to allow calibration of the proposed model.

The entire road network is considered. It includes two types of road segments (links):

1. Major roads with known AADT obtained from direct measurements or from a regional network flow model that focuses on major roads. These roads form a well connected (integrated) system (path can be found between any two nodes of the major road network).

2. Minor (local) roads complement the network of the major roads. The minor roads can be grouped into well-connected cells such that major roads are network cell’s boundaries. No major road penetrates a network cell.

Seven example cells were formed on a part of the West Lafayette, Indiana, road network and they are presented in Figure 1. The bold solid lines – major roads with known AADT values - are boundaries of the example cells. A regional road network representation prepared by Metropolitan Planning Organizations (MPOs), such as the Greater Lafayette MPO, may serve as the network of cell boundaries. From that point of view, the proposed road-cell model is a supplement of the regional planning model. The only difference is that the traffic used for estimating the local AADTs is recent (represent the current situation) and consequently, the estimated local AADTs apply to the presence. This focus on the present traffic rather than long-term prediction fits well the need for knowing the current local AADTs but also it is consistent with the microscopic land use data that represent the recent or current land development state. There is an intrinsic difficulty in predicting detail land use for remote future.
Dividing the regional road network to cells allows decomposition of the large network into a number of smaller parts and to model local in each cell separately from other cells. The following assumptions are made to simplify the modeling effort and to enable massive implementation of the model to large regional road networks. The assumptions applied to single network cells.

1. Minor roads do not experience capacity shortage thus; the interaction between vehicles on these roads is negligible. Travel times depend on the distance, prevailing cruise speeds, and delays caused by traffic control but not by the traffic queues at intersections.

2. Large majority of trips are made for personal purpose by individual travelers (cars, vans, pickups, etc). No truck or public transit traffic is considered.

3. In residential network cells (negligible presence of businesses), the internal (intra-cell) trips are neglected. In the heterogeneous cells with business and residential land use, there is a considerable amount of internal traffic.

4. External trips do not cross the border roads (major roads). They follow the border roads and leave-enter the cell border at one of the corner intersections of the cell’s border. Any road classified as minor that has a considerable through traffic at a border intersection must be converted to a major road and the initial cell has to be split accordingly.

5. There are is no through traffic that penetrates the cell. All the trough traffic uses the cell’s border roads.

The above assumptions allow two convenient simplifications of the local traffic model:

1. The system-wide (or regional) trips generation and distribution problem can be disaggregated into traffic model in subareas with major roads making the border of the areas and with only minor roads inside these areas. One network cell is considered at a time.

2. Traffic assignment inside a network cell neglects the interaction between flows, thus O-D flows can be assigned to the network regardless of the assignment of other flows. This assumption simplifies the traffic flows estimation.

MODEL

The following terms are used to describe the proposed road cell model for local roads.

*Network cell* – part of a large network enclosed by major links with known AADTs. These major links are the border of the cell.

*Internal link* – a link (minor road segment) that belongs to the network cell.

*Border link* – a major road segment that belongs to the cell or more precisely to the cell’s border.
External link – a major or minor road segment that does not belong to the network cell.

Internal node – an intersection with all internal legs.

Border node – an intersection that has two border legs, other legs are minor and at least one leg is internal.

Corner node – an intersection that has two border legs and at least one major external leg (not included in the network cell).

Trip end – trip origination or ending at a business or household location.

Trip generation – number of trip ends per day associated with a link; businesses and households are assigned to the each link.

Business type – retailer, office, school, industrial plant, etc.

Business size – business characteristic(s) that determined the traffic generation (number of employees, size of the lot).

Resident type – categories by age, gender, salary, etc. with different number of average trip ends generated per day.

Cruse link time – travel time between two consecutive nodes not affected by congestion.

Node delay – average extra time spent at a node due to a stop sign, red signal, or vehicle queue (the last one only on major roads), specific for each turning movement.

Link travel time - a cruise time plus a node delay (movement specific, but averaged for both direction of travel).

Path – sequence of links connecting a pair of internal and external nodes or two internal nodes. One pair of nodes may have several alternative routes.

Path travel time – a sum of link travel times and node delay along all links included in the path.

Shortest path - path with the shortest path travel time between a link and external node.

Path flow (or flow) – daily number of trips along a path.

Volume – AADT on a link.

A cell has N nodes and J links. Links are two-directional as are traffic flows. Any business or a household is assigned to the nearest link. External nodes have assigned external traffic volume equal the total traffic on external links ending at the external nodes. The household includes individuals of various categories (age, gender, etc), as well as business employees of various categories. External traffic is composed of vehicles of various categories (vehicle type, road type, etc.).

Daily traffic generation at links with households, businesses, and external traffic

\[ TH_l = \sum_{m=1}^{M} \alpha_m \cdot H_{ml}, \quad l=1, 2..L \]  

(1)
\[ TB_l = \sum_{h=1}^{H} \beta_h \cdot B_{hl}, \quad l=1, 2..L \]  
(2) 

\[ TE_j = \sum_{z=1}^{Z} \pi_z \cdot E_{xz}, \quad j=1, 2..J \]  
(3)

\( TB_l = \) number of business-generated trip ends at link \( l \),
\( TB_h = \) number of household-generated trip ends at link \( l \),
\( TE_j = \) attraction of external trips to node \( j \),
\( B_{hl} = \) business size of category \( h \) at link \( l \),
\( H_{ml} = \) number of residents of category \( m \) at link \( l \),
\( E_{xz} = \) external traffic volume of category \( z \) at node \( j \),
\( \alpha_m, \beta_h, \pi_z = \) model parameters.

**Split of generated traffic**

All traffic is assumed origin-destination.

\[ F_{lj} = \frac{(TH_l + TB_k) \cdot TE_j}{\sum_{n=1}^{N} TE_n} \]  
(4)

\( F_{lj} = \) trips between link \( l \) and external node \( j \),
\( TH_l = \) number of business-generated trip ends at link \( l \),
\( TB_l = \) number of household-generated trip ends at link \( l \),
\( TE_j = \) attraction of external traffic at node \( j \).

**Shortest path**

The shortest path is the path with the shortest travel time. A link travel time includes the cruise travel time and delay at a node:

\[ t_k = \frac{L_k}{V_k} + d_{kt} \]

\( t_k = \) travel time along link \( k \),
\( L_k = \) length of link \( k \),
\( V_k = \) speed along link \( k \) (depends on the road class),
\( d_{kt} = \) average delay (two directions) on link for turning movement \( t \) (straight, left, right for both ends).

The shortest-path travel time between link \( l \) and \( j \) is:

\[ t_{lj} = \sum_{k=1}^{K} n_{ijk} \cdot t_k \]  
(5)

\( t_{lj} = \) travel time along shortest path between link \( l \) and node \( j \).
\( r_{ijk} = \begin{cases} 
1 & \text{if link } k \text{ belongs to the shortest path between } l \text{ and } j, \text{ and } l \neq k \\
0.5 & \text{if link } k \text{ belongs to the shortest path between } l \text{ and } j, \text{ and } l = k \\
0 & \text{otherwise.} 
\end{cases} \)

depend on the calculation of travel time along link \( k \).

Traffic assignment to alternative routes
At this point, all-or-nothing assignment is used for route links, thus all route links on a single shortest path (shortest travel time) is loaded with \( F_{ij} \), and half assignment is used for origin links, which is loaded with \( F_{ij}/2 \).

Link volume

\[
F_k = \sum_{l=1}^{L} \sum_{j=1}^{J} r_{ijk} \cdot F_{ij} \tag{6}
\]

Traffic conservation
There is no need to conserve traffic at internal nodes (two-way traffic on links).
Traffic conservation constraint at external nodes takes the following form:

\[
\sum_{l=1}^{L} F_{ij} \leq \sum_{z=1}^{Z} E_{zj} \tag{7}
\]

MODEL ESTIMATION

The shortest paths between nodes can be obtained at the beginning without consideration of traffic flows thanks to the assumption no. 1. Then, traffic generation parameters can be optimized. The proportional traffic split is optimized using a linear representation and parameters that reflect the effect of various external traffic flows.

Approach 1
Minimize the sum of AADT estimation error squares by selecting optimal values of the model parameters \( \alpha, \beta, \pi \).

\[
\min_{\{\alpha, \beta, \pi\}} \sum_{k=1}^{K} (F_k - Q_k)^2 \tag{8}
\]

Approach 2
Interchangeable and iterative solving of two linear sub-problems until convergence is achieved.

Sub-problem One
Assume initial values of \( \pi \) parameters (for example, \( \pi_1 = \pi_2 = \ldots = \pi_Z = 1 \)). Replacing \( F_{ij} \) in Equation (6) with the RHS of Equation (4) yields:
Replacing TH and TB in Equation (9) with the RHSs of Equations (1) and (2) yields:

\[
F_k = \sum_{l=1}^{L} \sum_{j=1}^{J} r_{ijk} \cdot \frac{TE_j}{\sum_{n=1}^{N} TE_n} \cdot (TH + TB_l)
\]  

(9)

After rearranging Equation (10) the following has been obtained:

\[
F_k = \sum_{m=1}^{M} \alpha_m \sum_{j=1}^{J} \frac{TE_j}{\sum_{n=1}^{N} TE_n} \sum_{l=1}^{L} r_{ijk} \cdot H_{ml} + \sum_{h=1}^{H} \beta_h \sum_{j=1}^{J} \frac{TE_j}{\sum_{n=1}^{N} TE_n} \sum_{l=1}^{L} r_{ijk} \cdot B_{hl}
\]  

(10)

Simplifying Equation (11) yields:

\[
F_k = \sum_{m=1}^{M} \alpha_m \cdot SH_{mk} + \sum_{h=1}^{H} \beta_h \cdot SB_{hk}
\]  

(12)

where the total number of residents of category m who live in the network cell and contribute to AADT in link k are:

\[
SH_{mk} = \sum_{j=1}^{J} \frac{TE_j}{\sum_{n=1}^{N} TE_n} \sum_{l=1}^{L} r_{ijk} \cdot H_{ml}
\]  

(13)

and the total contribution of businesses of category h in the network cell to AADT on link k is represented by:

\[
SB_{hk} = \sum_{j=1}^{J} \frac{TE_j}{\sum_{n=1}^{N} TE_n} \sum_{l=1}^{L} r_{ijk} \cdot B_{hl}
\]  

(14)

Now, the objective function 8 takes a form:

\[
\min_{\{a,\beta\}} OF = \sum_{k=1}^{K} \left( \sum_{m=1}^{M} \alpha_m \cdot SH_{mk} + \sum_{h=1}^{H} \beta_h \cdot SB_{hk} - Q_k \right)^2
\]  

(15)

The solution of this problem exists and can be solved using the necessary condition for the solution:
\[ \frac{\partial OF(\alpha, \beta)}{\partial \alpha} = 0 \]
\[ \frac{\partial OF(\alpha, \beta)}{\partial \beta} = 0 \]

and specifically, the system of M equations:

\[ \frac{\partial OF}{\partial \alpha_{m_0}} = 2 \sum_{k=1}^{K} SH_{m_0 k} \cdot \left( \sum_{m=1}^{M} \alpha_{m} \cdot SH_{m k} + \sum_{h=1}^{H} \beta_{h} \cdot SB_{h k} - Q_k \right) = 0 \] (16)

Together with H equations:

\[ \frac{\partial OF}{\partial \beta_{h_0}} = 2 \sum_{k=1}^{K} SB_{h_0 k} \cdot \left( \sum_{m=1}^{M} \alpha_{m} \cdot SH_{m k} + \sum_{h=1}^{H} \beta_{h} \cdot SB_{h k} - V_k \right) = 0 \] (17)

After rearranging, there are M equations \((m_0=1..M)\):

\[ \sum_{m=1}^{M} \alpha_{m} \cdot \sum_{k=1}^{K} SH_{m_0 k} \cdot SH_{m k} + \sum_{h=1}^{H} \beta_{h} \cdot \sum_{k=1}^{K} SH_{m_0 k} \cdot SB_{h k} = \sum_{k=1}^{K} SH_{m_0 k} \cdot Q_k \] (18)

and H equations \((h_0=1..H)\):

\[ \sum_{m=1}^{M} \alpha_{m} \cdot \sum_{k=1}^{K} SB_{h_0 k} \cdot SH_{m k} + \sum_{h=1}^{H} \beta_{h} \cdot \sum_{k=1}^{K} SB_{h_0 k} \cdot SB_{h k} = \sum_{k=1}^{K} SB_{h_0 k} \cdot Q_k \] (19)

To enforce non-negative parameters \(\alpha\) and \(\beta\), an extension of the formulation may be needed. The solution should be obtained for all links available using all cells at once.

**Sub-problem Two**

The best values of \(\pi\) will be sought through solving another optimization problem of fitting the AADT estimates to the known values on K links. There may be at least three traffic categories: freeways \((z=1)\), non-freeway arterial roads \((z=2)\), other roads \((z=3)\). Equation (4) introduces non-linear dependence of \(F_{l_j}\) on \(TE_j\) which complicates solving the fitting problem in Equation (15). The formulation may be linearized by proper definition of parameters \(\pi\).

Let select values of parameters \(\pi\) such that:

\[ \sum_{j=1}^{J} TE_j = \sum_{j=1}^{J} \sum_{z=1}^{Z} \pi_z \cdot E_{zj} = \sum_{j=1}^{J} \sum_{z=1}^{Z} E_{zj} = E \] (20)

For the simplicity of equations let use the following notation for sums:
\[ E = \sum_{j=1}^{J} \sum_{z=1}^{2} E_{zj} \]

and

\[ E_z = \sum_{j=1}^{J} E_{zj} \]

Only \( Z-1 \) parameters \( \pi \) are to be optimized while parameter \( \pi_1 \) is set to ensure this equality:

\[ \pi_1 = \frac{1}{E_1} \left( E - \sum_{z=2}^{2} \pi_z \cdot E_z \right) \quad (21) \]

Inserting the RHS of Equation (21) to Equation (3) and rearranging the terms yields:

\[ \sum_{z=2}^{2} \left( \pi_z \cdot E_z - \frac{E_{zj}}{E_1} \cdot E_j \right) + \sum_{z=2}^{2} \pi_z \cdot \left( E_{zj} - \frac{E_{zj}}{E_1} \cdot E_j \right) \]

Using Equation (20) in Equation (4) yields the following new expression for \( F_{ij} \):

\[ F_{ij} = \epsilon_{1ij} + \sum_{z=2}^{Z} \epsilon_{zij} \cdot \pi_z \quad (23) \]

where:

\[ \epsilon_{1ij} = \left( TH_1 + TB_1 \right) \cdot \frac{E_{1j}}{E_1} \]

\[ \epsilon_{zij} = \frac{TH_1 + TB_j}{E} \cdot \left( E_{zj} - \frac{E_{1j}}{E_1} \cdot E_j \right) \] for \( z = 2 \ldots Z \)

Equation (6) for traffic volume on link \( k \) becomes:

\[ F_k = \sum_{i=1}^{L} \sum_{j=1}^{J} \tau_{ijk} \cdot \left( \epsilon_{1ij} + \sum_{z=2}^{Z} \epsilon_{zij} \cdot \pi_z \right) \quad (24) \]

And after transformation:
\[ F_k = \sum_{l=1}^{L} \sum_{j=1}^{J} r_{lkj} \cdot \varepsilon_{1lj} + \sum_{z=2}^{Z} \pi_z \sum_{l=1}^{L} \sum_{j=1}^{J} r_{lkj} \cdot \varepsilon_{zlj} \]  

Simplifying:

\[ F_k = SE_{1k} + \sum_{z=2}^{Z} \pi_z \cdot SE_{zk} \]  

Where:

\[ SE_{1k} = \sum_{l=1}^{L} \sum_{j=1}^{J} r_{lkj} \cdot \varepsilon_{1lj} = \sum_{l=1}^{L} \sum_{j=1}^{J} r_{lkj} \cdot (TH_l + TB_l) \cdot \frac{E_{1j}}{E_1} \]

\[ SE_{zk} = \sum_{l=1}^{L} \sum_{j=1}^{J} r_{lkj} \cdot \varepsilon_{zlj} = \sum_{l=1}^{L} \sum_{j=1}^{J} r_{lkj} \cdot \frac{TH_l + TB_l}{E} \cdot \left( E_{zj} - \frac{E_{1j} \cdot E_z}{E_1} \right) \]

Similarly to the previous solution for \( \alpha \) and \( \beta \) parameters, solving the fitting problem is equivalent to solving the system \( Z-1 \) equations:

\[ \frac{\partial OF}{\partial \pi_z} = 0 \quad \text{for} \quad z = 2 \ldots Z \]

Calculating the partial derivatives and simplifying the \( Z-1 \) equations gives:

\[ 2 \sum_{k=1}^{K} (F_k - Q_k) \cdot SE_{zk} = 0 \quad \text{for} \quad z = 2 \ldots Z \]

Or

\[ \sum_{w=2}^{Z} \pi_w \sum_{k=1}^{K} SE_{wk} \cdot SE_{zk} = \sum_{k=1}^{K} SE_{zk}(Q_k - SE_{1k}) \quad \text{for} \quad z = 2 \ldots Z \]  

Solving this system of equations for \( \pi \)s yields the optimal values of \( \pi_2, \pi_3 \ldots \pi_Z \). The value of \( \pi_1 \) is calculated with Equation (21).

**Iterations**

The sub-problem 1 is solved by assuming values of \( \pi \)s and estimating the parameters \( \alpha \)s and \( \beta \)s, then solving sub-problem 2 for new \( \pi \)s using the obtained parameters \( \alpha \)s and \( \beta \)s. Sub-problems 1 and 2 are kept being solved - each time using the newest values of parameters \( \alpha \)s, \( \beta \)s, and \( \pi \)s - until the consecutives estimates of the estimation error:
\[ \sum_{k=1}^{K} (F_k - Q_k)^2 \]  

are not much different from each other.

Summary of the estimation process includes the following major steps:
1. Divide the road network into cells; classify cells as rural or urban.
2. Prepare required data for each cell in a proper format.
3. Determine the shortest paths from internal nodes to corner nodes of each cell.
4. Group cells by type; remaining steps are performed for each group of cells.
5. Calculate the sums \( SH, SB, \) and \( SE \) needed for solving the system of equations for \( F \).
6. Assume feasible initial \( \pi \) parameters.
7. Using current \( \pi_s \) solve the system of Equations (18) for \( \alpha \) parameters and the system of Equations (19) for \( \beta \) parameters.
8. Using current \( \alpha_s \) and \( \beta_s \), solve the system of Equations (27) for \( \pi \) parameters.
9. Stop if convergence conditions satisfied; otherwise repeat p. 7 and p.8.

FUTURE RESEARCH AND SUMMARY

The presented concept and its assumptions were evaluated by Szarata and Tarko (2012) on the Tippecanoe County road network using VISSUM. Thanks to a relatively small size of the network, the genetic algorithm was used to find optimal values of the \( \alpha \) and \( \beta \) parameters. The simplified version of the model did not require optimization of the \( \pi \) parameters.

The next important step is to implement the full version of the method to the Indiana network. The size of the problem is reflected in the number of nodes, links, and cells presented in Table 1. Altogether 3,361 road network cells will be formed from nearly 200 thousand nodes and 400 thousand segments.

Calibration of the model parameters will be base on 501 cells divided into rural and urban cells and including nearly 45 thousand local roads. The full set of parameters will be calibrated through iterative solving of the system of linear equations. Initial tests of the iteration-based optimization indicated quick convergence to the solution.

Table 1 Size of Indiana road network and calibration subset

<table>
<thead>
<tr>
<th>Road and land use component</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household unit</td>
<td>2,167,142</td>
</tr>
<tr>
<td>Business unit</td>
<td>186,017</td>
</tr>
<tr>
<td>Road intersection</td>
<td>197,192</td>
</tr>
<tr>
<td>Road segment</td>
<td>394,399</td>
</tr>
<tr>
<td>Road network cell</td>
<td>3,361</td>
</tr>
<tr>
<td>Calibration road segment</td>
<td>44,862</td>
</tr>
<tr>
<td>Calibration cell (with at least one known local AADT)</td>
<td>501</td>
</tr>
</tbody>
</table>
Model performance in urban cell with possible congested local roads needs particular attention as some of the simplifying assumptions may not hold and the impact of their violation needs to be assessed. There are indications that the model works well for rural roads and for small and medium-size towns with uncongested traffic and relatively small urban road networks.

ACKNOWLEDGEMENT

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REFERENCES


Abstract

Public agencies in USA expand their safety and asset management systems to local roads in cities and counties. Managing these roads is seriously hurdled by the lack of traffic measurements due to the size of the network and costs of the measurements. Another option is to estimate the local traffic by utilizing traffic flow network models.

This paper proposes a novel model based on division of a regional road network into cells such that each cell’s boundary is made of major roads with known traffic volumes. Under certain simplifying assumption plausible for local roads, the vast modeling problem is disaggregated to manageable sub-problems.

The paper presents detail description of the model, its assumptions, and an iteration-based estimation of traffic generation and distribution parameters. The estimation procedure is further simplified by the linear form of most relationship that allowed a quadratic optimization problem applied to disaggregate land use data. This new type of data includes geo-coded household and business data obtained by private companies through linking commercial and public records.

Streszczenie

Amerykańskie stanowe i lokalne agencje drogowe rozszerzają zarządzanie drogowo w zakresie bezpieczeństwa i infrastruktury na drogi powiatowe i miejskie. Zarządzanie drogami lokalnymi jest szczególnie utrudnione z powodu braku danych o ruchu drogowym. Systematyczne pomiary nie są stosowane z powodu dużej liczby lokalnych odcinków drogowych i związanych z tym wysokich kosztów. Alternatywnym rozwiązaniem wydaje się estymacja ruchu drogowego na podstawie znanych nateżeni ruchu na drogach krajowych, regionalnych oraz niektórych ważniejszych drog lokalnych.

Istniejące regionalne modele ruchu drogowego nie są dostosowane do modelowania ruchu na dużą liczbę drog lokalnych. Prezentowany referat proponuje nowy rodzaj modelu opartego na podziale regionalnej sieci drogowej na klastry w taki sposób, że drogi ze znanymi nateżeniami ruchu (drogi krajowe, regionalne oraz niektóre ważniejsze drogi lokalne) stają się granica rozdziela ją się klastry drogowe. Podział sieci drogowej na klastry i zastosowanie uproszczających założen akceptowalnych dla ruch lokalnych prowadzi do dekompozycji pierwotnego modelu regionalnego na grupy uproszczonych modeli stosunkowo łatwych do kalibracji i implementacji na duża skalę.

Prezentowany referat szczegółowo opisuje proponowany model, jego założenia uproszczające, oraz kalibrację parametrów modelu w oparciu o znane nateżenie ruchu na niektórych drogach lokalnych. Linearyzacją problemu kalibracyjnego jest osiągnięcie dzięki uproszczeniom modelu i iteracyjnemu rozwiązywaniu układów równań liniowych.

Nowy rodzaj danych o zagospodarowaniu terenu został zastosowany w proponowanym modelu. Te dane są dostępne w USA poprzez łączenie danych osobowych z danymi o miejscu zamieszkania, pracy, i innych aktywnościach ludzi. Dane te są w formie zdezagregowanej (pojedyncze miejsca zamieszkania i pracy) zawierają w południowej geograficznej co pozwoliło zastosować je w proponowanym modelu.