



Gateway Blueprint Model Workshop 2005

The Spatial Allocation of Commercial and Industrial Sector Growth

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Abstract:

LEAM has developed a method for estimating the spatial distribution of future commercial and industrial development for nine economic sectors. Estimating spatial distribution involves conducting a spatial frequency analysis of existing commercial/industrial development and their travel distance to various attractors of development including roads, intersections, ramps, existing employment centers, and utilities.



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Introduction

LEAM utilizes a force – state – response approach to simulate the spatial dynamics of urban settings. Typically this process is based on: i) the identification of the forces that drive urban expansion and transformation, ii) the determination of the existing state of the system, iii) and the determination of the probable responses to the stimulus or forces a) given the force, and b) given the existing state.

The forces that drive transformation are subdivided into three categories; economic drivers – an analysis of the regional economy by economic sector and the likely changes that might occur in any given sector over time, social drivers – the socially significant factors that promote or decrease the likelihood of transformation, and ecologic drivers – the geography and physical features that affect the probabilities of urban transformation.

Typically, responses are viewed as the transformation of any given cell from one state to another, i.e. the transformation of an agricultural land use to a residential land use. The clustering of probabilities and the spatial patterns that emerge from individual cell responses (or changes) can be viewed as the spatial allocation of the new cell state or land use in the region. In the current version of LEAM, there are four possible cell state transformation outcomes: a cell changes to a residential land use, cells transform to commercial or industrial land uses, a cell changes to dedicated open space, or the cell remains in it's current state.

The forces that drive the spatial allocation of land uses differ from land use to land use. So that the forces that determine the attractiveness of a location for residential uses are different than those used to calculate its attractiveness for commercial use. For example, areas adjacent to a busy intersection might be more attractive for commercial land uses and less attractive for residential development because of the congestion of the intersection. LEAM takes advantage of these differences in determining the spatial allocation of commercial industrial cells.



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Method

The process of determining the forces that drive commercial industrial changes in a region are calculated first by the probable changes to the regional economy over time. We do this by combining a nine sector input-output economic model that is tied to a dynamic econometric model for the region. (For more information on this process see LEAMecon). Economic output is calculated for each sector (agricultural services, construction, manufacturing, TCPU, wholesale trade, retail trade, and financial and insurance services) at each time step in a LEAM simulation. This output is also used to determine the changes in area that will be needed to satisfy the changing economic demand in the region. For example, an increase in manufacturing output means that more factories might be needed in order to satisfy the new demand.

Table 1 shows the calculated area for each of the nine sectors in the St. Louis Metro region from 2000 landcover data. Based on the economics of the region the projected change in area needed to satisfy the new calculated demand for each sector, by year, can be calculated. Table 2 describes the changes calculated for metro St Louis.

Sector	Employment	Total Area	Acres	Jobs Per Cell
Agricultural / Extractive	148	94201.76	23.277	2.90
Construction	3811	3435659.576	848.966	3.60
Manufacturing	29547	20524981.65	5071.829	2.27
TCPU	7496	39066130.46	9653.413	1.93
Wholesale Trade	4784	9768624.47	2413.87	0.80
Retail Trade	15125	16879224.86	4170.94	1.06
FIRE	3328	3518966.089	869.556	2.90
Services	39775	66147051.04	16345.242	2.87

Table 1. LEAMecon sectors and resultant area calculations for the St. Louis metro region in 2000.



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Projected Change in Economic Sector Area (in acres)								
	Agriculture	Construction	Manufacture	TCPU	Wholesale	Retail	FIRE	SERVICE
2001	0	76	1233	338	533	666	0	639
2005	24	475	1650	1829	1265	3334	348	3284
2010	65	801	1650	2455	1638	5357	489	4374
2015	107	1148	1650	3016	2053	6881	1029	5804
2020	159	1442	1650	3347	2410	7792	1516	6961
2025	222	1714	1650	3638	2761	8311	2122	7898
2030	294	1986	1650	3965	3128	8556	2910	8776

Table 2. The projected changes in area by economic sector over time in the metro St Louis region.

Once the new areas are calculated the determination of where these new areas are likely to locate can be simulated. The spatial allocation process starts with a LEAM spatial frequency analysis - a determination of the existing cell states and their current allocation frequency by attractor (for more a more detailed description of the LEAM spatial frequency analysis process see LEAMsfa). Commercial/Industrial model attractors are the regional features that attract specific land uses – in this case, each of the nine sectors. Attractors in the Blueprint model for the St Louis region include: access to roads, intersections, utilities, slope characteristics, access to transportation systems – rail, and air, proximity to the workforce, access to water and water transport systems, and existing employment centers. Figure 1 is an image of spatial calculation of an attractor in the St Louis region.



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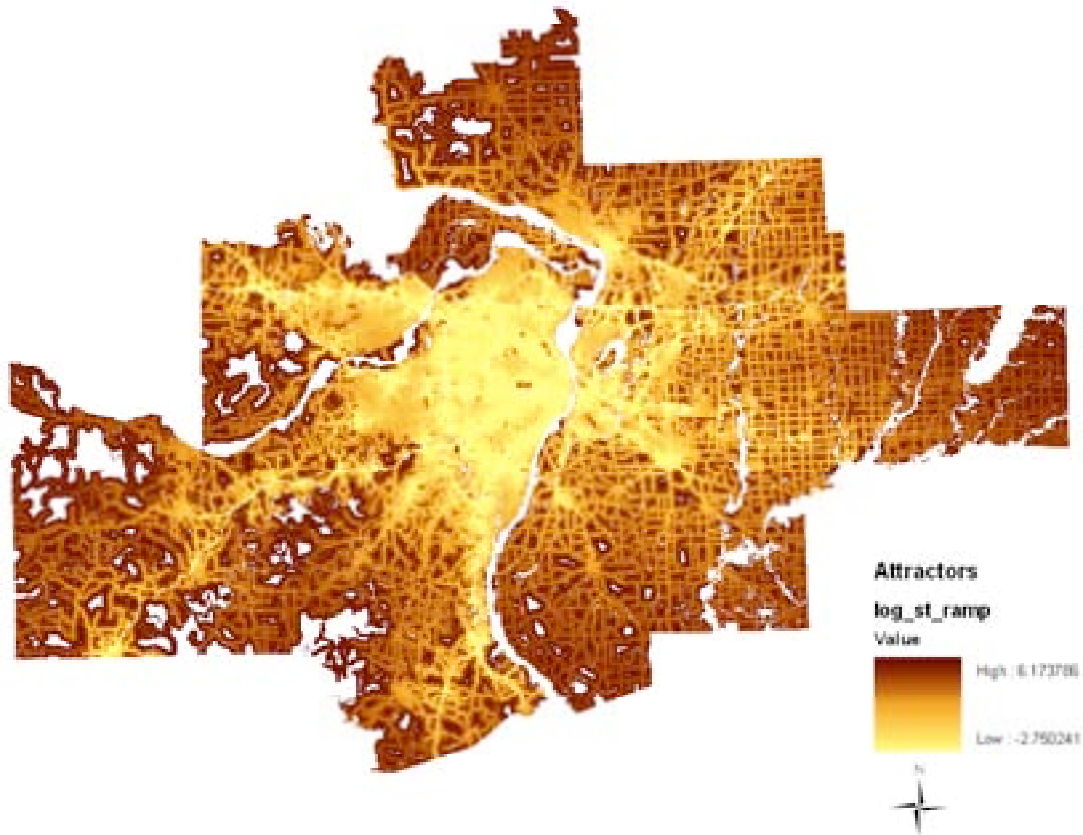


Figure 1, Ramp spatial attractor in the ST Louis region. The map measures the travel time distance (in quarter minutes) from each industry site to the nearest ramp.

The determination of the specific spatial attractiveness of any given cell in a region is then calculated. This is done by looking at the spatial location of existing cells relative to the attractor. Figures 2 and 3 describe the calculated relative attractiveness of each cell in the St Louis region by economic sector. In this way LEAM is able to locate specific commercial or industrial land use areas by their probable attractiveness to any given area in the region. An



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example LEAM output of the commercial/industrial areas in the St Louis region in shown in Figures 4 and 5.

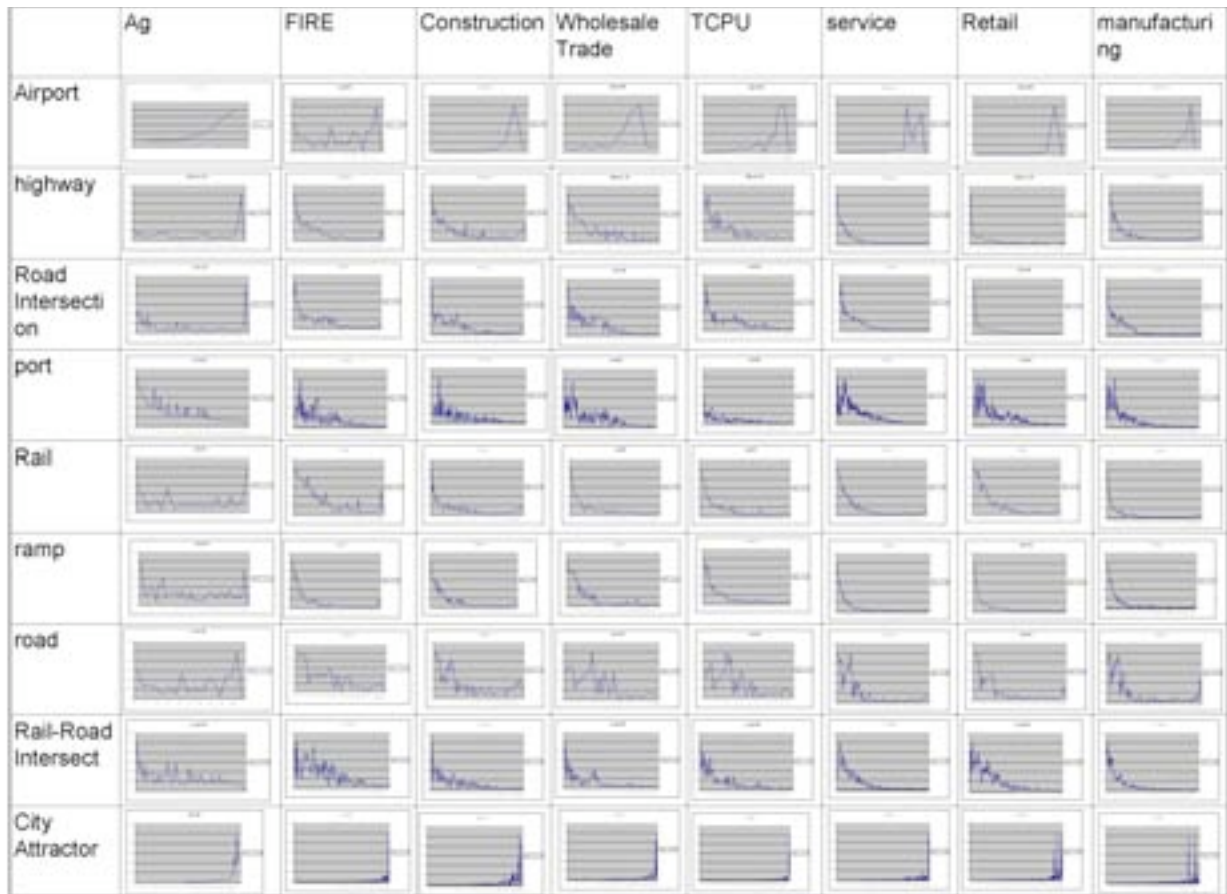


Figure 2. The calculated relative attractiveness of each commercial or industrial cell in the St Louis region by economic sector (x-axis) to the specified attractor variable (y axis).



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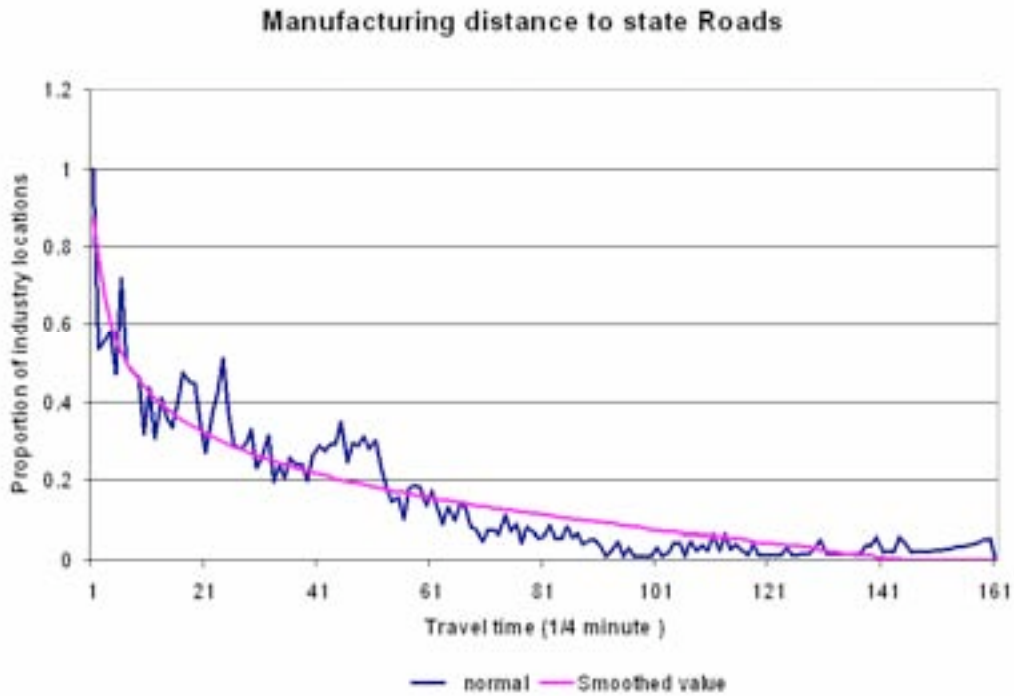


Figure 3. The calculated relative attractiveness of state roads for manufacturing land uses in the St Louis region. LEAM uses smoothed value.



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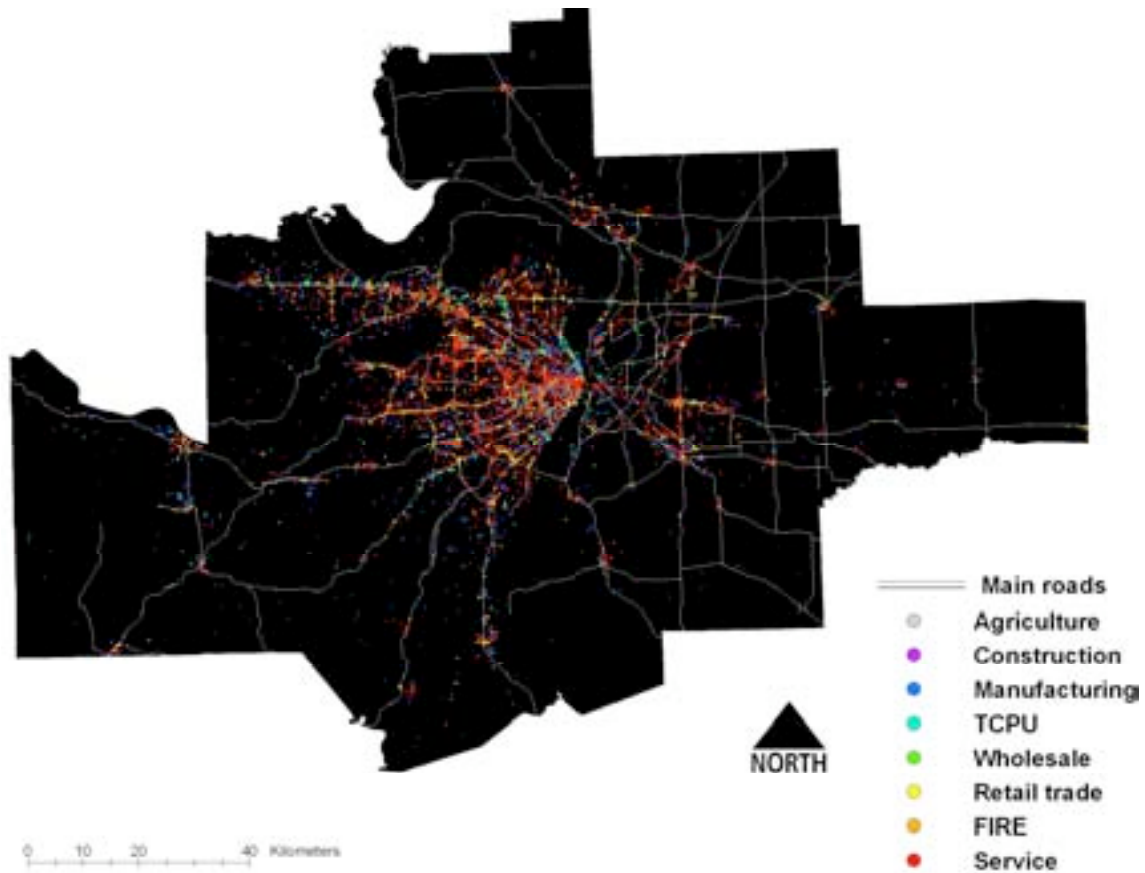


Figure 4. The spatial location of existing businesses and industries in the St Louis metro region.



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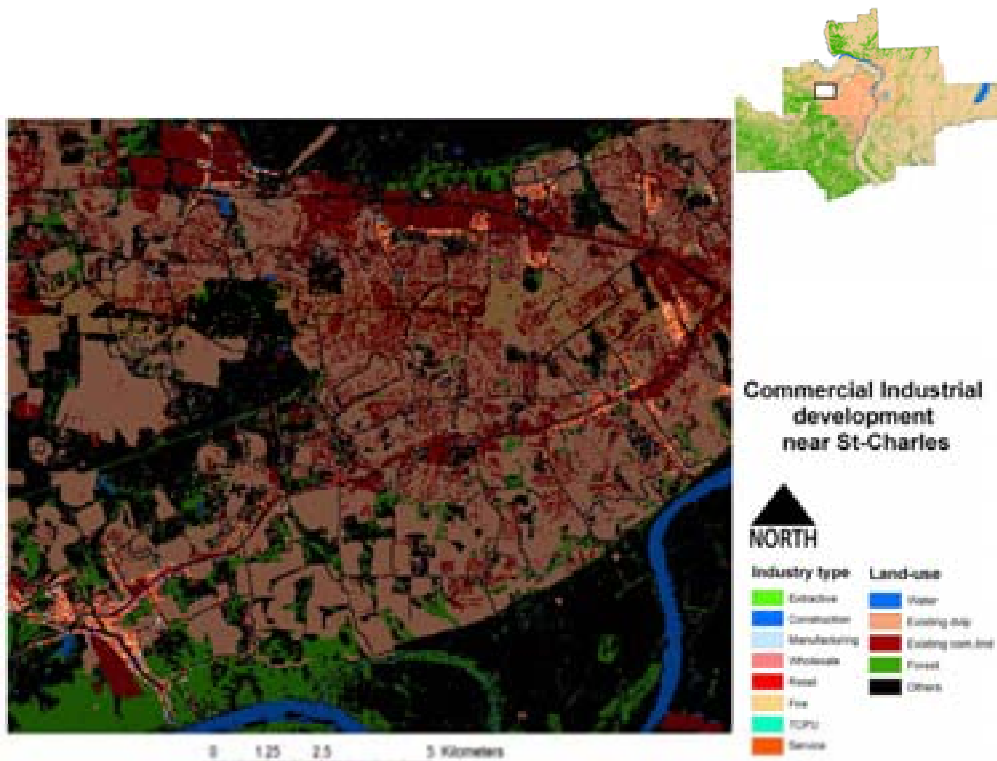


Figure 5. An example output of the LEAM spatial allocation of commercial industrial land uses in the year 2030.

Conclusions.

The forces that drive the allocation of commercial and industrial land uses differs from those that determine residential land use areas. The LEAM Commercial Industrial Allocation Model considers nine different economic sectors and their probable locations in a given region. The spatial distribution and separation of commercial and industrial land uses is important for facilitating an understanding of i) the forces that drive land use change and ii) determining the follow-up land-use impacts that these uses impose.



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Previous work in the area of the spatial distribution of commercial and industrial land uses is sporadic. This work attempts to impose a logical structure on the problem. Future work will involve a refinement of variables and an assessment of an approach using a multinomial logit model to calculate the probability of each land-use cell converting from one type of land use (e.g. agriculture, forest, etc.) to one type of commercial or industrial land-use (e.g. service, manufacturing, etc.).