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Research on Urban Engineering Applying Location Models

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1. Introduction

This chapter presents a methodology for spatial location employing offer and demand comparison, appropriate for urban engineering research. The methods and techniques apply geoprocessing resources as structured data query and dynamic visualization.
The theoretical concept is based on an industrial location model (Cosenza, 1981), which compares both offer and demand for a list of selected location factors. Offer is detected on location sites by intensity levels, and demand is defined from projects by requirement levels. The scale level of these factors is measured by linguistic variables, and operated as fuzzy sets, so that a hierarchical array of locations vs. projects can be obtained as result. The array is normalized at value = 1 to indicate when demand matches offer, which means the location is recommended.
The case study is solved with geoprocessing tools (Harlow, 2005), used to generate data for a mathematical model. Spatial information are georeferenced from data feature classes of cartographic elements on city representation, as administration boundaries, transportation infrastructure, environmental constrains, etc. All data are organized on personal geodatabase, in order to generate digitalized maps associated to classified relational data, and organized by thematic layers. Fuzzy logic is applied to offer and demand levels, translating subjective observation into linguistic variables, aided by methods for classifying quantitative and qualitative data in operational graduations. Fuzzy sets make level measuring more productive and contributes for a new approach to city monitoring methods.
Our proposition is to apply this model to urban engineering, analysing placement of projects that impact on urban growth and development. To operate the model, we propose to use as location factors the environmental characteristics of cities (generic infra-structure, social aspects, economical activities, land use, population, etc).

2. A Location Model

Location models have been used to study the feasibility of projects in a large range of possible sites, and can be applied in macro and micro scale. Macro scale location deals with general and specifics factors, in order to show hierarchical ranking of possibilities. Micro

scale location studies come in sequence to choose the most suitable place of a macro studied output, based on local characteristics of terrain, facilities, transportation, population, general services and environmental constrains.

One approach for location problem solving is based on cross analysis (ex: offer vs. demand) of general and specific factors. General factors are important for most projects, and their lack is not imperative for excluding a location site. These factors are related to infrastructure or to some support element that is part of external economies.

Specific factors are essential for some kind of projects, and their absence or deficiency on requested level invalidates the location site. These factors are often related to natural resources, climate, market, etc.

As general and specific factors are not immutable along time, future changes, such as strategic interventions or incoming projects, must also be considered and inputted as part of offer measurement.

The macro location studies here presented are based on offer vs. demand factors and first took place in Italy, with SOMEA research (Attanasio, 1974) to improve balanced development of south and north Italian regions. Their model used a crispy math formulation for the offer vs. demand comparison (Attanasio, 1976), and latter researchers of COPPE/UFRJ (Cosenza, 1981) built a fuzzy approach for this question.

Recently, fuzzy math was applied to find locations for Biodiesel fuel industrial plants and related activities, such as planting and crushing (Lima et al., 2006). The study was territorially segmented in municipalities, so offer level of location factors was measured for each city of Brazil. The government plan for Biodiesel is directed to join economics and social benefits to low-income population, so location studies in this case must deal with a large set of factors, such as agricultural production, logistics and social aspects.

Therefore, the analysis of the multiple facets involved in this kind of study is quite complex. In this sense, the used methodology tries firstly to identify locations potentialities for subsequent evaluation. In the last stage, not only the location options should be considered, but also the project scale and the costs of logistics.

It should be also observed that any methodological proposition cannot be dissociated from the availability and quality of the data for its full application. This means that the propositions of any project can suffer possible alterations along the time, so other aspects not predicted in the model should be analyzed according to the available secondary data.

3. The Mathematical Model

The concept of Asymmetric Distance (AD) does not satisfy the restrictions of Euclydean Algebra and cannot capture the further richness that makes possible to establish a more strict hierarchy. Then, the model was structured in order to evaluate location alternatives using fuzzy logic. The linguistic values are utilized to give rigorous hierarchy by decision-planner under fuzzy environment. In this research a specific fuzzy algorithm was proposed to solve the project site selection.

The first step is facing the demand situations and those of territorial supplying of general factor (basically infra-structure).

Assuming $A = (a_{ij})_{h\times m}$ and $B = (b_{jk})_{n\times m}$ matrices that represent, respectively, the demand of h types of projects relatively to n location factors, and supplying factors represented by m location alternatives.

Assuming F = {f_i |1, ..., n} is a finite set of general location factors shown generically as f. Then, the fuzzy set $\tilde{A}$ in f is a set of ordinate pairs:

$$\tilde{A} = \{(f, \mu_{\tilde{A}}(f) \mid f \in \bar{r}\} \quad (1)$$

$\tilde{A}$ is the fuzzy representation of the demand matrix A = $(\mu_{ij})_{h\times m}$ and $\mu_{\tilde{f}}$ is the membership function representing the level of importance of the factors:

Critical - Conditional - Not very conditional – Irrelevant

Likewise, if $\tilde{B} = \{(f, \mu_{\tilde{B}}(f)) f \in F\}$ where $\tilde{B}$ is the fuzzy representation of the B supplying matrix and $\mu_{\tilde{B}}(f)$ is the membership function representing the level of the factors offered by the different location alternatives:

Excellent - Good - Fair – Weak

The $\tilde{A}$ matrix is requirement matrix that means that the $\tilde{A}$ set does not have the elements but shows the desired f_i's that belong only to set $\tilde{B}$, defining its outlines, scales levels of quality, availability and supply regularity.

The $\tilde{B}$ matrix with the f_i's satisfies $\tilde{A}$ for proximity. f_1 in the $\tilde{A}$ set is not necessarily equal to f_1 available in $\tilde{B}$. On choosing an alternative, $\tilde{A}$ assumes the values of elements in $\tilde{B}$.

Considering A = {a_i/i=1, ..., m} the set of demands in different types of general or common factors for projects (see Table 1), A_1, A_2, ..., A_m are demands subsets and a_1, a_2,...,a_m different levels of attributes required by the projects.

	f_1	f_2	f_j	f_n
A_1	a_{11}	a_{12}	a_{1j}	a_{1n}
A_2	a_{21}	a_{22}	a_{2j}	a_{2n}
....	....	....	....	....
A_j	a_{j1}	a_{j2}	a_{jj}	a_{jn}
A_m	a_{m1}	a_{m2}	a_{mj}	a_{mn}

Table 1. F_{ij} Factor Demand for Projects

Considering B = {b_k | k=1, ...,m} the set of location alternatives, where F = {f_k | k=1, ...,m} is inserted, and represents the set of common factors to several projects (see Table 2), B_1, B_2, ..., B_m is the set of alternatives; f_1, f_2, ..., f_n is the set of factors; b_1, b_2, ..., b_n is the level of factors supplied by location alternatives; and b_{jk} the fuzzy coefficient of the k alternative in relation to factor j.

	Alternatives			
	B_1	**B_2**	**B_j**	**B_n**
f_1	b_{11}	b_{12}	b_{1k}	b_{1m}
f_2	b_{21}	b_{22}	b_{2k}	b_{2m}
....	....	....	....	....
f_j	b_{j1}	b_{j2}	b_{jk}	b_{jm}
f_n	b_{n1}	b_{n2}	b_{nk}	b_{nm}

Table 2. F_{ij} supplying of location alternatives

On trying to solve the problem already figured out on the use of asymmetric distance (AD) and increase the accuracy of the model for the two generic elements a_{ij} and b_{jk}, the product $a_{ij} \otimes b_{jk} = c_{ik}$ is achieved through the operator presented by Table 3, where c_{ik} is the fuzzy coefficient of the k, alternative in relation to an i project, $0^{+}=1/n!$ and $0^{++}=1/n$ (with n = number of considered attributes) are the limit in quantities and are defined as infinitesimal and small values (>0). Actually, there is an infinite number of values c_{ik} in the interval [0, 1].

$a_{ij} \otimes b_{jk}$	0	.	.	.	1
0	0^{+}	.	.	.	0^{++}
.		1			
.			1		
.				1	
1	0	.	.	.	1

Demand for Factors (d)

Table 3. Supplying Factors (S)

Assuming $a_{ij} = b_{jk}$ the indicator =1, when $b_{jk} > a_{ij}$ the derived coefficient is >1, and when $a_{ij} > b_{jk}$ the fuzzy coefficient is zero (in rigorous matrix) if there is no requirement for a determined factor, but there is a supplying. The fuzzy values are those mentioned above.
In not rigorous matrix $a_{ij} > b_{jk}$ imply in $0 \le c_{ik} < 1$.
Two operators were considered with the same results:
i) not classical fuzzy operation (Table 4);
ii) memberships relation (Table 5).

	supply of factors				
$a_{ij} \otimes b_{jk}$	0	.	$\mu_{\tilde{B}_i}(x)$	.	1
0	0^{+}	.	.	.	0^{++}
.		1	$1+\left[\mu\tilde{B}(x)-\tilde{A}(x)\right]$		
$\mu_{\tilde{A}_i}(x)$			1		
.	$1+\left[\mu\tilde{B}(x)-\tilde{A}(x)\right]$		1		
1	0	.	.	.	1

Demand by Factors

Table 4. Not classical fuzzy

			Weak	Fair	Good	Excellent
		0	$\mu_{B_1}(x)$	$\mu_{B_2}(x)$	$\mu_{B_3}(x)$	$\mu_{B_4}(x)$
	0	1/n!	1/(n-1)	1/(n-2)	1/(n-3)	1/n
Irrelevant	$\mu_{A_1}(x)$	-0,04	1	$1 + \mu_{B_1}(x)/n$	$1 + \mu_{B_2}(x)/n$	$1 + \mu_{B_3}(x)/n$
Not very conditional	$\mu_{A_2}(x)$	-0,16	$\frac{\mu_{B_1}(x)}{\mu_{A_2}(x)}$	1	$1 + \mu_{B_1}(x)/n$	$1 + \mu_{B_2}(x)/n$
Conditional	$\mu_{A_3}(x)$	-0,64	$\frac{\mu_{B_1}(x)}{\mu_{A_3}(x)}$	$\frac{\mu_{B_2}(x)}{\mu_{A_3}(x)}$	1	$1 + \mu_{B_1}(x)/n$
Critical	$\mu_{A_4}(x)$	-1,00	$\frac{\mu_{B_1}(x)}{\mu_{A_4}(x)}$	$\frac{\mu_{B_2}(x)}{\mu_{A_4}(x)}$	$\frac{\mu_{B_3}(x)}{\mu_{A_4}(x)}$	1

Table 5. Memberships relation

Among *n* considered attributes in the several applications, the most frequent ones and those of highest level of support were:

a) elements linked with the cycle of production or service;

b) elements related to transportation and logistics;

c) services of industrial interest;

d) communication;

e) industrial integration;

f) labor availability;

g) electric power (regular supply);

h) water (availability and regular supply);

i) sanitary drainage;

j) general population welfare;

k) climatic conditions and fertility of soil;

l) capacity of settlement ;

m) some other restrictions and facilities related to industrial installation;

n) absence of natural resources that is required by some kind of projects, etc.

The following example of degrees and weights for the i project (Table 6) makes clear the opposition between demand requirements and the conditions of each offering factors.
It can be observed that the operations $O_d \otimes O_s \neq 0$ and $O_D \otimes 1_s \neq 0$ model concerning the hierarchical arrangement of alternatives that do not permit the penalizing of an area that does not have a non-demanded factor or those areas that show more factors than those required, but they can satisfy other requirements and be able to generate external economies.

FACTORS	b_{jk} (Degrees for the k_i alternatives)			a_{ij} (Importance for possibilities)
	B_1	B_2	B_3	
f_1	Weak	Weak	Excellent	Conditional
f_2	Weak	Good	Good	Critical
f_3	Good	Good	Good	Critical
f_4	Weak	Good	Good	Not very conditional
f_5	Fair	Weak	Weak	Irrelevant
f_6	Excellent	Good	Excellent	Conditional
f_7	Good	Excellent	Good	Critical

a_{ij} : fuzzy coefficient of the degree of importance of factor j related to the i project, and
b_{jk} : fuzzy coefficient that results from the level of the factor related to the k area

Table 6. Example of degrees and weights for the i project

Assuming $A^* = (a^*_{ij})_{mxn'}$, the demand matrix of i types of project related to n' specific location factors. Concerning the use of the A matrix, all factors are critical, and for the activities concerning raw materials, these characteristics can be defined by means of the results:

1. Relation product weight / raw material weight
2. Perishable raw materials
3. Relation factor freight / product freight
4. Relation freight factor / factor cost, etc

$\tilde{A}^* = \{f, \mu_{\tilde{A}^*}(f) \in F\}$ is the fuzzy representation of the A* matrix.

Assuming $B^* = [bij]_{n'.m}$ the territorial supplying matrix of n' specific location factors of i kind of project, concerning specific resources or any other specific conditioning factor, and $\Gamma = [\gamma_{ik}]_{mxq} = C \oplus C^*$, where the aggregation of values (gamma operation) concerning the activities on specific resources is achieved by Table 7 (with $\tilde{c}_{ik}$ = fuzzy coefficient).

$\tilde{c}^*_{ik}$ \ $\tilde{c}_{ik}$	>0	0
0	0	0
>0	$c_{ik}+c^*_{ik}$	c^*_{ik}

Table 7. Aggregation operator

The $A = [\lambda_{ij}]_{mxn\Sigma}$ matrix results from that defines the demand profile for the location effect, where: $n_\Sigma = n + n'$.

Assuming $\Box = (e_{il})_{h \times h}$ is the diagonal matrix, so that $e_{il} = \begin{cases} 0, & \text{if } i \neq l \\ 1/\sum_{j=1}^{n\Sigma} a_{ij}, & \text{if } i = l \end{cases}$

$\Delta = [e \times F] = [\delta_{ik}]$ can still be defined as the representative matrix of the location possibilities of the h types of projects in the m alternatives, now represented by indices related to

demanded location factors. That means that each element δ_{ik} of the Δ matrix represents the indices of factors satisfied in the location of the i kind of projects in the k elementary zone.
If $\delta_{ik} = 1$ the k area satisfies the demand at the required level.
If $\delta_{ik} < 1$ means that at least one demanded factor was not satisfied.
If $\delta_{ik} > 1$ the k area offers more conditions than those demanded.
The concepts of fuzzy numbers are used to evaluate mainly the subjective attributes and information related to importance of de general and specific factors.
Figure 1 presents the membership functions of the linguistic ratings, and Fig. 2 presents the membership functions for linguistic values.

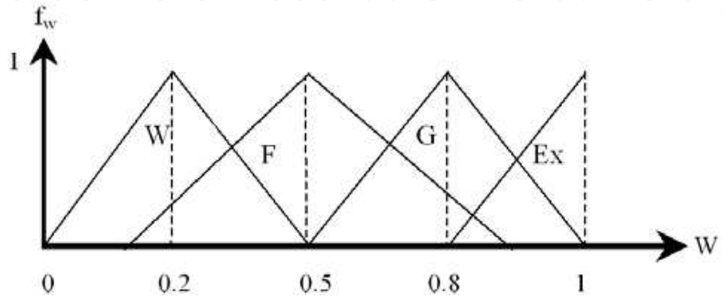


Fig. 1. Linguistic ratings: W = Weak: (0, 0.2, 0.2, 0.5), F = Fair: (0.17, 0.5, 0.5, 0.84), G = Good: (0.5, 0.8, 0.8, 1), Ex = Excellent (0.8, 1, 1, 1)

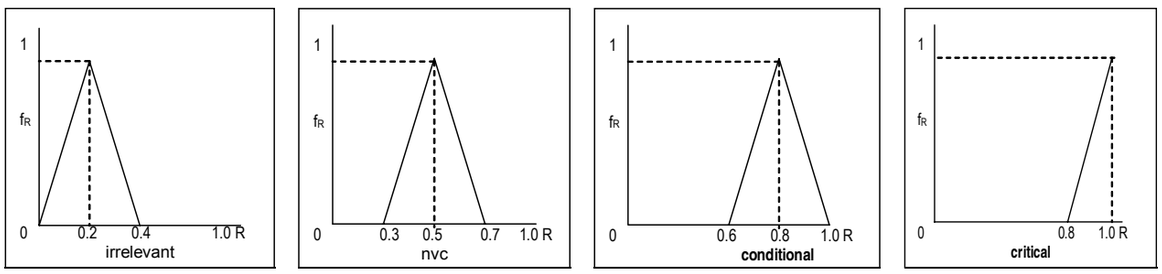


Fig. 2 Linguistic values: I = Irrelevant: (0, 0.2, 0.2, 0.4) , NVC = Not Very Conditional: (0.3, 0.5, 0.5, 0.7), C = Conditional: (0.6, 0.8, 0.8, 1.0), C = Critical : (0.8, 1.0, 1.0 , 1.0)

4. Methodology

The methodological approach consists in selecting a set of location factors that can be measured in territorial sites and associated to characteristics of under study projects. The offer and demand levels of these location factors must be defined and quantified, and a fuzzy algorithm operates the datasets obtained, in order to produce a hierarchical indication for sites and project location (Fig. 3).
The first step consists in listing appropriate location factors as resulting from territorial study and project research. Territorial study also help on site contours adopted for offer measurement, in general the suitable for available thematically data (economics, population, etc.), such as municipal or district census boundaries. Project research describe what kind and amount of facilities, resources, and logistics are necessary to improve related services and activities. The initial information is used for classifying offer and demand in several levels, corresponding to linguistic variables mentioned before in the mathematical model.

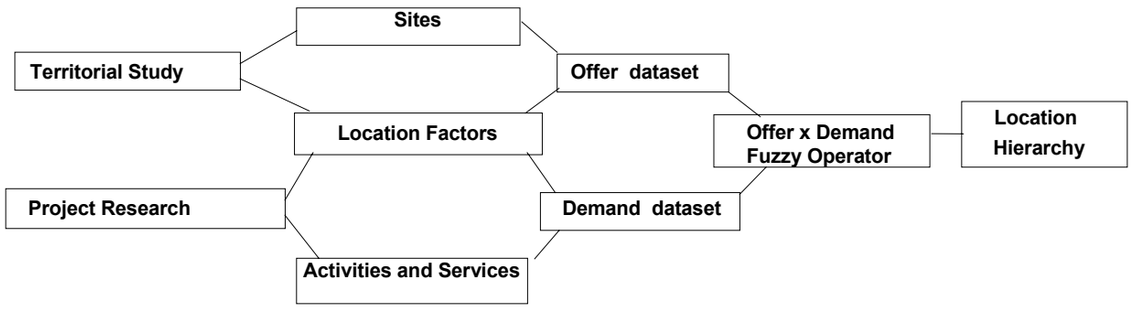


Fig. 3. Methodology

The offer is measured in levels for each considered site, and a geoprocessing tool can turn this job more effective and precise. A geographic code is used as key column for relational operations with the studied sites, as join and relates with tables containing thematic data. The number of levels can vary from 4 (four) to 10 (ten), more levels are better for classifying and displaying data in GIS ambient, but later they will must be regrouped in 4 (four) levels (Cosenza & Lima, 1991) to attempt the linguistic concept (Excellent - Good - Fair – Weak).
The rules for converting data in operational values to indicate these levels are previously defined in registry tables (relations between parameters and concepts) and could be generated by geoprocessing tools in two ways:

- Spatial analyses, when properties as distance or pertinence to georeferenced items (roads, pipelines, ports, plants, etc) are used to assign the level (Fig. 4),
- Statistic classification, when data is directly associated to the site contours (population, incomes, etc), and a range of values must be classified by statistics and grouped as assigned levels (Fig. 5).

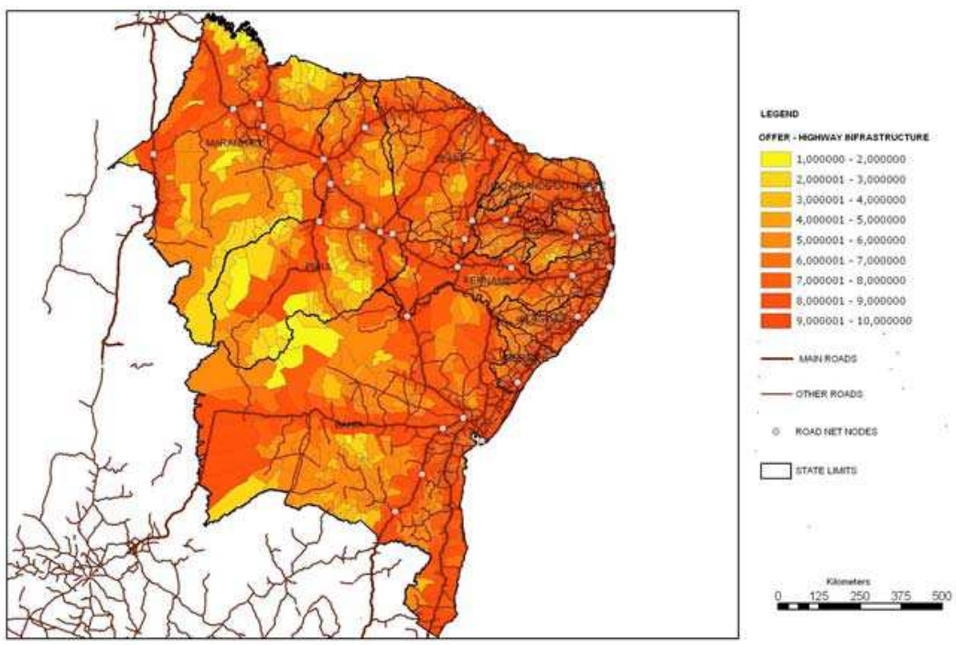


Fig. 4. Georeferenced levels of highway infrastructure offer performed by spatial analyses

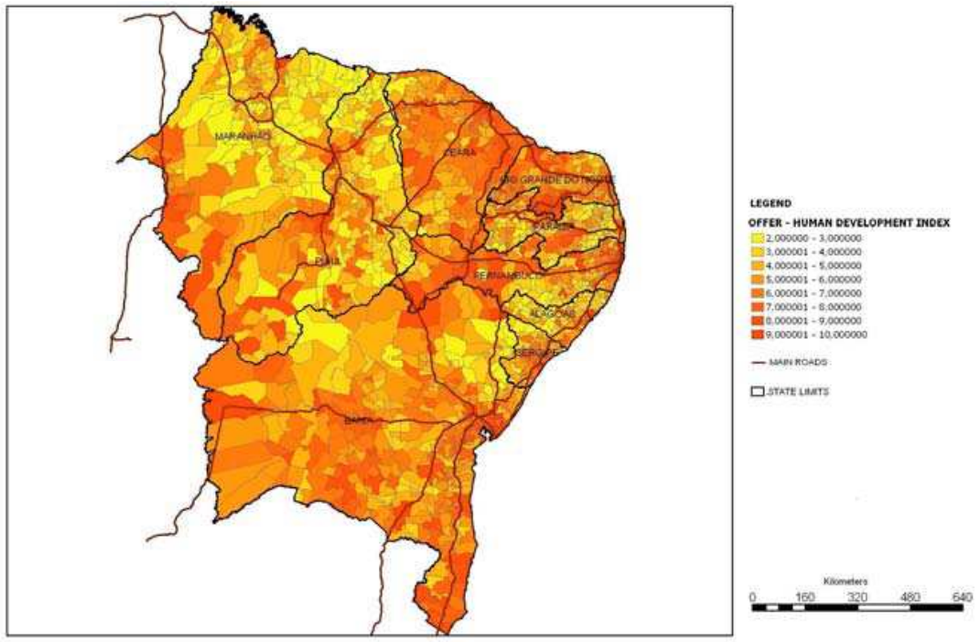


Fig. 5. Georeferenced levels of human development index offer performed by statistic classification

The demand is also organized in registry tables (Table 8), whose values are assigned by subjective interpretation of experts, based in their experience on implementing and operating similar projects. The more dependent projects are on a given factor; the highest is the demand level assignment. The demand levels can be defined in a different number them offer levels, but 4 (four) levels could deal more properly with the linguistic concept (Critical - Conditional - Not very conditional – Irrelevant).
The factors must be defined on each project as general (G) or specific (S). As seen before, a specific factor is more impacting than a general factor, because less offer of specific factor (natural resources, climate, market, etc) them requested by project could harm the location.

FACTOR ID	PROJECTS:												FACTOR DESCRIPTION
	A		B		C		D		E		F		
Fat_Infra_RODOV_3	3	G	3	G	3	G	3	G	4	G	3	G	Roadway infrastructure
Fat_Infra_FERROV	1	G	3	G	3	G	2	G	3	G	2	G	Railway infrastructure
Fat_Infra_HIDRO	1	G	3	G	3	G	2	G	3	G	1	G	River transportation
Fat_PORTO_Exportador	2	G	2	G	3	G	2	G	2	G	2	G	Exportation Ports
Fat_ETANOL	1	G	1	G	2	G	4	S	2	G	4	S	Ethanol Industrial Plants
Fat_Forn_METANOL	1	S	1	S	2	S	1	G	2	S	1	G	Methanol Ports

S = factor set as specific, G= factor set as general
4= Critical - 3= Conditional - 2= Not very conditional – 1= Irrelevant

Table 8. Demand table: project (identity preserved) in columns, location factors in lines

After assigned, both offer and demand datasets could be inputted as arrays and processed by computational resources, that compare offer vs. demand relations for each site and each project, in order to produce an output array containing hierarchical indicators.

To rule the process is used a relationship table (Table 9), where an equal offer vs. demand diagonal is placed with value = 1, which represents situations that offer matches demand. The other values could represent lack or excess, and may be adjusted to minimize or maximize effects around diagonal. For instance, when a project still considers sites where a little lack of offer as not critical, it could be assigned values near zero for poor offer relations, if lack of offer cancel the project, all values where offer is less than demand should be zero. In other way, when is interesting to know sites with a greater amount of offer, it could be assigned an increment for best offer relations.

		WEAK	FAIR	GOOD	EXCELLENT
	0	$\mu_{B_1}(x)$	$\mu_{B_2}(x)$	$\mu_{B_3}(x)$	$\mu_{B_4}(x)$
0	1/n!	1/(n-1)	1/(n-2)	1/(n-3)	1/n
IRRELEVANT $\mu_{A_1}(x)$	0	1	$1 + \mu_{B_1}(x)/n$	$1 + \mu_{B_2}(x)/n$	$1 + \mu_{B_3}(x)/n$
NOT VERY CONDITIONAL $\mu_{A_2}(x)$	0	$\mu_{B_1}(x)/\mu_{A_2}(x)$	1	$1 + \mu_{B_1}(x)/n$	$1 + \mu_{B_2}(x)/n$
CONDITIONAL $\mu_{A_3}(x)$	0	$\mu_{B_1}(x)/\mu_{A_3}(x)$	$\mu_{B_2}(x)/\mu_{A_3}(x)$	1	$1 + \mu_{B_1}(x)/n$
CRITICAL $\mu_{A_4}(x)$	0	$\mu_{B_1}(x)/\mu_{A_4}(x)$	$\mu_{B_2}(x)/\mu_{A_4}(x)$	$\mu_{B_3}(x)/\mu_{A_4}(x)$	1

Table 9. Relationship table for offer vs. demand comparison and attributes: on columns weak, fair, good and excellent; on lines irrelevant, not very conditional, conditional and critical

The results are obtained as a table (Table 10), where columns are projects and lines are sites, and the obtained values express how territorial conditions match project requirements. A value normalized to 1 (one) represents the situation where both offer and demand are balanced, so location is recommended. Values greater than 1 (one) indicates that the site has more offer conditions than required, and values less than 1 (one) indicates that at least one of the factors was not attempted.

105.Assis Chateaubriand	4102000	1,043	1,044	0,876	0,945	0,966	1,094	*0,995*
106.São João do Ivaí	4125001	0,986	1,008	0,898	0,944	1,018	1,114	*0,995*
107.Rio Claro	3543907	0,973	0,94	0,906	0,986	1,019	1,143	*0,995*
108.Campo Mourão	4104303	0,996	0,978	0,874	0,986	1,006	1,126	*0,994*
109.Rolândia	4122404	0,991	0,966	0,891	0,978	1,021	1,118	*0,994*
110.Imbituva	4110102	1	0,996	0,901	0,909	1,029	1,13	*0,994*
111.Ipiranga	4110508	1	0,996	0,901	0,909	1,029	1,13	*0,994*
112.Apucarana	4101408	0,985	0,99	0,93	0,97	0,999	1,088	*0,994*
113.Santa Mariana	4123907	0,969	0,968	0,9	0,955	1,053	1,115	*0,993*
114.Mal Cândido Rondon	4114609	1,024	1,019	0,891	0,96	0,999	1,066	*0,993*
115.Lençóis Paulista	3526803	0,958	1,005	0,885	0,981	1,025	1,105	*0,993*
116.Candelária	4304200	1,003	1,073	0,9	0,949	0,98	1,053	*0,993*
117.Colina	3512001	0,983	1,001	0,874	1	0,993	1,104	*0,993*
118.Ribeirão Preto	3543402	0,915	0,953	0,89	1,001	1,029	1,166	*0,992*
119.Cruz Alta	4306106	1,001	1,005	0,888	0,961	0,979	1,116	*0,992*
120.Canoinhas	4203808	1,008	1,009	0,921	0,93	0,993	1,088	*0,992*

Table 10. Hierarchies location results for a set of municipalities, where project (identity preserved) is placed in columns, with last column shows media for all projects

Table could be now georeferenced to the sites (Fig. 6) by their geographic codes, using join or relate operations with the georeferenced tables. In the next step, location indicators are classified by statistics and displayed as chromatic conventions, in order to interpret spatial possibilities of placement. The chromatic classification for results can use various statistic methods, such as: natural breaks, equal interval, standard derivation and quantile.

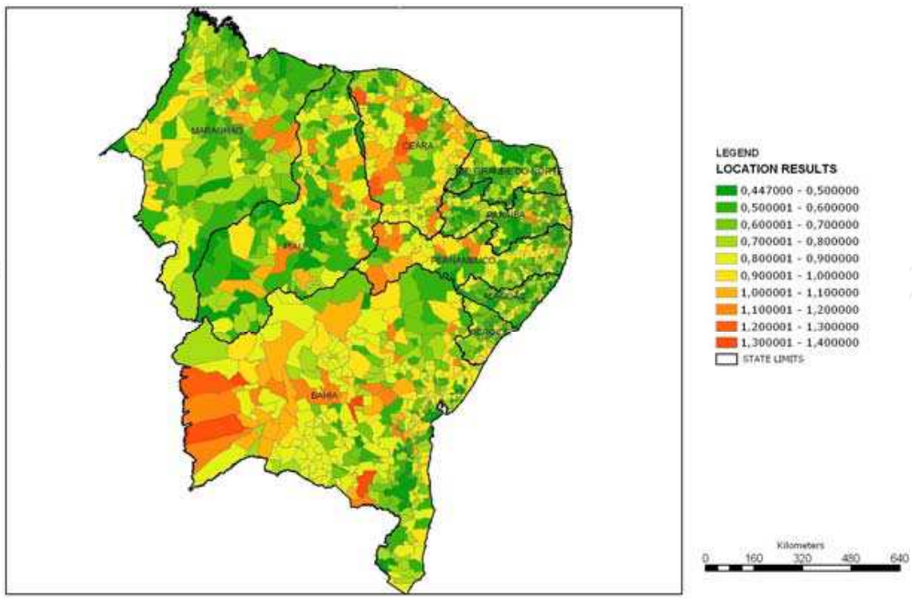


Fig. 6. Location indicators are classified and displayed as chromatic conventions

Natural breaks are indicated to group a set of values between break points that identifies a change in distribution patterns, and is the most frequent used form of visualization for identifying best location. Equal interval is used to divide the range into equal size values sub-ranges, and is used to identify results perform in comparison analysis. Standard derivation is used to indicate how a value varies from the mean, and is often used to show how results are dispersed. Quantile groups the set of values in equal number of items, and is used less frequently because results are normalized.

7. Conclusion

Location models can also be employed for previewing land use and occupation of urban areas. An analogy could be done considering an occupation typology (habitational buildings, industrial zone, etc.) as a project for an urban site (district, zone, land, etc.). A list of location factors that direct urban development could be selected from spatial, economic and social data records (population, market, education, prices, mobility, health care, etc.).
The offer of these location factors could be measured on urban sites from local surveys or official census data. Most of geographic offices in charge of registering official data make available their operational boundaries as feature classes compatible with GIS platforms.
Urban planners, engineers, public services managers, political authorities, should define the demand set, and will determinate the relevance of a factor on occupation typology, and multi criteria analysis will be helpful to equalize their opinion (Liang & Wang, 1991).
But how a location model can help urban engineering research? If a land use or activity placement could be treated as a project, ordering distinct location factors, it should be possible to measure territorial offer and typology demand. Presuming that recent placement situations can be studied to produce diagnosis based on configuration of related offer and demand sets, researching past offer sets may be interesting for understanding how factors evolution influences a site.

For instance, registering and analyzing the offer records along a significant time, and consulting specialists for demand attribute, it will be possible to isolate pattern characteristics of a situation. Observing offer increase or decrease along the time, a general urban evolution tendency (residential, industrial, commercial, etc.) could be expressed by its particular demand set. Comparing the urban site offer with a demand assigned pattern, it is possible by simulation to explore future scenarios. A georeferenced array of urban sites vs. pattern characteristics could indicate how intense each site matches the pattern characteristics, and based on the values obtained verify the possibilities of occurrence.

So, if the responsible authority inquires about a place that would be a commercial zone in the next five years, the researcher would construct an offer fuzzy set of the urban site based on recent data, and check it with a proposed pattern of typical commercial zone factors demand. The possibility of occurrence, defined by the hierarchic values, could be used to determinate and prioritize actions.

By extracting specific geodata of offer and demand sets, it is also possible to identify which factors have significant influence on the results, and so define strategic intervention that could direct the expected results.

To conclude, an offer and demand logic operator attached to geoprocessing resources could enhance the horizon of researches on urban engineering methods, and improve queries and simulations that will help to understand and simulate the dynamic of cities growth.

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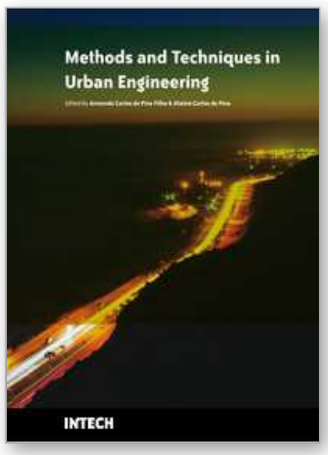
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Methods and Techniques in Urban Engineering

Edited by Armando Carlos de Pina Filho and Aloisio Carlos de Pina

ISBN 978-953-307-096-4
Hard cover, 262 pages
Publisher InTech
Published online 01, May, 2010
Published in print edition May, 2010

A series of urban problems such as dwelling deficit, infrastructure problems, inefficient services, environmental pollution, etc. can be observed in many countries. Urban Engineering searches solutions for these problems using a conjoined system of planning, management and technology. A great deal of research is devoted to application of instruments, methodologies and tools for monitoring and acquisition of data, based on the factual experience and computational modeling. The objective of the book was to present works related to urban automation, geographic information systems (GIS), analysis, monitoring and management of urban noise, floods and transports, information technology applied to the cities, tools for urban simulation, social monitoring and control of urban policies, sustainability, etc., demonstrating methods and techniques applied in Urban Engineering. Considering all the interesting information presented, the book can offer some aid in creating new research, as well as incite the interest of people for this area of study, since Urban Engineering is fundamental for city development.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Carlos Alberto N. Cosenza, Fernando Rodrigues Lima and Cesar das Neves (2010). Research on Urban Engineering Applying Location Models, Methods and Techniques in Urban Engineering, Armando Carlos de Pina Filho and Aloisio Carlos de Pina (Ed.), ISBN: 978-953-307-096-4, InTech, Available from: http://www.intechopen.com/books/methods-and-techniques-in-urban-engineering/research-on-urban-engineering-applying-location-models

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