THE TERRITORIAL COMPETITIVENESS OF SUSTAINABILITY CANNOT BE ASSESSED BY A SINGLE DOMAIN

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Abstract. Sustainability evolved towards a multifarious concept, with four pillars (economic, social, environmental and cultural) and more dimensions, including a territorial one. Therefore, the study hypothesized that in order to check whether development achieved sustainability, the indicators must account for several sectors. The case study looked at the urban settlements of the North-East region of development in Romania using 2011 data analyzed using the Principal Component Analysis integrated with GIS. Results indicated that the variation of the level of development can be explained by population, turnover of the primary sector, share of the employees in the tertiary sector, density of wastewater sewerage networks, density of water supply networks and area of green spaces per inhabitant, supporting the underlying hypothesis.

Key words: sustainable spatial development, GIS, Principal Component Analysis, territorial imbalances, North-East Region of Development

1. Introduction

Many authors believe that sustainability has three traditional pillars – economic, social and environmental (Basiago, 1999; OECD, 2004; Littig and Grießler, 2005; Gibson, 2006; Murphy, 2012). However, other authors acknowledge the existence of a fourth cultural one, due to its potential for fostering economic growth (Hawkes, 2001). Its recognition in 2010 (with an equal importance to the traditional ones) was the consequence of the intense lobbying from the United Cities and Local Governments (United Cities and Local Governments, 2010), although researches were carried out even before.

Some of the dimensions of sustainability coincide with the four pillars; a fifth dimension (of equal importance) was consider in order to acknowledge the fact that development takes place in territories with variable sizes, corresponding to the administrative divisions (Bottero and Peretti, 2010; Péti, 2012). The other dimensions are simple sub-divisions of the mainstream ones, or result from their overlap. Examples can include transportation, energy, housing, infrastructure, education, science, ethics and management. Nevertheless, the core principle is the same: the ability of a system to sustain its own existence using its own means after its creation (autarchy), but adding a (sustainable) growth to the simple subsistence (Daly, 1990; Tofan, 1999; Curtis, 2003; Müller *et al.*, 2011; McLellan *et al.*, 2012).

Due to these reasons, this article relies on the hypothesis stating that when indicators are used (alone or aggregated in indices) to assess the characteristics of development (including sustainability), the reality cannot be revealed from the perspective of a single sector – economic, social etc. More exactly, only a set of indicators or indices corresponding to different sectors is able to reveal correctly territorial disparities in the level of development.

2. Methods

The method used in the study was published by Petrişor *et al.* in 2012, and consists of integrating the Principal Component Analysis (PCA) in a geographical Information System (GIS) and was used in different cases: to analyze the overall level of development in Romania (Ianoş *et al.*, 2013); to perform a similar micro-scale analysis in the hydrographic basin of Ialomița (Ianoş and Petrişor, 2010); to underline the axes and corridors of development in Iaşi County (Iurea, 2011a); and to map the distribution of the overall level of development in Danube Delta Biosphere Reserve (Văidianu, 2011).

PCA starts from the premise according to which the variation of the general level of development, starting from all variables included in the study, is explained by the variation of factors specific to each variable separated, but also by common factors, and identifies the principal components corresponding to variability, which are correlated to some variables. The variable which shows the highest absolute value of the correlation coefficient with one of the principal components is significantly responsible for contributing to variability in the level of development.

The study was carried out in the urban settlements of the North-East region of Development in Romania using 2011 data. 17 variables were included in the analysis; their list is found in the first column of Table 2.

The most important components were embedded into a model used to look at the spatial distribution of the level of development in the administrative units of North-East region of development. In order to elaborate the model, based on the weights determined previously (Table 1, gray column), their ranking (including a reverted ranking scale for the variables inversely correlated (share of the turnover of the primary sector and share of the employees in the tertiary sector), an ArcView 3.2 model was produced (Fig. 1) using few transformations required by the program (vector-raster conversion, reclassification, weighted overlay). The final result is the overall level of development, with five levels (very low, low, average, high, and very high).

Finally, disfavored areas were identified by building an index **I** starting from the results of PCA:

$$I = \frac{\begin{array}{c}51.769 \times I1\_11 - 12.892 \times C31\_11 - \\ -8.245 \times C51MODIF + 5.589 \times I13\_11 + \\ +4.115 \times I12\_11 + 3.149 \times I6\_11\end{array}}{85.76}$$

The values were ranked in five quantile-based classes and used to show disfavored and developed units.

Table 1. Total variation explained by components

Component	Initial Eigen Values			Extracted sum of squares for load factors			
	Total	% variability	Cumulative %	Total	% variability	Cumulative %	% variability (adds to 100%)
1	16.566	51.769	51.769	16.566	51.769	51.769	60
2	4.125	12.892	64.661	4.125	12.892	64.661	15
3	2.638	8.245	72.906	2.638	8.245	72.906	10
4	1.789	5.589	78.495	1.789	5.589	78.495	7
5	1.317	4.115	82.611	1.317	4.115	82.611	5
6	1.008	3.149	85.760	1.008	3.149	85.760	4
7	0.896	2.799	88.559				
8	0.654	2.043	90.601				
9	0.630	1.968	92.569				
10	0.522	1.632	94.201				
11	0.444	1.386	95.588				
12	0.392	1.224	96.811				
13	0.251	0.784	97.596				
14	0.206	0.643	98.238				
15	0.179	0.560	98.798				
16	0.106	0.331	99.130				
17	0.087	0.272	99.402				
18	0.073	0.227	99.629				
19	0.045	0.142	99.771				
20	0.039	0.123	99.893				
21	0.016	0.050	99.943				
22	0.007	0.022	99.966				
23	0.006	0.018	99.983				
24	0.003	0.010	99.994				
25	0.001	0.004	99.998				
26	0.001	0.002	100.000				
27	<0.001	<0.001	100.000				
28	<0.001	<0.001	100.000				
29	<0.001	<0.001	100.000				
30	<0.001	<0.001	100.000				
31	<0.001	<0.001	100.000				
32	<0.001	<0.001	100.000				

Results show that there are six components which, taken together, explain 85.76% of the overall variability in the level of development (see above).

In this table, the numbers corresponding to the 17 components are not assigned to the 17 variables used in the studies. The correspondence to variables is found in Table 2 based on the highest absolute value of the correlation coefficient between components and variables (gray).

3. Results and discussion

The results show that the variation of the level of development can be explained by population (51.77%), turnover of the primary sector (12.89%), share of the employees in the tertiary sector (8.25%), density of wastewater sewerage networks (5.59%), density of water supply networks (4.12%) and area of green spaces per inhabitant (3.15%). Accounting only for these variables and considering that they explain 100% of the variability in the level of development, new weights were re-computed in Table 1 (gray column). Two maps were produced using the GIS model (Fig. 3) and indicator (Fig. 4) developed based on these results.

The results are consistent with previous findings. As Fig. 3 shows, Iaşi became a strong pole of development, despite of the low level of development in its region. The city structures axes of development underlined by Iurea (2011a, b) and reconfirmed by the findings of this study – Fig. 4.

Table 2. Correlations between components and variables

	Component					
	1	2	3	4	5	6
I1_11 (no. of inhabitants)	0.958	-0.249	-0.038	-0.005	0.064	0.003
I2_11 (share of employees in nonagricultural activities)	0.223	0.641	-0.586	-0.120	0.349	0.042
I3_11 (no. of households with water supply)	0.705	0.611	0.140	0.151	-0.045	-0.088
I4_11 (share of households with indoor bath and toilet)	0.743	0.579	0.166	0.122	-0.078	-0.132
I5_11 (share of households with central heating)	0.810	0.363	0.220	0.198	-0.051	-0.107
I6_11 (number of hospital beds per 1000 people)	0.537	0.395	0.276	-0.388	-0.318	0.163
I7_11 (number of physicians per 1000 people)	0.766	0.166	0.094	-0.302	-0.333	0.188
I8_11 (education units)	0.957	-0.215	-0.045	-0.036	-0.007	0.053
I9_11 (culture and sports facilities)	0.955	-0.221	-0.069	-0.079	0.020	0.063
I10_11 (hotel rooms)	0.794	-0.045	-0.121	-0.070	-0.024	0.295
I11_11 (share of modernized streets out of total length)	0.577	0.281	-0.073	0.214	-0.145	-0.458
I12_11 (density of water supply networks, km/km^2)	0.191	-0.138	0.330	0.442	0.605	0.249
I13_11 (density of wastewater sewerage networks, km/km^2)	0.498	0.144	0.333	0.584	0.264	0.023
I14_11 (volume of drinkable household water per person, in m^3)	0.802	0.238	0.169	-0.093	-0.125	0.181
I15_11 (existence of a wastewater treatment plant – mechanical or mechanical and biological treatment)	0.444	0.522	0.367	0.054	0.005	-0.009
I16_11 (area of green spaces per inhabitant in m^2)	0.199	0.258	-0.040	0.365	-0.110	0.538
I17 (household waste transfer stations – no.)	-0.035	0.443	0.449	0.173	-0.157	0.130
I18 (landfills – no.)	0.816	-0.258	-0.129	0.026	0.020	-0.068
A_11 (population)	0.958	-0.249	-0.038	-0.005	0.064	0.003
B1_11 (total no. of employees)	0.953	-0.268	-0.078	-0.036	0.043	0.028
B2_11 (total no. of employees in nonagricultural activities)	0.952	-0.267	-0.081	-0.044	0.044	0.034
B21_11 (share of employees in nonagricultural activities)	0.223	0.641	-0.586	-0.120	0.349	0.042
C_11 (total turnover)	0.948	-0.270	-0.081	-0.038	0.034	-0.035
C_11_URBAN (turnover in the urban areas)	0.949	-0.269	-0.080	-0.038	0.034	-0.035
C3_11 (turnover of the primary sector)	0.612	-0.203	0.061	0.364	-0.113	-0.389
C31_11 (share of the turnover of the primary sector)	-0.295	-0.685	0.458	0.150	-0.137	0.103
C4_11 (turnover of the secondary sector)	0.926	-0.239	-0.059	-0.110	0.095	0.000
C41_11 (share of the turnover of the secondary sector)	0.254	0.307	0.512	-0.558	0.418	-0.148
C5_11 (share of the turnover of the tertiary sector)	0.941	-0.286	-0.107	-0.009	-0.007	-0.034
C51MODIF (share of the employees in the tertiary sector)	-0.042	0.167	-0.781	0.422	-0.300	0.071
D2_11 (no. of companies contributing to the turnover)	0.949	-0.269	-0.095	-0.051	0.015	0.034
D1_11 (no. of companies per 100 people)	0.802	0.389	0.061	0.079	-0.139	-0.027

4. Conclusions

The study confirmed the underlying hypothesis, as the PCA-based indicators belong to different sectors: demography (population), economy (turnover of the primary sector and share of the employees in the tertiary sector), infrastructure (density of water supply networks) and environment (density of wastewater sewerage networks and area of green spaces per inhabitant). Consequently, in assessing sustainable competitiveness under a territorial framework, more dimensions should be considered simultaneously for analysis.

Sustainable competitiveness is defined as the "*ability to achieve and maintain the (economic) competitiveness of industry in accordance with sustainable development objectives*" (Ecorys, 2011).

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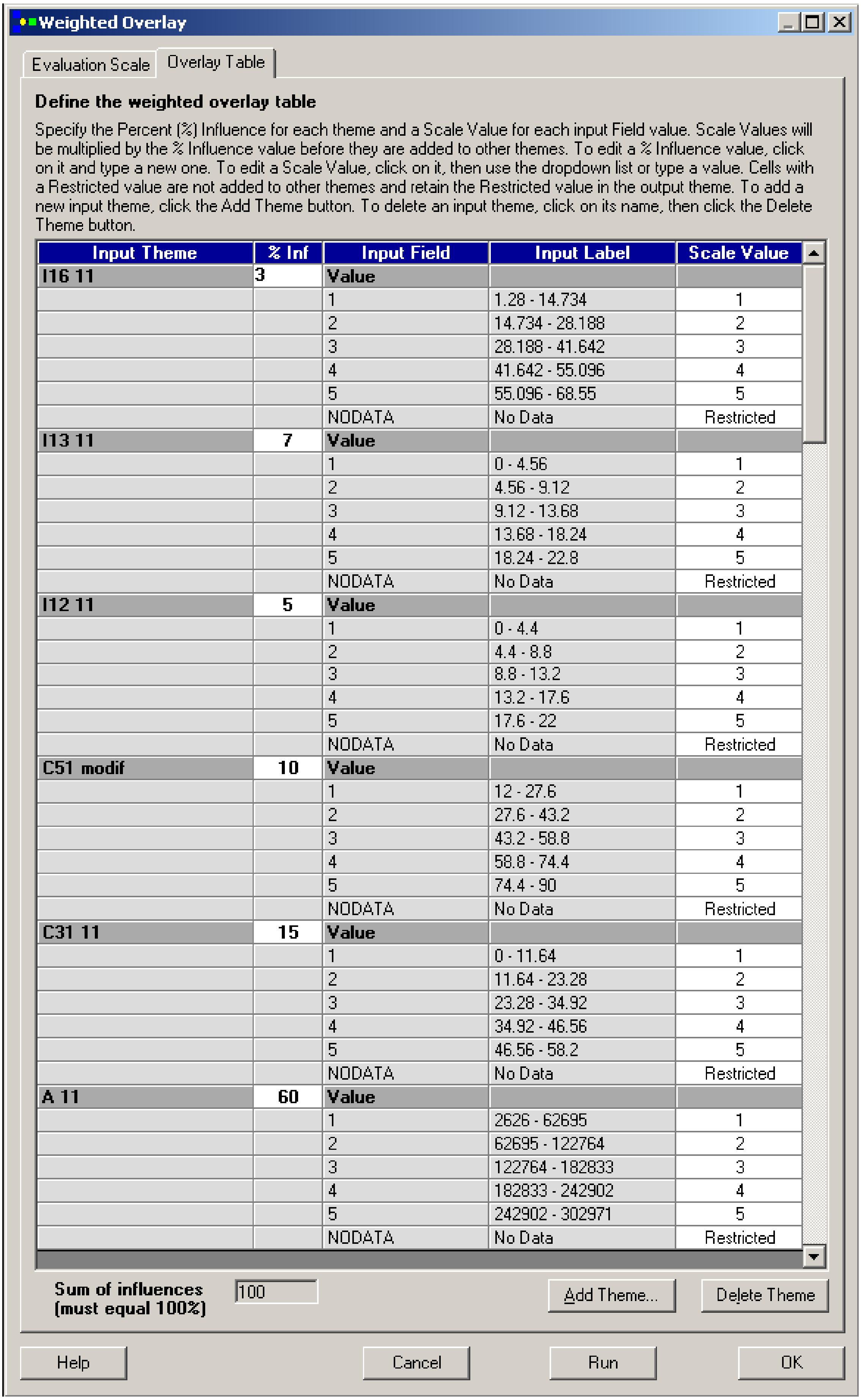

Input Theme	% Inf	Input Field	Input Label	Scale Value
I16 11	3	Value		
		1	1.28 - 14.734	1
		2	14.734 - 28.188	2
		3	28.188 - 41.642	3
		4	41.642 - 55.096	4
		5	55.096 - 68.55	5
		NODATA	No Data	Restricted
I13 11	7	Value		
		1	0 - 4.56	1
		2	4.56 - 9.12	2
		3	9.12 - 13.68	3
		4	13.68 - 18.24	4
		5	18.24 - 22.8	5
		NODATA	No Data	Restricted
I12 11	5	Value		
		1	0 - 4.4	1
		2	4.4 - 8.8	2
		3	8.8 - 13.2	3
		4	13.2 - 17.6	4
		5	17.6 - 22	5
		NODATA	No Data	Restricted
C51 modif	10	Value		
		1	12 - 27.6	1
		2	27.6 - 43.2	2
		3	43.2 - 58.8	3
		4	58.8 - 74.4	4
		5	74.4 - 90	5
		NODATA	No Data	Restricted
C31 11	15	Value		
		1	0 - 11.64	1
		2	11.64 - 23.28	2
		3	23.28 - 34.92	3
		4	34.92 - 46.56	4
		5	46.56 - 58.2	5
		NODATA	No Data	Restricted
A 11	60	Value		
		1	2626 - 62695	1
		2	62695 - 122764	2
		3	122764 - 182833	3
		4	182833 - 242902	4
		5	242902 - 302971	5
		NODATA	No Data	Restricted

Fig. 2. Weights and re-classifications of variables

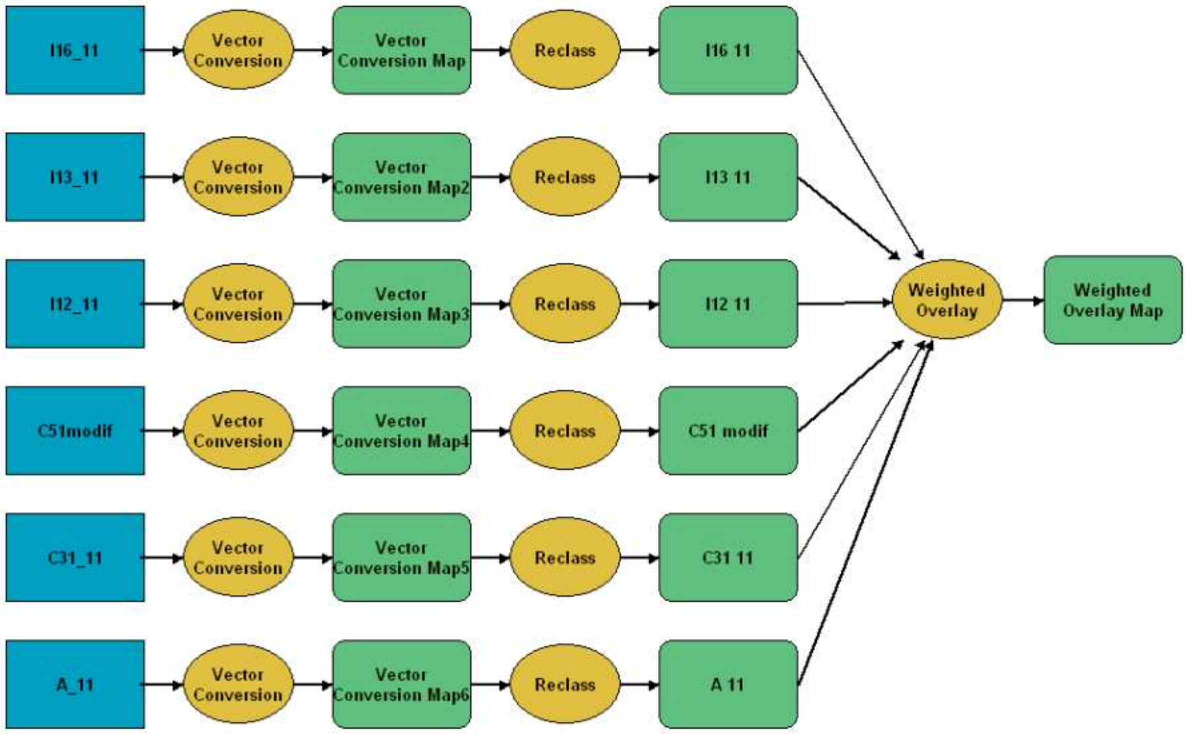

Fig. 1. GIS model: variables and required transformations

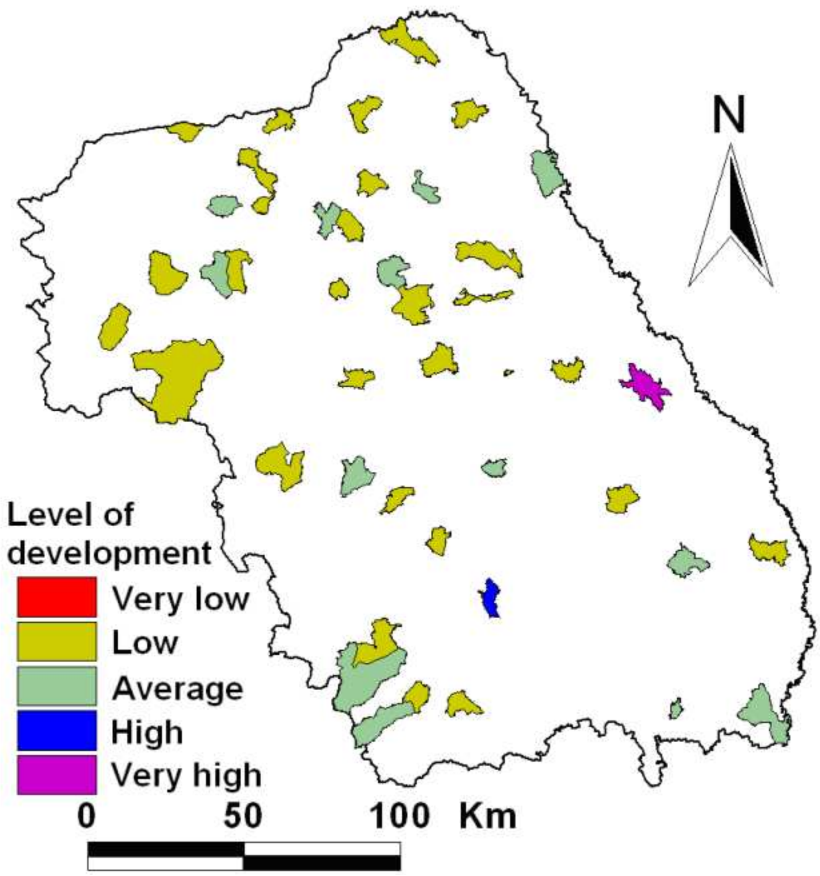

Fig. 3. Results of the GIS analysis

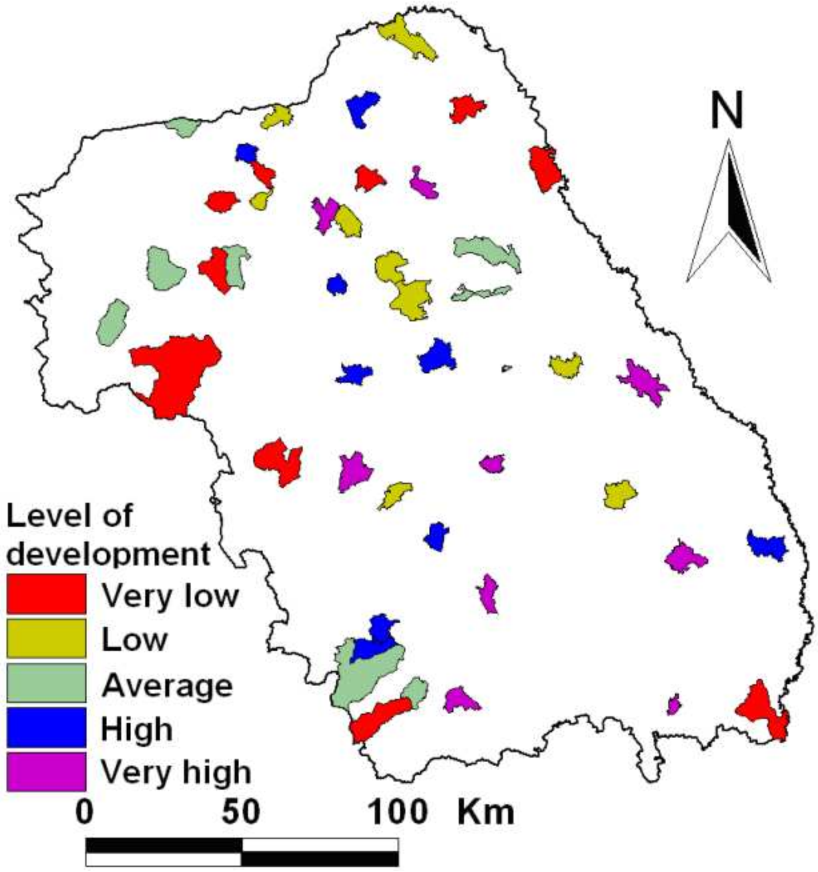

Fig. 4. Results of using the index of development

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