Spatial autocorrelation of communes websites: A case study of the region Stredné Považie in Slovakia

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Abstract. Since its origination the Internet has been the basic communication channel through which e-Government processes in our society are carried out. The basic element of such processes is an existing website. This paper is the result of long-term research during which the authors collected information on the presence or absence of websites of self-governments in Slovakia. The output can be divided into two main parts. The first one, on the basis of the acquired data, evaluates the overall trend of self-government websites between 2008–2012. The results were distributed in the form of a website devoted to communes of Slovakia, using technology enabling the graphical and cartographic interpretation of the results. In the second part, on the basis of the gathered data, the authors applied spatial autocorrelation, specifically the 'join count statistics' method with the subsequent application to selected phenomenon in society, in particular the occurrence of websites of a selected region of Stredné Považie in Slovakia at the same time interval. This way the authors wanted to point out the interaction of communes in the development of websites, whether through inspiration or rivalry among neighbouring communes. From this point of view, mainly in the first period under review (2008), positive spatial autocorrelation is apparent in the occurrence of communes with websites.

Contents:

1. Introduction

Human geographers focus on methodological-analytical contributions and studies related to the area of human and social sciences. Among significant contributions and research studies, statistical and mathematical analyses can be ranked, in particular thanks to progress in the study of spatial autocorrelation. Following the development of geographic information systems in recent years, it is possible to display and analyse a large quantity of spatially distributed field data and display them in appropriate cartographic output.

Spatial autocorrelation is one of the most important aspects in the concept of geography. The principle of spatial autocorrelation basically confirms the existence of Tobler's First Law of Geography – everything is related to everything else, but near things are more related than distant things (Tobler, 1970).

The purpose of this paper is to refer to the spatial dependence of communal web page development in the region of Stredné Považie (Slovakia) by using 'join count statistics'. The primary research phase consisted in collecting necessary data on the existence of communes webpages. These findings were subsequently distributed on the web in the form of a website created by the authors.

Yet, the issue of spatial autocorrelation in scientific research indicates that this area of spatial analysis is very frequently tractated in scientific circles, although its specific part applied in this paper is rare. The first group of papers is on theoretical aspects and knowledge of spatial autocorrelation. It includes mainly ground-breaking work, which stood at the birth of the method and technique of spatial autocorrelation, and its gradual introduction into social life. Among the first leading authors engaged in this issue are Cliff and Ord (1969, 1973, 1981), follwed by Goodchild (1986), Odland (1988), and the latest – Griffith (2010). Other authors who dealt with the issue of spatial autocorrelation include Anselin (1988), Griffith (1988), Fischer and Getis (1997), Florax and Plane (2004), as well as recently Anselin and Rey (2010), Fischer and Wang (2011). These are mainly the authors who

refer to the application of spatial autocorrelation to selected phenomena in society. In the area of electoral geography O'Loughlin (2002), Tam Cho and Nicley (2008), and Wing and Walker (2010) can be mentioned; in medical geography – Gatrell (2002), Waller and Gotway (2004), and recently Meade and Emch (2010), Brown et al. (2010), Krämer et al. (2011); in economic geography, e.g., Le Gallo and Ertur (2000), Ma and Pei (2010), Chen et al. (2010) and Martinho (2011). Demogeography in the context of spatial autocorrelation has become a key issue in the papers of Loftin and Ward (1983), Borgoni and Billari (2003), Weeks (2004), Malczewski (2010), Yu and Chun (2010); settlement geography and urbanisation – in the papers of Baumont et al. (2004), Páez and Scott (2004), Cho and Newman (2005), Jisheng and Yanguang (2007), Besussi et al. (2010). Other human geographic research include criminology by such authors as Weisburd et al. (2009), Piquero and Weisburd (2010), Kikuchi (2010); and social sciences in conjunction with spatial autocorrelation – such as Martori et al. (2005) and Ratcliffe (2010).

From the brief specification of the bibliography it is evident that the issue of spatial autocorrelation is also detailed in geographical research. In many cases mainly its application in various topical geographical disciplines is significant, which will also be analysed in this paper.

In terms of join count statistics there are papers of a geographical nature where the relevant method was applied. Odland (1988) examines the existence of spatial autocorrelation focused on inspections of the sale of alcoholic beverages in Georgia, the USA. Lembo (2007) points out the victory of Democrats and Republicans in particular states in the US elections in 2008 as an example of positive spatial autocorrelation. Retel and Valleron (1991) were engaged in the research of spatial analysis of the occurrence of AIDS in France in 1990. It is clear from the examples that join count statistics can be applied to various phenomena of social life, and in many cases it can point out results that cannot be disregarded.

There are also some scientific works devoted to the relation of communal web pages with the global e-Government process. Žilinskas and Gaulé (2013) describe external factors affecting e-Government processes in municipalities of Lithuania. Similar problems are analysed by Baldersman and Øgård (2008) in an example from Nordic countries. The research question is concerned with explaining variations among Nordic municipalities as to the features of their respective web pages. Municipality websites and e-Government processes are also well described by Jun and Weare (2008), whose study highlights the organisational factors underlying the rapid adoption of e-Government websites and e-Government services.

2. Data acquisition and distribution on the Web

An integral prerequisite for the application of spatial autocorrelation was the acquisition of information about the existence or absence of a website of particular self-governments in Slovakia. Data gathering as such was not methodologically difficult; the difficulty consisted only in the quantity of acquired entities (2,928 communes in Slovakia). Primarily, Google search was applied, through which the authors acquired approximately 95% of the required information. Since the first collection was in 2008, and this period was characterised by rather high dynamics in the field of the internetisation of Slovak communes, certain websites might not have been indexed yet. Therefore, for the needs of checking, direct addresses were entered in the following form: commune_name.sk, commune_name. eu, commune_name.ocu.sk, commune_name.ocu. eu (these are the most frequent forms of addresses of particular websites of self-governments). In this way the final database was completed. With respect to the nature of the research, it was considered appropriate to distribute the results obtained on the Web in the form of a website summarising the gathered facts (the website with results is available at: www.sodbtn.sk/obce/eng). The final layout of the website is the result of a long process, whereas particular functions were supplemented gradually so that the website contains the most precise and

current information on the existence of self-government websites in a well-arranged and user-friendly format. In the context of the purpose of application, the authors utilised standard data handling techniques and procedures (MySQL database system), as well as visual tools close to the geographical analyses. In this case, several services and APIs (Application Programming Interfaces) from Google were applied. There are many definitions of API; generally it can be understood as a library that includes specifications for routines, data structures, object classes, and variables for various applications (Svennerberg, 2010). The purpose of the application was to display the basic information on available Web sources for particular communes in Slovakia. In addition to displaying a commune website itself, also a link to particular communes was included in the database from similar Web projects in Slovakia. Communes are, among other things, also the basic statistical units, therefore it is appropriate to inquire about at least some of the statistical indicators. A graphical interpretation in the form of static pie charts generated as images using the Google Chart Tools (static form) was selected A significant aspect of the communes is their spatial location. In this case Google Maps API v3 were used, which allow the application of several functions for working with localised objects as dots. The purpose was not to develop one of many websites devoted to communes in Slovakia, but to attempt to present information on the basis of applied methods interesting from the users' point of view, and thus expand the information value of the entire website.

3. Spatial autocorrelation research methodology (join count statistics)

As many different flows exist among objects which create spatial dependence, spatial autocorrelation in various studies by foreign geographers can be found (Robinson, 1998). Within the terminology this term is explained quite clearly, and no significant differences occur in its interpretation among several authors. Munroe and Biles (2005) expand it further, and define spatial autocorrelation as a tendency or plan to observe social and economic variables dependent on geographical position, as well as

experience regularities in which the value of one geographical observation is affected by the value of other values, usually located near the place of observation. Another interesting definition is by Getis (2008), one founder of a significant indicator and statistics within the issue of spatial autocorrelation. In this area he markedly switches to the foreground the space as such in which the variable operates. The author himself claims that while comparative statistics were designed to display the relations and dependence between variables, spatial autocorrelation shows a correlation between variables within geographical space from which its importance arises, and thus it cannot be considered only as a special case of correlation. In principle, the authors who deal with this issue in a broader sense, not only today but also in the past, stated definitions which do not differ much from the above one.

Join count statistics is statistics which allows to detect the existence of spatial autocorrelation and describe the character of this phenomenon. Huge

progress in those terms was made by Cliff and Ord in 1973 in their paper 'Spatial Autocorrelation' (Changshan, 2006). This type of spatial autocorrelation is applied in particular to two-colour maps (spatial autocorrelation for the US elections – Republican and Democrat wins). The authors of this study have applied the mentioned type of autocorrelation to the selected region where autocorrelation was observed in space: whether the commune disposes of or has no website; also in this case the arrangement of phenomena created a two-colour map.

Similarly to spatial autocorrelation, certain types are distinguished in join count statistics. The types are as follows: (a) *positive spatial autocorrelation* – similar phenomena or attributes are arranged closer in space, i.e. they autocorrelate positively; (b) *negative spatial autocorrelation* – alignment of phenomena or attributes with different values, they autocorrelate negatively; (c) s*patial non-autocorrelation or randomness* – neither positive nor negative spatial autocorrelation occurs, phenomena are aligned in space at random.
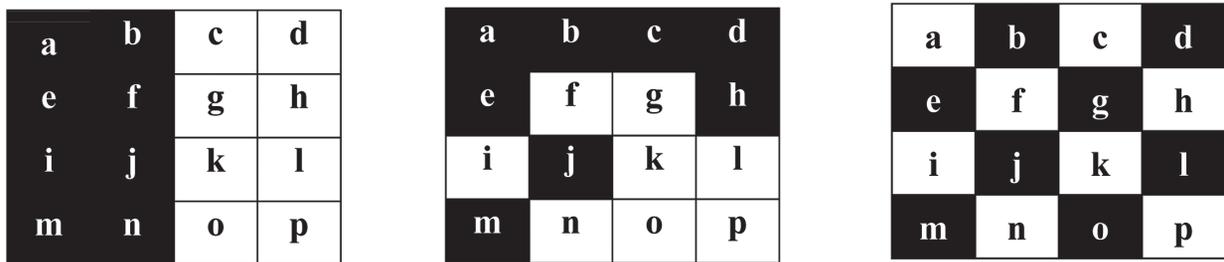
Fig. 1. Types of spatial autocorrelation in join count statistics

a) positive autocorrelation   b) non-autocorrelation   c) negative autocorrelation

Source: Own processing

Based on the above, to determine the spatial autocorrelation of two-colour maps it is necessary to know: (a) quantity of spatial units, i.e. *quantity of all spatial units* (e.g., the number of all communes), *quantity of 'black' units* (e.g. communes with a self-government website), *quantity of 'white' units* (e.g. communes without a self-government website) and (b) quantity of joins: (in this case joins between the borders of spatial units are taken into account, therefore the relevant methodology of spatial autocorrelation is often entitled *join count statistics*), i.e. *quantity of WW joins (white and white) or joins be-*

tween white units (e.g. the number of joins between communes without a self-government website), *quantity of BB joins (black and black) or joins between black units* (e.g. the number of joins between communes with a self-government website), *quantity of BW joins (black and white) or joins between black and white units* (e.g. the number of joins between communes with and without a self-government website, or vice versa).

A combination of the given attributes (the number of spatial units and the number of joins) into relations will result in a final evaluation of

whether the given phenomenon is spatially auto-correlated or not, and if so, whether it is autocorrelated positively or negatively. Various authors show only minor variations of such relations. According to Lembo (2007), the following relations apply:

(a) calculation of the *probability of the occurrence of a relevant phenomenon in a spatial unit from all analysed units* (e.g. the probability of the occurrence of a commune with a website of all communes in the region). The following relation applies:

$$p_b = n_b / n$$

where:

p_b – probability of phenomenon b (the probability of the occurrence of a commune with a website)

n_b – quantity of spatial 'black' units (number of communes with a website)

n – quantity of all communes

Implicitly the following will apply:

$$p_w = n_w / n$$

where:

p_w – probability of the phenomenon w (the probability of the occurrence of a commune without a website)

n_w – quantity of spatial 'white' units (number of communes without a website)

n – quantity of all communes

Of the two preceding relations, mutual probability can be computed. For probability p_{bw} the following will apply:

$$p_{bw} = 2 p_b p_w$$

Since join count statistics works further with the relevant relations, the information on the above probabilities of such phenomena will ensure an assumption that the presence of an unproportional occurrence of phenomenon b and also of phenom-

enon w does not play a significant role and will not disturb or distort the final results.

(b) calculation of *two variables L and K*

The variable L provides the sum of all joins (joins BB + joins WW + joins BW)/2. According to Fig. 1, in particular, type b, i.e. non-autocorrelation, can be determined from the statements:

If we take into account the weight Rook (cells neighbouring on edges), cell *a* (black) has two black neighbours (*b,e*) i.e. there will be two BB joins; cell *b* (black) has two black neighbours (*a,c*) and one white neighbour (*f*); i.e. there will be two BB joins and one BW join, etc. Thus we will get to the end when the cell *p* (white) has two white neighbours (*o,l*), i.e. there will be two WW joins. Since the join between cells *b* and *f* is identical to the join between *f* and *b* respectively, the resulting value of variable L is divided by 2. Table 1 shows an example of the calculation of variables L and K in join count statistics type (b) non-autocorrelation.

Table 1. Example of calculation variables L and K in join count statistics

Cell	Colour	BB	WW	BW	L	L (L-1)
a	B	2	0	0	2	2
b	B	2	0	1	3	6
c	B	2	0	1	3	6
d	B	2	0	0	2	2
e	B	1	0	2	3	6
f	W	0	1	3	4	12
g	W	0	2	2	4	12
h	B	1	0	2	3	6
i	W	0	0	3	3	6
j	B	0	0	4	4	12
k	W	0	3	1	4	12
l	W	0	2	1	3	6
m	B	0	0	2	2	2
n	W	0	1	2	3	6
o	W	0	3	0	3	6
p	W	0	2	0	2	2
Total		10	14	24	48	104

Source: Arthur J. Lembo. Spatial Autocorrelation – Join Count Analysis

Table 1 shows the procedure is relatively time consuming as joins for each spatial unit or com-

mune have to be processed (from *a* to *p*). In fact, variable K is the amount L (L-1)/2, which is in the above stated case 104/2 = 52. Then both variables are used in the following relations gradually. It applies to the counts of joins BB, WW and BW (applied in the final relation) that they must also be divided by 2 because the border between spatial unit A and spatial unit B is the same border as between B and A respectively. One must be careful and not divide variable L by 2 twice (thus it is good to keep all joins and divide them by 2, as the example shows). In the final relation, real joins between cells will apply (BB=5, WW=7, BW=12).

The example shows that:

$$BB = 10, WW = 14,$$
$$BW = 24 \quad L = (10+14+24)/2 = 24$$

(c) The third step is the *calculation of expected neighbours (joins)* on the basis of real neighbours (joins). Table 1 shows real neighbours or joins (BB, WW, BW). For the calculation of expected neighbours it is necessary to use the following relations:

$$E(BB) = \mu(BB) = p_b{}^2 L$$
$$E(WW) = \mu(WW) = p_w{}^2 L$$
$$E(BW) = \mu(BW) = p_{bw} L$$

The relations show that in many cases expected *neighbours* (E) are also marked with the Greek letter μ (mee), and again the computed values of the probabilities of phenomena are required for their calculation and the variable L, the calculation of which has been explained above.

(d) Another step is the *calculation of standard deviations* marked with the Greek letter σ (sigma), which are required for the final calculation of spatial autocorrelation. Since in relations the involution of partial variables occurs, for the simplification of relation probability p_b was replaced by letter p and probability p_w by letter q.

$$\sigma(BB) = \sqrt{p^2 L + p^3 K - p^4 (L+K)}$$
$$\sigma(WW) = \sqrt{q^2 L + q^3 K - q^4 (L+K)}$$

$$\sigma(BW) = \sqrt{2pqL + pqK - 4p^2 q^2 (L+K)}$$

Again, it has to be stressed that standard deviations are computed for all types of joins (BB, WW and BW) and for their calculation the required values of the probabilities of phenomena are variables L and K.

(e) The final step is the *statistical test of spatial autocorrelation* in which it is determined whether it is autocorrelation (positive or negative) or a random spatial phenomenon. Two last partial steps in the procedure become evident here, when the expected neighbours of joins (μ) and standard deviations for particular types of joins (σ) are calculated. The following applies to particular types of joins:

$$Z(BB) = \frac{BB - \mu(BB)}{\sigma(BB)}$$

$$Z(WW) = \frac{WW - \mu(WW)}{\sigma(WW)}$$

$$Z(BW) = \frac{BW - \mu(BW)}{\sigma(BW)}$$

To interpret the results of spatial autocorrelation *join count statistics* the last relation is the most important:

$$Z(BW) = \frac{BW - \mu(BW)}{\sigma(BW)}$$

It is a statistical test of spatial autocorrelation which relates to the join count BW (i.e. 'black and white'). Changshan (2006) claims that a high *negative figure* Z(BW) indicates *positive spatial autocorrelation*, and vice versa, a high positive figure indicates *negative spatial autocorrelation*. The more the result approaches 0, the more it is non-autocorrelated or random phenomenon.

The values Z(BW), Z(BB), Z(WW) are called *z-scores* in technical literature and in general terminology. If absolute values Z(BW) >1.96 or the values are within a set of values not belonging to the interval <-1.96; 1.96>, it can be claimed that

the final phenomenon (regardless of whether we consider independently BB or WW) is spatially autocorrelated. If the hypothesis that the phenomenon is spatially autocorrelated is to be accepted, *z-scores* must have a higher value than 1.96 (or lower than -1.96) when one can speak about 95% probability that the phenomenon is positively or negatively autocorrelated (Briggs, 2010). In this case the value Z(BW) is higher than the value 1.96, or lower than the value -1.96 (negative or positive spatial autocorrelation, respectively). However, in many cases a situation occurs when just the values Z(BW) are from the interval <-1.96; 1.96>. Although it may seem that in this case one cannot speak about spatial autocorrelation, it is a wrong statement as in this case attention must be paid to the values Z(BB) and Z(WW), which can be lower or higher than the critical value 1.96 (De Smith et al. 2007). Table 2 shows the final values of *z-scores* calculated for types of spatial autocorrelation of Fig. 1. When one notices the values Z(BW) for particular types, one can see high values for positive and negative autocorrelation, and what is substantial, the values do not belong to the interval <-1.96; 1.96>. The opposite case occurred in non-

autocorrelation when the value Z(BW) reached 0 and was thus in the interval mentioned.

Table 2. Comparison of z-scores values for different types of spatial autocorrelation

Value of z-scores	a	b	c
Z(BB)	1.4368	-0.3592	-2.1553
Z(WW)	1.4368	0.3592	-2.5530
Z(BW)	-3.2660	0.0000	4.8990

Explanation: a – positive autocorrelation; b – non-autocorrelation; c – negative autocorrelation

Source: Own processing

4.   The results of the research applied to the region Stredné Považie (Slovakia)

Since the results of spatial autocorrelation vary depending on scale and time, to analyse the region several consecutive periods have been selected (5/2008, 6/2010 and 6/2012). Fig. 2 shows the trend of the share of communes with a self-government website in the region Stredné Považie for the above stated periods.
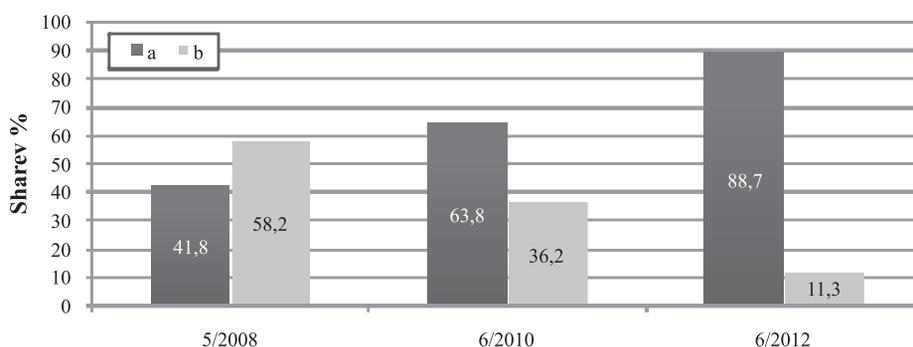
Fig. 2. Evolution of the share of communes with their own web page in the region of Stredné Považie (5/2008-6/2010-6/2012)

Explanation: a – communes with web page; b – communes without web page

Source: Research of authors (based on existing web pages)

In the first period under review (5/2008), it is clear that the number of communes without their own website exceeded the number of communes which had one. The same research was applied to the

second period (6/2010), where already the number of communes without a website was reduced and was lower than the share of communes with a self-government website. Such a growing trend contin-

ued in the third period under review (6/2012) too, where almost 90% of the communes of the region had their own website. Generally, for the four-year time span under review (5/2008 - 6/2012), the share of communes in the region with a website increased by almost 47%. From this point of view, it will be interesting to compare the results of spatial autocorrelation for the three periods under review, as the method works with the probabilities of the occurrence of a website in the region (p_b, p_w a p_{bw}), which in upshot has no effect on the misrepresentation of results.

The research, the procedure of which has been explained in the methodological part of the paper, was also applied to the origination of the self-government website in the selected region of Stredné Považie. Thus the objective was to determine whether the arrangement of self-government websites is spatially autocorrelated, which would mean that particular communes can affect one another on the origination of their website. It could be summarised, in fact, that when a commune ensures the development of a website, the neighbouring commune will be inspired, and in some respect keep a certain communal 'rivalry' and will also develop its self-government website. It can be one of the main arguments for the development of clusters of communes with self-government website, which can be proved right by the research of spatial autocorrelation join-count statistics.

The entire research insisted that each spatial unit or commune from among all 141 communes of the region had to be analysed. The procedure was as follows: a commune was selected and it was specified whether it had a website or not, on which then joins BB, WW or BW depended. If the commune had its own website, it was shown on the map in 'black' colour, and all neighbouring communes with www sites meant joins BB; all neighbouring communes without a website meant joins BW. If a commune did not have its own website, on the map it was displayed in 'white' colour, and all neighbouring communes without a website meant joins WW; all neighbouring communes with a website meant joins BW. In such a manner we continued with all communes in the region. In practice, the communes with websites could only have joins BB or BW; the communes without a website had only joins WW or BW.

Since spatial autocorrelation is a phenomenon changing not only in space but also in time, in the relevant research we relied on three periods of time. For space we selected the already mentioned Stredné Považie, and for a spatial unit we selected the territory of a commune (the region consists of 141 communes). Thus we have prepared three two-colour maps where (Fig. 3): (a) 'black' unit meant the commune with a website, (b) 'white' unit meant the commune without its own website.

The process of website development is rather long (self-governments develop a website only after a certain period of time; they wait for the allocation of budget or negotiations with different firms, change of mayor, etc.), thus analysed several consecutive periods were analysed: (a) 5/2008 (59 communes with a website, 82 communes without); (b) 6/2010 (90 communes with a website, 51 communes without); (c) 6/2012 (125 communes with a website, 16 communes without).

Similarly to the methodology, for each of such three periods we have discovered the following attributes:

(a) quantity of units:
- quantity of all communes (for all periods 141 communes);
- quantity of communes with a website – 'black' units (5/2008 – 59 units, 6/2010 – 90 units, 6/2012 – 125 units);
- quantity of communes without their own website – 'white' units (5/2008 – 82 units, 6/2010 – 51 units, 6/2012 – 16 units);

(b) join count or neighbours count: as it has already been mentioned, for the counts the spatial weight type Quenn was considered, whereby the neighbours of communes joined in points or along the edge (as Queen moves in chess). For the required analysis the attention was paid to:
- *join count or quantity of neighbours BB* (black-black), (in 5/2008 – 188 BB neighbours, 6/2010 – 358 BB neighbours and in 6/2012 – 626 BB neighbours);
- *join count or quantity of neighbours WW* (white-white), (in 5/2008 – 222 WW neighbours, 6/2010 – 88 WW neighbours and in 6/2012 – 8 WW neighbours);
- *join count or quantity of neighbours BW* (black-white or white-black) (in 5/2008 – 340 BW

neighbours, 6/2010 – 304 BW neighbours and in 6/2012 – 116 BW neighbours).

For better transparency, these results were recorded into a neighbourhood matrix where BB joins are black squares, WW joins are white squares and finally BW joins are grey squares. Table 3 shows a part of such a large matrix. In evaluating joins in categories BB, WW and BW it can be noted that in each period there is a constant non-variable quantity of joins (750), which is logical because the borders of communes during the development period had not changed, only the join counts in particular categories had. With the growth of the number of communes with their own websites during the analysed years in the region the growth of joins BB, drop of joins WW and drop of joins BW is noted. In this context, however, one must be careful with statements of spatial autocorrelation as here appear partial portions of calculations (the probabilities of the occurrence of the relevant phenomenon in a spatial unit of all analysed units; expected neighbours or standard deviations) stated above.

Table 3. Selected part of neighbourhood matrix BB, WW, BW in statistics of the number of connections

Commune	Adamovské Kochanovce	Beckov	Beluša	Bobot	Bodiná	Bohunice	Bolešov	Borčice	Bošáca	Brunovce	Brvnište	Bzince pod Javorinou	Čachtice	Častkovce	Čelkova Lehota	Červený Kameň	Dohňany	Dolná Breznica	Dolná Mariková	Dolná Poruba
Potvorice										1			1							
Považany													1							
Považská Bystrica			1		1															
Prečín					1															
Pruské						1														
Pružina																	1			
Púchov			1														1		1	
Sádočné																	1			
Sedmerovec						1														
Selec		1																		
Skalka nad Váhom																				
Slavnica																				
Slopná			1																	

Legend:
1 Join count or quantity of neighbours BB (black-black)
1 Join count or quantity of neighbours BW (black-white, or white-black)
1 Join count or quantity of neighbours WW (white-white)

Source: Own processing

Due to the length of this paper, only the final results for *z-scores* are specified. Two-colour maps with the final figures of *z-scores* determined for each period for joins BB, WW and BW (black-black, white-white, black-white) are shown in Fig. 3. From the final values for the particular periods the following can be determined: it is crucial to pay attention to the final values of joins BW, which will help reveal comprehensive spatial autocorrelation (positive or negative) of the phenomenon under review (communes with or without a website). For minor values of BW (in the interval <-1.96; 1.96>), the values of *z-scores* of joins BB or WW are paid attention to.

The first analysed period, 5/2008, shows that the value Z(BW) is in the critical interval, therefore the spatial autocorrelation of both phenomena under review cannot be considered simultaneously. However, when the value Z(BB) is noted, one can see that it exceeded the critical value of 1.96. Thus, the occurrence of communes with websites in the period of 5/2008 is positively autocorrelated. However, this cannot be said about communes that had no website in place. As a result, in this period in the region under review the effect of spatial autocorrelation can be noticed due to the origination of self-government websites or commune neighbours positively affecting one another on the origination and expansion of self-government websites into space.

The second period under review, 6/2010, is specific in that the value Z(BB) had already dropped below the critical value 1.96; also Z(WW) drops, which, however, markedly affected the value Z(BW), the final value of which remained just below the critical value. Since spatial autocorrelation is a time dependent phenomenon, at this moment it is not possible to define exactly whether the situation occurs, and if so, whether it was earlier than 6/2010 or later than 6/2010 when the value of Z(BW) exceeded 1.96, which would mean that both phenomena (the occurrence of communes with and without a website) were mutually and simultaneously positively autocorrelated.

The third analysed period, 6/2012, again demonstrates the growth of communes with websites in the region. At a glance it might seem that the positive spatial autocorrelation becomes evident, but as stated above, the method works with probabilities BB, WW, which will be reflected mutually also in probability BW. The final value can even differ quite a lot, as in this case. The case of this period can be marked as random because no *z-score* showed a significant value. Generally, the start of new opportunities, technology, needs of citizens, and available solutions for the development of websites had significantly affected the situation of self-governments. The trend affected the mayors of communes without a website to a greater extent; it is not possible to speak here of the neighbours of communes in comparison with the period of 5/2008. Over the last period there had been a rapid growth of communes with a website, but their quality and workmanship is an issue. Although many communes accede to the presentation of commune in the form of a website, not always can one see their quality version or available information on self-government ebsite.

Value *z-scores*	5/2008	6/2010	6/2012
Z(BB)	2.4172	1.5825	1.2389
Z(WW)	-1.0117	-0.5018	-0.3067
Z(BW)	-1.2132	-1.8718	-1.3086
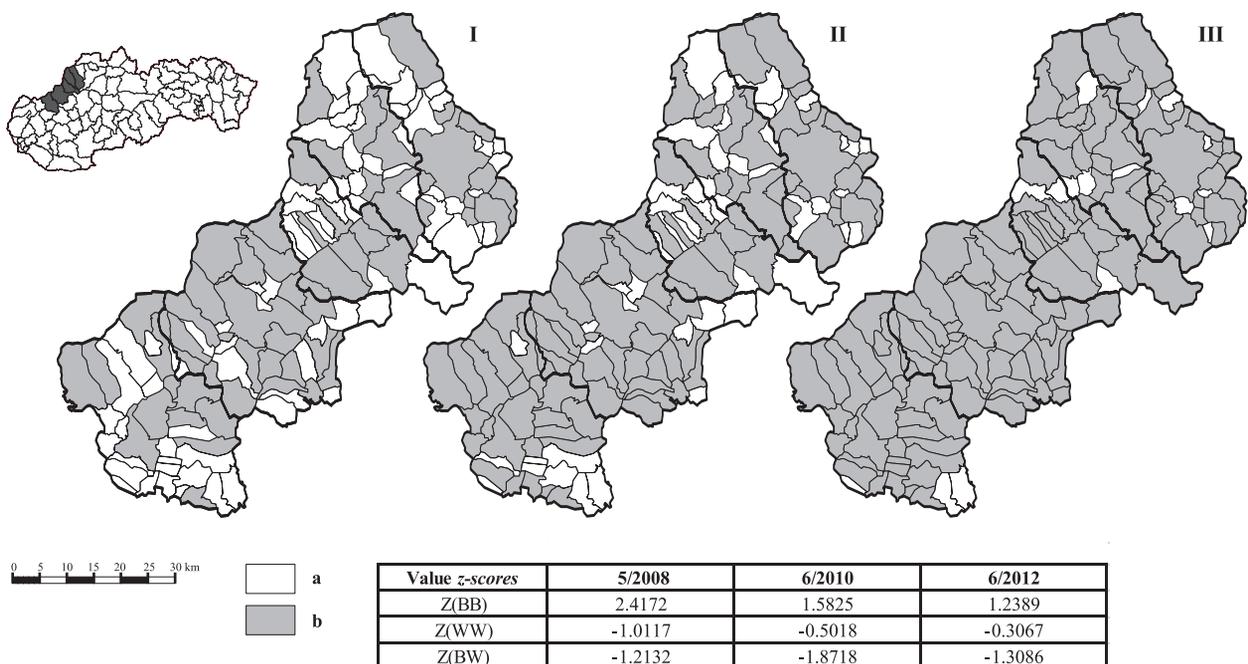
Fig. 3. Two-colour maps of communes with and without websites with resulting values of z-scores in periods 5/2008, 6/2010 and 6/2010

Explanation: I – share of communes with web page (30/5/2008); II – share of communes with web page (26/6/2010); III – share of communes with web page (26/6/2012); a – communes with web pages b – communes without web page

Source: Own processing

5. Discussion

According to the data on the existence of websites of particular self-governments acquired over a long period of time, certain basic development trends related to this area can be briefly characterised. In their study Székely and Michniak (2010) point out the existence of commune websites in 2006, when their participation was only 30.7% of the to-tal number of communes in Slovakia. The current study considers the conditions in 05/2008 as the reference status, i.e. the period in which the authors started to develop a complete database of websites for Slovak communes and then distribute it on the Web. At the beginning of this period all regions except the Bratislava region (characterised by a considerably higher share of communes with their own website in all periods) the share of communes with their own website was lower than 70%, whereas for the Banská Bystrica and Prešov regions these figures were lower than 50% (Fig. 4).
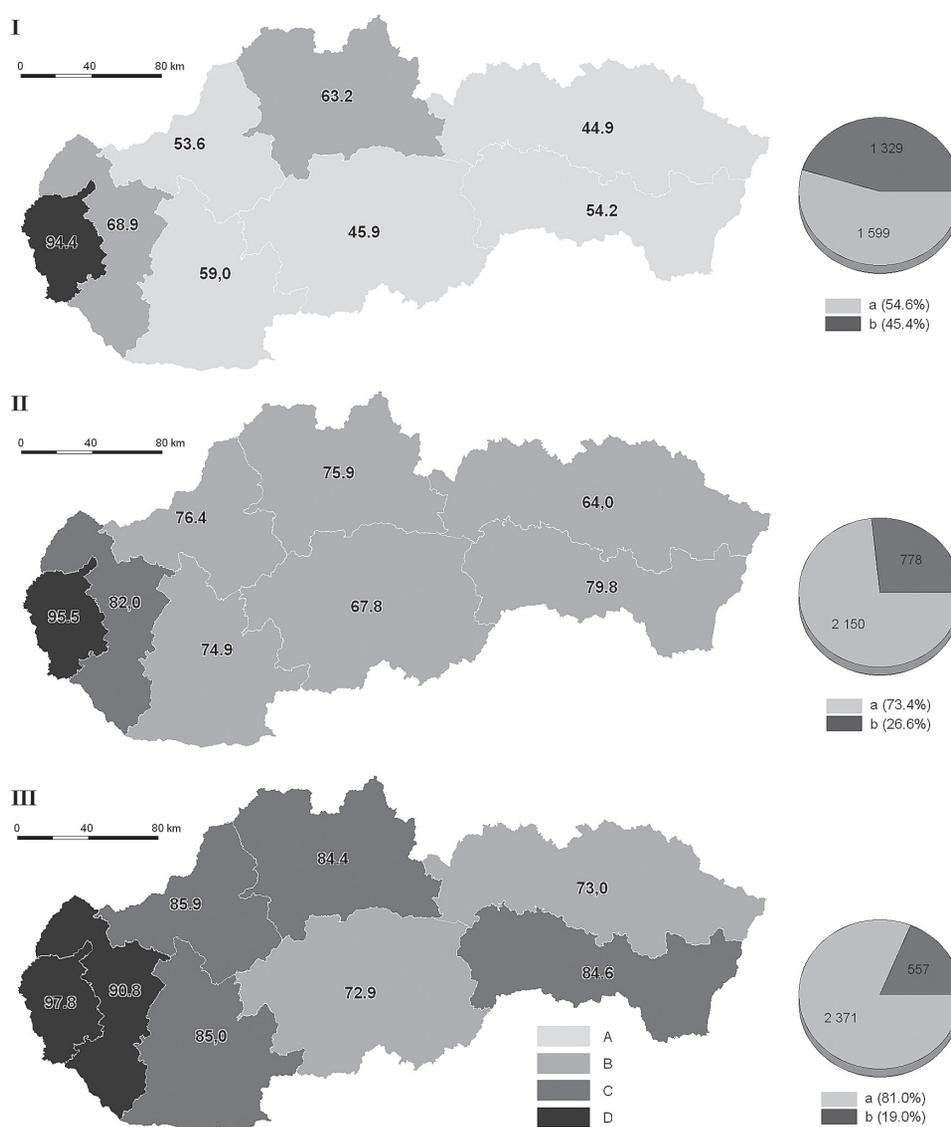
Fig. 4. Evolution of cummunes websites (regional level)

Explanation: I – share of communes with web page (30/5/2008); II – share of communes with web page (26/6/2010); III – share of communes with web page (26/6/2012); A – share of communes with web page (%) <40 – 60); B – <60 – 80); C – <80 – 90); D – <90 and more; a– communes with web pages b – communes without web page

Source: Own processing

From this basic perspective, it can be seen that the role of a website as the main tool of commune promotion in a broader context was disregarded by self-government representatives in the relevant period. The share of communes with their own website accounted for 54.6% of all communes in Slovakia. In the next period, 06/2010, there was movement in all regions which reached a share of communes with their own website higher than 60%, whereas the average value of indicator grew to 73.4%. In evaluating the current situation as of 2012, a reduction in the growth rate of the development of websites in particular communes can be observed, which naturally could have been expected. This period is also characterised by significant qualitative changes in the content and functional structure of such websites, occurring with the growing importance of websites in the communication of self-governments with citizens or other persons interested in information from the region's environment. The share of communes with their own website accounts for 81% of all communes in Slovakia. A certain difference is found in the evaluation of official sites of communes where this fact is declared in writing on the website itself. The share of official websites of the total number of communes websites is 83%. Some of the sites, however, can be official without such a declaration – but with respect to the high amount of units under review, it is not possible to capture this, and in some cases such a finding would require direct communication with the self-government representatives. Declaring a site official is, however, in the direct interests of the self-government representatives to avoid the distribution of incorrect information about the relevant commune on the Web. It is not rare that representatives of local opposition form a 'shadow site of a commune' where they provide their own opinions on activities in the commune, usually critical with respect to the commune management. Such activity is quite frequent, naturally divergences of opinion are current, and constructive criticism is welcome; however, official websites should also contain many official

documents of self-governments (generally binding orders, regulations of commune, information on board of representatives' meetings, etc.).

In evaluating the distribution of communes with their own website in Slovakia, two significantly lagging regions can be identified (Fig. 5). They are the southern districts of the Banská Bystrica region (Krupina, Veľký Krtíš, Rimavská Sobota) and north-eastern districts of the Prešov region (Bardejov, Stropkov, Svidník, Humenné, Snina). These regions have a marginal position in evaluating several economic indicators, therefore such lagging is not surprising. Obviously, the space allocation is significant, but the evaluation of the availability of websites for local inhabitants is more important, and thus a view of the allocation of websites as regards the size categories of Slovak communes. It is positive that each commune with a population higher than 5,000 has its own website. The absence of sites is typical mainly for very small communes with up to 400 inhabitants.

For such communes the leaders of self-government have relatively small incentives for the development of web information centres; they prefer traditional methods in communication with citizens. In evaluating this situation as regards e-Government processes and communication opportunities of Government to Citizen type, it is crucial to draw attention to the fact that more than 95% of the inhabitants of Slovakia live in communes that have their own website, and thus can communicate online with the elected self-government representatives. For very small communes the development of a website and then its termination is not rare, with respect to the ratio of operating costs to the potential use. With respect to the fact that a dramatic growth in the number of websites is not expected, the current situation can be considered a saturation condition. A much more important aspect as regards the future development is particularly the issue of the qualitative growth of the information content of self-government websites.
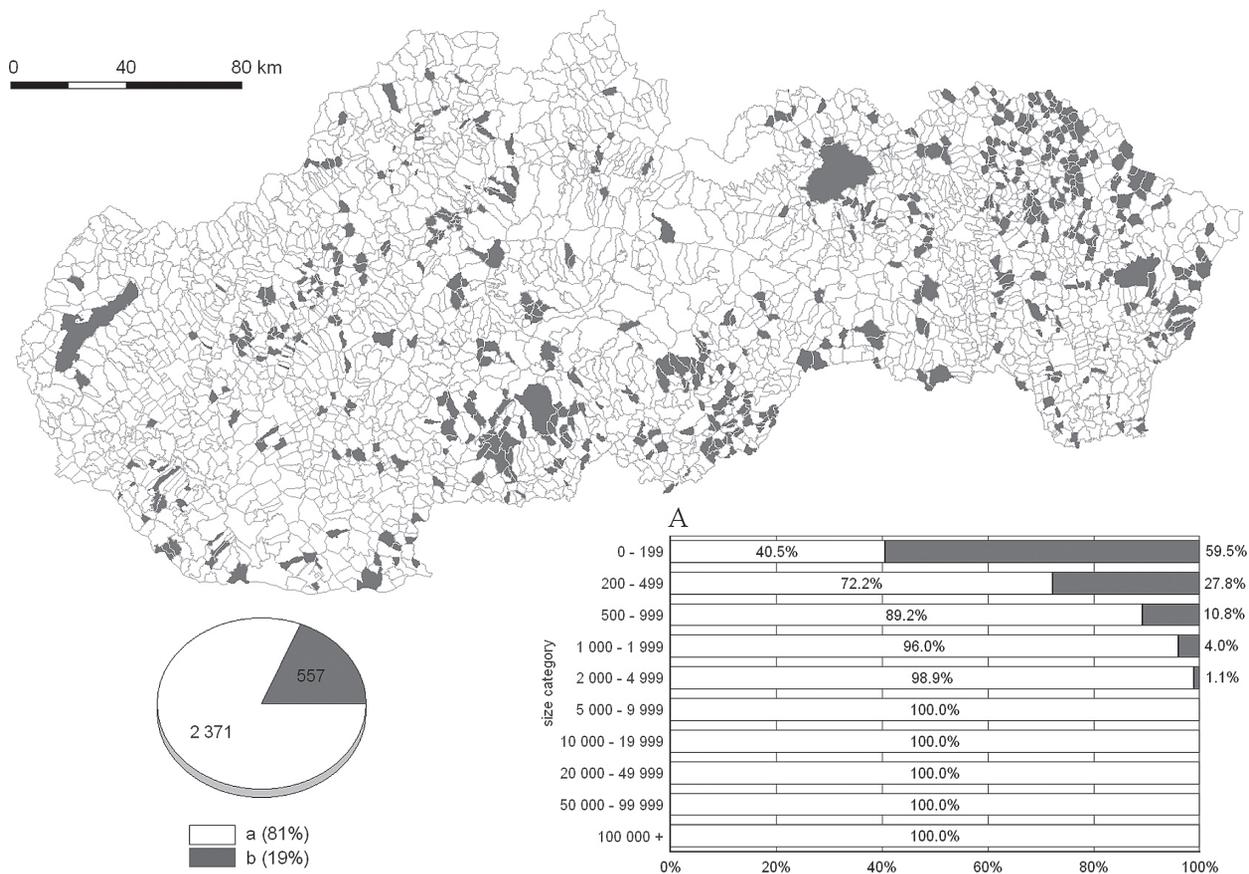
Fig. 5. Communes web pages in the Slovak Republic (21/06/2012)

Explanation: A – Chart: Web pages of communes according to size category (population); a – communes with web page; b – communes without web page

Source: Own processing

6. Conclusion

In this paper the authors focused on the analysis of the method of spatial autocorrelation 'join count statistics' in the occurrence of websites for the selected region of Stredné Považie in Slovakia. An integral prerequisite for the application of spatial autocorrelation in the first step was the acquisition of information about the existence or absence of a website of particular self-governments in Slovakia. Due to the demands of the method and its subsequent calculations, as stated in the methodological part of the paper, the authors focused only on a selected region of Stredné Považie where the method of join count statistics was applied. Since the results of spatial autocorrelation vary depending on the scale and time, to analyse the region several consecutive periods (5/2008, 6/2010 and 6/2012) were selected.

The first analysed period, 5/2008, showed positive spatial autocorrelation of the occurrence of communes with websites. Thus in this period in the region under review the effect of spatial autocorrelation can be noticed due to the origination of self-government websites or commune neighbours positively affecting one another on the origination and expansion of self-government websites.

The second period under review, 6/2010, was specific in that both phenomena, i.e. the occurrence of communes with and without a website remained just below the critical value of *z-scores*, i.e. just below the value of positive spatial autocorrelation of these phenomena. Since spatial autocorrelation is a time dependent phenomenon, it is possible that sooner or later after the period under review the critical value of *z-scores* of 1.96 would be exceeded, which would indicate that both phenomena in question were mutually and simultaneously positively autocorrelated.

The third analysed period, 6/2012, demonstrates the growth of communes with websites in the region. The case of this period can be marked as random because no value of *z-scores* was significant. The start of new opportunities, technology, needs of citizens, and available solutions for the development of websites also considerably affected the situation of self-governments. The trend affected more the mayors of communes without a website; it is not possible to speak here of the neighbours of communes in comparison with the period 5/2008. Recently there had been a rapid growth of communes with a website, but the question is their quality and workmanship. Although many communes acceded to the presentation of commune in the form of a website, not always can one see their quality or available information on a self-government website.

When the selected region is transformed to the territory of the whole country and possible interference of 'neighbouring' communes in the development of a self-government website are taken into account, the following conclusion can be drawn. At the beginning of the period under review, in 5/2008, all regions, except the Bratislava region, had a share of communes with their own website lower than 70%, whereas five regions did not exceed 60%. From this basic perspective we can see that the role of a website as the main tool of commune's promotion in the broader context was disregarded by the self-government representatives in the relevant period.

If we assumed 'neighbourly' interaction in the development of self-government websites, logically growth must occur in the following period. In the next period, 06/2010, there was a shift in all regions as they reached a share of communes with their own website higher than 60%, whereas the average value of the indicator grew to 73.4%. In evaluating the current situation from 2012, we can see a reduction of the growth rate of the development of websites in particular communes, which naturally could have been expected. This period is characterised by significant qualitative changes in the content and functional structure of such websites, occurring with the growing importance of websites in the communication of self-governments with citizens or other persons interested in information from the relevant region's environment. For this reason it is primary to examine the spatial autocorrelation starting from this period only for websites that have a certain selected content and functional structure, which allows an insight into the area other than the standard occurrence of websites.

Acknowledgements

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