

THE REILLY-CONVERSE URBAN ATTRACTION MODEL APPLIED TO BANAT USING GIS

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Abstract. - The Reilly-Converse urban attraction model applied to Banat using GIS. The theoretical areas of attraction achieved by using Reilly-Converse formula clearly indicate the relationship between neighbouring urban centres on the basis of their size. Such an analysis upon Banat urban system using GIS revealed noticeable similarities of the theoretical attraction areas to the presumed ones. Urban centres (and even large rural centres) have been divided into six ranks and maps indicating the attraction areas for each town according to Reilly's formula have been created in ArcView for each of the six considered ranks. Errors occurred due to Reilly's isotropic view upon geographical space. Thus, the formula does not take into consideration any discontinuities, such as mountain ranges, which may greatly affect the shape of the attraction area of a city.

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There are several ways to determine theoretically the attraction areas of urban centres or central places. One of the best known methods is the Reilly-Converse gravitational model.

Even since 1929, before Christaller's central place theory, the American geographer W.J. Reilly tried to establish an analogy between the commercial attraction of two cities and Newton's universal attraction theory. This was stated as such: two cities attract buyers from the rural surrounding areas directly proportional to their population and inversely proportional to the square of the distance between them.

Let there be two cities, A and B, their population be P_A and P_B respectively, and between them a settlement H, at the distance D_A from the city A and D_B from the city B respectively. The weight of those who prefer to go shopping in the city A is C_A and the weight of those who would rather go shopping in the city B is C_B .

Thus, according to the above-stated hypotheses:

$$\frac{C_A}{C_B} = \frac{P_A}{P_B} \times \frac{(D_B)^2}{(D_A)^2}$$

As a consequence, the influence of a city upon the surrounding area decreases with the distance and increases proportional to the size of the city.

This formula was used in 1935 by P.D. Converse, who added to Reilly's theory an interesting idea: the existence of a breaking point between the two cities, A and B. According to Converse, there is an intermediate point C located on the AB straight line, where the number of those who go shopping in one city is equal to the number of those who go shopping in the other city.

It comes out that $\frac{C_A}{C_B} = 1$.

Then, one may calculate the distance from the city A and from the city B respectively where the intermediate point C is located.

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$$\text{If } \frac{P_A}{P_B} \times \frac{(D_B)^2}{(D_A)^2} = 1, \text{ then } D_B = \frac{D_{AB}}{1 + \sqrt{\frac{P_A}{P_B}}} \text{ and } D_A = D_{AB} - D_B.$$

Therefore, the “breaking” point marks the limit of the attraction area of the two cities. An example for Romania is given by V. Surd (2003) regarding the “breaking” point (or “zero attraction” point) between the cities of Cluj-Napoca and Turda. Thus, rounding the data concerning population and distance (Cluj-Napoca 360,000 inhabitants, Turda 60,000 inhabitants, distance = 30 km), it comes out that the zero attraction point lies at about 8.5 km from Turda and 21.5 km from Cluj-Napoca, which is a fairly acceptable result. A deficiency of the theory is that it does not take into consideration the possible presence of geographical discontinuities between the cities, and space is considered homogeneous, as in most spatial theories. Better results are acquired if the real distance along the communication lines (mainly roads) between the cities is used instead of the straight line. The results have a low generalization capacity. Even contested, Reilly’s urban attraction theory continues to attract researchers. It was developed by Huff in the 50s and the 60s, and by Wilson in the 80s, who attained more complicated formulae, taking into consideration more variables, such as the attraction of the destination areas, eliminating the simplistic vision regarding distance etc (I. Ianoş, J.B. Humeau, 2000).

In order to establish the attraction areas in Banat according to Reilly-Converse formula, ArcView programme was used. Although this is not necessary, urban centres and other rural central places were ranked 1 to 6, and a map was realized for each of the six ranks. Banat region was considered to consist of the counties of Arad, Timiș and Caraș-Severin. However, urban centres from outside these counties were also taken into consideration, if they exert an attraction upon certain parts of the analysed area. The resulting attraction areas have all types of shapes; limits may be straight lines when the cities have more or less the same number of inhabitants, but most of the times they are curved. In most cases, the attraction areas have an elliptic shape, with the urban centre located in the focal point nearer to the neighbouring larger city. A basic feature is that the coordinating centre of the settlement system – the city having the highest number of inhabitants – always has an attraction area which, in fact, includes all the others. In other words, all the settlements taken into consideration have their attraction area included within the attraction area of an upper-ranked settlement, except for the highest-ranked city, which is Timișoara in the case of Banat.

Taking into account the first-ranked cities – Timișoara, the only one in Banat, Cluj-Napoca and Craiova, the nearest ones outside the analysed region, one may notice that the limits between the attraction areas of these cities resemble very much to straight lines, due to their similarity in size. The attraction area of Timișoara covers almost the entire region, except for the north-eastern corner and a small patch in the South-East. In fact, the attraction area of Cluj-Napoca cannot reach there because of the Apuseni Mountains. At the second level, the attraction area of Arad is restricted because of the competition from Oradea in the North and Timișoara in the South. It is noticeable that the limit between Arad and Timișoara attraction areas greatly corresponds to the county limit of Arad and Timiș counties, especially in its western half. However, the attraction of Timișoara in the south-eastern part of Arad County is not realistic at this level, because the flows are directed along Mureș river, towards Arad, while Lipova Hills are hardly penetrated by roads.

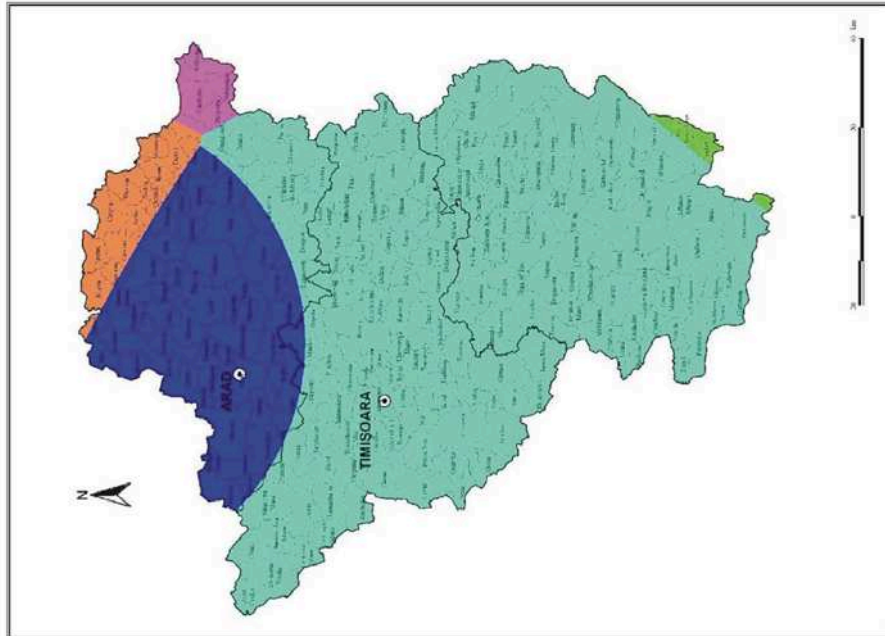


Fig. 2. The theoretical attraction areas according to Reilly-Converse formula for Banat urban centres ranked 2

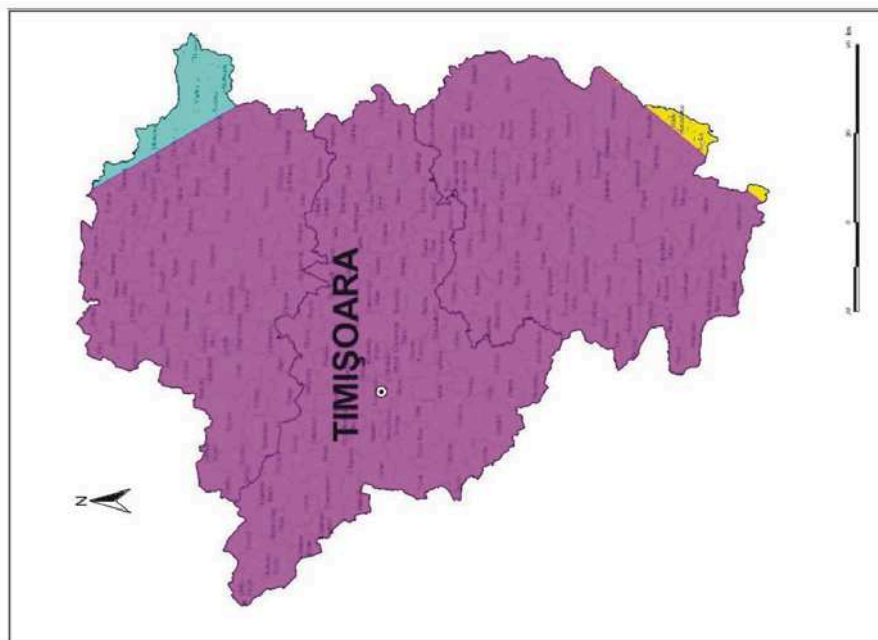


Fig. 1. The theoretical attraction areas according to Reilly-Converse formula for Banat urban centres ranked 1

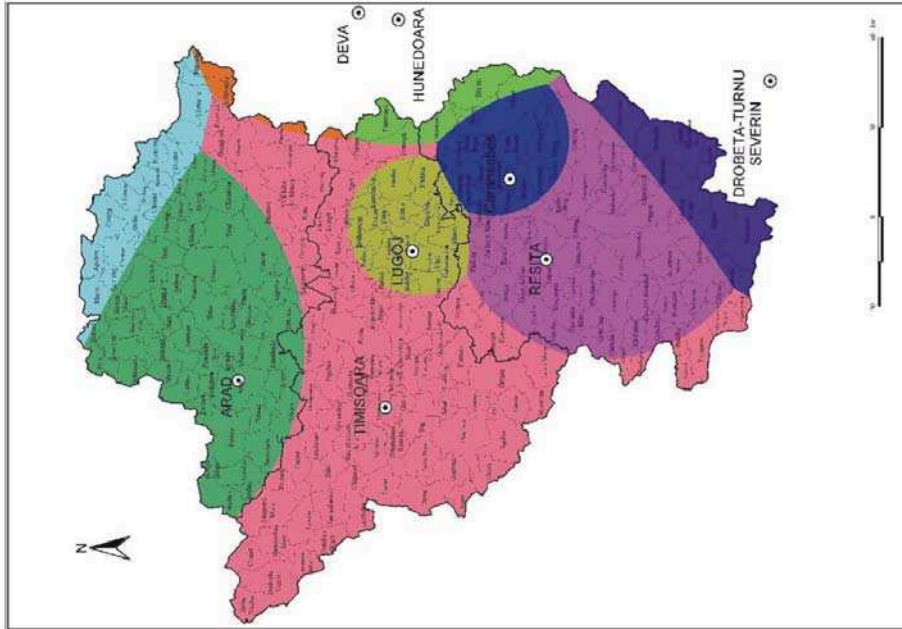


Fig. 4. The theoretical attraction areas according to Reilly-Converse formula for Banat urban centres ranked 4

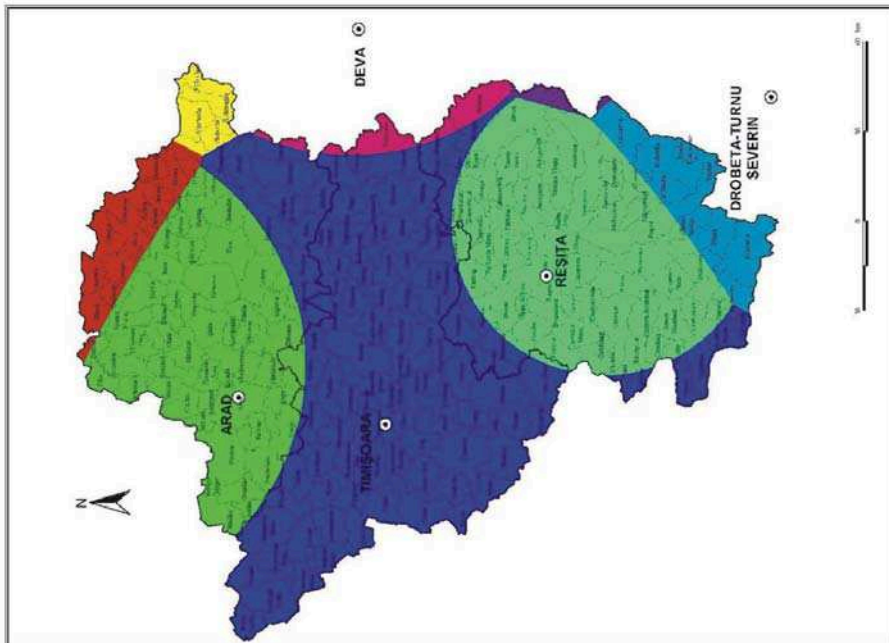


Fig. 3. The theoretical attraction areas according to Reilly-Converse formula for Banat urban centres ranked 3

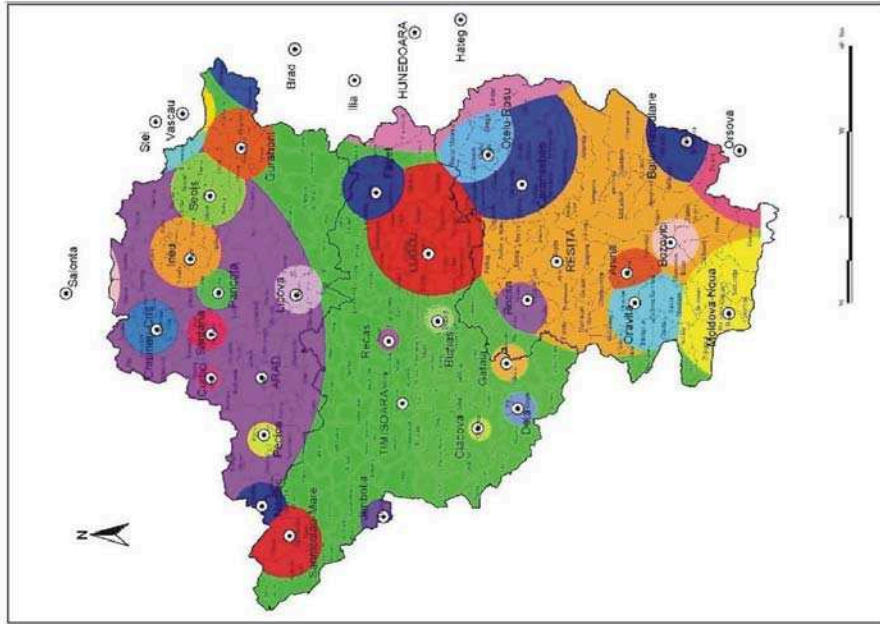


Fig. 6. The theoretical attraction areas according to Reilly-Converse formula for Banat urban centres ranked 6

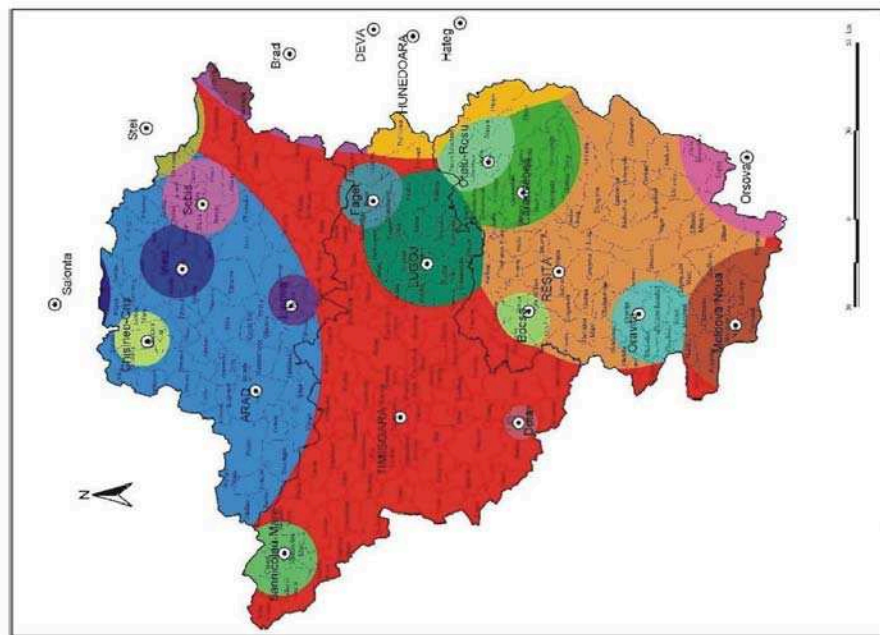


Fig. 5. The theoretical attraction areas according to Reilly-Converse formula for Banat urban centres ranked 5

The attraction area of Oradea in the northern part of Arad County is also debatable, because of the presence of Codru Moma Mountains and the orientation of the communication lines towards Arad.

The next level (rank 3) corresponds to the county seats. Reșița, although half the size of Arad, has a similar attraction area, due to its location farther away from Timișoara and its weaker competition in the South, from Drobeta Turnu Severin. Thus, it succeeds in attracting almost the entire Caraș-Severin County, except for a few communities in the North and a few others in the South. The limits of the attraction area of Deva in the East greatly corresponds to the county limits.

At level 4, the cities of Lugoj and Caransebeș are also brought up, along with Hunedoara from the neighbouring county, whose area of attraction covers mostly the southern half of Deva attraction area at the previous level. The area of attraction of Lugoj is almost completely included in Timișoara attraction area, while the same is true for the attraction area of Caransebeș within the one of Reșița. In the north-eastern corner of Arad County, eliminating the theoretical influence of Cluj-Napoca, Hălmagiu Depression is divided between the areas of attraction of Oradea, Deva and Timișoara.

In the case of the rank 5 towns, most of the areas of attraction are included within the ones of the larger urban centres, already taken into consideration at previous levels. For example, the towns of Sebiș, Chișineu Criș, Ineu and Lipova have almost round-like attraction areas within the larger one of Arad, given that the attraction area of Oradea has not been included in the analysis at this level. Because the towns ranked 6 are similar in size to those of the previous rank, there are no major changes, but only a higher number of small round-like attraction areas of these small towns included within the ones belonging to the larger urban centres. Usually these towns are located even closer to the large cities, so their influence is limited to themselves and a few communities around them at best.

The theoretical areas of attraction achieved by using Reilly-Converse formula clearly indicate the relationship between neighbouring urban centres on the basis of their size. However, geographical space is considered isotropic, and important geographical discontinuities are not taken into account as a result of that conception. Some of these discontinuities, such as mountain ranges or borders, may in a great deal restrict or modify the areas of attraction of the considered cities.

Nevertheless, the shaping of the theoretical attraction areas using the Reilly-Converse formula represents a useful preliminary tool in the spatial analysis of the urban systems. GIS provides an easier and a direct way to have such areas drawn and the analysis of the theoretical attraction areas of Banat proved that light may be shed upon certain aspects concerning the urban systems.

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