# USING GIS IN TERRITORIAL CRIME ANALYSIS

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***Abstract:*** *The paper focuses on the application of Geographic Information Systems (GIS) in analyzing and understanding territorial crime phenomena. By utilizing geospatial data and GIS technology, we have demonstrated how this technique can be used to map and analyze crime across various geographical areas.*

*The study conducted over a 10-year period (2012-2021) reveals that Bucharest, the country's capital, records the highest crime rate, followed by counties hosting municipalities with over 300,000 inhabitants. Conversely, other counties with populations below 100,000 inhabitants are at the opposite end of the list, presenting lower crime rates. These findings highlight significant disparities in crime across different regions, emphasizing the importance of long-term analysis of this phenomenon and its impact across diverse geographic areas.*

***Keywords:*** *GIS; urban population; spatial analysis; crime rates; geostatistics*

## 1. Introduction

The addressed theme falls within the domain of Geomatics, particularly in geospatial sciences aimed at resolving geostatistical issues, specifically related to quantifying and spatially distributing the specific crime coefficient. This specific crime coefficient is quantified by the number of committed crimes and their participants within a certain population, in Romania's case - per 100,000 inhabitants. Criminology defines crime as a mass social phenomenon that encompasses all offenses committed throughout human history or solely in relation to certain civilizations, eras, time intervals, or specific geographical spaces.

From this perspective, in the conducted study, we will apply the narrow sense of the word (stricto sensu), where we understand the totality of crimes committed within specific time limits and a determined geographic area.

In an international context, the concept of modus operandi was introduced by the Metropolitan Police in London to classify actions and perpetrators. This concept migrated to America after resolving the first series of crimes at the end of the 19th century in London, rightly considered as the beginning of crime analysis.

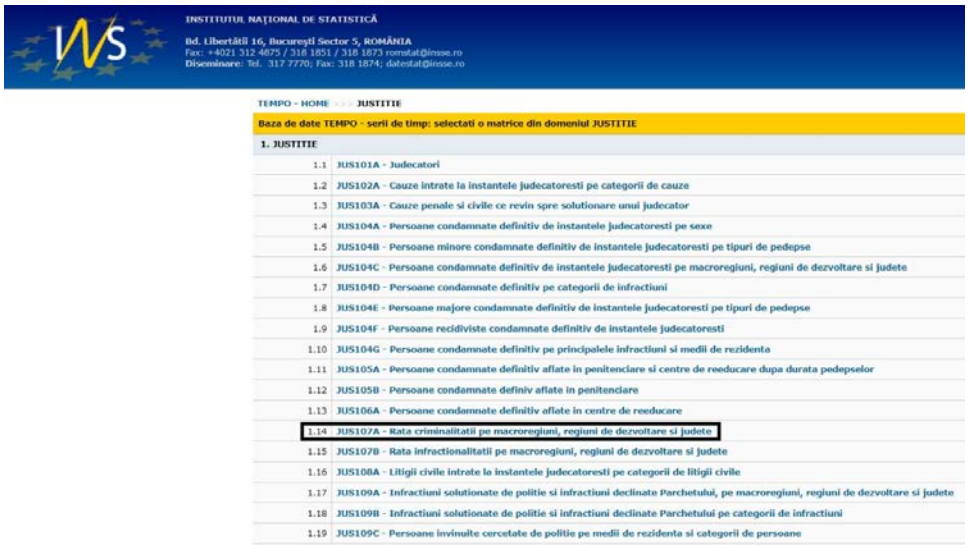
Fig.1 August Vollmer (1876-1955) - "The Father of American Policing"

## 2. Data Integration

Considering the territorial analysis, it was necessary to bring attention to the geometries of the 41 entities representing the counties of Romania, as well as the country's capital, Bucharest. Acquiring this data did not pose an impediment as such spatial data is transparent. Consequently, the defined layer was loaded into the GIS environment, structured in STEREO 70 projection. Therefore, the thematic maps have a correct representation concerning the geodetic datum to which Romania aligns.


Fig. 2 The display of the thematic layer “COUNTIES”

As for the descriptive data, these were extracted from the annual reports of the National Institute of Statistics (INS), reports compiled through the accumulation of information provided by the County Police Inspectorates (IPJ).



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| | |
|---|---|
| 1. JUSTITIE | |
| 1.1 | JUS101A - Judecatori |
| 1.2 | JUS102A - Cauze intrate la instantele judecatoresti pe categorii de cauze |
| 1.3 | JUS103A - Cauze penale si civile ce revin spre solutionare unui judecator |
| 1.4 | JUS104A - Persoane condamnate definitiv de instantele judecatoresti pe sexe |
| 1.5 | JUS104B - Persoane minore condamnate definitiv de instantele judecatoresti pe tipuri de pedepse |
| 1.6 | JUS104C - Persoane condamnate definitiv de instantele judecatoresti pe macroregiuni, regiuni de dezvoltare si judete |
| 1.7 | JUS104D - Persoane condamnate definitiv pe categorii de infractiuni |
| 1.8 | JUS104E - Persoane majore condamnate definitiv de instantele judecatoresti pe tipuri de pedepse |
| 1.9 | JUS104F - Persoane recidiviste condamnate definitiv de instantele judecatoresti |
| 1.10 | JUS104G - Persoane condamnate definitiv pe principalele infractiuni si medii de rezidenta |
| 1.11 | JUS105A - Persoane condamnate definitiv aflate in penitenciare si centre de reeducare dupa durata pedepselor |
| 1.12 | JUS105B - Persoane condamnate definiv aflate in penitenciare |
| 1.13 | JUS106A - Persoane condamnate definitiv aflate in centre de reeducare |
| 1.14 | JUS107A - Rata criminalitatii pe macroregiuni, regiuni de dezvoltare si judete |
| 1.15 | JUS107B - Rata infractionalitatii pe macroregiuni, regiuni de dezvoltare si judete |
| 1.16 | JUS108A - Litigii civile intrate la instantele judecatoresti pe categorii de litigii civile |
| 1.17 | JUS109A - Infractiuni solutionate de politie si infractiuni declinate Parchetului, pe macroregiuni, regiuni de dezvoltare si judete |
| 1.18 | JUS109B - Infractiuni solutionate de politie si infractiuni declinate Parchetului pe categorii de infractiuni |
| 1.19 | JUS109C - Persoane invinuite cercetate de politie pe medii de rezidenta si categorii de persoane |

Fig. 3 The descriptive database of the National Institute of Statistics (INS)

The external database was captured in XLSX tabular format across 10 sheets, each representing distinct crime coefficients from 2012 to 2021 (10 years). To access a comprehensive database at the level of external tabular files, all existing sheets were

concatenated. This was necessary to establish a connection between the spatial database and the descriptive one. Ultimately, the final situation reached was:

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ID | JUD_ABI | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 2 | 1 | AB | 52.21 | 48.96 | 59.37 | 51.88 | 60.57 | 68.43 | 62.24 | 58.74 | 56.67 | 41.68 |
| 3 | 2 | AR | 77.13 | 79.45 | 81.40 | 91.40 | 81.83 | 76.31 | 75.57 | 68.48 | 72.17 | 73.68 |
| 4 | 3 | AG | 119.19 | 123.90 | 104.44 | 91.79 | 76.73 | 93.97 | 126.59 | 96.23 | 79.93 | 78.73 |
| 5 | 4 | BC | 126.52 | 127.25 | 96.34 | 106.74 | 109.06 | 111.15 | 115.87 | 111.32 | 130.43 | 119.15 |
| 6 | 5 | BH | 86.26 | 80.72 | 92.79 | 87.37 | 85.91 | 94.44 | 111.48 | 95.41 | 87.28 | 106.09 |
| 7 | 6 | BN | 24.24 | 33.95 | 23.55 | 30.03 | 31.45 | 36.74 | 37.86 | 34.73 | 40.16 | 39.36 |
| 8 | 7 | BT | 57.17 | 60.85 | 72.54 | 54.09 | 57.51 | 56.76 | 56.07 | 50.95 | 49.71 | 48.42 |
| 9 | 8 | BV | 131.25 | 156.12 | 161.53 | 137.82 | 142.11 | 140.32 | 138.94 | 158.54 | 143.35 | 149.04 |
| 10 | 9 | BR | 60.55 | 67.55 | 73.68 | 64.49 | 94.93 | 70.48 | 69.88 | 74.97 | 74.56 | 65.47 |
| 11 | 10 | BZ | 54.13 | 66.86 | 69.37 | 80.09 | 79.65 | 64.80 | 71.67 | 60.36 | 57.86 | 66.94 |
| 12 | 11 | CS | 56.61 | 57.97 | 43.80 | 46.42 | 40.77 | 48.56 | 43.71 | 53.87 | 56.47 | 54.73 |
| 13 | 12 | CL | 50.07 | 48.04 | 36.84 | 30.42 | 18.06 | 23.65 | 24.70 | 18.99 | 23.26 | 26.31 |
| 14 | 13 | CJ | 158.77 | 153.58 | 163.18 | 146.14 | 176.18 | 175.48 | 159.58 | 156.91 | 149.32 | 170.30 |
| 15 | 14 | CT | 216.50 | 222.40 | 173.69 | 210.10 | 200.94 | 225.77 | 192.41 | 190.50 | 155.88 | 169.67 |
| 16 | 15 | CV | 27.18 | 27.83 | 20.51 | 21.58 | 18.35 | 21.28 | 21.45 | 19.15 | 21.47 | 28.21 |
| 17 | 16 | DB | 49.61 | 44.11 | 43.17 | 50.84 | 49.94 | 38.63 | 41.76 | 44.46 | 41.36 | 53.68 |
| 18 | 17 | DJ | 101.15 | 87.99 | 86.84 | 84.77 | 80.08 | 82.14 | 85.64 | 108.07 | 104.58 | 91.36 |
| 19 | 18 | GL | 107.80 | 113.74 | 106.85 | 98.16 | 99.74 | 102.48 | 101.73 | 130.95 | 105.97 | 113.46 |
| 20 | 19 | GR | 28.19 | 23.56 | 22.15 | 20.54 | 23.59 | 36.42 | 50.70 | 37.65 | 43.54 | 34.52 |
| 21 | 20 | GJ | 29.09 | 32.33 | 26.71 | 28.60 | 27.52 | 30.90 | 26.98 | 30.67 | 28.43 | 27.58 |
| 22 | 21 | HR | 33.49 | 31.76 | 24.69 | 31.72 | 32.32 | 23.02 | 27.14 | 24.66 | 22.47 | 22.95 |
| 23 | 22 | HD | 111.63 | 108.20 | 119.12 | 93.48 | 102.94 | 112.10 | 130.33 | 111.32 | 99.21 | 103.57 |
| 24 | 23 | IL | 27.74 | 30.25 | 35.19 | 39.13 | 41.06 | 42.25 | 33.31 | 41.38 | 45.53 | 38.94 |
| 25 | 24 | IS | 143.66 | 147.11 | 163.56 | 178.38 | 197.44 | 202.91 | 199.07 | 192.78 | 199.82 | 183.14 |
| 26 | 25 | IF | 70.25 | 71.82 | 84.69 | 84.51 | 90.28 | 82.77 | 99.78 | 106.77 | 147.93 | 141.25 |
| 27 | 26 | MM | 75.55 | 76.10 | 67.09 | 52.40 | 64.79 | 63.70 | 63.70 | 60.04 | 65.61 | 71.78 |
| 28 | 27 | MH | 26.72 | 22.40 | 26.96 | 31.20 | 27.52 | 26.17 | 21.61 | 25.64 | 16.70 | 25.47 |
| 29 | 28 | MS | 86.71 | 76.33 | 95.83 | 109.08 | 116.34 | 113.36 | 125.94 | 118.78 | 113.33 | 141.25 |
| 30 | 29 | NT | 95.06 | 104.73 | 107.98 | 89.32 | 72.95 | 75.52 | 76.22 | 72.05 | 74.16 | 71.57 |
| 31 | 30 | OT | 59.09 | 41.92 | 45.95 | 63.71 | 84.89 | 75.05 | 66.14 | 65.88 | 59.85 | 50.31 |
| 32 | 31 | PH | 160.46 | 159.35 | 197.23 | 199.18 | 154.20 | 170.91 | 144.96 | 159.51 | 165.42 | 150.51 |
| 33 | 32 | SM | 56.83 | 56.70 | 51.78 | 55.52 | 58.53 | 49.19 | 43.06 | 30.99 | 34.99 | 35.36 |
| 34 | 33 | SJ | 37.10 | 25.64 | 29.62 | 31.46 | 28.98 | 28.69 | 32.66 | 32.13 | 28.03 | 27.79 |
| 35 | 34 | SB | 89.76 | 91.92 | 104.19 | 89.97 | 88.53 | 93.97 | 105.63 | 100.77 | 106.37 | 116.20 |
| 36 | 35 | SV | 68.11 | 64.32 | 80.64 | 88.41 | 87.80 | 80.25 | 78.65 | 87.30 | 78.54 | 79.36 |
| 37 | 36 | TR | 49.73 | 47.11 | 56.08 | 48.50 | 55.48 | 43.36 | 54.76 | 35.21 | 39.96 | 41.47 |
| 38 | 37 | TM | 218.08 | 190.65 | 174.83 | 170.06 | 157.84 | 163.97 | 147.07 | 131.11 | 139.97 | 148.20 |
| 39 | 38 | TL | 30.33 | 29.45 | 27.60 | 26.65 | 32.03 | 30.59 | 20.96 | 22.23 | 25.05 | 23.16 |
| 40 | 39 | VS | 61.68 | 56.47 | 65.20 | 76.06 | 81.83 | 98.07 | 86.13 | 90.55 | 74.76 | 87.99 |
| 41 | 40 | VL | 70.02 | 64.43 | 73.17 | 57.86 | 57.81 | 58.81 | 59.48 | 48.19 | 58.65 | 59.15 |
| 42 | 41 | VN | 41.04 | 38.91 | 42.66 | 41.73 | 43.54 | 48.09 | 47.29 | 42.84 | 48.91 | 51.57 |
| 43 | 42 | B | 973.35 | 1.003.93 | 967.05 | 1.008.14 | 967.99 | 918.08 | 921.25 | 908.93 | 1.032.30 | 969.38 |

Fig. 4 The record of specific crime coefficients (2012-2021) after concatenation

Three specific classes within the domain of crime rate classification based on the values of specific crime coefficients are as follows:

1. 0 - 75 per 100,000 inhabitants – LOW
2. 75 - 100 per 100,000 inhabitants – MEDIUM
3. Over 100 per 100,000 inhabitants – HIGH

The registration of these rates involves duplicating the relevant fields (10 for the period 2012-2021) populated with variables representing specific crime coefficients at the level of each entity (counties and the country's capital). It requires encoding these with text-based inscriptions, followed by sampling the values according to the aforementioned specifications. This will impact the typology of the crime rate.

Technically, syntaxes in the form of '<Field_name> <Operator> <Value or String>' will be created. Once validated, these will impose a new selection in the attribute table, simplifying the number of records.

```
"2012" <75
"2012" > 75 AND "2012" <100
"2012" >100
```

## 3. Results And Discussions

To accurately and vividly represent the data, I imposed a template applied to the ten cartographic products corresponding to the spatial distribution of crime coefficients in Romania for the period 2012-2021. Although initially it might seem that we are deprived due

to the presence of coefficient values, this shortcoming has been rectified by directly applying labels that present these values over the entities' backgrounds.

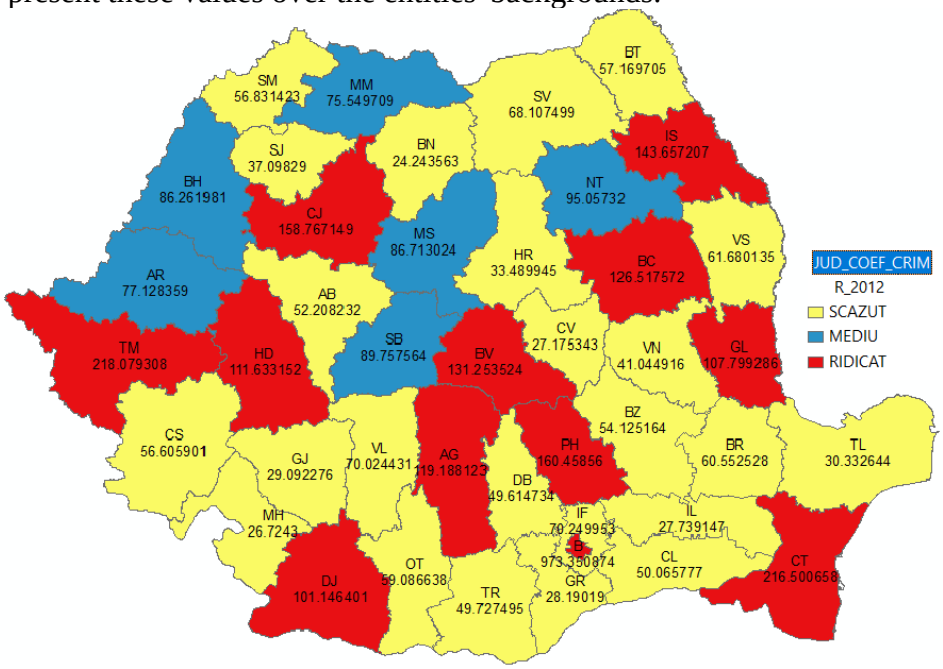


Fig. 5 Template for multi-year representation of crime coefficient

Following the conducted analysis, I concluded that Bucharest, the country's capital, exhibits the highest specific crime rate, followed by counties whose municipalities themselves have a population of over 300,000 inhabitants. Among these are Iași, Cluj, Timiș, Constanța, Brașov, etc. On the opposite end, we find counties such as Mehedinți, Covasna, Harghita, Tulcea, Bistrița-Năsăud, etc. Particularly interesting is the average calculated over each of the 10 years, coinciding with the minimum value within the domain categorizing the 'HIGH' crime rate.

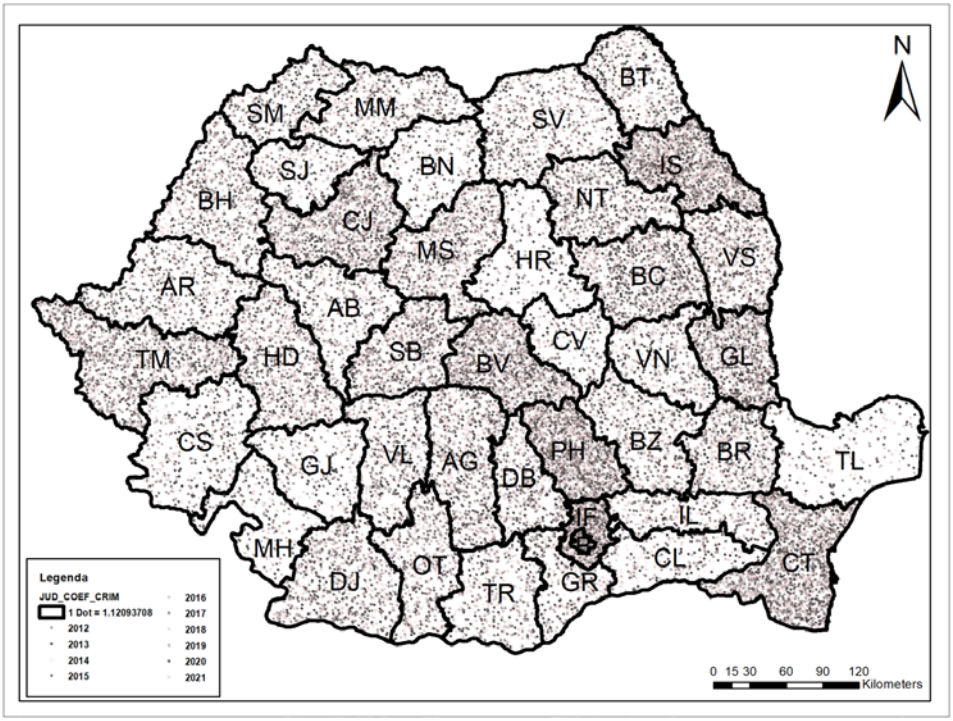


Fig. 6 The density of the specific crime indicator in the period 2012-2021

The county of Alba stands out among the counties with a low crime rate, attributed partly to its small population and also due to a relatively high standard of living. In terms of the evolution of specific crime rates from 2012 to 2021, a minimum was observed in the year 2021 – 41.68 per 100,000 inhabitants, while a maximum of 68.43 per 100,000 inhabitants was recorded in 2017. Across the entire dataset, an average of 56.07 was determined, which closely approaches the specific crime coefficient value for the year 2020 (56.66).


Fig. 7 The specific crime rate of Alba County in the period 2012-2021

These values are mostly influenced by the urban environment (7 out of the 11 entities represented by cities and municipalities – Alba Iulia, Sebeș, Aiud, Blaj, Cugir - having a high rate, Baia de Arieș and Teiuș – medium rate), complemented by certain rural areas – Șibot and Câlnic, both falling into the high-rate category.

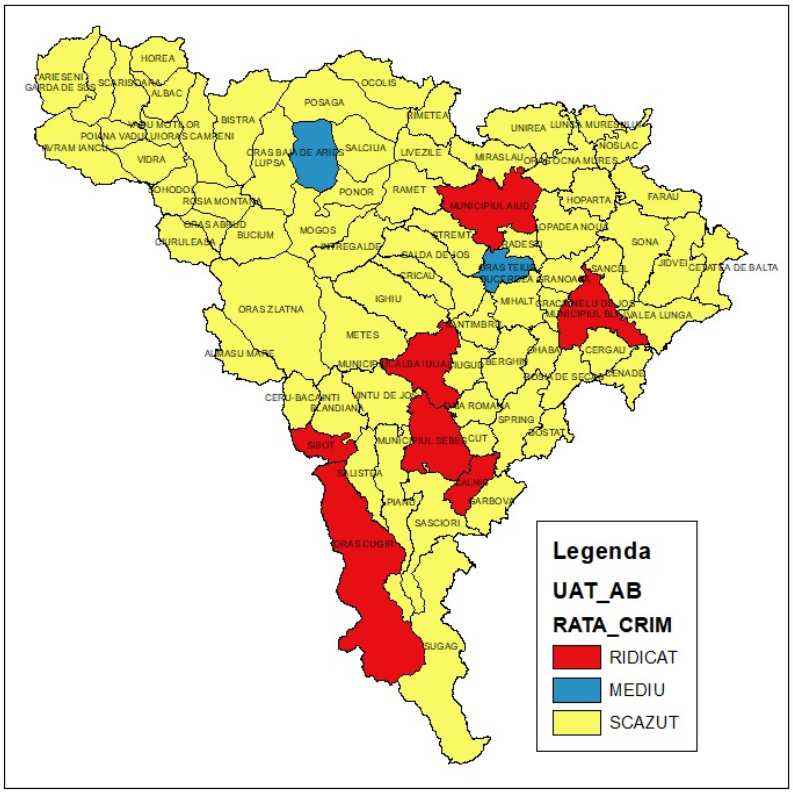


Fig. 8 The specific crime rate of Alba County in local administrative-territorial units (UATs)

## 4. Conclusions

In a concise conclusion, understanding the territory as well as the trends and forms of criminal behavior represent premises in the context of the conducted study, prompting us to approach a theme that illustrates, in a cartographic manner, quantitative aspects related to specific crime. A more analytical approach would have been ideal, leading to the resolution of predictive models, such as analyzing population dynamics as a determining factor in quantifying crime (areas with specific mining, migration to highly industrialized zones, etc.). Population dynamics can offer derived indicators in identifying the causality relationship between the proximity factor (neighboring counties of Alba, for example) and the outcomes that could eventually arise (increase or decrease in crime rates as the case may be).

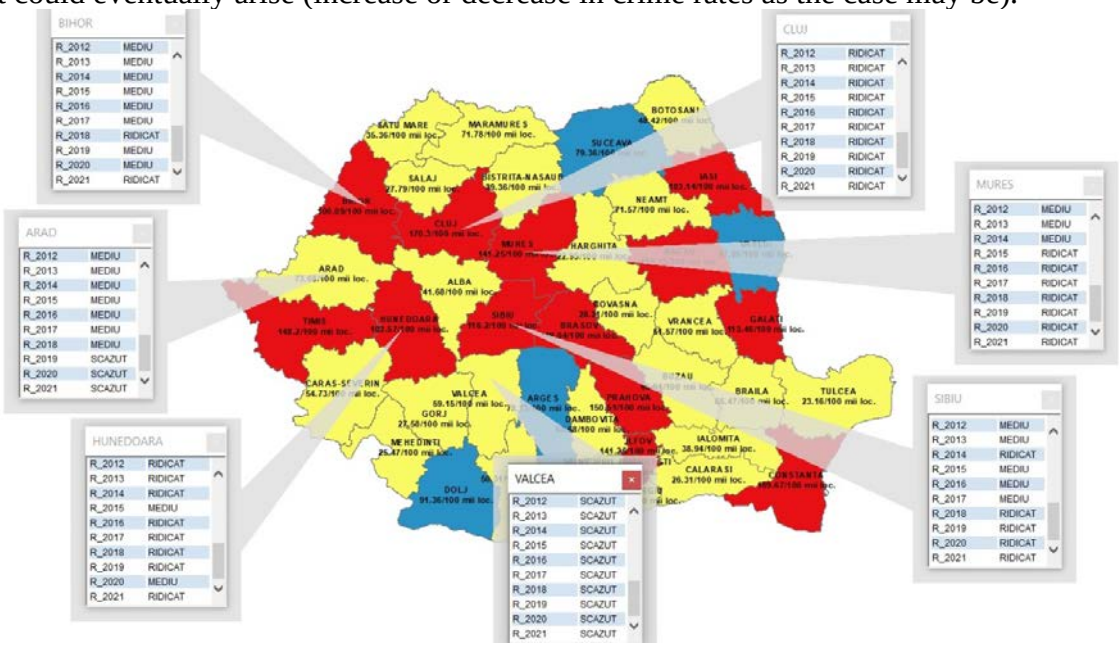


Fig. 9 Premises in assessing neighborhoods

In conclusion, the improper use of general data/information, whether geospatial or descriptive, can lead to a serious degradation of actions intended to reduce crime, and implicitly, social order.

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