TRENDS IN THE EVOLUTION OF REGIONAL DISPARITIES OF ONCOLOGICAL PREVALENCE AND MORTALITY IN ROMANIA

DOI: http://dx.doi.org/10.18509/GBP.2019.45
UDC: 314.14:616-006-.036.8(498)

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ABSTRACT

The geographical distribution of cancer in a space brings a consistent plus of knowledge in understanding the environmental determinants of the appearance and development of carcinogenic tumors. This article presents the main trends in the dynamics of oncology prevalence and mortality in Romania. Limited access to relevant data has made the spatial dimension of cancer lacking in specific public policies. With Romania's accession to the European Union, the institutions responsible for these data were obliged to centralize all these data in a database verified and updated by specialized persons. The final database includes both oncology prevalence and mortality, reported for the period 2008-2017, before that date, medical records are irrelevant due to the wrong way of registering, differently, from one institution to another. The resulting database is reported to the territorial administrative units of Romania, analyzed statistically and modeled using GIS techniques. The results show that there are obvious disparities in the distribution of cancer in Romania, with large concentrations in cities and old industrial areas.

Keywords: Cancer, oncological mortality, public policies, geographical distribution, GIS techniques

INTRODUCTION

Worldwide, cancer tends to become the most important public health problem and one of the main causes of death, with 9.6 million deaths in 2018, 1 in 6 deaths due to cancer [1]. One important thing to mention, in order to better understand the determinants of cancer, is that about 70% of deaths are recorded in countries with low or medium income [1]. As a result, many studies include the spatial side of cancer for a clearer view of the behavior of cancers in different geographic conditions. The results of these approaches have led to new hypotheses regarding the causes of cancer [2], [3], [4], [5], [6], [7], but also to the implementation of public policies in relation to regional disparities [8].
The onset of cancer is due to the 3 major factors, the genetic factor, the behavioral factor and the environmental factor [9]. The genetic factor was until recently the main cause of occurrence, but studies have shown that, there is no significant increase in the number of patients in this context; the same thing happens also for the behavioral factor that refers to the way of life, tobacco, alcohol and nutrition [10]. Responsible for 50% of cases is the environmental factor in the broad sense of the word, that is, everything that is not considered hereditary [11].

Geography plays an important role in understanding human life and medical science when it comes to the geographical distribution of diseases. The introduction of GIS technologies into cancer analysis has enabled space models to be used for making public policy for each type of disease [12]. The increasing use of these technologies has been an important step in understanding how regional discrimination is distributed, which allows huge amounts of data to be processed in a reasonable time, depending on the hardware configuration [13], [14]. Geographic Information Systems (GIS) allow researchers to investigate spatial patterns to better understand the links between cancer and other socio-economic factors and environmental factors, and it is also a way to explore, analyse and represent medical data, to have a clearer view of the phenomenon [15]. Spatial representation of cancer types has made it possible to understand the determinants of this disease from a new perspective, GIS modeling being the linking element, as mentioned above, between spatial specificity in terms of environmental conditions and patterns of spread of cancers [16], [17], [18]. Spatial representation of cancer is a defining element when it comes to the effectiveness of public policies to prevent, combat and treat cancer [19] [20], [21], [22].

METHODOLOGY

Study area

The medical database used for this study is reported at national level, at the territorial administrative unit level, for all 3181 localities (Figure 1), for the period 2008, immediately after the accession of Romania to the European Union, and 2017. This period was chosen because, before this time, the data were irrelevant, the values recorded for the same locality by different institutions, presented major differences, impossible to correct.

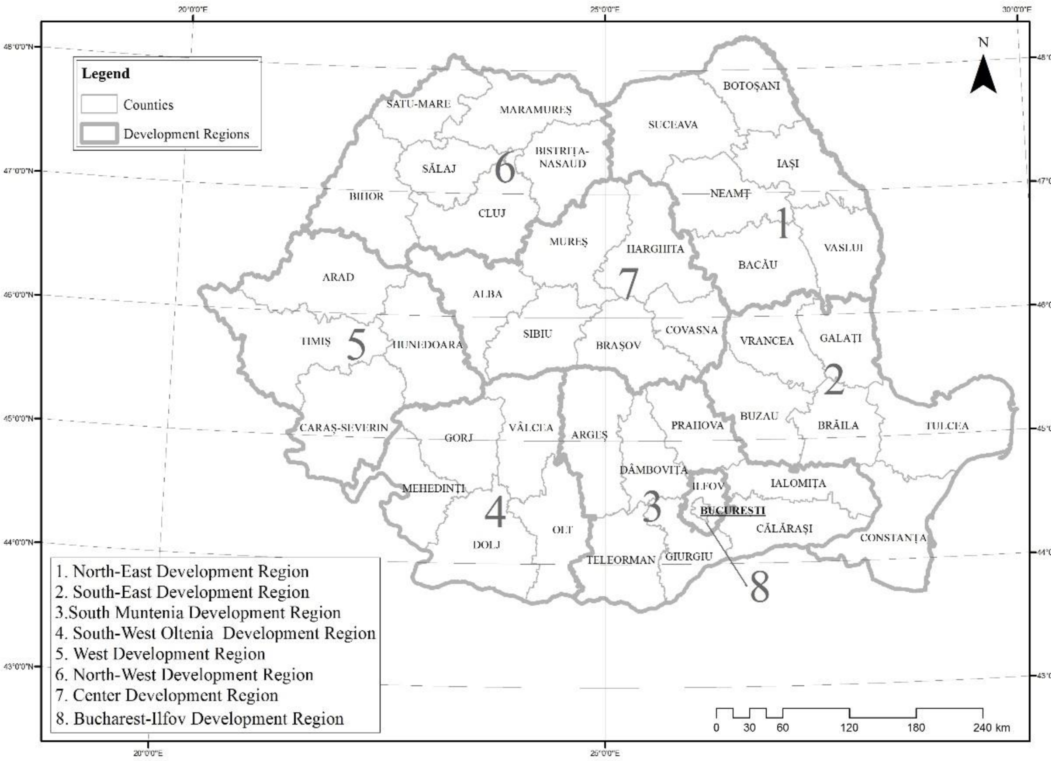

Figure 1. Development regions and counties of Romania

Statistical data used

The database was created at the level of the territorial administrative unit for the period 2008-2017 regarding the number of cases registered for each year (prevalence) and the number of deaths that have as a main cause, one or more types of cancer (oncological mortality) depending on international classification. The data are structured, according to the international classification, on three levels, level I Malignant Tumors (C00-C96), level II malignant tumors, declared or supposed to be primary, with specified locations except those of lymphoid, hematopoietic and related tissues (C00-C75), malignant tumors with defined, secondary and unspecified (C76-C80), malignant tumors of the lymphoid, hematopoietic and related tissues (C81-C96), and level 3 that includes much more detailed code groups located at the level of organs or groups of organs, but for this study we used only the level I values, the total of malignant tumors.

Spatial modeling of oncology prevalence and mortality

Based on primary medical data, the prevalence of cancer ((C00-C95) was calculated based on the total number of cases, female and male. The processing of medical data involved the aggregation of all types of cancer at the level of the territorial administrative unit, then spatially represented using GIS tools. To begin with, a relational database system RDBMS - PostgreSQL was used to generate a database with a huge number of records. One important thing to refer to is the processing time in SQL, which includes the aggregation operation and then pivoting the data necessary to obtain statistical situations, time that differs according to the hardware configuration, on which these processes are performed. The data was tabulated and exported in Microsoft Excel compatible format for the different statistical situations required for the analysis. These tables were later used for the spatial representation of cancer incidence with an open source software, QuantumGis, through which we connected to the database to assign to each locality the appropriate cancer values based on a common element, the locality code (SIRUTA-Information System of the Register of Territorial - Administrative Units). These tables once inserted into QuantumGis were classified into 5 intervals and cartographically represented in grayscale, high values with light tones to white, and low values with dark tones to black. Thus, the prevalence of cancer was represented by the total number of cases, the number of cases corresponding to the female population and the male population as 30 cartographic materials specific for the period 2008-2017; oncological mortality was represented in 4 intervals, respecting the same symbolization, for the period 2008-2016.

RESULTS

Prevalence of malignant tumors in Romania

Analyzing the three figures (Figure 2, Figure 3 and Figure 4) concerning the geographical distribution of the prevalence of total, female and male cancer (C00-C96) for the period 2008-2017, as well as the data used for spatial models, we can observe that the extreme values, over 1000 cases of illness, which persist throughout the analyzed period (Figure 2), are present in the major urban centers, most of them being registered in Bucharest (approximately 35,000 cases) followed by Timisoara (Timis County), Pitesti (Arges County), Craiova (Dolj County), Braşov (Brasov County) with several thousand records. Regarding the minimum values, under 9 cases registered each year, we have the following localities: Ponor from Alba County, Prăjesti from Neamţ County, Vlădeşti from Argeş County, Secaş from Timiş County, etc ; all these localities are from rural areas.

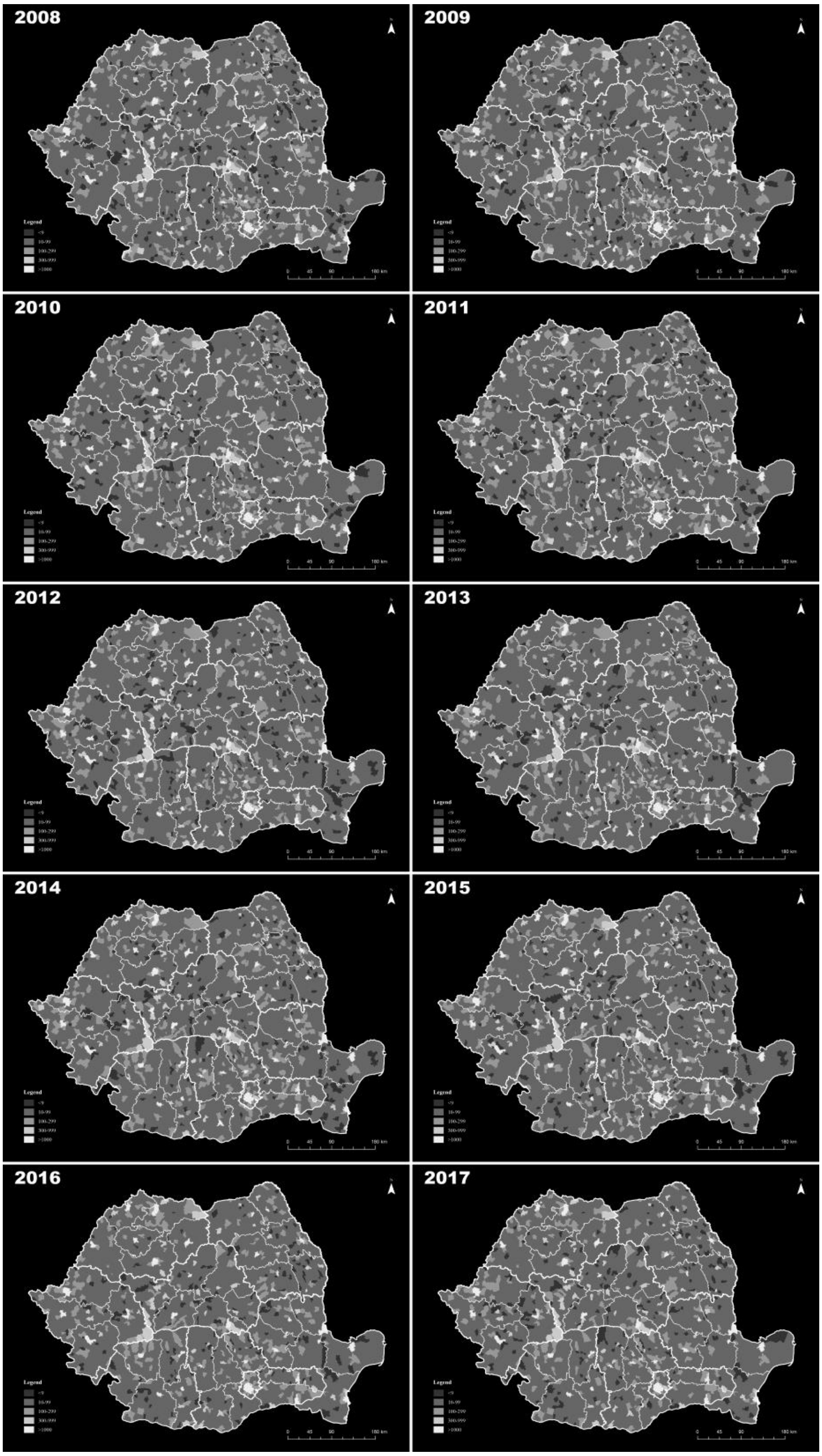

Figure 2. Geographic distribution of malignant tumor prevalence (C00-C96) -total (persons). Source: Ministry of Health

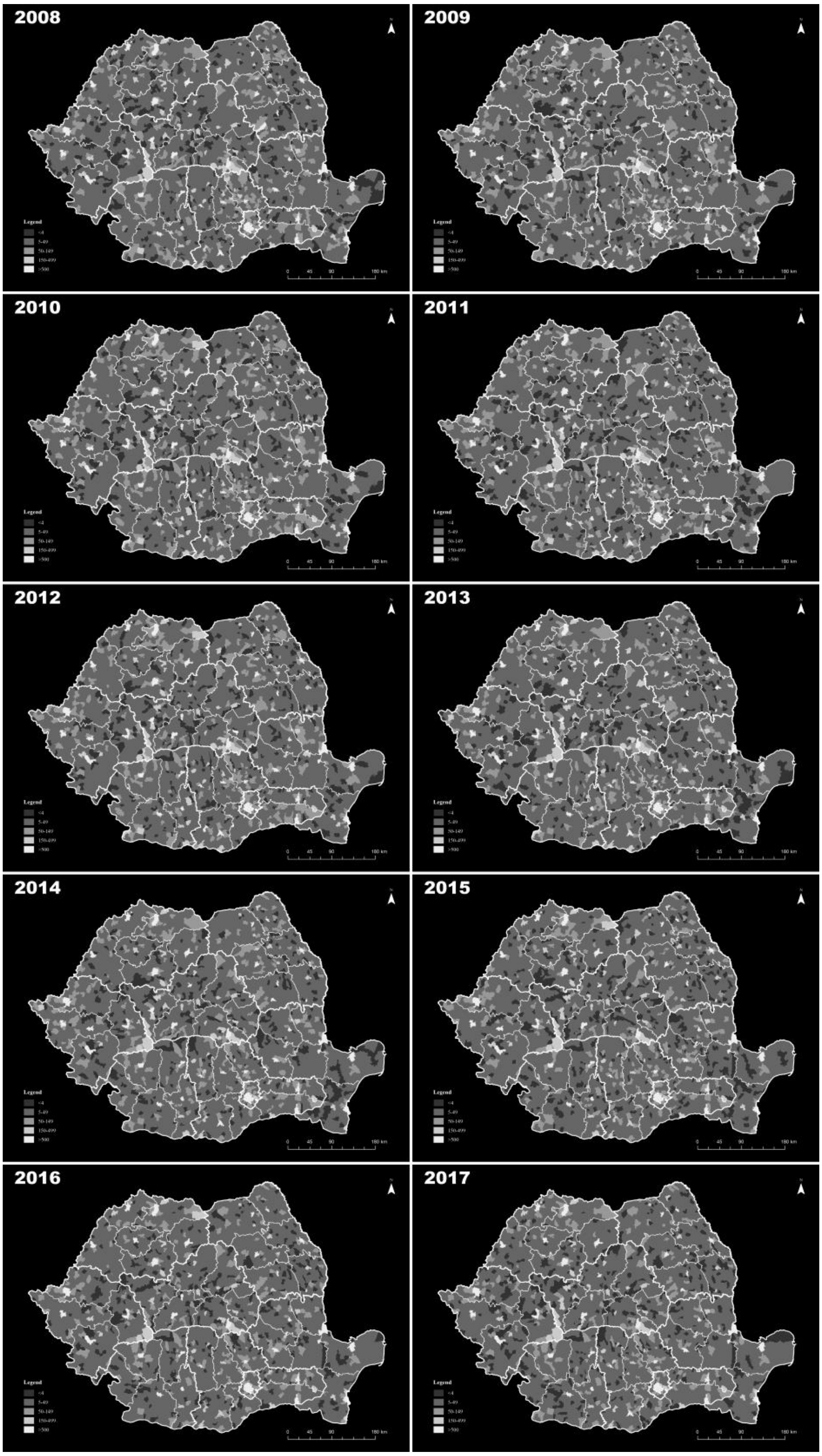

Figure 3. Geographical distribution of malignant tumor prevalence (C00-C96) -female (persons). Source: Ministry of Health

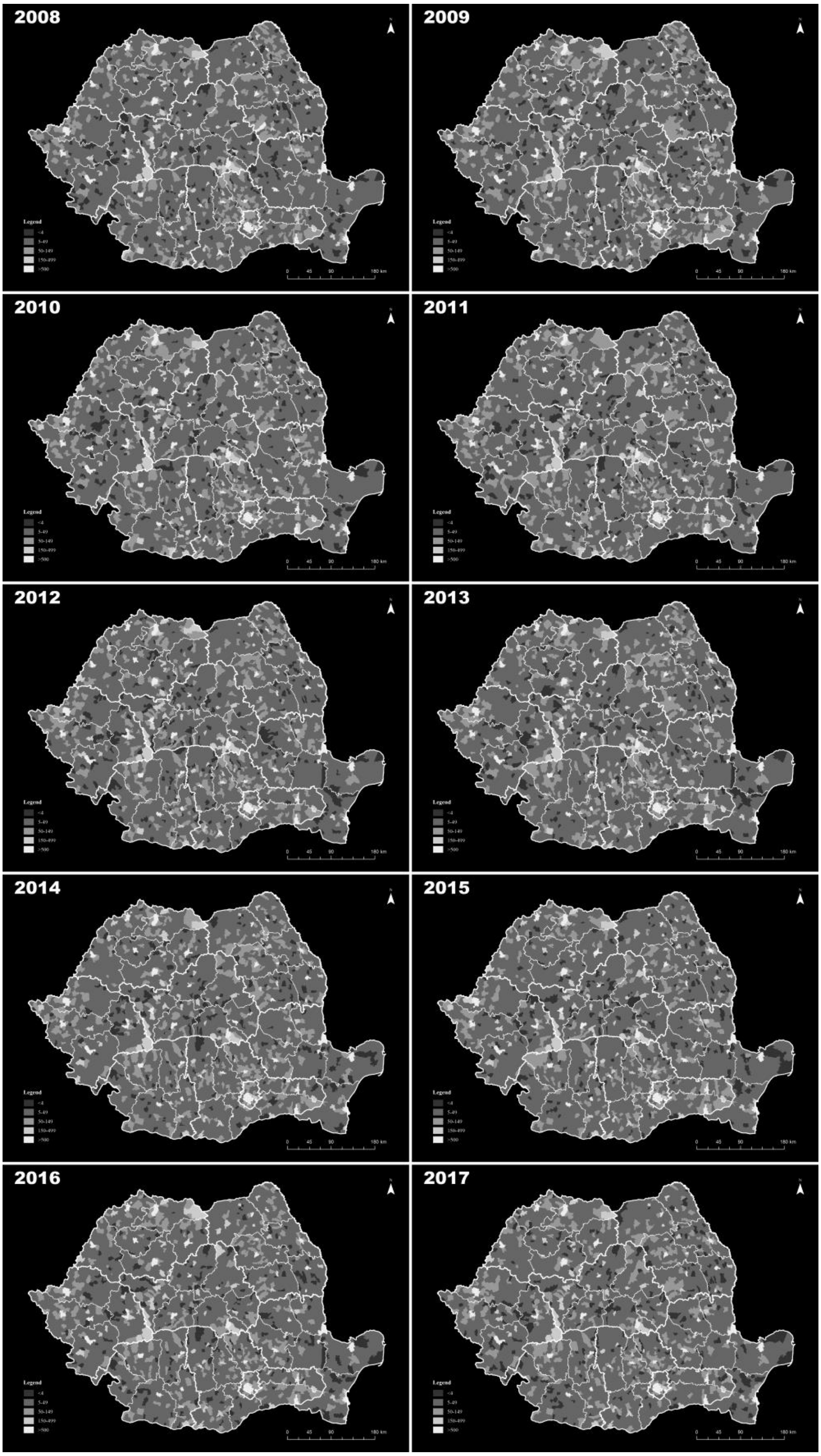

Figure 4. Geographical distribution of malignant tumor prevalence (C00-C96) -male (persons). Source: Ministry of Health

From Figure 3, which represents the geographical distribution of the prevalence of malignant tumors (C00-C96) in the female population, we have the following situations: the highest values are recorded in Bucharest, about 18,500 cases in 2008 with decreasing trend, then Timisoara (Timiş County), Piteşti (Argeş County), Braşov (Braşov County) with values above the last interval in all 10 years. The minimum values, under 4 cases, are maintained in the rural areas of Romania, Horleşti (Iaşi County), Vulturu (Constanţa County), Ponor (Alba County) and others.
Figure 4 illustrates the geographical distribution of the prevalence of malignant tumors (C00-C96) in the male population where the following situations were observed: the highest values are maintained in the major urban centers, in Bucharest were recorded, in 2008, 16,000 cases, reaching about 12,000 in the last year analyzed. As in the situation of the female population, extreme values are found in the following cities: Timişoara, Piteşti, Craiova, Braşov etc. Regarding the minimum values, less than 4 cases per year, reported to the territorial administrative unit, we have the following localities: Văleni from Vaslui County, Mitoc (Botoşani County), Ponor County from Alba County and others; also in this situation, the minimum values are found in rural areas.

Oncological mortality in Romania for the period 2008-2016.
The second category of results refers to the geographical distribution of oncological mortality, how many people died due to one or more types of cancer; the analysis was done for the period 2008-2016 based on the total number of deaths and the female and male categories.
Analyzing both the spatial representation of the phenomenon as cartographic material, as well as the database, some concrete situations regarding the intensity of the phenomenon can be presented. Thus, in Figure 5, the geographical distribution of oncological mortality (C00-C96) for all persons highlights the extreme values over 401 deaths per year, reported to the territorial administrative unit. Cluj Napoca (Cluj County) registered about 800 deaths in 2008, and in 2016 the number increases to 958, Iasi (Iasi county), where the number of deaths increases from 700 to 1000 cases; and other municipalities with extreme values. Capital of the country, Bucharest ranks 11th as the number of deceased, rising (from 460 to 742). Low values are found in localities such as the Izvoarele in Dolj County, Chirnogi in Calarasi County, Greaca in Giurgiu County etc. All these localities maintain their values below 50 deaths.
Figure 6 shows the geographical distribution of oncological mortality (C00-C96) for the male population, with extreme values over 201 deaths in all 9 years analyzed in Cluj Napoca (Cluj County), Constanta (Constanta County), Iasi (Iaşi County), Braşov (Braşov county) etc. In the case of Bucharest, the values increase considerably, reaching 405 deaths in 2016 due to an oncological disease. The values from the first threshold, are found in rural areas, in localities such as Videle (County Giurgiu), Bragadiru (Teleorman County), Bechet (Dolj County) and others.
Figure 7 shows the situation of the geographical distribution of oncological mortality (C00-C96) for the female population. The highest values exceeding the threshold of 201 deaths, were recorded in Cluj Napoca (Cluj County), Timişoara (Timiș County), Braşov (Brașov County), Iaşi (Iași County) and Bucharest, which has registered an increase since 2008, in 2016 reaching 337 deaths. Also in this situation, the values from the first threshold are recorded in rural areas, largely the same as in the case of the male population.

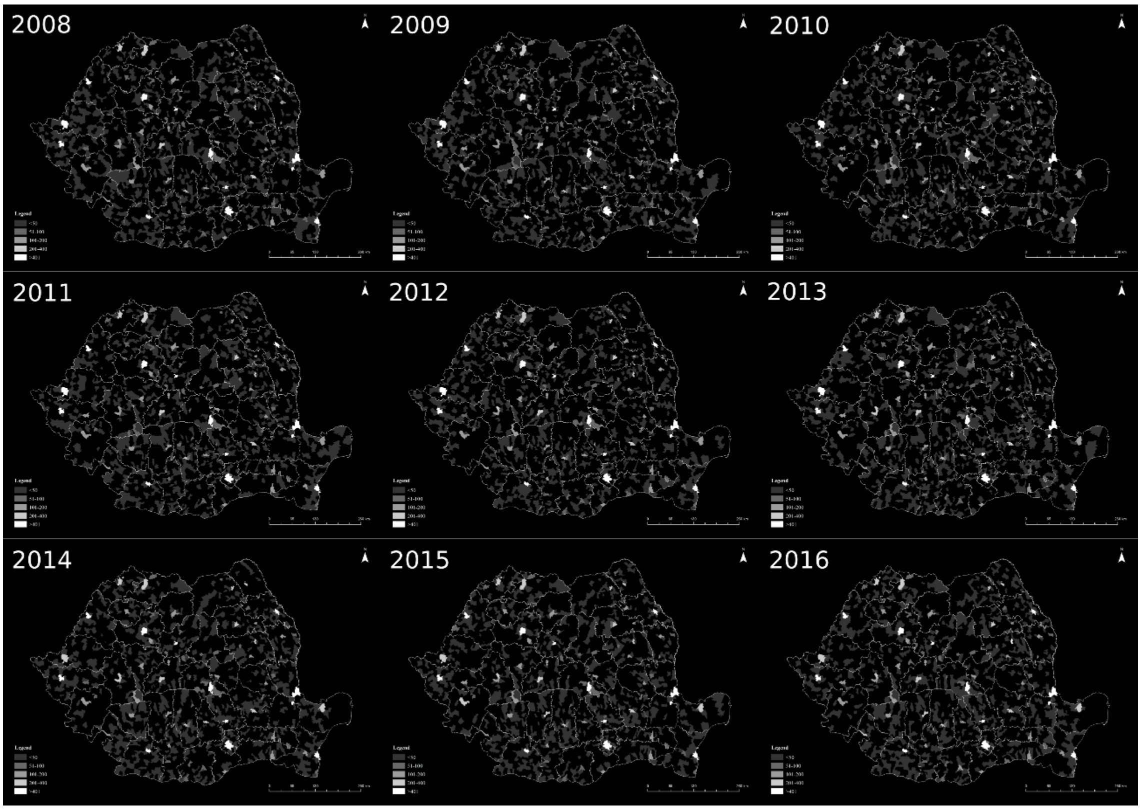

Figure 5. Geographical distribution of oncological mortality (C00-C96) -total (persons).
Source: Ministry of Health

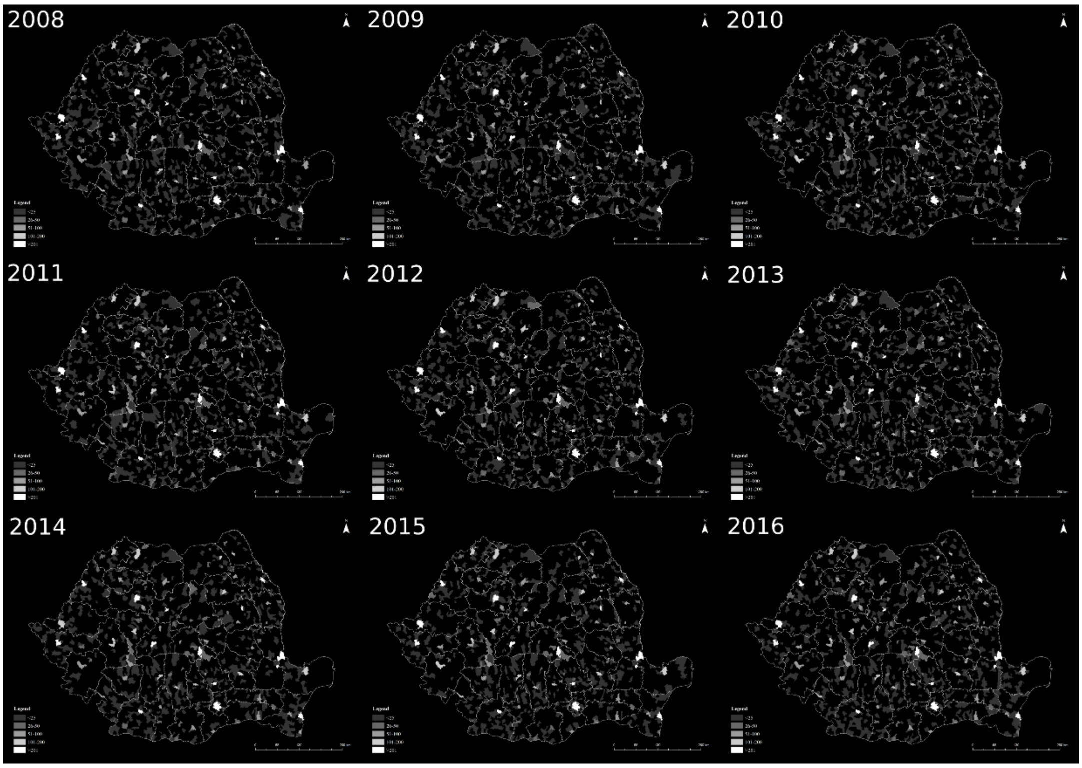

Figure 6. Geographical distribution of oncological mortality (C00-C96) -male (persons).
Source: Ministry of Health

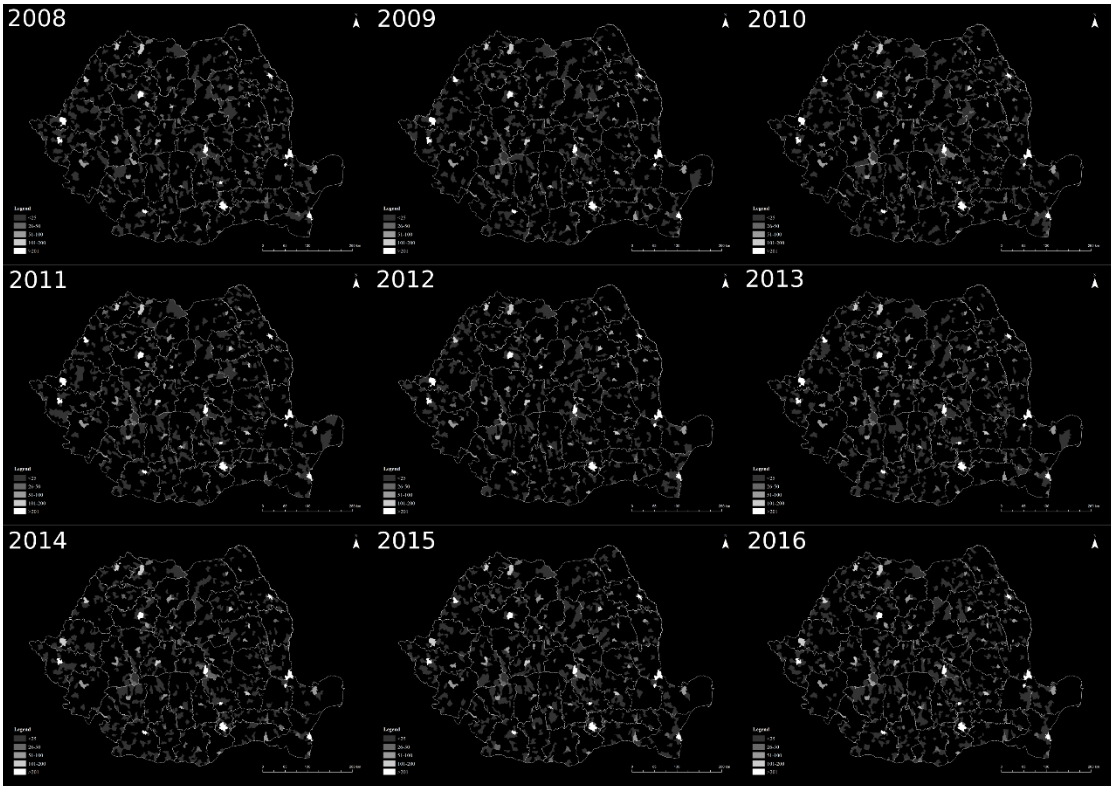

Figure 7. Geographical distribution of oncological mortality (C00-C96) -female (persons).
Source: Ministry of Health

CONCLUSIONS

After studying the specialty literature, we noticed that the lack of relevant data at a detailed level to allow detailed analysis is an impediment. Taking into account the obvious current situation of geographical disparities, it is necessary to introduce new approaches needed for understanding the determinants of cancer. The methodology approached provides a broader view of the cancer distribution in Romania, the basis for further in-depth research and a complement to the studies completed so far on the disruption of territorial systems affected by ecosystem interventions [23-29].

At the level of development region, regarding the total cases of malignant tumors over the 10 years analyzed, most of the records are in the South Muntenia region, about 490,000 patients, and the fewest cases are in the West development region, about 310,000. In terms of gender distribution, the regions with maximum and minimum values are the same.

As can be seen, the maximum values are present in the large urban centers, intensely polluted by different agents, mining areas, metallurgical centers and industrial centers, intense traffic, all of which make the big cities suitable for the development of one or more types of cancer. By making a parallel between oncology incidence and mortality, we can say that, extreme values are encountered in large urban centers, and the lowest in rural areas. The multitude of possible trigger factors that are present in high-value areas identified by us, refer to the old centers of mining and siderurgy.

REFERENCES

[1] World Health Organization 2018 https://www.who.int/;

[2] Oh, W. S., Yoon, S., Noh, J., Sohn, J., Kim, C., Heo, J. (2018) Geographical variations and influential factors in prevalence of cardiometabolic diseases in South Korea, 2018, PLoS ONE;

[3] Al-Ahmadi, K., Al-Zahrani, A. Spatial autocorrelation of cancer incidence in Saudi Arabia, International Journal of Environmental Research and Public Health, 2013, pp 7207-7228;

[4] Glass, G. E., Schwartz, B. S., Morgan, J. M., Johnson, D. T., Noy, P. M., Israel, E. Environmental risk factors for lyme disease identified with geographic information systems, American Journal of Public Health, 1995, pp 944-948;

[5] Xu, M., Cao, C., Wang, D., Kan, B., Xu, Y., Ni, X., Zhu, Z. C. Environmental factor analysis of cholera in China using remote sensing and geographical information systems, Epidemiol & Infection, 2016, pp 940-951;

[6] Fowkes, F. G. R., Rudan, D., Rudan., I., Aboyans, V., Denenberg, J. O., McDermott, M. M., Norman, P. E., Williams, L. J., Mensah, G. A., Criqui, M. H. Comparison of global estimates of prevalence and risk factors for peripheral artery disease in 2000 and 2010: A systematic review and analysis, The Lancet, 2013, pp 1329-1340;

[7] Gou, F., Liu, X., Ren, X., Liu, D., Liu, H., Wei, K., Xiaoting, Y., Yao, C., Yunhe, Z., Xiaojuan, J., Juansheng, L., Lei, M., Wenbiao, H. Socio-ecological factors and hand, foot and mouth disease in dry climate regions: a Bayesian spatial approach in Gansu, China. International Journal of Biometeorology, 2017, 137-147;

[8] Parrish, I., McDonnell, S. M. Sources of health related information. In Principles and practice of public health surveillance 2 (Teutsch SM, Churchill RE, eds). New York, Oxford, 2000, pp 76-94;

[9] CAUDEVILLE, J., Masson, J., B. Projet SIGFRIED 1: SIG Facteurs de Risques Environnementaux et Décès par cancer Integration de bases de données environnementales dans un SIG pour servir à l'analyse des disparités géographiques de cancer, 2014;

[10] CICOLELLA, A., Sasco, A., Valdes-Lao, D., Trugeon, A., Declercq, C., Gremy, I., Pepin, P., Guye, O., Sonko, A., Colonna, M. Analyser les in´egalit´es spatio-temporelles de cancer pour mieux comprendre le lien cancer environnement Le projet CIRCE (Cancer in´egalit´es r´egionales cantonales et environnement), 2008;

[11] National Institute of Environmental Health Sciences (https://www.niehs.nih.gov/).

[12] Hay, S. I., George, D. B., Moyes, C.L., Brownstein, J. S. Big data opportunities for global infectious disease surveillance, PLoS Medicine, 2013;

[13] Ferlay, J., Partensky, C., Bray, F. More deaths from pancreatic cancer than breast cancer in the EU by 2017. Acta Oncologica, 2016, pp 1158-1160;

[14] Jemal, A., Bray, F., Center, M. M., Ferlay, J., Ward, E., Forman, D. Global cancer statistics, CA A Cancer Journal for Clinicians, 2011, pp 69-90;

[15] Brewer, C. A. Basic Mapping Principles for Visualizing Cancer Data Using Geographic Information Systems (GIS). American Journal of Preventive Medicine, 2006;

[16] Jarup, L., Best, N., Toledano, M. B., Wakefield, J., Elliott, P. Geographical epidemiology of prostate cancer in Great Britain. International Journal of Cancer, 2002, pp 695-699;

[17] Onicescu, G, Lawson, A. B., Zhang, J., Gebregziabher, M., Wallac,e K., Eberth, J. Bayesian accelerated failure time model for space-time dependency in a geographically augmented survival model, Statistical Methods in Medical Research, 2015, pp 2244–56;

[18] Correa, P., Piazuelo, M. B., Camargo, M. C. Etiopathogenesis of gastric cancer. Scandinavian Journal of Surgery, 2006, pp 218–224;

[19] Siegel, R. L., Miller, K. D., Jemal, A.Cancer statistics, 2016 CA: Cancer Journal for Clinicians, 2016, pp 7-30;

[20] Mosavi-Jarrahi, A., Moini, M., Mohagheghi, M.-A., Alebouyeh, M., Yazdizadeh, B., Shahabian, A., Nahvijo, A., Alizadeh, R. Clustering of childhood cancer in the inner city of Tehran metropolitan area: a GIS-based analysis, International Journal of Hygiene and Environmental Health, 2007, pp 113–119;

[21] Rainey, J. J., Omenah, D., Sumba, P. O., Moormann, A. M., Rochford, R., Wilson, M. L. Spatial clustering of endemic Burkitt's lymphoma in high-risk regions of Kenya, International Journal of Cancer, 2007, pp 121-127;

[22]Jones, L., Chilton, J., Hajek, R., Iammarino, N., Laufman, L. Between and within: international perspectives on cancer and health disparities, Journal of Clinical Oncology, 2006, pp 2204–2208;

[23] Pintilii, R, D,, Andronache, I., Diaconu, D. C., Dobrea, R. C., Zelenakova, M., Fensholt, R., Peptenatu, D., Draghici, C. C., Ciobotaru, A. M. Using Fractal Analysis in Modeling the Dynamics of Forest Areas and Economic Impact Assessment: Maramures County, Romania, as a Case Study, Forests, 2017, vol. 8;

[24] Peptenatu, D., Draghici D., Merciu, C. Characteristics of entrepreneurial profile in some emergent territorial structures in Romania, Actual Problems of Economics,2012, vol. 12, pp 448-458;

[25] Schvab, A., Pintilii, R. D., Peptenatu, D., Stoian, D. Spatial profile of poverty. Case study: the North-Eastern development region in Romania, Transylvanian Review of Administrative Sciences, 2015 vol. 45, pp 201-2016;

[26] Drăghici, C. C., Andronache, I., Ahammer, H., Peptenatu, D., Pintilii, R. D., Ciobotaru, A. M., Simion, A. G., Dobrea, R. C., Diaconu, D. C., Vișan, M. C., Papuc R. M. Spatial evolution of forest areas in the Northern Carpathian Mountains of Romania, Acta Montanistica Slovaca, 2017, vol. 22, pp 95-106;

[27] Da Silva, P. R. B., Makara, C. N., Munaro, A. P., Schnitzler, D. C., Diaconu, D. C., Sandu, I., Poleto, C. Risks Associated of the Waters from Hydric Systems Urban's The case of the rio Barigui, south of Brazil, REVISTA DE CHIMIE, 2017, vol 68, pp 1834-1842;

[28] Diaconu, D. C., Andronache, I., Ahammer, H., Ciobotaru, A. M., Zelenakova, M., Dinescu, R., Pozdnyakov, A. V., Chupikova, S. A. Fractal drainage model - a new approach to determinate the complexity of watershed, ACTA MONTANISTICA SLOVACA, 2017, vol 22, pp 12-21;

[29] Zelenakova, M., Ganova, L., Purcz, P., Horsky, M., Satrapa, Blistan, P., Diaconu, D. C. Mitigation of the Adverse Consequences of Floods for Human Life, Infrastructure, and the Environment, NATURAL HAZARDS REVIEW,2017, vol 18.