Violent crime in Lithuania: trends and patterns in 2015–2020

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Abstract. The paper presents the results of analysis of spatial distribution of violent crime in Lithuania. Two periods are compared: 2015–2019 that can be characterized as a period with relatively stable crime dynamics and 2020, the year of Covid-19 pandemic. Violent crime (events that have elements of direct threat to a person) was chosen because it is the type of crime that causes the most harm and because the worrying trend of its growth has been observed against a backdrop of declining overall crime. We demonstrate how the distribution of violent crime had changed in Lithuania in 2020 compared to the trends of 2015–2019 and, specifically, during the two lockdown periods of 2020 – between March 3 and June 17 and from 4 November to the end of the year.

Keywords. Violent crime, Lithuania, distribution, trends

1 Introduction

Crime is one of the most serious social problems in every country, every city or town. It is impossible to completely prevent crime, it occurs everywhere and all the time. Thus, it is important to look for the causes, monitor the situation, analyze the available data, and look for possible solutions to the problem. A safe living environment is an aspiration that is relevant for decision-makers (police representatives, municipal representatives) seeking to create a better, more beautiful, safer environment for people to live in, and for the residents themselves, for whom it is instinctively important to ensure a sense of security.

Spatial distribution of crime in Lithuania has been investigated since 2011. Since 2015, consistent event data for the entire Lithuania are available from the departmental Register of Events Registered by the Police. The period of 2015–2019 could be characterized by the relative stability of the situation and a slow but constant decrease of crime in general. However, the situation was not the same in different parts of the country as it was demonstrated in our earlier papers. Also, different types of crime show different distribution and dynamics. Whereas the total crime constantly decreased from 2015 (Beconytė et al., 2021), it was not the case with violent crime (Figure 1). The number of violent crime events also increased in 2020 – the first year of the Covid-19 pandemic. Several studies of crime in the years of Covid-19 pandemic (Payne and Morgan, 2020; Matthew and Ashby, 2020; Mohler et al., 2020; Abrams, 2021, Yang, 2021) demonstrated that there were changes compared to general trends – both increase and decrease of particular type of crime. In this poster, we demonstrate how the distribution of violent crime had changed in Lithuania in 2020 compared to the trends of 2015–2019 and, specifically, during the two lockdown periods of 2020 – between March 3 and June 17 and from 4 November to the end of the year. The study was based on the data on the events registered by the police. Even though the registered events reflect only a portion of all crime, we consider it the best of available quantitative indicators of true situation of crime.
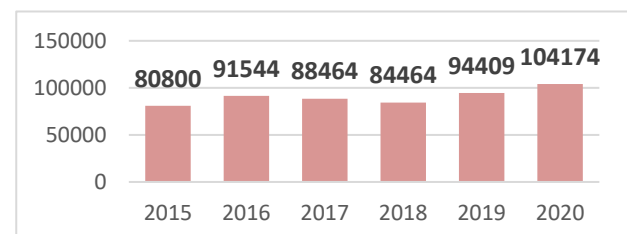

Figure 1. Number of registered events of violent crime in Lithuania in 2015–2020

2 Methods

The analysis has been performed on the most actual of the available data – incidents recorded by the police in 2015–2020. This six-year period is examined in the light of current events. 2020 – is a Covid-19 pandemic year, so it has been decided to divide the whole period into two parts: the pre-pandemic period (2015–2019) and the pandemic period (2020).

The dataset that was used in the research contains 3.46 million records of events reported to the police of Lithuania in 2015–2019 and 0.5 million records in 2020. In the register, there are seven main types of events: violent crime (homicide, murder, assault, manslaughter, sexual assault, rape, robbery, abduction, harassment), thefts, property crime (criminal damage), economic offence (forgery, tax evasion, trade diversions, handling contraband and counterfeit goods), infringement of public policy (breach of the peace, illicit consumption of alcohol), traffic accidents and various other incidents (drug related crime, arrests, suspicious persons or things, aid for special services, lost and found documents, activation of burglary alarm systems etc.).

Intensity of violent crime.

Violent crime intensity maps of 2020 have been compiled using two methods of estimation:

- for sparsely populated cells – absolute number of registered events. Sparsely populated cells contain less than 20 people/$0,01km^2$ for the cities (100x100 m cells) and less than 16 people/km^2 for Lithuania (2.5x2.5 km cells);
- for cells with population greater than the threshold – relative number of registered events.

Similar, but different gradual colour schemes allow combining two cartographic representations in one map. The map clearly shows that distribution of violent crime is not even.

The series of six city maps show intensity of violent crime in higher level of detail. It is usually higher in central areas.

Location quotient (LQ) map

Based on the total amount of crime in in 2020, the LQ map of 2020 shows the share of violent crime in the cell in comparison to the cell's share of the total occurrence of crime:

$$LQ_{ij} = (\frac{c_{ij}}{C_j}) / \frac{\sum_{j=1}^{N} c_{ij}}{\sum_{j=1}^{N} C_j};$$

where c_{ij} is the number of events of type i in cell j, C_j is the number of events of all types in cell j, N is the number of cells in the country.

If LQ > 1, this indicates a higher spatial concentration of violent crime in a given cell, compared to the average share of each cell. If LQ < 1, violent crime has a share less than is found throughout Lithuania. On the map, disproportionally high LQ values (more than 1.5) do not indicate that violent crime prevails in the given area – it just manifests there more strongly than in the country in general.

The cells in which no events were reported have not been represented.

Changepoint Detection.

Change point detection (CPD) method allows detecting significant changes in the time series data. The points when the statistical properties change and the intervals of no change between those points are detected. Such changes may represent transitions occurring between states. We used CPD likelihood ratio algorithms to segment time series data by finding multiple change points at which the statistical properties of the registered violent crime events of 2020 change. In our case, the binary segmentation (BinSeg) method (Killick, et al., 2022) with significant mean shift detection identify multiple abrupt changes clearly. The following *BinSeg* parameters were tested: penalty types of SIG, AIC and BIC; normal and CUSUM test statistics. Changes of these parameters caused no significant difference in the resulting segmentations. Restrictions on the number of searched segments and the number of changepoints to search were not applied.

Trend Dynamic Estimation.

Temporal trends of violent crime events were modelled using the univariate Mann Kendall trend test (M-K test). M-K test detects monotonic increasing or decreasing trends in values by comparing the relative magnitudes of sample data (Mann, 1945; Kendall and Gibbons, 1990). The bins of 2500 m and 18 days were used for the fishnet grid of square 4000 x 4000 meter cells. The entire space time cube spans an area 368000 meters west to east and 280000 meters north to south. The global M-K test showed statistically significant increase in point counts over time both for 2015–2019 (global trend M-K statistic 3.4090, trend p-value 0.0007) and for 2019–2020 (global trend M-K statistic 3.1562, trend p-value 0.0016).

The experiments have been conducted using *R Studio* with the contributed package *changepoint*, *spatstat* and *sparr* from the *CRAN* website (cran.r-project.org) and *ESRI ArcGIS Pro* software which also has been used for dataset preprocessing and visualization purposes.

Results

Location quotient (LQ) map

The location quotient map of Lithuania (Figure 2) clearly shows that violent crime is still relatively bigger problem in rural areas. High LQ values are also observed in bigger cities northern Lithuania (Šiauliai, Panevėžys).
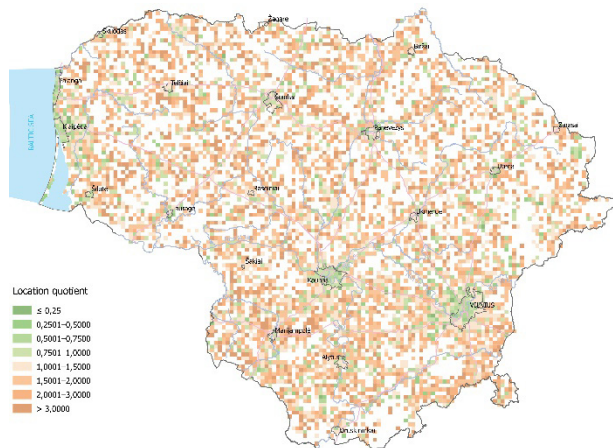

Figure 2. Location quotient of violent crime in 2020

Changepoint Detection

The detected changes in temporal distribution of violent crime are represented in Figure 3 – the pattern cannot be directly linked to the dates of quarantines; however, it differs from previous years in that there is an increase in the number of incidents during the summer (2020-06-05–2020-09-27).
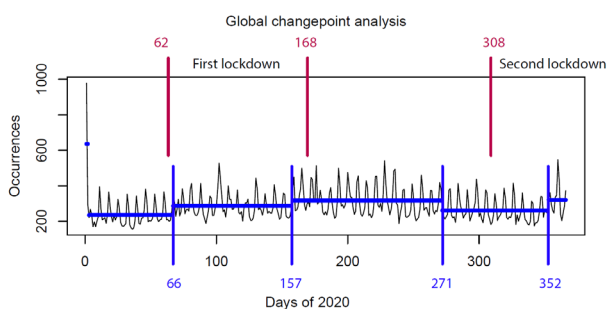

Figure 3. Crime dynamics changepoints, 2020

Trend Dynamic

The local trends estimated for 2015–2019 and for 2019–2020 are shown in Figures 4 and 5. The pattern of significant increase of violent crime in 2020 is different from the trend of 2015–2019.

2015–2019. The space time cube has aggregated 439813 points into 6510 fishnet grid locations over 102 time step intervals. Each of the time step intervals is 18 days in duration so the entire time period covered by the space time cube is 1836 days. Of the 6510 total locations, 3869 (59.43%) contain at least one point for at least one time step interval. These 3869 locations comprise 394638 space time bins of which 105765 (26.80%) have point counts greater than zero. There is a statistically significant increase in point counts over time (Figure 4). All major cities (except Klaipėda sea port) and rural areas in the central and eastern part of Lithuania show an upward trend.
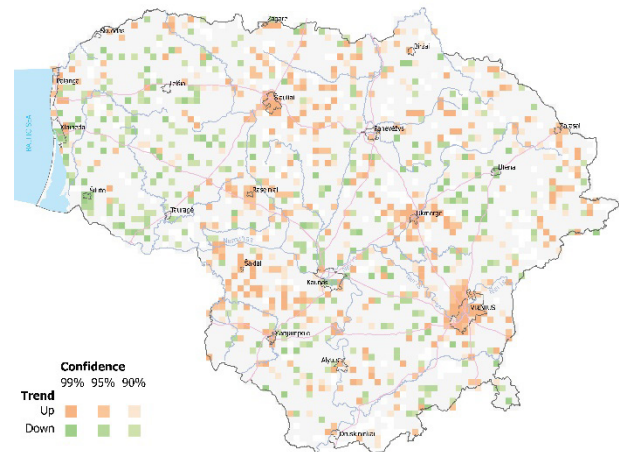

Figure 4. Temporal trends of violent crime in 2015–2019

2020. The space time cube has aggregated 104174 points into 6440 fishnet grid locations over 21 time step intervals. The entire time period covered by the space time cube is 378 days. Of the 6440 total locations, 3357 (52.13%) contain at least one point for at least one time step interval. These 3357 locations comprise 70497 space time bins of which 23396 (33.19%) have point counts greater than zero.
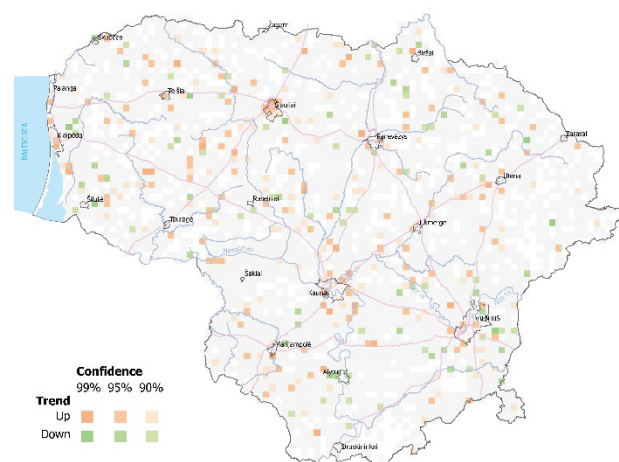

Figure 5. Temporal trends of violent crime in 2019–2020

In 2020, the first year of the pandemic, the trend of violent crime reversed in Klaipėda (from downward to upward) and retained roughly the same spatial distribution pattern in the rest of Lithuania.

Spatio-temporal distribution of violent crime in cities

The methods of density, cluster and hotspot analysis allowed to compare the distribution of violent crime in the years before the pandemic and in 2020.

Violent crime has always been the bigger problem in rural areas and in open spaces in the cities. Some shift of highest density of the registered events from the centre to suburban zones was observed in the biggest cities during the quarantines of 2020 that can be explained by the gathering restrictions. The case of Vilnius is shown in Figure 6.
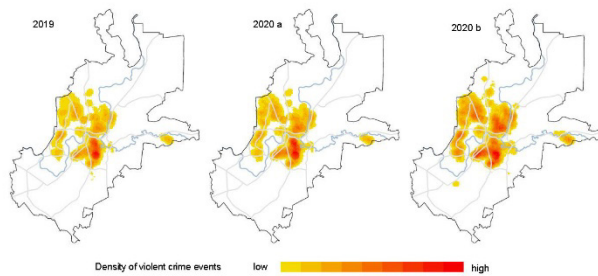

Figure 6. Hotspots of violent crime in Vilnius City Municipality in 2019 and in 2020 outside quarantine (a) and during quarantine (b)

The series of city maps of violent crime dynamics represent changes between classified hotspot maps of 2017–2019 and 2020. During the year of Covid-19 pandemic, decrease of violent crime in the central hotspots and increase in densely populated residential districts is characteristic for the biggest cities, especially Vilnius and Kaunas. Panevėžys exhibited an unexpected pattern of massive overall increase, but decrease in the central areas can still be observed (Figure 7).
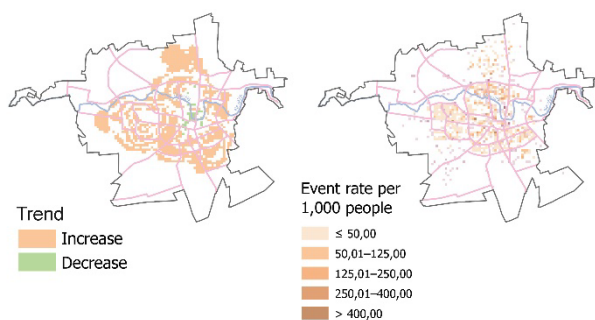

Figure 7. Hotspots of violent crime in Vilnius City Municipality in 2019 and in 2020 outside quarantine (a) and during quarantine (b)

Interactive internet maps and dashboards were created, representing the situation with registered violent crime in various aspects in detail (available at https://experience.arcgis.com/experience/d9fa101555434 f4da644ff9a3e255b45). The situation of violent crime in Vilnius City municipality is presented in detail on 87 interactive dashboards. One of such dashboards that enables visual comparison of violent crime clusters during the quarantine periods of 2020 and during other years selected is shown on Figure 8.
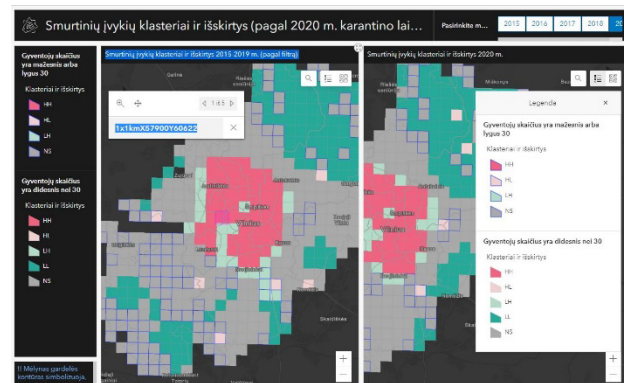

Figure 8. A sample of violent crime map dashboard

Conclusion and discussion

The statistics of events registered by the police of Lithuania in 2015–2019 and in 2020 shows that there have been significant changes in the number of events registered and in the spatio-temporal patterns of violent crime. It is not possible to say at this point how much of the change is really due to the Covid-19 pandemic, but it is reasonable to assume that its impact was significant. Further research may provide quantitative support for this assumption.

It was noticed that in the residential areas, higher numbers of violent crime (including domestic violence) in 2015–2019 were recorded on weekends and after working hours. In 2020, more violent crime, with a higher proportion of domestic violence, has been recorded in the earlier hours, from 1–2 PM until midnight. In the cities, the relative numbers of registered violent crime were higher in the areas around the central parts and in the peripheral areas.

The maps created as the result of the research represent the spatial distribution of the violent crime in Vilnius City Municipality in detail. They help to explain the phenomenon and may contribute to the better management of crime, especially in the rural areas where local analytical/GIS capacity is limited.

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