Dr. Szabolcs Mátyás

CRIME GEOGRAPHY

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"Sin is geographical."

Bertrand Russell

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INTRODUCTION

Nowadays, good public security is classified as a fundamental human right, so everyone who is a citizen of a democratically organized state has a right to public safety. So the question of whether every country can provide public safety for its citizens is pertinent. Unfortunately, the answer is no. It is no exaggeration then to say that the number and composition of crimes is a crucial question for each and every society.

Over the past two decades, social and economic changes and processes have taken place worldwide that make public security even more important. Crime geography, which is an unjustifiably neglected field of social sciences, is an essential discipline in exploring causes, mapping problems, and finding possible solutions. Furthermore, the spatial approach and perception of spatial differences characteristic of geography can significantly contribute to research in other crime sciences.

In today's rapidly changing, globalized world, it must be recognized that new methods are needed alongside traditional investigative work to reduce and prevent crime. The actuality of crime geography is shown, among other things, by the fact that studies have been regularly published over the last decade that have offered solutions to new types of public security problem using the research methods of crime geography. This field of social science is increasingly gaining the attention of researchers, which is demonstrated by the fact that ever more studies are being published around the world.

Researchers of the geography of crime represent a wide range of disciplines, and this publication is intended to summarize international scientific findings until now and to provide a guide that can be applied in practice, conveying knowledge from a practical point of view, and not just for students engaged

in law enforcement higher education, but for anyone working in law enforcement who is interested in crime sciences and geography, and is concerned with the spatiality of crime.

This publication differs slightly from "traditional" crime geography books. Partly because the author interprets crime geography differently to most other researchers. In *Understanding Crime – Analyzing the Geography of Crime*, Spencer Chainey writes: "The main theoretical discipline that underpins the geography of crime is the practical subset of mainstream criminology known as environmental criminology." (Chainey, 2021, 16.) Moreover, in *Kriminalgeographie: Eine Geographie ohne Geographen* the German criminologist M. Rolfes, (2003) said that crime geography is "geography without geographers". These quotes illustrate how many researchers think of crime geography as part of criminology (of course, we could present many more quotes that represent the above point of view).

Many criminologists in the topic understand crime geography as *crime mapping*, but while crime mapping is a very important area of crime geography, the research area of this social science is far broader than that. Crime geography cannot be simplified to such a degree. The emergence of GIS (Geographic Information System) software brought about a huge change in the field of crime geography, shedding light on previously unknown connections and sometimes also providing predictions for the future. There is, however, geographical information (physical and human geography) behind the mapping, without which the obtained results could not be interpreted.

It is the author’s opinion that the theoretical roots of crime geography cannot be found exclusively in criminology (environmental criminology). Finding geographic indicators helps criminologists, investigators, cartographers, law enforcement professionals, and so on, to reduce the number of crimes. The

antagonism between the two points of view is not irreconcilable, they just look at the issue from a different perspective. From the author's point of view, the field that many call crime geography is more about law enforcement analysis rooted in criminology and cartography, not crime geography as such.

Based on the above, the author focuses here primarily on geographical factors. This is partly due to the fact that the author is a geographer, who also views crime geography as a criminalistics (forensic science) method that aids investigations and plays an essential role in crime prevention. This approach is partly derived from previous definitions of crime geography (see: Horst Herold, 1973) and partly from the decade and a half of experience the author had as a detective.

It is the author's belief that the causes of crime can only be truly understood if their true cause (geographical cause) is first revealed, and the greatest help in this, as a classically spatial science, is geography, although clearly the role more recent scientific fields play in this area cannot be denied either.

If anyone has any concerns about what crime geography is suitable for, or why this field of social science might be useful, then the best explanation can be found in an article published in 2011 by the author partnership of James L. LeBeau and Michael Leitner.

> *"The trajectory of the geography of crime is upward and will be that way for some time to come. There are many reasons for this, but the most important is that the geographical and spatial analysis of crime and the criminal justice system does matter. It helps the police and community identify, address, and monitor neighborhood problems. It helps the agencies work more efficiently. It helps identify consistencies in criminal behavior that can inform crime prevention or apprehension efforts. The list of reasons can go on and on. There is a plethora of basic and applied research questions that need to be*

addressed. Therefore, early career geographers should be encouraged to address these questions and join the rest of us in the study of the geography of crime." (LeBeau and Leitner 2011, 168.)

Finally, I would like to thank all the reviewers of this book (Andrea Pődör, Vince Vári and Máté Sivadó), Attila Máté, Tamás Tímár, György Szabó (University of Debrecen), Miklós Dürr (University of Durham), Irem Teciman (Turkish National Police Academy) and Webb Michael James (Ludovika University of Public Service).

Debrecen, 26. 8. 2024.

The Author

Chapter 1.
THE PLACE OF CRIME GEOGRAPHY IN SOCIAL SCIENCE, THE CONCEPT AND TASK OF CRIME GEOGRAPHY

1.1. The place of crime geography in social science and its divisions

With the scientific classification of crime geography, it should be noted that many researchers have different views on the place of the discipline within social science. Three distinct approaches can be distinguished:

A) The criminological approach

B) The geographical approach

C) The middle ground.

A) THE CRIMINOLOGICAL APPROACH

It is primarily criminologists who classify crime geography as something that belongs to the field of criminology. However, most of them also number geographical methods among the research methods for the spatiality of crime.

Among criminologists, four Germans stand out: MANFRED ROLFES was the most prominent on the scientific position of crime geography, and in whose opinion crime geography is "geography without geographers" (Rolfes, 2003, 335.); JOACHIM HELLMER, who studied the distribution and territorial differentiation of crime (Hellmer, 1972, 13-21.); HORST HEROLD, the former chief of police at Nuremberg, who also considered crime geography to be a part of the crime sciences (Mátyás, 2017a). In addition to criminology, the role of forensic science was emphasized by HANS-DIETER SCHWIND, who

said that crime geography could be a tool in the preventive struggle against crime (Mátyás, 2018a).[1] Many Hungarian criminologists also view crime geography as belonging to criminology.

B) THE GEOGRAPHICAL APPROACH

Within geography, crime geography is most closely linked to human geography. ISTVÁN BERÉNYI, among others, emphasizes the socio-geographical connection, according to whom crime geography "deals with the connections between space, social groups, and crime" (Tóth, 2007, 15.). ISTVÁN KOBOLKA and FERENC KOVÁCSICS also classify crime geography as geography, according to which the area can be considered part of security geography. "Criminal geography excludes subjective factors (history, nationality) based solely on objective data, which sheds light on the relationship between the environment, the place, and the appearance of the offense." (Kobolka and Kovácsics, 2004a, 54.)

According to VINCE VÁRI, a researcher in the field of law enforcement,

> *"This discipline fits into the field of social sciences in Hungary, utilizing the knowledge gained from the spatial approach of geography and its mathematical and statistical methods. Views are divided on whether crime geography belongs to a branch of crime science or geography, human geography. There is no doubt that criminal geography is located on the border of geography and criminology* (…)" (Vári, 2016, 547.).

[1] In Germany, it is mainly criminologists who deal with the territorial nature of a crime, so the majority of researchers there consider the field to belong to criminology. Within criminology, a lot of weight is given to emphasizing the importance of geographical factors (Mátyás, 2017a). "So much so that in the criminology education of the higher level police training, criminal geography is placed in a unified theme with latency and police statistics." (Vári, 2015, 253.)

C) THE MIDDLE GROUND

Most researchers can be grouped in the middle ground. That is, they consider crime geography to be a field between criminology and human geography. Among the Hungarian geographers, ZOLTÁN KOVÁCS was the first to write an article on the geography of crime (1989) in which he highlighted that:

> *"During the examination of the territorial nature of the crime, geographers introduced a new approach and methods to criminology, which gradually led to the development and independent development of a new interdisciplinary field, the geography of crime."* (Kovács, 1989, 1.)

JÁNOS SALLAI, a researcher in the field of law enforcement, also sees the area as interdisciplinary. From his point of view:

> *"The spatial structure, territorial intensity, tendency and dynamics of crime as a mass social phenomenon; one of the relatively new, but increasingly important, trends in human geography is crime geography, which examines its social background and the spatial shifts that can be expected based on the knowledge of ongoing social processes, which is an interdisciplinary social science between criminology and human geography."* (Kobolka and Sallai, 2008, 86.)

According to the geographer ANTAL TÓTH, the geography of crime is an inter-subdiscipline that lies between human geography and criminology (Tóth, 2007).

SZABOLCS MÁTYÁS emphasizes that complex (geographical and criminological) knowledge is needed for high-level cultivation of the area (Mátyás, 2011); while GÁBOR ERDEI mentions the mutual and subordinate relationship between criminology and human geography (Erdei, 2013).

Overall, we can say that most researchers consider the geography of crime to be a field between geography and criminology. Of the two major branches of geography (physical and human), the field belongs to human geography,

while within crime science, it belongs to criminology. Within criminology, environmental criminology is the area that deals with the spatial nature of crime.

If we want to mention countries that can be grouped into the middle-ground approach (besides Hungary), then the United Kingdom and France should be highlighted. In any case, it should be mentioned that English geographers have conducted extremely broad and practical crime geography research for decades (Dennis and Clout, 1980). In addition, British law enforcement is also open to investigations with a geographical aspect, which is taken into account, among other things, when evaluating organizational performance (Mátyás, 2018b).

In the case of France – when compared to the United Kingdom – the literature on the geography of crime is less extensive. Despite that, here too, it can be stated that a wide range of publication activity can be observed in geography and law enforcement (see more: Alain Bauer, 2006: Géographie de la France criminelle; Mátyás, 2018a).

Based on the above, crime geography can be seen as a field of research between social sciences (interdisciplinary), one most closely linked to geography and criminology, and its relationship with law enforcement (criminology) is becoming increasingly close (Figure 1). With regard to the relationship between the geography of crime and other social sciences, it can be said that the research methods employed within it include those of many fields of social science; consequently, an interdisciplinary approach cannot be dispensed with during investigations. We cannot make a precise prediction for the future because it is impossible to say to which discipline(s) crime geography will be closely related in 20-30 years.

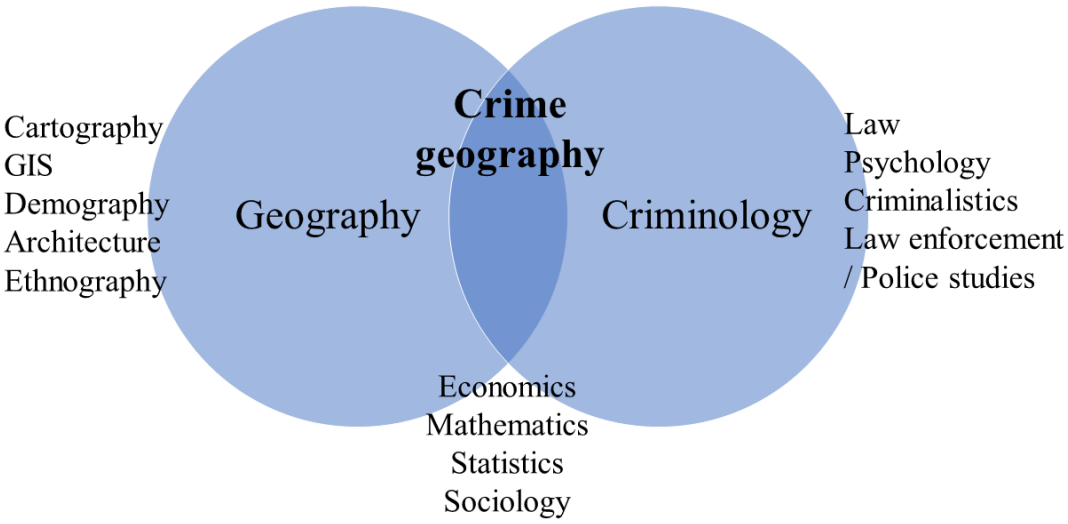


Figure 1.
Crime geography and its most important auxiliary social sciences

We cannot ignore the trends observed in scientific life, which are increasingly blurring the sharp boundaries between the individual social sciences, or as the Debrecen academic András Lipták put it, "different disciplines cross each other's invisible boundaries and cross-fertilize each other, sometimes creating truly new disciplines" (Garai 1999, 339.). In the case of crime geography, we can currently speak of an interdisciplinary relationship, and for now, it is a question for the future as to whether crime geography can become a multi- or trans-discipline in the years or decades to come (Mátyás, 2018a).

1.1.1. Division of crime geography

The Hungarian geographer Szabolcs Mátyás was the first to divide crime geography into two parts, *general* and *applied* crime geography. The general part of crime geography deals with theoretical questions and the methodology for general application, which affects crime geography as a whole. The theoretical questions include the investigation of the main

concepts of the field, its place in science, its points of connection with other social sciences, its division, and its research objects. The main areas of general crime geography are:

- The history of crime geography
- Theories and laws applied by crime geography (criminological and geographical theories and laws)
- Methodology (tools and methodology in crime geography research)

Applied crime geography deals with the analysis and mapping of crime, and the prediction of probable spatial changes for the future, which helps to create crime prevention and law enforcement strategies.

The main areas of applied crime geography are:

- Crime mapping
- Urban and settlement development
- Predictive policing
- Geographic profiling

Some areas of applied crime geography are also related to other scientific fields, but due to the significant role of geography, crime geography also considers them to be research areas.

1.1.2. Ancillary sciences of crime geography

- *From a geography perspective*

CARTOGRAPHY AND GIS

One of the most spectacular end products of crime geography is the location of a crime depicted on a map. The scientific fields of cartography and Geographical Information Systems (GIS) are worth mentioning together nowadays since cartography is no longer significant in the traditional sense.

We rarely use paper-based maps, and researchers and people in general tend to use digital, GIS-based maps. However, cartographic knowledge is essential in creating GIS-based maps, so this prior knowledge is not lost; it has just been somewhat transformed. You can read more about the connections between GIS and crime geography in the chapter on "Crime mapping".

DEMOGRAPHY

In order to understand the crime characteristics of an area, it is necessary to use the demographic analysis of the city, county, etc., in question, and demographic knowledge is not only needed to understand current situations but also for prognostic crime analyses. Demographic analysis is essential if we want to know how the number and structure of crimes in a settlement can be expected to develop in the coming five or ten years. This is particularly important from a crime prevention perspective.

ARCHITECTURE

The point of connection between geography and architecture is urban development. If part of a city is developed, solutions can be applied to reduce the number of crimes that will be committed; that is, to create a crime prevention effect. This is where urban development meets Crime Prevention Through Environmental Design (CPTED), which recommends architectural solutions that reduce the possibility of crimes being committed.

ETHNOGRAPHY

People living in each area are different. Customs can vary for religious, historical, or cultural reasons, not only from country to country but often even within countries. Getting to know and examining these differences is therefore essential when conducting crime geography investigations, as this

is the only way the often significant quantitative and qualitative differences that can be observed in crimes can be understood. In this, ethnography helps to explain these essential differences, and the causes that are rooted in the past.

- *From the side of criminology*

JURISPRUDENCE

A country's legal system and legislation greatly influence the number and structure of crimes (Lippai, 2023a). Knowledge about legislation is therefore essential when analyzing the number of crimes. For the differences between individual countries, we can think of, for example, laws related to drugs, the age of criminal responsibility, etc.

PSYCHOLOGY

The study of human behavior goes back several centuries (Farkas et al., 2020a). It is evident that the examination of the psychological factors behind crime is gaining an increasing role in crime science, and criminal psychology is becoming an increasingly extensive field of social science (Farkas and Sallai, 2021). Moreover, the innovative research opportunities provided by imaging equipment (CT, MRI) are opening up new dimensions for psychologists (Farkas, 2021).

CRIME / FORENSIC SCIENCE

From the point of view of forensic science, crime geography can be seen as an area that offers police officers new investigative methods. In mapping the causes of crime it examines other areas in addition to the previously used methods (in Hungary, crime geography is sometimes called *criminalistics geography*).

LAW ENFORCEMENT / POLICE STUDIES

Law enforcement employs the research results of several scientific fields, for example, forensics, criminology, law, etc. Crime geography can show many research results that are part of policing and can be adapted for use in practice. The connection of crime geography to many areas of law enforcement can be demonstrated, such as criminology, criminal psychology, security policy, and so on (Farkas et al., 2020b).

- *Social sciences brought together by geography and criminology*

ECONOMICS

Several researchers have examined criminals from an economic perspective (Irk, 2008). It has been established that criminals consider whether or not to commit a crime (it is "the result of a rational decision-making process"); that is, their action is "based on a cost-benefit analysis" (rational choice theory) (Irk, 2008). One example we can cite is transport infrastructure, which significantly determines the mobility of criminals. Economic laws also operate in the relationship between criminals and the journeys they make. The greater the distance offenders travel, the more serious the crime they have to commit to make it ‘worth it’ (travel cost, time spent, etc.).

MATHEMATICS (STATISTICS)

Criminal prognostic predictions are mainly based on mathematical calculations (primarily mathematical statistics: regression, correlation, probability calculation). The author of this book does not consider it necessary to describe these in detail here, partly because in practice, various software programs perform the complicated mathematical operations completely nowadays, rather than the users. Mathematical statistics can be viewed as a part of applied mathematics, which can be learned relatively easily, and can be used in many areas of life (e.g., medicine, economics,

psychology) (Hajtman, 1991). Predictive policing also uses the results of mathematical statistics.

SOCIOLOGY

Sociology is a social science that studies the way society functions. Along with many other fields, crime can, of course, also be classified as a research area of sociology. In the case of crime geography, it can therefore be considered to be one of the most important scientific fields. At the beginning of the 20th century, sociologists at the University of Chicago played a pioneering role in the field research of crime (see more: Chapter 2.2).

1.2. The concept of crime geography

A) CONCEPT

Depending on which scientific field a given researcher represents, significant differences in content can be observed in the various definitions they provide. German crime geography research has a long history. Despite that, the scientific classification of the discipline is unclear, even in German-speaking areas. This is also demonstrated by the definitions below.

According to HENTIG H. V. (1961), crime geography is "...a description of the relationship that exists between crime on the one hand, and climate, land, landscape, history, economy and popular movement on the other" (Herold, 1973, 81).

According to HEROLD, H.:

> *"Criminal geography tries to show the relationship between crime and geographical location. The starting point is, therefore, not the perpetrator of the crime (...) or the place where the crime was committed, but the geographical location, the particular characteristics, the structural and functional characteristics, i.e., the*

> *geographical location in its surface appearance, with its technical, civilizational, cultural and social characteristics*." (Herold, 1973, 81.)

J. HELLMER (1972) "considers criminal geography to be a part of criminology, which deals with the territorial distribution of crime, its factors (criminogenic factors) and territorial differences in law enforcement" (Tóth, 2007, 9.).

D. E. GEORGES says that it is "the study of the spatial manifestation of criminal acts. It is the study of the social and cultural organization of criminal behavior from a spatial perspective" (Georges, 1978, 2.).

ZOLTÁN KOVÁCS writes:

> *"Criminal geography forms an interdisciplinary relationship between criminology and human geography, and as such, it examines not only the spatial distribution of crimes, but also the spatial rules and social background of crime, and it predicts the expected spatial displacements of crime based on the knowledge of the ongoing social processes."* (Kovács, 1990, 2.)

The following definition can be found in the English edition of the human geography dictionary:

> *"The geography of crime is a sub-discipline of human geography and refers to studies which analyze the understanding of the interplay between crime, space, and society through analyses of offences, offenders and the effects of crime."* (Fyfe, 2000)

According to SZABOLCS MÁTYÁS, the geography of crime is:

> *"A common intersection of several scientific fields most closely related to criminology, criminalistics, and geography (human geography). Criminal geography is a social science field between criminology and geography, which examines the spatiality and spatial distribution of crime (crimes, perpetrators, victims) in the light of social and economic factors. It aims to provide an answer to possible*

future spatial changes in crime, thus effectively helping law enforcement." (Boda, 2019, 84.)

GEORGE OWUSU and LOUIS KUSI FRIMPONG (2020): "Crime geography involves the study of the relationships between crime, space, and society through the critical analysis of victims and perpetrators and the impact of crime on society." (Owusu and Kusi, 2020, 5.)

The study of crime geography "is a multi-discipline research concerning criminology, urban social geography and other related subjects." (Xiaobing and Huafu, 2012, 1390.)

In defining crime geography, we can state that most of the above definitions mention that it is related to the fields of human geography and criminology. The discipline examines the spatiality of crime and its distribution, social projection, victims, and perpetrators. Some definitions have also mentioned that crime geography can also play a role in crime prevention.

1.3. Names for crime geography

In various languages the name for *crime geography* consists of two parts. For each designation, one part is geography, and the other is criminology. The word *geography* is of Greek origin (*geo* = Earth, *grapho* = I write, writing ≈ description of the Earth).

> *"Geography is the study of places and the relationships between people and their environments. Geographers explore both the physical properties of Earth's surface and the human societies spread across it. They also examine how human culture interacts with the natural environment and the way that locations and places can have an impact on people. Geography seeks to understand where things are found, why they are there, and how they develop and change over time."* (URL 1)

The term *criminology* comprises the Latin word for crime (*crimen*) and the name for the Greek doctrine of science (*logos*) (≈the science of crime).

> *"Criminology, scientific study of the non-legal aspects of crime and delinquency, including its causes, correction, and prevention, from the viewpoints of such diverse disciplines as anthropology, biology, psychology and psychiatry, economics, sociology, and statistics."* (URL 2)

The name of the scientific field and the composition of the term are similar in most languages, that is, are made up of the words for criminology and geography.

bűnözésföldrajz, kriminálgeográfia, kriminálföldrajz (Hungarian)
criminal geography, geography of crime, crime geography (English)
geografía del crimen (Spanish)
geografia del crimine (Italian)
geografia do crime (Portuguese)
geografie criminală (Romanian)
géographie criminelle (French)
kriminalgeographie (German)
suç coğrafyası (Turkish)

1.4. The task of crime geography

Evident connections between the geographical location and the number, type, intensity, etc., of crimes can be shown. One of the main tasks of crime geography is to examine the connections between these components. Typically, for those skilled in geography, the uniqueness of the discipline lies in its spatial approach which, unlike other crime sciences that use

geography, is characterized by a dynamic approach, not by a static one.[2] By using constant elements, it tries to find out, among other things, why criminals prefer certain areas.

> *"Criminal geography does not content itself with comparing geographic location and crime statistics but asks the following question: What are the descriptive indicators that determine crime growth and that explain the attractiveness of a given geographic location to crime?"* (Herold, 1973, 82.)

JÁNOS KOBOLKA and JÁNOS SALLAI (2008) approached the task of crime geography primarily from the aspect of practical law enforcement work. In their view, crime geography:

> *"Deals with the analysis and investigation of crimes related to geographical space. It is important that the criminal geographic analysis provides data for the detection of crimes and also provides assistance in choosing the appropriate and correct police and law enforcement intervention."* (Kobolka and Sallai, 2008, 90.)

HEROLD, HORST (1977) also defined the task of the discipline from the perspective of law enforcement police work. Based on this, he interprets crime geography as a target social science that can be adapted mainly in deployment.

[2] "Investigating the dynamics of crime answers the question of how the volume of crime changes from year to year, and what the trend of change is in the shorter or longer term." (Vígh, 2002, 112.)

Chapter 2.
THE HISTORY OF CRIME GEOGRAPHY RESEARCH IN A NUTSHELL

2.1. The first era of crime geography research[3]

The roots of the discipline lie in the 19th century. At that time, statistical data provision and data collection came to the fore in many European countries, and became increasingly important. The statistical data processors were confronted with the fact that the territorial intensity, the spatial structure and other regularities could also be observed from the crime statistical data, particularly when the specified values were also shown on a map. The first significant practitioner of crime geography (and criminology at the same time) was a French lawyer, A. M. GUERRY, (1802–1866) (Figure 2), who in 1833 wrote an essay on the moral statistics of France (*Essai sur la Statistique, Morale de la France*). In his book, he "processed the relationship between gender, age and crime in territorial distribution based on statistical data" (Vígh, 2002, 8.).

In doing so, Guerry recognized that crimes against persons occurred in greater numbers primarily in the southern part of France, while crimes

[3] The history of criminal geography has been divided by several people. The division of the era is mostly the same, only the names are different. Some separated the first, second and third eras (e.g. Tóth, 2007; Mátyás, 2011), while others named the eras (Spencer, 2021; Erdei, 2013). They named the Cartographic School (Guerry and Quetelet), the Chicago School, and the GIS School as different stages of criminal geography.

The author's view is that it is worth separating the GIS era from the third era, since the tools and methods used are significantly different.

against property were mainly characteristic of the wealthier, northern areas of the country (Vígh, 2002) (Figure 3).

Figure 2. André Michel Guerry (1802-1866) (URL 3)

"André-Michel Guerry was born and raised in Tours (...) He can be considered one of the founders of the empirical study of criminology and modern social science. (...) Guerry, a 29- year-old lawyer, presented a slim manuscript to the Académie Française des Sciences titled Essai sur la Statistique Morale de la France. His findings, regarding crime, suicide and other moral aspects, were both startling and compelling. His presentation, in tables and cartes figuratives, showed that the rates of crime and suicide remained remarkably stable over time, when broken down by age, sex, region of France and even month or season of the year; yet these numbers also varied systematically across departments of France."
(Friendly, 2022, 1-3.)

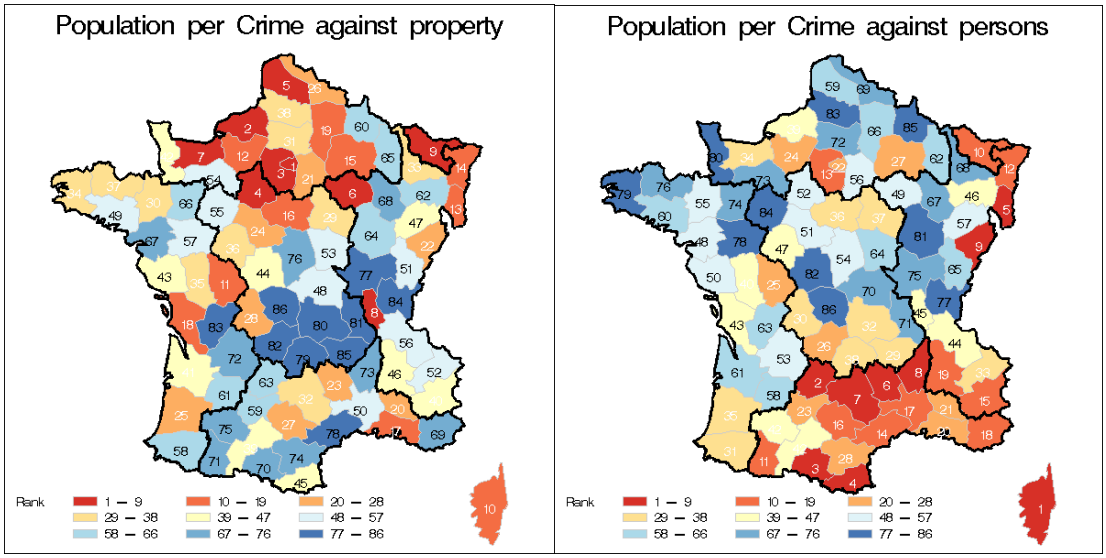


Figure 3. Crimes against the person and against property in France (URL 4)

Guerry's work greatly influenced and encouraged A. QUETELET (1796–1874), later dubbed the "father of criminology" (Figure 4). He established that the same laws could be observed in the case of "sinful human behavior" as in the case of natural phenomena (Vígh 2002, 9.). In his opinion, crime has natural and social causes (Borbíró et al., 2016).

Figure 4. Adolphe Quetelet (1796-1874) (URL 5)

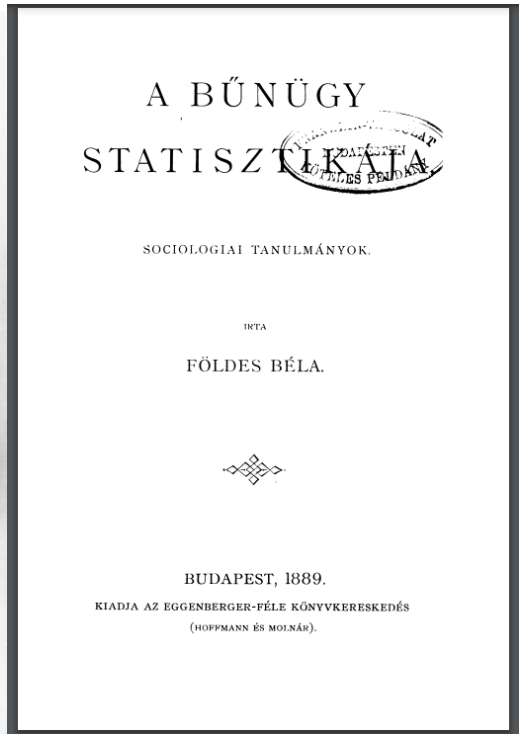
The spatiality of crime has been examined not only in French-speaking countries but also in many other countries, some of which we will mention. MAYR, G. (1868) depicted the crime infestation of some areas of the Kingdom of Bavaria on moral statistical maps. He found that a positive correlation between thefts and the development of grain prices could be observed.

SEUFFERT, H. (1906) also conducted investigations in the German-speaking area, investigating the spatial distribution of crimes.

In the United States, REDFIELD, H. V. (1880) was the first to study the territorial distribution of crimes and found that the rates were higher in the southern part of the country (Tóth, 2007).

In Hungary, FÖLDES, B. was the first researcher to analyze the territoriality of crime by analyzing statistical data (Figure 5 and 6). In his book *Statistics of Crime* (A bűnügy statisztikája) (1889), Földes, relying on the census data of 1881, found that the proportion of the poor was high at the national level,

which, in his opinion, was one of the reasons for the increase in crime. He also found that the proportion of convicts was highest in the poorer, eastern part of the country, and 30% lower in the richer, western part of the country (Borbíró et al., 2016).


A BŰNÜGY
STATISZTIKÁJA

SOCIOLOGIAI TANULMÁNYOK.

IRTA

FÖLDES BÉLA.

BUDAPEST, 1889.
KIADJA AZ EGGENBERGER-FÉLE KÖNYVKERESKEDÉS
(HOFFMANN ÉS MOLNÁR).

Figures 5 and 6. Béla Földes (1848-1945) and his book (URL 6)

2.2. The second era of crime geography research

Internationally, the creation of the first settlement-level analyses in the sense we use it today can be linked to the United States (Chicago School[4]), where

[4] "The Chicago School: a social science research workshop established in the United States (University of Chicago) at the beginning of the twentieth century, which, according to many, achieved its most influential results in urban structure research. The researchers of the Chicago school were the first practitioners of settlement sociology as a social science. The driving force behind the research was the city's significant population growth, which provoked many sociological problems (crime, prostitution, alcohol, ethnic conflicts, etc.). The most influential researchers of the Chicago school were: Robert E.

human ecology[5] research (also known as urban ecology and social ecology) was carried out at the beginning of the last century.

The population of the city of Chicago multiplied over a few decades (1840: 4,470 people, 1900: 1.7 million, 1930: 3.3 million), which not only resulted in the economic development of the city but also induced serious social problems. Alcoholism, homelessness, prostitution, and organized crime groups appeared as serious issues around the 1900s (Figures 7).

Figure 7. Mafia hideouts in Chicago in the 1920s. Frederic Thrasher, a sociologist at the University of Chicago, identified more than 1,300 gangs (URL 7).

During the investigations, researchers from the SCHOOL OF CHICAGO established "that the place where the crime was committed clearly determines the affiliation of the given criminological event or series of events and, in general, its essential circumstances." (Michalkó, 2002, 68.) Initial research can be attributed to the head of the Department of Sociology at the University of Chicago, PARK, E. R. (1915, 1925, 1926) (Figure 8). Park also adapted his

Park, Ernest W. Burgess, Roderick D. McKenzie, Louis Wirth and Clifford R. Shaw." (Boda, 2019, 101.)

[5] ecology = the perception and set of concepts of the researchers were determined by ecological analogies (confrontation, segregation, competition, succession, etc.)

ecological findings to the residential communities of the settlements. We regard the publication in 1915 of Schifferné Kovács' study (1999) as the birth of urban sociology as a scientific field.

Many researchers joined Park's research, and with them, the work of the Chicago school was completed (BURGESS, E. W., MCKENZIE, R. D.).

Figure 8. Robert Ezra Park (1864-1944) (URL 8)

"In their work published in 1925, they point out that in understanding the phenomena of urban society and society in general, the environmental conditions, the material conditions of life, and especially the structure and physical structure of space have an explanatory power; regularities can be demonstrated in the spatial organization of society." (Szirmai, 1995)

The book published jointly by Park and Burgess in 1921 (Introduction to the Science of Sociology) was an important milestone in urban sociology and also deserves mention. The development of the typology of ecological processes can be attributed to McKenzie (1926), who paid special attention to the city-shaping effect of migration during his research. The scene of their research was initially Chicago, which later proved to be an ideal work area based on its size and diversity. In their opinion, knowledge of environmental conditions is essential in understanding how a city works. The society of a given city is like a natural community in which various populations are

mutually dependent. The concept of "concentric zone model/theory" (1926) became known primarily thanks to Burgess's research. The theory drew attention to the inverse proportionality between the number of crimes and the distance from the city center (Tóth, 2007). Burgess found that in Chicago the development of the settlement takes place along concentric circles (this is a semicircle in Chicago) (Figure 9).

In his theory, Burgess distinguished the following five zones:

1. LOOP: Downtown, characterized by highly built-up areas. The residential function is relegated to the background, the administrative, business and entertainment functions dominate. The local name for the city center is the "Loop", but it is often referred to as the central business district (CBD).
2. TRANSITION ZONE: The area surrounding the city center resembles a ring in which the residential function dominates (apartment zone). Its population comprises mainly of workers who have flowed in from the countryside. Once an upmarket neighborhood, in Burgess' day it had already become a crime-infested area, and less significant industrial activity took place on the outer edge of the area. Within the zone, there are residential areas (neighborhoods) acquired on an ethnic basis (ghettos: Chinatown, Little Sicily), many of whose residents were first-generation immigrants. In the most neglected parts, slums formed.
3. WORKING CLASS ZONE: this zone includes both industrial and residential functions. The (blue-collar) workers are mainly employed in the factories in the zone, which they can reach cheaply and quickly due to the geographical proximity.

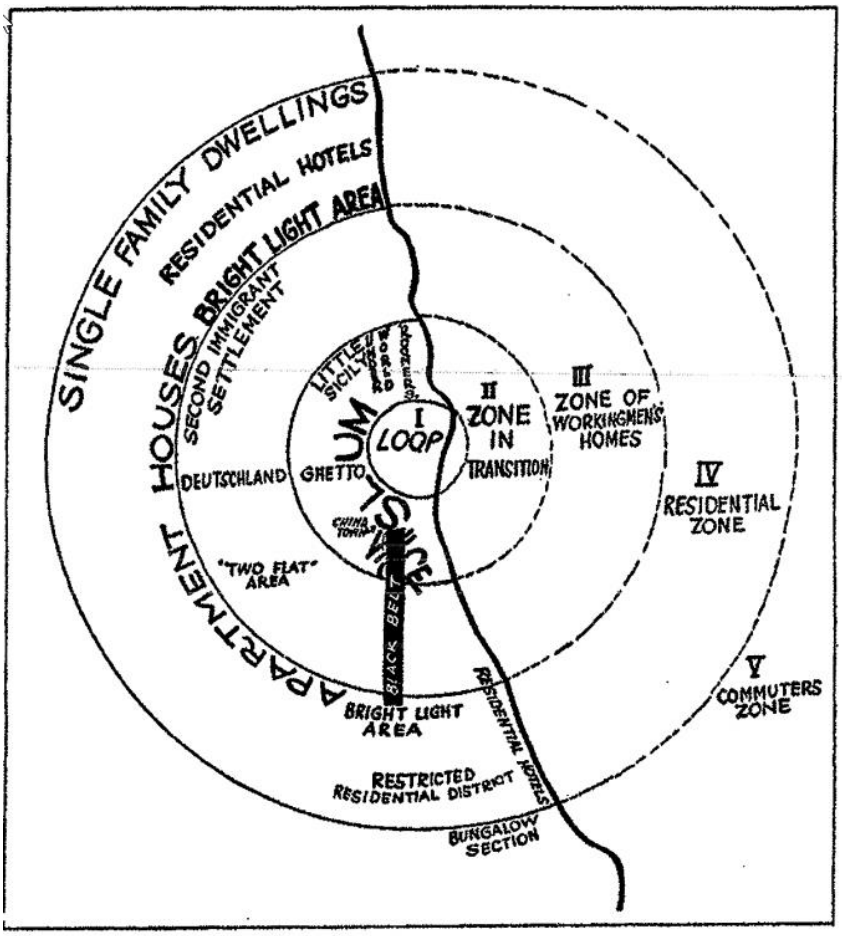


CHART II. Urban Areas

Figure 9. Burgess' simplified concentric city model (URL 9)

4. RESIDENTIAL ZONE: The most valuable real estate in the city is located here, and it also serves as a middle class residential district. Within the zone, decentres form, that is, places that function as quasi-sub-centers within the area. These core areas mean that the zone has not only a residential but also a commercial function.

5. COMMUTER ZONE: Most of the people who live here go to work in the city center (CBD) from the agglomeration around the settlement and the suburbs. It takes an average of 30-60 minutes to get to the center of the settlement. The single-family house is the dominant housing type in this zone (Hajnal et al.).

> It was primarily SHAW, C. R. and MCKAY, H.D. who noticed in their research that some parts of Chicago have a much higher crime rate than other areas of the city. During the sociological examination of the individual parts, it was also established that the inhabitants of the more crime-infested zones are primarily from the poorer strata of the population who live a precarious existence with a value system differing from the average (Shaw and McKay, 1942).

With the Chicago results, the above researchers examined several other American cities where they reached similar conclusions (Boston, Cincinnati, Cleveland, Philadelphia, and Richmond); that is, there were areas in every city where the number of crimes far exceeded the city average. The crime-infested areas of the city, where the building stock has deteriorated, are where the alcoholics, drug users and the poorest people live. These are the slums of the big city, where a completely different subculture to other parts of the city develops. BURGESS examined the mobility of social groups and deduced from this behavior that it deviated from social norms. He held the opinion that if a social stratum was not under proper control and had no contact with other groups, it had a higher chance of becoming criminal (Szirmai, 1995).

The representatives of the Chicago school achieved significant and outstanding results. However, after a while, certain theories could no longer explain certain social phenomena. In consequence, from the second half of the 1940s, the researchers became the focus of much criticism. Thus, for example, the zone theory received the most criticism because, during later research, it was found that it could only be applied to North American cities and even then only to those that had been founded earlier (Schifferné Kovács, 1999). WIRTH, L., who combined the above research with classical sociology, tried to break out of this impasse. He explained: “the pathological

phenomena and the signs of crisis experienced in human relations with the three essential characteristics of the big city: the large number of people, the population density, and the differentiated social structure of the city." (Szirmai, 1995)

Wirth's research had such an impact on later research that it was considered the "marked path" for many in the scientific life of settlement sociology for about a quarter of a century (Schifferné Kovács, 1999).

Researchers at the University of Chicago (e.g., Wirth, L.) were greatly influenced by European and, particularly, English sociological trends. They were already faced with problems similar to those of the early 1900s in the United States. The people who had been torn from their traditional environment and thus rootless became victims of the big city life created as a result of industrialization, and many of them, unable to find their place, became criminals. Despite the criticisms, most of which were justified and based on scientific results, it can be said that the roots of settlement-level analyses can be traced back to the research of the Chicago school, and their influence can still be observed in the literature to this day.

The social disorganization theory emerged from the Chicago School's research, explaining the high crime level in some areas. According to the social disorganization theory, crime is high in areas where communities with high turnover (many people leaving and moving in) have formed, there is no homogeneity (multiple nationalities live together), and therefore the structure of the community is not strong. Together, these result in the fact that there is less social control in the case of young people, and the community is unable to influence norm-breakers. Due to the heterogeneity, there are no generally accepted rules that all residents would accept (Spencer, 2021).

2.3. The third era of crime geography research

YOUNG, M. and WILLMOTT, P. (1957) conducted settlement sociological studies in South London in the 1950s, during which they found that the zone theory was not applicable to South London. This conclusion was also reached by MORRIS, T. (1957), who also conducted tests in London and was unable to apply the zone theory, as he believed that European cities did not always develop in a radial direction (Tóth, 2007).

From the 1960s onwards, West German researchers achieved significant results in crime geography research. HENTIG, H. V. drew attention to the role of geography in the crime sciences and the relationship between the economic environment and crime (Hentig, 1961). Rupprecht, R. dealt with criminal chronography, that is, the spatial distribution of crime (Rupprecht, 1974); Schwind, H. D., has carried out much crime geography research since the end of the 1970s, of which the literature usually highlights his research on Bochum (he created crime maps of the settlement) (Schwindt et al., 1978). HORST HEROLD's name is also widely known in professional circles here (Figure 10).

Figure 10. Horst Herold (1923-2018) (URL 10)

He was the police captain of Nuremberg, and he implemented his theoretical research results in practice (e.g., he reorganized the town's police stations) (Tóth, 2007).

Research on crime geography was conducted not only in Nuremberg but also in several other cities in West Germany, such as Bochum, where,

among other things, latent crime and the connections between crime and social factors were investigated.

After German reunification (1990), these studies were extended to the newly joined East German territories (Tóth, 2007). Since the 1960s, a trend toward examining ever smaller territorial units in crime geography analyses has become evident. OSCAR NEWMAN carried out inspections at the apartment block level as early as the 1970s. He studied 150,000 apartments in New York and, in the process, established correlations between crime and the type of residential property (number of apartments, number of floors, etc.) Newman introduced the "Defensible Space" concept into public consciousness (Newman 1972, 1996).

2.4. The fourth era of crime geography research

THE GIS SCHOOL

The birth of the GIS era was made possible when the cost of GIS software was steadily reduced for both research institutes and private individuals. The police force underwent significant technological development with digitized criminal records, and geocoded crime scene data (Chainey, 2021).

Since the 2000s, geographic information technology has also given new research opportunities and direction to crime geography research. This research initially took place mainly in the United States. SHERMAN, GARTIN and BUERGER investigated the hot spots of Minneapolis, while SHERMAN, L. W. and SPELMAN, W. investigated the life cycles and development stages of those hot spots. Several people tried to group the hot spots according to their characteristics, but RATCLIFFE, J.H.'s typification has become the best known.

Among the research topics of the last decade, the territorial distribution studies carried out with GIS tools (Ceccato and Dolmen, 2011; Ferreira et al., 2012; Wang et al., 2013), and research exploring the relationship between

crime and individual social and economic factors should be highlighted. Crime geography has also "transcended" its own boundaries and applies the results of other fields, for example, COREY SPARKS (2011) used epidemiological methodology in a GIS environment (Piskóti-Kovács, 2014).

2.5. An overview of the past 15 years of crime geography research

In the short chapter below, the author would like to show just how familiar and researched crime geography has become in some countries. Of course, this book cannot present the crime geography research of every country, the goal is rather to give a brief overview of the research opportunities offered by crime geography, the problems researchers encounter on each continent, and the answers they can provide. From the available databases, the author highlights one piece of research from each country from the last 15 years.

The most extensive crime geography research can be found in the USA. On the one hand because research has a long history there (see: Chicago School) and, on the other hand, new research methods and theories come most frequently from the United States. We can state that the main catalyst for crime geography research is the USA, where both geographers and criminologists research crime geography in large numbers.

Violent crime is also a serious problem in the USA, especially in low-income areas. In South Los Angeles, Subica and his co-authors investigated the level of crime around tobacco shops, liquor stores, and medical marijuana dispensaries. The authors performed buffer zone analysis and regression analysis to examine the geographic location of crimes against property and violent crimes. Studies have shown that crime rates are much higher near alcohol and tobacco shops (within a 100-meter buffer zone) (Subica et al., 2018).

In large countries, the location of prisons is a fundamental issue because visiting convicts is problematic if someone has to travel thousands of kilometers to visit a relative. In Russia, this is a severe problem. Two geographers and a criminologist author investigated the geographical location of prisons in Russia. The research was carried out because many investigations had confirmed that Russian prisons are grossly overcrowded, human rights are violated, infectious diseases spread in them, and convicts are placed in penal institutions far from their families. British researchers examined the prison regions, comparing them with the locations of prisons built in Soviet times. The location of penitentiaries was examined in proportion to both the population and the occurrence of more severe crimes (Moran et al., 2013).

Erman Aksoy is a researcher at Gazi University in Ankara who studied the geography of crime in Balıkesir. Aksoy investigated the relationship between crime and space and the distribution of crimes in urban space. Based on the 2012 and 2014 data, he found that theft is the most common crime (stealing from homes, workplaces, and cars, and car thefts).

> *"In all kinds of planning decisions concerning city centers, such as the choice of location for major transportation axes and routes, and public transportation stations and stops, the selection of new residential areas, transformation and gentrification projects and choice of location for shopping malls, the crime status of spaces should be investigated. (...) The method of preventing crime through urban design is one of the frequently used spatial solutions. In areas designated according to high-scale crime analyses, it is necessary to implement spatial organizations towards decreasing crime."* (Aksoy 2017, 10.)

Portuguese researchers wanted to use crime geography research to help in crime analysis (2012). The spatial distribution of crime in the city of Porto was investigated, during which a cluster analysis was made, and spatial models were created that assisted in better allocating the use of police resources. These methods can also help to predict crime, that is, where crimes can be expected to be more likely to occur ("next crime"). At the end of the study, the authors note that

> *"Criminality is very complex, and its remarkable dynamic nature is not easy to model with a simple multivariate statistical method. The help of sociologists and other specialized workgroups is also essential to choose the most correct and rigorous statistical models, but also crucial to obtain reliable results. Geography gives the spatial coherence, and GIS advances explore the true possibilities of spatial analyses*." (Ferreira et al. 2012, 49.)

The geographical (crime geographical) approach is therefore indispensable when examining the spatiality of crime.

The high rate of rape in India is a serious problem. This mainly affects the local population, but sometimes tourists as well, which usually creates a huge international scandal. Gang rape is a common phenomenon in India, as well as "simple" violence, which has resulted in several fatalities. As Dwivedi (2014, 1.) pointed out, this brings into question both "the safety and security issues of women" in Indian cities and casts a critical light on the framing of amendments to legislation following such "barbaric crime". The author described the territorial characteristics of crime and the legal environment through statistical data.

In Croatia, the co-authors Butorac and Marinović examine how useful crime geography is in everyday police work from the practical point of view of the police force. It has been established that GIS, crime mapping, geographic

profiling, and spatial pattern analysis are all useful in analytical work to facilitate successful detection.

> *"Cognitive mapping, environmental perception and values and meanings attributed to 'place', 'space' and 'environment' have constructed a framework for interaction between criminology and human geography and for development of geography of crime."* (Butorac and Marinović, 2017, 1.)

It has also been established that the various techniques make it possible to learn about the future development of crime (Butorac and Marinović, 2017). In Hungary, research on the geography of crime could only begin after the change of regime (after 1989) since the crime statistics data had previously been secret. Now, increasingly, geographers, criminologists, and law enforcement professionals are working on the topic, which is also shown by the fact that more and more people are getting Ph.D. degrees in this field.

The investigation of organized crime is one unique research opportunity since the statistical data on organized crime is mostly kept secret, and researchers do not have access to it. Furthermore, the number of crimes is relatively small, which often does not allow adequate conclusions to be drawn. The Hungarian police have, however, allowed some researchers to study the criminal files on organized crime. In the process, the researchers also examined the spatial characteristics of organized crime. It was established that the Hungarian-Serbian border section and Budapest and its agglomeration are most affected by it (Mátyás, 2020a).

Violent crime is a severe problem in Brazil, greatly affecting the subjective sense of security of the population. The researchers studied the concentration of crime in the city of Campinas. The relationship between robbery, rape, and theft was investigated using the regression method. These crimes were compared with socioeconomic factors (apartments with bathrooms, apartments with electricity, ethnic heterogeneity, etc.) During the research,

it was established that "(...) variables such as tenant-occupied areas and measures of friendship networks are quite similar to Western European and North American contexts" (Chataway et al., 2017, 1566.).

Polish crime geography research goes back several decades. Even in 1986, a study on the crime geography of Warsaw was published, in which the author deals with the spatial location of burglaries (Bartnicki, 1986). Recently, Polish researchers have been working with public safety (Piskorsky et al., 2013), crime mapping, and the spatial determinants of crime (Sypion and Dutkowska, 2010ab; 2012; 2014). Despite the decades-long history, we can state that relatively few people are engaged in crime geography research in Poland (Mordwa, 2016).

In developing countries, they are primarily trying to find a solution to crime caused by great poverty. The significant differences between individual social classes cause serious problems.

> *"(...) in South Africa, Ghana, and elsewhere in the developing world where increasingly citizens have to protect themselves against criminals as a result of the limited police infrastructure and service revealed that target hardening is often the first solution and the most widely used measure by residents and designers, especially in high- and middle-class neighborhoods."* (Owusu and Frimpong, 2020)

Chapter 3.
SOURCES IN CRIME GEOGRAPHY RESEARCH

The data and information required for crime geography research can come from secondary sources (see: the data sources listed in this chapter), or we can also produce them ourselves if the data from the secondary source is insufficient (e.g., empirical studies, questionnaire surveys, data collection, etc.). In this case, we can talk about primary data and primary research.

In another approach we can use quantitative (e.g., data mining, questionnaire surveys, experiments, correlational research) and qualitative sources (e.g., interview, observation, document and content analysis) for crime geographical research.

Below, we will list what can be considered to be the most important sources for crime geography research.

– SPECIALIST BOOKS AND JOURNALS

Of course, any library can contain specialist books and journals that can be used in crime geography research (university, academic and research institute libraries), but large university libraries are where the largest number of professional materials can be found.

Nowadays, we mostly search for journal articles from databases on the Internet. You can most likely find relevant crime geography articles in the following databases. Most databases are subscription-based, so they should be used in libraries and research institutes.

Brill Journals (https://brill.com/)

Cambridge University Press (CUP) Journals (https://www.cambridge.org/core)

EBSCO - Academic Search Complete (https://search.epnet.com/login.aspx?authtype=cookie,ip,url&community=y&IsAdminMobile=N)

Elsevier ScienceDirect (https://www.sciencedirect.com/)

Google Scholar (https://scholar.google.com/)

HeinOnline (https://heinonline.org/HOL/Welcome)

JSTOR Security Studies (https://www.jstor.org/security-studies/)

MATARKA (Magyar Folyóiratok Tartalomjegyzékeinek Kereshető Adatbázisa) (https://matarka.hu/)

MTMT (Magyar Tudományos Művek Tára) (https://m2.mtmt.hu/gui2/)

Oxford University Press (OUP) Journals (https://academic.oup.com/journals?login=false)

Springer Nature - SpringerLink (https://link.springer.com/)

Statista (https://www.statista.com/)

Taylor & Francis (https://www.tandfonline.com/)

In professional journals, there are many scientific studies and articles, some of which may not have been specifically written for crime geography purposes, but whose findings and factual statements can be important sources for crime geography literature. The journals are mainly on human geography and criminology; however, many relevant articles can also be found in law enforcement journals.

We would like to highlight one of the journals, the world's only English-language crime geography periodical, the *Criminal Geographical Journal*

(URL 11), which has been published online since 2019 (a criminal geography journal is also available in Hungarian, with the title: *Bűnözésföldrajzi Közlemények* (URL 12), which was founded in 2020 and is also published online).

– POLICE CONFERENCES, ANNUAL EVALUATIONS AND WORK MEETINGS

Many police conferences, annual evaluations, and work meetings are organized at which not only police staff but also the general public (researchers, interested parties, etc.) can participate. Special mention must be made of the annual evaluation meetings, which are always held at the end of any given year.

– GETTING TO KNOW EXISTING CITY-LEVEL ANALYSES

Dissertations and diploma theses have already been published in many countries on crime geography, which may be important for researchers to learn about.

- RULES OF LAW

Legislation must also be mentioned as a source of research, as a source the knowledge of which and monitoring of changes in are essential. In some cases, however, it is not only necessary to know the laws that are in force but also those that have been repealed (e.g., the appearance of new crimes).

– POLICE DATABASES

Nowadays, administration is carried out digitally in all countries. For this, police agencies use a variety of computer systems, with data recorded in the particular system when a report is received. Only police personnel have access to the systems which are password protected. Workers in each field

have access to different levels. With the right permission, valuable crime statistical data can be extracted from the given system.

– DATA THAT CAN BE PRODUCED FROM PRIMARY RESEARCH

Much data that researchers produce themselves can also be used for research purposes. These include personal observations, case studies, consultations, and questionnaire surveys. Personal observation can take place in both structured and unstructured ways. Case studies can also be important in the wide range of research and data collection methods.

1. Consultations

Distortion can often be observed in crime statistics data that cannot be explained without the knowledge that can be obtained during a personal, professional consultation. The background information obtained during the consultations can help in objectively evaluating some processes. Personal contact with police leaders may not only be necessary to discuss a specific issue but may also be the beginning of a well-functioning, later scientific collaboration. In some cases, professional consultations can also be personal interviews. If we want to get information from several managers at the same time, conducting a group interview is recommended. On the other hand, in a given topic, a prominent survey can be prepared among the police leaders most experienced in the matter.

Alongside police leaders, personal contact could be useful with officers on the ground and other local and municipal law enforcement bodies (municipal police, citizen guards, etc.).

2. Questionnaire survey

Compiling the questions for a public questionnaire is a big responsibility because the specialist who compiles the questionnaire often unwittingly edits

the questions in a manner that will establish their working hypothesis. In order to avoid this mistake, made by many, carefully study of the crime geography and criminological literature, and preparation of the questionnaire based on that experience is worthwhile. Due to limitations in the scope of this publication, it is impossible to describe the detailed methodology for questionnaire surveys, but some important things must be mentioned: Sample size should reach at least 300 people, but testing your questionnaire on a sample of at least 20 people before sending it out will reveal any errors it may contain (e.g., points that are unclear and difficult to interpret questions). Any problems arising during the 'testing' can be remedied later. Try to complete the survey as quickly as possible. In that way, it will be possible for you to avoid any changes in the environment of the respondents that could provoke a significant difference between the content of questionnaires taken earlier and later (e.g., as a result of a relevant criminal event). Due to the above, while the questionnaire survey is underway, it is necessary to constantly monitor news broadcasts to see if there has been any event affecting the questionnaire that could affect the answers given by the respondents. If there is, it is necessary to examine whether this may influence the respondents to such an extent that it may even cause a significant disparity when compared to a questionnaire taken at an earlier date.

– INTERNET RESOURCES

There are many databases on the Internet that provide a suitable basis for the preparation of analyses. However, you should strive to choose an accurate, up-to-date database of an appropriate size for the research in question. It is also an essential requirement for databases to have clear content (to be user-friendly); otherwise, the user may draw the wrong conclusions. Finally, let's mention the cost factor. Some of the databases are cost-reimbursed, but it is worth keeping in mind that a good database can be considered to be one in

which the costs of access do not exceed the benefits of the information obtained (Kóródi, 2011).

Internet sources worth using include the website of a given country's statistical office, police databases, university and research institute databases, ministry databases, etc. The primary source of European data is the website of the EUROPEAN STATISTICAL OFFICE (URL 13). However, when comparing international crime statistics data, we face many difficulties. One reason for this lies in the varied legal norms and crime categories.

Within the realm of internet resources, crime maps should be mentioned separately. They are also important sources of data. In most countries, there is a separate menu item on the police website where you can find crime maps; however, crime maps (or maps that can be used to research the spatiality of crime) can be found not only on police websites but also on local government websites, universities, and research institutes in many cases.

Chapter 4.
TERRITORIAL UNITS OF CRIME GEOGRAPHY RESEARCH

Several territorial levels can be distinguished based on social and spatial organization. We can identify macro spaces (world, group of nations, country), regional spaces (large, medium-sized and small areas), local spaces (town, residential area, neighborhood) and micro spaces (family, individual) (Nemes Nagy, 1998). During crime geography analysis, the following territorial levels can also be discerned: (1) national/international level, (2) regional level, (3) county level, (4) micro-regional level, (5) settlement level, (6) level within a settlement.

In relation to the analyzed areas, we can conclude that the more we move forward in time, the more the researchers analyze smaller territorial levels (country → level within a settlement).

During investigations, it must be kept in mind that only territorial units at the same level are compared with each other (e.g., county with county, district with the district, etc.) since significant territorial, population, etc. differences induce radically different problems. Moreover, even in the case of analyses at the same level, due care must be taken. The main rule is that in terms of size, population, etc., it is worth comparing almost identical territorial units. The territorial units for investigation proposed here are the following:

NATIONAL/INTERNATIONAL LEVEL

Partly for the sake of each country's membership of international organizations, and partly for comparability with other countries, it is

necessary to analyze the largest territorial level. However, when comparing countries, it should be borne in mind that international comparisons pose a number of difficulties due to differing legal standards (see more: boxed text).

Conditions for international comparability of crime data

(Piskóti-Kovács 2014, 23.)

1. Knowledge of crime statistics system

- Criminal records

- Whether the time at which a crime was committed or only the investigation is entered into the statistics at the end of the section (input or output statistics)

- How are the number of perpetrators of cumulative and continuous crimes calculated?

2. Knowledge of the criminal code

- What constitutes a crime?

- How are crime types defined?

- Does the country's criminal code handle crimes and misdemeanors separately (and if they do, do they appear in the statistics)?

- Minimum age of criminal responsibility

- Is the execution of a crime in the given country bound to a value limit?

3. Knowledge of legislative changes (possibly also changes in penal policy)

4. Knowledge of the scope, dynamics, structure and composition of latent crime

LEVEL OF REGIONS

The European Union designated planning and statistical regions. This was primarily necessitated by the European Union's statistics-based support system [Nomenclature of Territorial Units for Statistics – *Nomenclature des Unités Territoriales Statistiques* (NUTS)]. The aim in creating statistical regions was to "designate territorial units that are comparable in terms of area and population size, based on which uniform regional statistics can be collected and compiled." (URL 14) Regional level analysis with a crime geography aspect is rarely carried out (Figure 11).

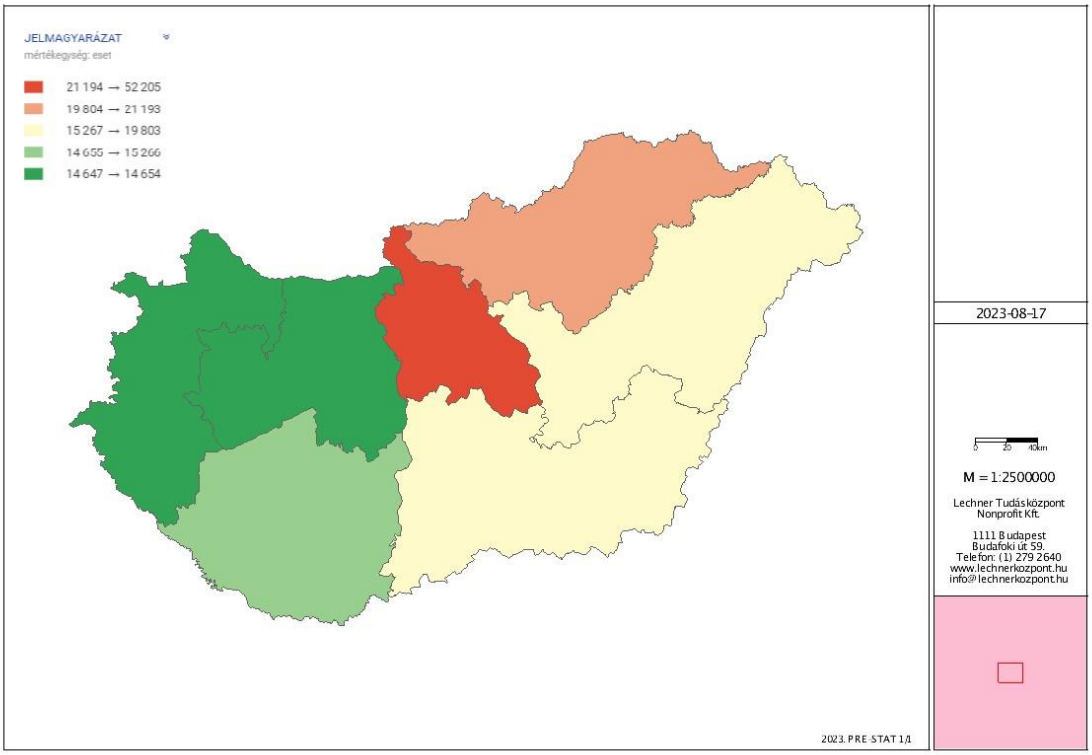


Figure 11. Number of crimes in the various regions of Hungary (2021) (Regional level) (Created by PRE-STAT system) URL 15)

COUNTY-LEVEL

The county is one of European public administration's most enduring territorial units. Crime statistics are often provided at the county level. However, county territorial units can show a very heterogeneous picture, as

significant territorial differences can be observed between them. Comparing county values with each other is essential and useful; however, many criminological trends will only be revealed during the analysis of the lower levels.

DISTRICT LEVEL

The district level does not exist in all countries. The administrative unit below the county level is the district, but in European countries their size is not uniform. Across Europe, for example, there are districts in Hungary (járás), Poland (powiat), Austria (Bezirk), Germany (Landkreis), and Slovakia (okres). In some countries, districts even elect municipalities and mayors (e.g., Poland, Ukraine). In analysis, a much more realistic crime geography image of a particular county can be obtained than if we were to examine the values of a county as a whole (Figure 12).

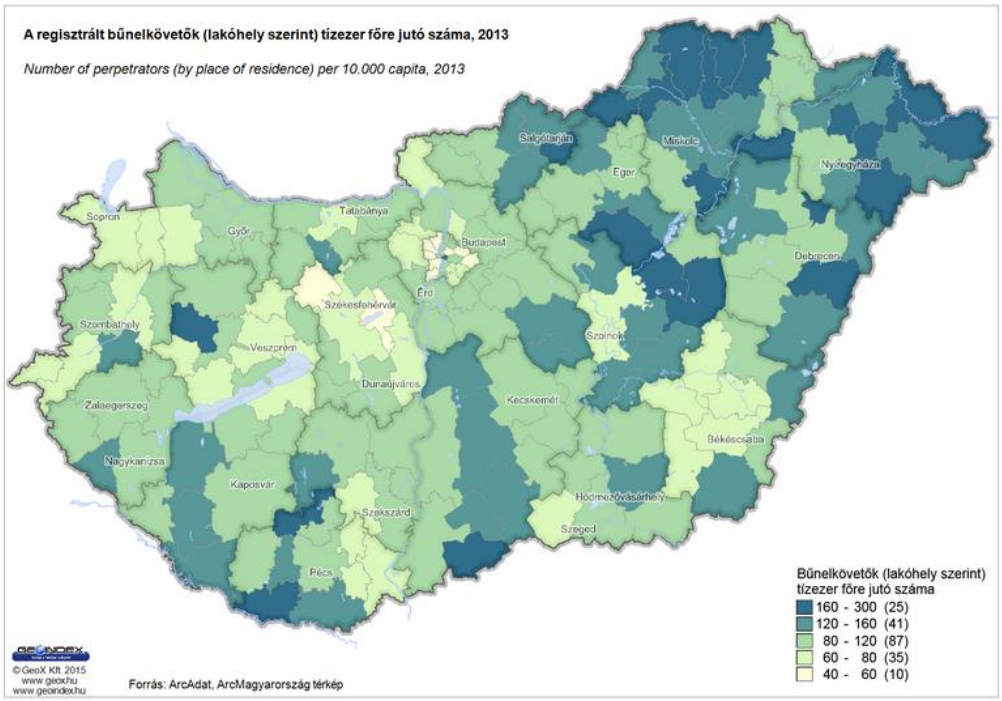


Figure 12. Number of registered criminals per ten thousand inhabitants in Hungary (District level) (2013) (URL 16)

SETTLEMENT LEVEL

It is a legitimate expectation for any population that they be able to find out the crime conditions in their neighborhood. Nowadays, the settlement level is the most frequently researched territorial unit. In the case of smaller settlements, usually only a less significant territorial difference can be discovered between the criminality of each part of the settlement. In the case of larger cities, on the other hand, people with differing values and social status live in sharply clearly defined and separate areas, among which significant variations in criminality can be observed.

LEVEL WITHIN THE SETTLEMENT

Nowadays, investigations within settlements are increasingly coming to the fore. One of the main driving forces behind this is the change in public expectations. As mentioned above, in the case of a larger settlement, clearly defined and separate parts can be observed, where people of radically different status live due to segregation, which results in significant differences in crime statistics. It is natural for everyone to want to know the crime conditions of their immediate living environment (housing complex, district, etc.), consequently, the number of analyses carried out at the settlement level is expected to increase in the coming years (Figure 13).

Inspections within settlements can be carried out at the following three sublevels (Tóth, 2007):

- Districts, police stations
- Neighborhoods
- Streets, blocks of houses.

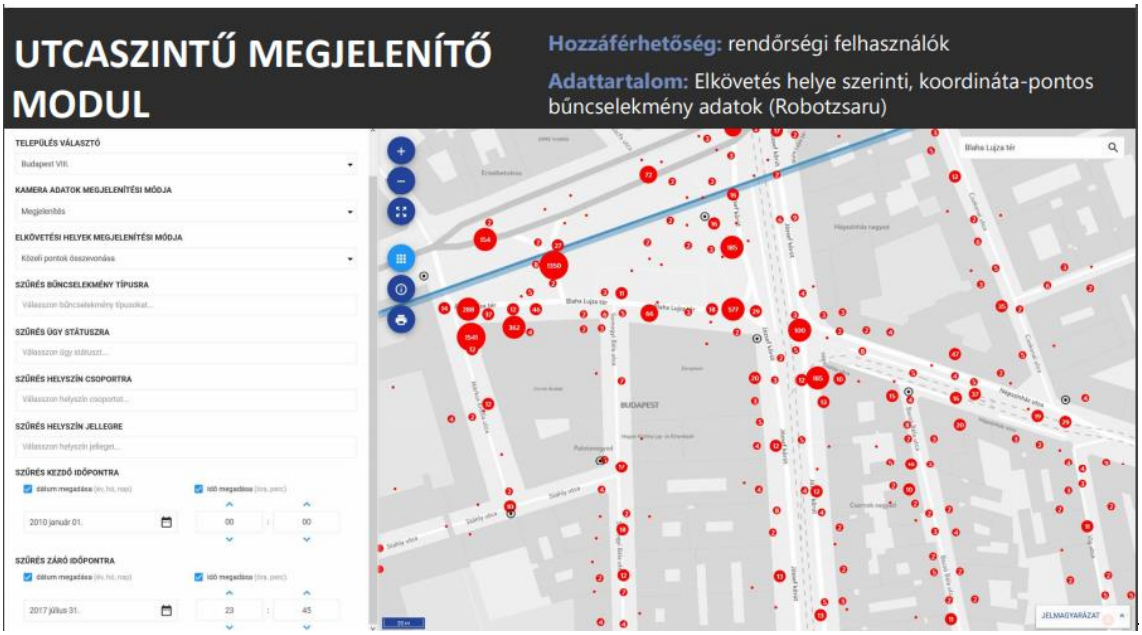


Figure 13. Street level analysis
(Created by the Hungarian police crime mapping system) (URL 15)

Chapter 5.
GEOGRAPHICAL FACTORS

5.1. Physical and human geographical indicators of crime

Even in the wars of antiquity, knowledge of geographical factors was important because certain factors can help or hinder a military operation (Kozma et al., 1993). It is no different for law enforcement work, some factors can help an investigation, while other factors make it more difficult. Although the role of geographical factors was recognized in ancient times, it took a while before systematic military geography works were prepared. In the field of law enforcement, the situation is even worse. Few people have investigated the role of geographical factors so far, and crime geography focuses on something other than the role of geographical factors, with crime being approached from a criminological point of view, the role of geography receding into the background.

In practical crime geography, it is necessary to examine many factors that can affect crime. As yet, there is no unanimous recognition of these in police circles, although in some countries, some geographical indicators have been used for decades (for example, during organizational performance evaluation). Moreover, in the case of predictive software, nowadays we can also witness the fact that some software uses physical geographic data to predict crime, as well as social and economic data (see: Hunchlab® software, URL 17).

In order to analyze and predict the process of crime, it is not enough to know only the basic crime data (place and time of commission, type of crime). In order to be able to understand and explore a process in depth, knowledge of

many other factors is also necessary. One possible route to resolving these issues can be crime geographical analysis.

The geographical factors that can affect the evolution of crime can be divided into two parts (just like geography): physical and human. The latter have a more significant impact on crime, but the influence of physical factors should not be neglected either. Regarding the role of physical factors, we can state that their role is negligible in some countries. Nevertheless, in certain cases (e.g., extreme weather situations), they can affect the development of crime. However, natural factors may play a more significant role in countries with more extreme weather and topography (e.g., the United States of America and China) (Figure 14).

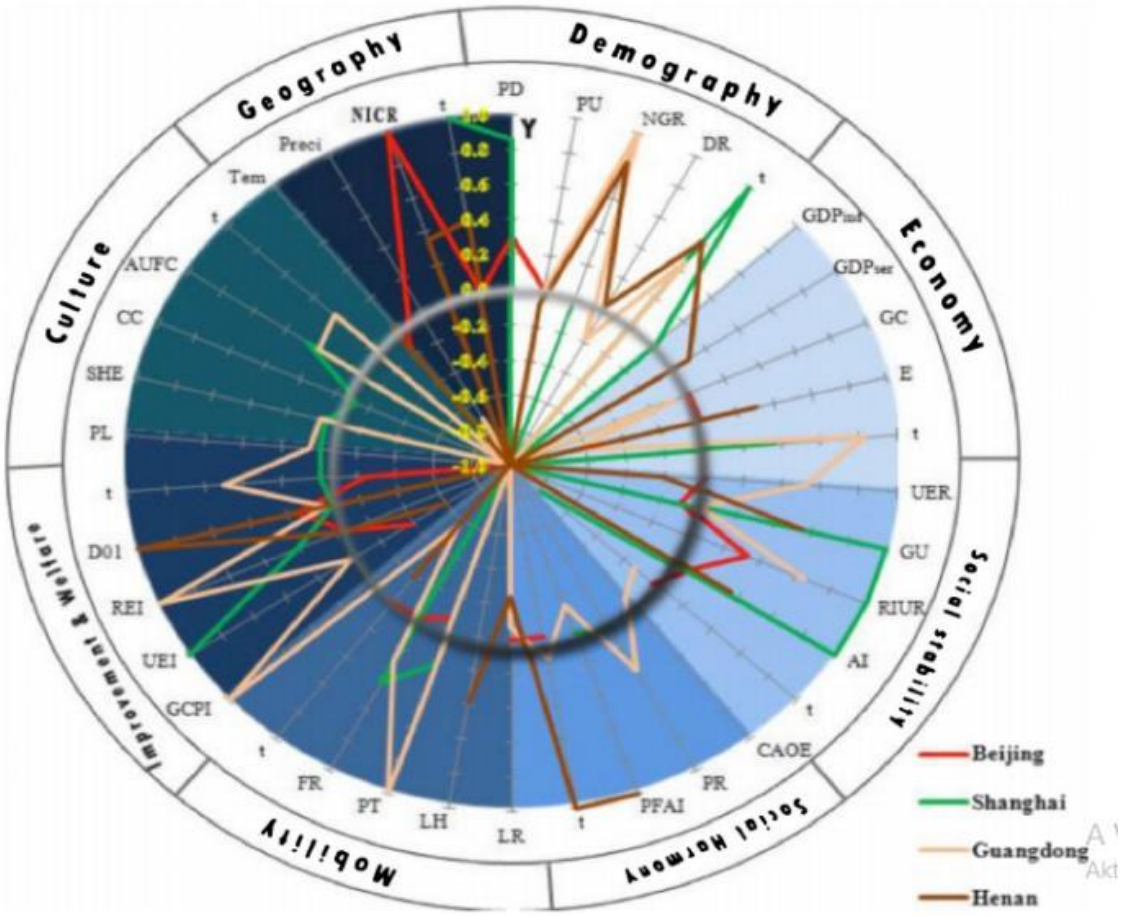


Figure 14. The influence of social, economic and geographical (physical and human geographical) factors on crime in four provinces of China (*Yijing 2017, 25)*

The role of geographical factors was mentioned by Béla Földes as early as a century and a half ago in his book *The Statistics of Crime* (A bűnügy statisztikája) (1889). "If we investigate the factors that find expression in the different results, among them, population, material, spiritual and moral factors may be of greater importance." (Földes, 1889, 41.)

Examining the policing literature of past decades, it is possible to find many scientific materials that recommend the inclusion of geographic indicators in the field of policing.

Below, the main geographic factors that affect crime are laid out. Of course, in addition to the listed factors, other factors can also play a role in the development of crime, but their role is mostly of minor importance.

HUMAN GEOGRAPHICAL FACTORS

- Economic indicators
- Structure of the economy
- The population of settlements
- Demographic factors and family structure
- Gender ratio
- Transport geography features
- The function of settlements
- The size of settlements
- The structure of settlements
- Education, the presence of educational institutions
- Anthropogenic objects
- Ethnic and religious minorities
- Examination of dialects
- Sports facilities and entertainment venues

PHYSICAL GEOGRAPHICAL FACTORS

- Water network
- Relief
- Climate, weather
- Soil type
- Vegetation

5.2. Human geographical factors

5.2.1. Economic indicators

Analysis of the relationship between economic data and crime can be classified as one of the well-researched areas. In many cases, a close correlation can be discovered between the quality of economic indicators and crime. Among the most frequently analyzed indicators are the number of taxpayers per 1,000 inhabitants, the amount of the income forming the personal income tax base, the GDP (showing the economic potential of residents, the commercial value per 1,000 inhabitants, the number of shops (purchasing power parity), and unemployment (Piskóti-Kovács, 2014; Vári, 2015). It is important to emphasize that none of the indicators should be treated as the cause of crime in themselves; they should only be interpreted in a complex manner.

One essential economic indicator is the unemployment rate. A high unemployment rate negatively affects the number of crimes. It is worth emphasizing that a person does not become a criminal just because they lose their job. However, if someone is out of work for a long time, the chances of that person committing a crime are higher.

A clear correlation can be shown between the economic indicators of a given area and the number of crimes. However, it is worth noting that the number of crimes will not necessarily be higher in areas with worse economic

indicators. In poorer areas, crimes against property will be higher (e.g., robbery, burglary, theft) and crimes committed for daily living.

We should also mention an interesting connection between economic data and traffic accidents. In areas where wealthier people live, there are fewer traffic accidents related to the poor technical condition of cars (e.g., more money is spent on car repairs, cars are better equipped with safety features, and they use tires that are appropriate to the season).

5.2.2. Economy structure

The structure of the economy also affects the number and structure of crimes. The economic sector can be divided into primary (agriculture), secondary (industry), tertiary (services) and quaternary [research & development (R&D)] sectors. Today, individual sectors are less dominant in settlements than a few decades ago, and the proportion of the tertiary sector is largest in developed countries. Despite this, there is demonstrable variance in the number and structure of crimes between settlements with different economic structures. This may be due to the different levels of education of the people living in them, the higher number of men, the higher number of tourists, etc. The size of the tourism sector (as part of the tertiary sector) also significantly affects the number, structure, and temporal and spatial distribution of registered crime (Ernszt et al., 2018). Where the number of tourists is high, there is usually a higher number of minor property crimes (e.g., pickpocketing, car break-ins). The higher damage values primarily affect tourists and not the local population (Péter et al., 2018; Keller and Tóth, 2021). The number of significant tourist arrivals also affects the spatial and temporal distribution of crimes. Where crimes are committed naturally affects the most frequented tourist destinations and the period peaks in the tourist season (this can vary depending on whether it is a winter or summer resort) (Mátyás, 2020a).

5.2.3. Population of settlements

Settlements are also categorized by population. It can be seen that differences in size (population) also lead to significant differences in the number, structure, distribution, etc., of crimes. It is a demonstrable fact that as the population grows, so does the incidence of crime.

In police materials, it can often be seen that attempts are made to compare two settlements by proportioning the population; that is, if one of the settlements has half the population, there must be half as many crimes. It is not possible to compare crimes with each other in this way (Tihanyi, 2017).

In connection with this, laws are also formulated through the *universal scaling law*, a theory developed by GEOFFREY WEST, a British theoretical physicist and professor at the Theoretical Research Institute of the University of Santa Fe (New Mexico, USA). According to Professor West, comparing a municipality with a population of x to a municipality with a population of 2x, most social and economic factors (e.g., length of roads, crime rate, size of the water supply network, the number of patents filed, the number of flu cases, etc.) will increase. It will not be twice as large but increase by 2x + 15% (Herke, 2016).

It should also be mentioned that it is not always possible to compare the crime values of two settlements based on the number of inhabitants alone. The reason for this is that the demographic situation, function, economic data, etc., of the settlement must also be examined.

Empirical data does indeed show sublinear scaling for the physical infrastructure in cities – which is analogue to biological networks – and the main discovery of urban scaling is the superlinear scaling of income, crime and patents. According to West, the two observations are related: "the approximate 15 per cent increase in social interactions and therefore in socioeconomic metrics such as income, patents, and crime generated with every doubling of city size can be interpreted as a bonus, or payoff, arising from the 15 percent savings in physical infrastructure and energy use." (West, 2017, 322.)

As for why this is supposed to happen so regularly across such a diverse range of socioeconomic phenomena: "There is a natural explanation for why social connectivity and socioeconomic quantities scale superlinearly with population size. Socioeconomic quantities are the sum of interactions or links between people and therefore depend on how correlated they are. [...] the underlying reason we are limited in the number and rate of interactions we can sustain with other people in the city is rooted in the hidden constraints imposed by space and time. We simply can't be in all places at all times." (West, 2017, 319.)

5.2.4. Demographic factors and family structure

The analysis of demographic indicators (e.g., number of live births/deaths, population decline/reproduction, migration) is extremely important in crime geographical analysis of settlements, as they can provide information that can explain some causes of crime. Demographically unstable settlements are generally characterized by higher crime rates.

Knowing the migration differential can be particularly important. If a settlement is characterized by large values, either in a negative or positive sense, it will have a negative impact on the number of crimes. In particular,

a large positive migration differential can increase the number of crimes. This is primarily because newcomers to a settlement will be mainly from the younger age group (who have a higher propensity to commit crimes), the first round of arrivals tend to be mainly men (without families; who commit more crimes than women) and, in breaking away from their usual environment, the newcomers will be rootless, which also has a criminogenic effect. A large negative migration differential results in an increase in the proportion of elderly people in a given settlement, who are less able to protect themselves from various crimes.

Knowing the age structure of a settlement can significantly contribute to successful crime prognostication, thereby predicting the expected volume and structure of crime. To give one extreme example of this that clearly illustrates its importance: imagine two settlements each with a population of 1,000 people. One settlement is inhabited exclusively by people over 80 years old (village1), while the other is inhabited by young and old people (village 2). Many families with 4-5 children also live in the settlement. These families live at a below-average standard of living. There are significant differences in the number and structure of crimes in the two settlements. In settlement No. 1, the likelihood of elderly people committing crimes is low since they mostly stay at home and can hardly move due to their age. Several types of crimes are committed in settlement No. 2, as many young adults live there. If we look at the settlements a decade later, we see that very few people now live in settlement No. 1 as many residents have died. Crimes are much reduced in that village. Most of the children living in settlement No. 2, however, have become adults, several of them are also criminals.

This example clearly illustrates the importance of knowing the age structure of the population of a given settlement. The best way to learn about this and to carry out the analysis is to create an age (population) pyramid. This shows the current situation, and the expected demographic trend can be easily

predicted (Figure 15). An essential indicator in the social disorganization theory is family structure (e.g., the proportion of divorcees) (Ceccato and Dolmen, 2011; Vavró, 1995; Piskóti-Kovács, 2014). Children who grow up in a harmonious family environment with two parents (father and mother) are less likely to commit crime.

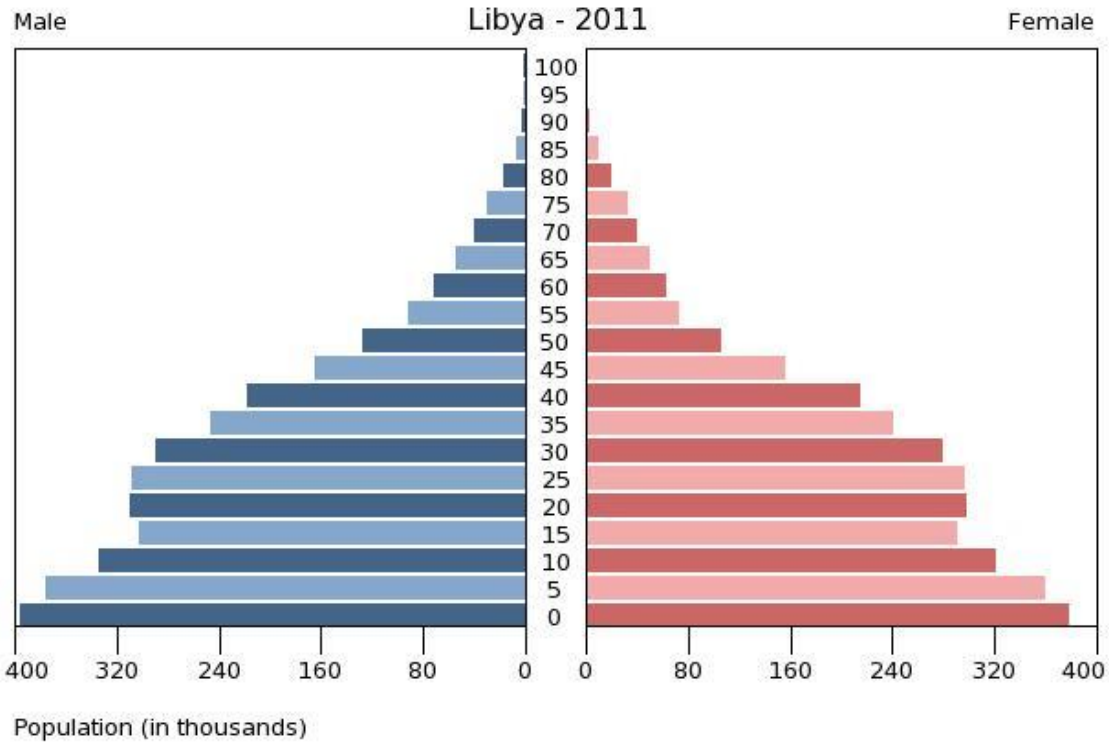


Figure 15. Age pyramid for Libya in 2011 (URL 18)

5.2.5. Gender ratio

It is a criminological fact that men commit more crimes than women. Approximately 80 percent of registered crimes are committed by men. With the progress of emancipation, the proportion of female criminals is getting ever higher, but in the coming decades, there will still be more male than female criminals.

Above average numbers of crime can be registered in settlements where the proportion of men in the population is above average. Decades ago,

industrial towns and mining towns were common, where tens of thousands of men worked, but whose families stayed at home elsewhere, and to whom they only returned at weekends. Today, fewer and fewer cities of this type can be found. However, there are settlements where factories employing thousands of people have been built, where usually only men go to work initially, and whose families stay at home. If, after a few months, if they see that the working conditions are adequate, and the conditions for the family's stay there have been created, and once the trial period is over, the family will then also arrive in the new city. The first few months (about half a year) created a significant surplus of men in the settlement. Many men work without their families for years in the settlement, resulting in a significant surplus of men overall. The effect of this can also be seen in the crime statistics.

5.2.6. Transport geography features

Several studies have already highlighted that the transport infrastructure significantly determines the mobility of criminals (Gabor and Gottheil, 1984; Smith and Clarke, 2000). There are economic laws at work in the relationship between criminals and the route taken. The greater the distance an offender travels, the more serious the crime they have to commit to make it "worth" traveling the greater distance (travel cost, time spent, etc.). An inverse correlation between the number of criminals and the distance travelled to commit crime can be observed. A developed transport network in a settlement is an attractive factor for criminals and thus broadens the area of attraction for criminals within the settlement.

Road and rail transport have the greatest relevance in transport geography studies. When examining road traffic, it is recommended that all factors that may affect crime (connection with primary spatial structure lines and urbanization axes, highway connections, etc.) be analyzed. The greater

accessibility of a settlement has advantages not only for law-abiding citizens but also for criminals. Hence, the area of attraction for criminals in easily-accessible settlements is much broader (travelling and transiting criminals) than that of less accessible settlements (Mátyás, 2012). The linear transport infrastructure affects traffic safety (e.g., the presence/absence of cycle paths, bypasses), and local public transport junctions form hot spots in many places in the city (tram, trolleybus, bus and metro stops) (Bói, 2024b).

Good rail accessibility also increases the size of the criminal catchment area (criminal agglomeration), and railway stations appear in many places as neuralgic points on the crime map of settlements.

In the case of water and air transport, we can draw the following conclusions. Water transport is not significant for passenger transport, but it is for freight transport. Large ports (e.g., Rotterdam, Hamburg, New York) are therefore important targets for smugglers, so they appear as hot spots on crime maps (e.g., drug, arms and human trafficking). Air traffic is heavily controlled, yet smugglers still often attempt to smuggle certain goods. The number of drug smugglers on flights from South America to North America and Europe is particularly high.

Transport geographical factors also affect the number of thefts. In particular, the number of pickpockets increases in busy metro stations, bus stops, tram stops and railway stations. Not only the stops themselves, but also the means of transport are suitable venues for crime to be committed, especially when many people are travelling on them.

5.2.7. Function of settlements

The responsibilities of a municipality can also significantly influence the number, structure, temporal distribution, etc., of crime (Dürr, 2023a). A settlement can be characterized in various ways, as an industrial town, or a market town, a mining town, a trade town, a tourism town, a religious town,

a cultural town, and so on. (Szűcsné Kerti and Szűcs, 2007). The function of a specific settlement is an area of responsibility that has an importance that extends far beyond all others. Most settlements have several functions (especially larger ones), and these functions can change over time (disappear, become stronger, etc.).

Decades ago, the primary function of most settlements could be determined much more clearly (e.g., mining town, industrial town, cultural town). Nowadays, individual functions are less sharply defined, and one function is less frequently dominant.

Therefore, the comparison of settlements with the same population contains dangers since, if the settlement function is different, it is not possible to make a meaningful comparison (e.g., a Hungarian example would be that Hajdúszoboszló can be compared with Siófok but not with Komló. Hajdúszoboszló and Siófok are tourist centers, whereas Komló is a former industrial town where few tourists visit. However, we could just as easily mention the capital of Switzerland, Bern, and Sarh, a big city in the south of Chad, which have almost identical population sizes but entirely different functions. Moreover, the two countries have differing legal systems, different names for the types of crime, and a variety of demographic conditions regarding the population, etc., which hinders any meaningful comparison.

5.2.8. Size of settlements

The size of a settlement also provides essential information during an analysis. It is not enough to know the size of the administrative area in km^2, it is also necessary to know the settlement structure and the ratio of the individual settlement parts to each other (urban, rural, and agricultural parts). Each type of settlement area requires different police measures, and they also have a variety of requirements for coverage by the police force.

In the case of police stations, special attention must be paid to the ratio between the central settlement and the area of jurisdiction (area, population, etc.). Two police departments, for example, are not necessarily meaningfully comparable just because they have the same size and population.

5.2.9. Structure of settlements

It is evident that in many settlements marked differences in the structure and economic performance of the resident population can be discovered in the individual parts of the settlement as a consequence of different urbanization development (Dürr, 2023b). It is essential to examine these as they largely determine the spatial distribution of crime (see more in Chapter 6). With regard to investigation of the structure of a settlement, the quantitative and qualitative examination of the building stock that defines its structure is important. It can be stated that very significant differences can be observed between the level of comfort and the structure of the population of the various building types in some parts of the settlements, which are also clearly apparent in the individual types of crimes and methods of committing them.

5.2.10. Education, presence of educational institutions

Numerous studies have demonstrated that education significantly influences criminality (quantity, structure) (Bodonyi et al., 2015). A relationship can be shown between crime and education (literacy). The tendency to commit crimes decreases as a result of higher levels of education, (e.g., higher average earnings, lower unemployment rate). However, it cannot be said that a directly proportional decrease can be observed with increased education. The number of crimes committed decreases, but a structural transformation can also be observed (white-collar crime) (Horváthné Takács, 2003; Piskóti-Kovács, 2014).

At university centers in particular, it can be seen that student numbers in a city can be in the tens of thousands. The characteristics of the lifestyle, way of thinking, etc., of young people have an impact on crime (e.g., frequency of theft at entertainment venues, physical assault, and disorderly conduct); therefore, it is essential to look for the presence of educational institutions.

5.2.11. Anthropogenic objects

Human constructions can serve as important hiding places for criminals. Knowledge of these structures can be particularly important in border areas, where illegal border crossers hide in disused buildings (e.g., abandoned houses, huts, hunting lodges, and agricultural buildings). Mapping them out and recording such locations on a map can be extremely useful during an investigation. The easiest way to check them is in person or by drone.

5.2.12. Ethnic and religious features

In relation to the population, it is worth examining the ethnic characteristics of an area, because in the case of some settlements (or parts of those settlements), you will encounter significant ethnic or religious minorities (e.g., London, Berlin, Paris, Brussels, Stockholm).

Ethnic homogeneity reduces the number of crimes, while ethnic heterogeneity increases it. The number of crimes is usually higher in settlements (districts) where several ethnic or religious groups live together (Xiaobing and Huafu, 2012). The reason for this lies in cultural differences, language and communication problems, economic performance, and so on, and must be searched for. This is especially true for non-native minorities who have been residing in a new country for a just a few years or decades. Coexistence causes many problems between a nation-state and immigrants.

As an example, we can cite some large cities in Western and Northern Europe where significant numbers of immigrants (religious and ethnic

minorities) live. Integration is made difficult by the fact that they tend to live in segregation and, due to the initial level of their linguistic and social integration, some of these groups are characterized by higher levels of criminality. We can cite sad examples of this disharmonious coexistence. Organizations promoting extreme Islamic views [e.g., al-Qaeda, Islamic State (ISIS) and individuals have carried out a number of acts of terrorism.] These have caused the death of hundreds of people in Western Europe since 2004 (e.g., terrorist attacks, trampling attacks, stabbings) (Vajda, 2022).

The difficulty various cultures (e.g., Christian and Islamic) have in coexisting is also apparent in the difference in the relationship between men and women. During several New Year's Eve and mass events in recent years, hundreds of women have been sexually harassed in European cities (e.g., 2016: Cologne, Hamburg, Stuttgart; 2022: Milan).

The difficulty in coexistence for Islam and Judaism is evident in the increase in attacks against Jews and synagogues in Western Europe. It must be emphasized that these problems are mostly caused by religious extremism and fanaticism.

Regarding religion and crime, however we should mention that some studies have established an inverse relationship between crime and religiosity (the more religious people are, the lower the number of crimes) (Ellis and Peterson, 1996), but other researchers were unable to demonstrate this (Carneiro et al., 2005).

In areas where a significant religious or ethnic minority lives, we have to reckon with a different type of criminal behavior and criminal structure. Dealing with this is only partly a law enforcement task, the problem must be dealt with jointly with other professionals (e.g., social workers, education specialists). In such areas, it may be necessary to know the minority’s language and the rules of the dominant religion, because misunderstandings

caused by language deficiencies and differences in customs can be the source of many conflicts.

From the author's point of view, as many scientific fields as possible should be involved in the resolution of problems of ethnic and religious criminality, as this is in the common interest of all of us. Crime geography also has a place among these scientific fields, which, due to its particular approach, can also contribute to treatment of the problem.

5.2.13. Examination of dialects

Geography has few points of connection with linguistics. However, if we examine them, significant spatial differences can be observed between individual dialects. On the other hand, there is a forensic aspect to this, which is dealt with by the linguistic field of forensic linguistics.

Forensic linguists deal with several areas, such as forensic text linguistics, forensic phonetics, language profiling, creating crime dictionaries, prison language tests, and courtroom discourse analysis (Ránki, 2019).

In the case of languages that are spoken by many people (in several countries, e.g., English, French, German, or in large countries, e.g., Russia, the USA, China), this issue does have a forensic aspect. However, there are also often significant differences in spoken language in the cases of smaller languages and smaller countries (e.g., in the case of Scotland and Wales in the United Kingdom). Likewise, different language usage between settlements of various sizes (village or city) can be observed.

Forensic linguistics is, therefore, a kind of linguistic profiling, the identification of characteristic vocabulary, pronunciation, accent, and so on, based upon which we can attempt to infer a place of origin or residence, that is, the geographical environment.

Forensic linguistics is the most applied field in studies of the language of legal processes, and usually covers two tasks: the analysis of linguistic

evidence, and the detection of the perpetrators of language based crimes, such as threatening, bribery, abetting, requesting sexual services, blackmailing, verbal harassment, and hate speech (Ürmösné and Nyitrai, 2021). The fundamental task of forensic linguistics is the analysis of linguistic evidence (Ürmösné, 2019). Considering the localization of a perpetrator, the involvement of a forensic linguist is indispensable, one who can pick out stylistic and idiolect elements that characterize one particular region or a particular person's language use, or who perceives a certain dialect from the recorded sound that characterizes a certain region as well.

5.2.14. Sports facilities and entertainment venues

The number of entertainment venues and sports facilities greatly influences the number and structure of crimes. Both places attract crowds, which make them "ideal" places to commit many types of crime.

In entertainment venues (e.g., pubs, bars, nightclubs, and discos), taking advantage of the inattention and intoxication of guests, thefts and frauds are commonplace. As a result of drunkenness, public nuisance and battery also occur in and around entertainment venues. Clubs are nests for drug-related crimes, too.

Some sporting events attract tens of thousands of people. Fights are common around them, mainly due to opposing fan interests. However, conflicts also occur within the sports facilities (Tóth, 2021a). Predictive software plays an increasingly important role in predicting crimes at sports events (see HunchLab® software) (Tóth, 2021b).

5.3. Physical geographical factors

5.3.1. Water network

Water transport can be divided into the categories of passenger transport and commercial goods transport. For most countries, it is evident that the role of rivers and lakes in passenger transport is not significant. However, there are some countries where a proportion of city dwellers live directly adjacent to rivers or canals (e.g., Venice, Amsterdam).

Commercial shipping has several dangers. River and sea vessels are ideal for smuggling, and large port cities (e.g., New York, Rotterdam) play a significant role in drug smuggling, human trafficking and the distribution of counterfeit goods. Millions of containers arrive at a major port every year, and checking all of them would be impossible, thus the risk analysis method is generally used to filter out containers containing illegal goods.

Some rivers, lakes and beaches are major tourist destinations that pose a significant risk from a criminal point of view (Figure 16). Where many people gather, there is usually a greater incidence of crime, a higher number of drug users, etc., and water is in itself potentially dangerous, for example, drowning accidents.

Boggy, swampy areas around water can serve as hiding places for criminals. Checking such places can be important when seeking a wanted person. These places should be inspected by someone who visits the area routinely (fishing warden, dam guard, ranger) and knows the main hiding places well (e.g., fishing houses, huts) (Lippai, 2023b).

Lakes and rivers are also neuralgic places from the point of view of migration. For many countries, the state border is marked by a natural one (e.g., a lake or river, such as between Hungary and Slovakia: the River Danube and the River Ipoly; Hungary and Croatia: the River Dráva; Bulgaria and Romania: the River Danube; the Republic of South Africa and Botswana: the Limpopo River), so regular inspection of these is vital.

Figure 16. Potentially a target for thieves (Riccione, Italy)
(Photo taken by the author)

5.3.2 Relief

Topography largely determines the extent of human settlements. The higher the altitude, the fewer and smaller settlements we encounter. The highest settlements are to be found in the Andes and Tibet.

Settlements located between high mountains are difficult to access. There are winding roads, and large differences in height within the settlement, thus police action is more difficult there than in a flat area. In an extreme weather environment (e.g., heavy rain, snowfall), the above factors make the work of the police even more difficult, and can impair their effectiveness.

5.3.3. Climate, weather

The climate largely determines where settlements are formed. The temperate zone is where the largest cities are found. The weather is becoming increasingly extreme these days, which has a significant impact on crime and

accidents. From the point of view of law enforcement, we can consider extreme cold and heat, heavy precipitation, large amounts of snow, wind and sandstorms as being negative. Criminals don't like extreme weather either. Fewer crimes are committed in extreme cold or heat. However, the police may be obliged to take action during extreme weather, which means that they will be exposed to much greater danger (e.g., slippery roads, getting sunstroke, or frostbite). The location of a crime scene must be approached, but this must be done cautiously as it poses a greater danger for officers.

Extreme weather also increases the number of accidents (e.g., slippery roads, sandstorms), which imposes extra tasks on the police force, which must be prepared for such eventualities, both technically and mentally. They need to participate in simulation exercises when they have the opportunity to practice taking action, driving, etc., in extreme conditions.

Weather and climate affect river levels. After heavy rains, rivers can overflow and floodplains become a continuous surface of water that makes walking difficult, and swimming or boating likewise becomes more difficult during floods due to strong currents (Kozma et al., 1993).

Wind conditions (direction and strength) can also affect police work. Strong winds can destroy certain tracks and fool police dogs. Strong winds can make it difficult to use drones, or for police helicopters to take off and land (Kozma et al., 1993).

5.3.4. Soil type

Knowledge of the soil type can also be important during an investigation. Even at the beginning of the last century, criminologists attached great importance to soil remains because they could be used to prove whether someone could have been at the scene of a crime (Balláné Füszter, 2019). Examining the soil is particularly important in cases where there is evidence that the offender has changed their residence. Soil samples can serve as

important evidence of whether or not a given person has visited a location relevant to a criminal case (e.g., where they have crossed a border, or visited another county). Soil samples can be obtained from many objects, the most obvious of which are the soles of shoes and the tires on vehicles; however, soil particles can also remain on the legs of trousers, unused shoes and rubber boots, work clothes, tools and any other means of committing crimes.

Knowing and examining soil is also important because the soil residues can be clearly distinguished from each other. A significant difference can be determined even in samples that are from places relatively close to each other. These soils were tested by a geological expert (Balláné Füszter, 2019). (Figure 17, 18, 19, 20).

Figure 17. Dry sandy soil
(Photo taken by the author)

Figure 18. Wet sandy soil
(Photo taken by the author)

Figure 19. Clay soil
(Photo taken by the author)

Figure 20. Wet brown soil
(Photo taken by the author)

The type of soil affects track formation. In dry, gravelly or sandy soil, track formation is much weaker than, for example, in humus-rich chernozem (black) soil. When collecting evidence at the scene of a crime, it is also necessary to take soil samples on-site (Balláné Füszter, 2019).

Soil type determines natural or secondary vegetation. Vegetation affects the possibilities of hiding (e.g., when crossing the border) and the speed of travel. Different soil types have various absorption capacities, which are apparent in a variety of meteorological conditions. Certain soil types store precipitation well, thus becoming difficult to walk on following rain ("sticky"), which reduces walking speed (e.g., clay soil) (Cselleng, 2022).

Some types of soil significantly affect pedestrian activity and vehicular traffic. Some soils are easy to walk on in dry weather (e.g., clayey, salty, meadow soils), but are challenging to drive on in rainy weather, which significantly affects driving speed. On the other hand, it isn't easy to walk on sandy soils in dry conditions, but they are easy to walk on when it rains (Kozma et al., 1993).

5.3.5. Vegetation

In addition to knowing the soil type, it is also necessary to know the natural or secondary plant cover. The soil type is what largely determines the plant cover. Traces from the plant cover can serve as important evidence during procedures. Primarily, pollen tests are able to prove or rule out whether or not the perpetrator has visited a specific location (occurrence of plants, flowering season). Pollen easily sticks to hair, clothing and certain parts of a vehicle (e.g., seat covers); so, during the collection of evidence, a great deal of emphasis must be placed on them. When looking for clothes, it is worth confiscating even dirty clothes, as the perpetrator could have also used these or, if clothes were used in the commission of the crime previously, pollen might also have adhered to other clothes.

During the expert examination, the most essential task is to compare plant remains and determine their place of origin. In the case of a homicide, for example, plant remains can help find the primary location, but pollen can also determine the approximate time of death (Balláné Füszter, 2019).

In connection with analysis of vegetation, its type and density must be examined, too. Dense vegetation slows walking speed and makes it difficult or impossible to drive by car, but it also makes hiding and hidden movement more possible (Kozma et al., 1993).

Chapter 6.
SETTLEMENT STRUCTURE AND ITS CRIME GEOGRAPHICAL PROJECTIONS

Several areas of social science have shown a clear connection between settlement structure, the closely correlated social environment, and the extent and quality of criminal behavior. In most cases, therefore, the duality that characterizes the crime situation of an area can only be understood by getting to know the structure of the settlement, so an examination of settlement structure is indispensable when starting a settlement level analysis.

The structural examination of a settlement can bring spectacular results, especially in the case of larger settlements where, due to the size and structure of the settlement, crime exhibits a dual nature: there are both crimes typical of big cities and of village – and sometimes farm – settlements.

Urban crime is primarily characteristic of the ancient settlement core and housing estates, while totally different crime types appear in garden city zones and garden zones. People with different values and social statuses live in separate areas, among whom significant differences in criminality can be observed (Figure 21).

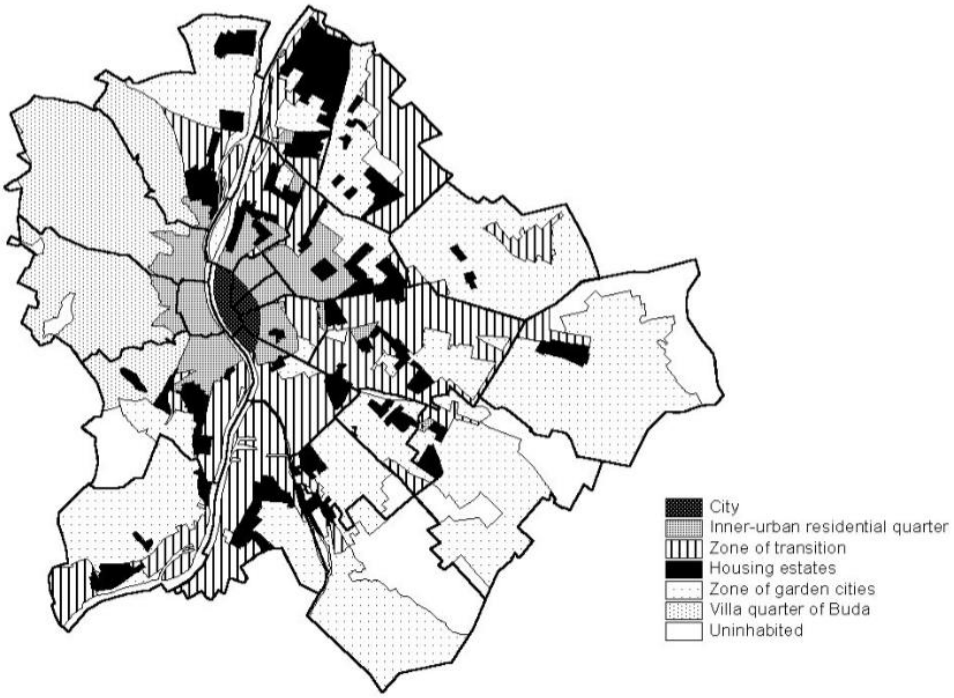


Figure 21. Spatial structure of Budapest (Kovács, 2005, 4.)

6.1. Relationships between settlement structure and subcultures

If we study the geography of crime in a city, especially a big city, it is worth examining the subcultures that have developed there, that is, cultures that differ from what is customary in the given environment. Of course, in the case of a small town, we cannot really talk about slums, but even in a town with few tens of thousands of people, there are usually separate parts of the settlement in which the population will have different values and social status. Differences in criminality can already be detected here, and the distribution of crimes is adjusted to the nature of the residential area.

DÉNES SZABÓ (Denis Szabo) was an internationally recognized researcher of the topic, with a degree in sociology (Figure 22), who left Hungary in 1947 and eventually settled in Canada. In his ground-breaking work, *Crimes and Cities* (Crimes et villes) (1960), published in Paris, he examines the relationship between settlement structure and crime. The publication received a UNESCO prize.

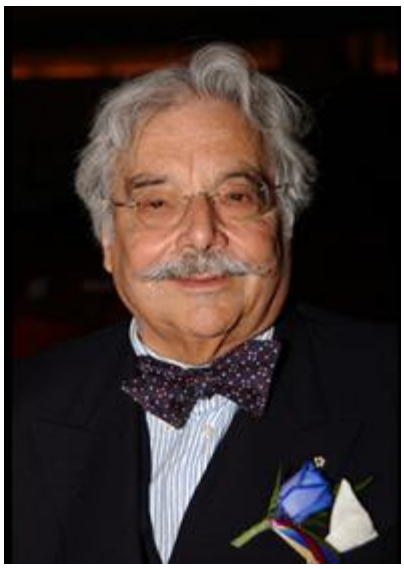


Figure 22. Denis Szabó (1929-2018) (URL 19)

"Szabo, Denis was born on June 4, 1929 in Budapest, Hungary.
Education: University of Budapest, Louvain and Paris.
Career: Assistant, University of Louvain 1952-1956. Lecturer in Sociology, Catholic University of Paris and Lyon 1956-1958. Assistant Professor University of Montreal 1958-1959, Associate Professor 1959-1966, Professor of Criminology since 1966.
Founder and Director, School of Criminology, University of Montreal 1960-1970. Founder and Director Institute Center for Comparative Criminology, University of Montreal 1969-1984, now Chair of the Board. Consultant to Canadian, United States, French and United Nations comms. and bodies on crime prevention.
Honorary President Institute Society of Criminology. Honorary degree (Siena, Budapest). Commander Ordre National du Merit, Cote d'Ivoire." (URL 20)

The DOWNTOWN (city) part of settlements are usually where the city's founders settled first, as the area would have offered the best conditions for a secure life (e.g., flood-free, well-protected). Later, what are downtown areas today would have been surrounded by ramparts or stone walls, thus increasing the safety of the residents. The buildings here are usually the oldest in the settlement, and the population density is highest (Figure 23).

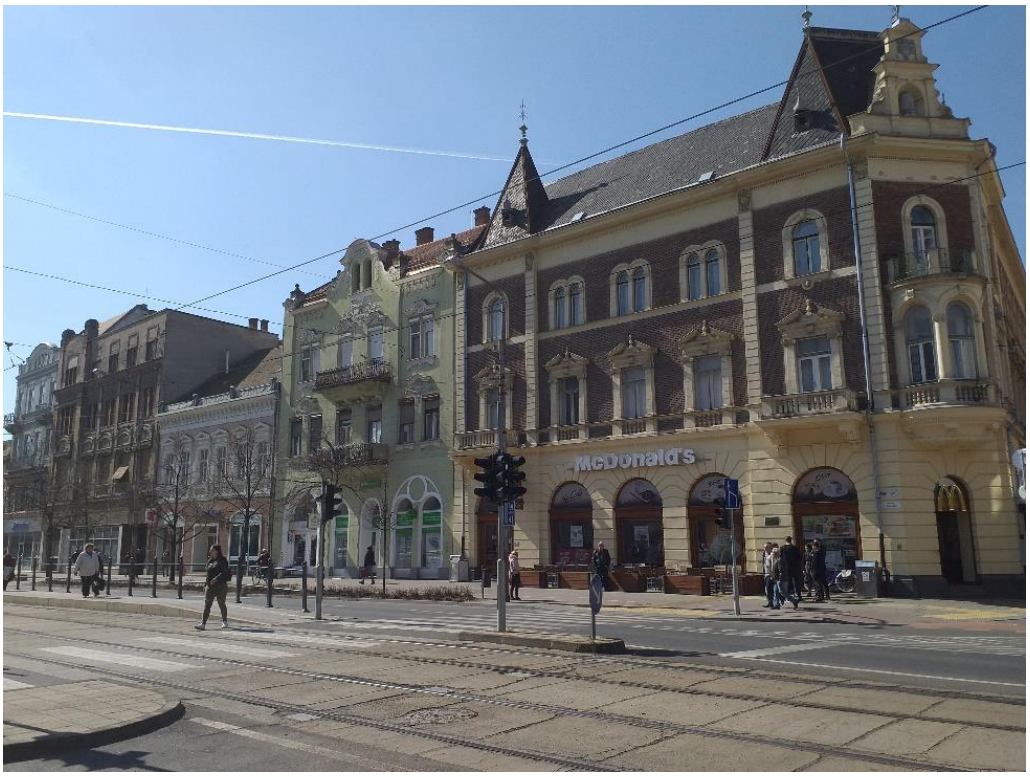


Figure 23. Piac Street, the main street of Debrecen (Hungary) (Photo taken by the author)

Both physically and socially run down areas can develop in the inner-city parts of larger cities (i.e., poor urban districts or slums). These slum areas can still be found in many cities around the world.

With regard to Central and Eastern European settlements, it can be said that in the inner centers of big cities, the wounds caused by the Second World War deepened in many settlements in the 1970s and 1980s as the younger and more affluent people moved from the downtown areas to other parts of the settlements (e.g., housing estates, and the agglomerations), which provided a decreasing quality of living conditions. This unfavorable process was reversed after the change of regime (1989) and, albeit slowly, the downtown areas of the big cities are now being continually renewed thanks to block rehabilitation works (restructuring of the downtown population, physical renovation of buildings, social rehabilitation of residents, etc.).

Downtown is the area most affected by crime in most settlements, and the spectrum of crimes is extremely wide (e.g., pickpocketing, armed robbery, car break-ins, assault). This is partly due to the fact that this part of the settlement is an economic, cultural, touristic and administrative district, so it is visited by many city residents and those living in the catchment area of the settlement[6] (Figure 24 and 25).

Figure 24. Shanghai's ever-busy city center (China)
(Photo taken by the author)

[6] According to the Burgess model, the downtown area can be considered the city, the Central Business District (CBD) or the Loop.

Figure 25. Prague's downtown (Czech Republic)
(Photo taken by the author)

INNER, URBAN RESIDENTIAL AREA

The city center (the historical core) is surrounded by a belt with a high residential density, but here the residential function is dominant (in contrast to the city center). As mentioned above, the inner-city parts have mostly been renovated, but this cannot always be said of the inner-urban residential zone. The population is therefore often segregated, and the building stock is awaiting physical renovation (Figures 26, 27 and 28). One way to rehabilitate buildings is to demolish old buildings and construct condominiums with a few apartments in their place. Still, in many cases, these will not fit architecturally into the previous streetscape, significantly detracting from the

cityscape as a whole (Figure 29). The most typical types of crime in such an area are car break-ins, vandalism (graffiti), robbery and burglary.[7]

Figure 26. Urban residential area (Zagreb, Croatia)
(Photo taken by the author)

Figure 27. New urban residential area (Ankara, Turkey)
(Photo taken by the author)

[7] Based on the Burgess model, the inner urban residential zone corresponds to the transition zone.

Figure 28. The characteristic stilt apartment buildings built mainly in the 1960s in Tel-Aviv (Israel) (Photo taken by the author)

Figure 29. Inappropriate building in an urban residential area (Budapest) (photo taken by the author)

The inner residential zone is surrounded by the FAMILY HOUSING AND GARDEN CITY ZONE, which, when compared to the city center and the inner residential zone, has a particularly low residential density. Within this belt, two markedly different parts can be distinguished in terms of their characteristics. The difference can also be observed in the age distribution of the residents, the types of crimes committed and the methods of their perpetration, and the quality of the building stock (Figure 30).

Figure 30. Houses from the 1960s in the garden city zone (Debrecen, Hungary) (Photo taken by the author)

In a garden area that was established in the past, there will be a significant proportion of elderly people (although the population is changing, younger age groups are increasingly moving to such areas) who have a lower income and can spend less on asset security. Due to their age, they more often become victims of hawker cheating (buying goods, sewer renovation, etc.),

and due to the lack of property security, thefts are more common in these parts of the city (vulnerable valuables are garden tools, mechanical equipment, agricultural products). On the other hand, the newly built parts of the settlements with single-family houses are mainly inhabited by the younger, financially better-off age group, who pay more attention to asset security. In these areas, significant amounts of mechanical equipment and building materials are stolen during construction, and dogs and garden furniture are of greater value later on (Mátyás, 2018c).

Since the 1990s, the Central European countries have been affected by a phenomenon already familiar in North America and Western Europe, separate neighborhoods (residential parks) being created on the outskirts of cities in undeveloped areas. Detached, multi-story houses with a comfort and quality level above the city average were built in these places, where the wealthier intellectuals moved in (Figure 31).

Figure 31. The residential area of the "Liget residential park" in Debrecen (Hungary) (Photo taken by the author)

There is practically no large city in Europe that does not have HOUSING ESTATES of some size, which have greatly changed the spatial distribution of the population of most settlements as they expanded. Alongside their rise to prominence, they in turn caused movement in many places within the settlement as their inhabitants tended to come from the historic city core, the outer zone and from the surrounding settlements. Many forms of urban crime can also be discovered on housing estates, which primarily appear in the forms of car, basement and apartment break-ins, vandalism (e.g., graffiti, vandalizing public transport stops, breaking phone booth glass), robbery, etc. The building of housing estates was an attempt to deal quickly and cheaply with the housing shortage that followed the Second World War. The urban housing shortage, which occurred as a result of demographic and urbanization pressure, appeared as a serious problem in most European countries. The former socialist countries started building housing estates by adopting Soviet housing prefabrication technology.

In the case of housing estates, it is worth mentioning that significant differences can be observed between housing estates built in different periods, both from an architectural and sociological point of view (and, of course, also from the point of view of crime). In Eastern and Central European countries, large-scale housing construction began at the end of the 1950s (Figure 32 and 33).

Figure 32. Housing estate from the 60's (Budapest, Hungary)
(Photo taken by the author)

Figure 33. Housing estate in Łódź (Poland)
(Photo taken by the author)

At the end of the 1960s, large-scale housing estate construction programs began to remedy the housing shortage, which was increasingly becoming a problem. The resident population of these housing estates was already less homogeneous (this was obviously impossible because of the larger resident population) and was more affected by crime. Tens of thousands of people were sometimes crowded into these housing estates, which could hardly be described as ideal, and which became the source of many sociological problems (and are still the source of many issues). However, it is worth mentioning that significant differences can also be observed between housing estates in terms of real estate prices, the general condition of residential blocks, the living conditions of the people living there, and so on (Lakatos, 2006) (Figure 34).

Figure 34. Housing estate from the mid-80's (Debrecen, Hungary) (Photo taken by the author)

In Eastern and Central European countries, the number of public housing projects gradually declined from the mid-1980s, and the large public (housing) construction companies began to build high-quality housing of their own design. The houses on these housing estates were also based on prefabrication technology, but they were much more aesthetically pleasing and liveable. All of which created much more ideal living conditions, which are still reflected in real estate prices and crime data today (Figure 35 and 36).

Figure 35. Aesthetically-appealing housing estate from the late 80's, providing better living conditions than previously (Debrecen, Hungary) (Photo taken by the author)

Figure 36. Aesthetically-appealing housing estate from the 2000's (Seoul, Korea) (Photo taken by the author)

Some large cities are surrounded ring-like by a ZONE CONTAINING GARDENS, VINEYARDS AND FARMLAND. This mainly characterizes former socialist countries. Before the regime change, working, middle-class people in these areas had holiday homes for recreational purposes. In addition to leisure, it was also possible for them to supplement their salaries through the production of agricultural products, albeit to a modest extent. The permanent populations of the garden zones were tiny. At the time of the system change,

the population of these areas was fed from two sources. On the one hand, many of those who experienced the system change as losers were able to sell their apartments in the housing estates and buy cheap, winter-proofed holiday homes here; and on the other hand, during the downtown block rehabilitation, arbitrary tenants of the downtown or cheap municipal apartments were also settled in these areas. Thanks to this, the garden areas gained a significant permanent population. Still, due to the increasing number of crimes, they became areas that are difficult to live in from the point of view of property security (Dürr, 2023b). A marginalized social setting significantly different from life in the big cities has developed in the areas surrounding them. The vast majority of the old holiday home owners have sold their properties, and the population has thus been significantly restructured. The properties are spread out and the still sparse population provides "ideal" targets for burglary, trespassing, outbuilding break-ins (garden tools, machines, logs, metal, and crops get stolen from these), and animal theft (e.g., poultry, bees) (Mátyás, 2018c) (Figure 37 and 38).

Figure 37. A once well-kept "holiday home zone" on the edge of town (Debrecen, Hungary) (Photo taken by the author)

Figure 38. Farmhouse (Hungary) (Photo taken by the author)

And finally, we should not forget to mention those settlements (SUBURBANIZATION ZONE) that surround a central settlement like a ring. In many cases, these belong administratively to the central settlement or the area of jurisdiction of the police station, and from the "parent settlement" they are located within a radius of approximately 10 km –15 km. The criminality of these settlements can also show significant differences from that of the settlement's center (Table 1).

Table 1. The predominant crime types by settlement area

Name of settlement part	Predominant crime types
City center	pickpocketing, car break-in, robbery, armed robbery, bank robbery, vandalism
Inner residence zone	car break-in, theft, robbery, vandalism, hawker cheating (imposter fraud)
Garden city zone	burglary, hawker cheating
Housing estate	car and bicycle theft, cellar break-in, burglary, vandalism, robbery
Holiday homes / farms	burglary, animal and crop theft
Agglomeration zone	burglary, animal theft, hawker cheating (imposter fraud)

6.2. Functional changes of settlement structure (stages of urbanization)

To understand the criminogenic processes taking place in individual settlement units, it is essential to know the stages of urbanization. The term urbanization comes from the Latin *urbs, urbis* (city). The following four stages of urbanization can be distinguished:

1. URBANIZATION (CITY EXPLOSION)

Urbanization started in England as a result of the industrial revolution, when urban industrial plants needed a lot of workers. As a result of extensive industrialization, a significant population flow from the villages to the cities

began. The living conditions in the city were rudimentary, which induced many social problems. In many European countries, the first phase of urbanization began with a significant phase delay, from the second half of the 1850s only. In some African and Asian countries, however, it only started in the second half of the 20th century and continues to this day.

2. SUBURBANIZATION

In the course of suburbanization, the number of people moving from the villages to the cities decreases sharply, as the city no longer offers living conditions favorable enough to make leaving the villages worthwhile. As a result of the worsening living conditions offered by the cities (air pollution, parking problems, high real estate prices, increasing crime, etc.), the more affluent urban population moves to smaller settlements around the big cities (deconcentration of the population). One of the most important prerequisites for the process of suburbanization is an improvement in people's spatial mobility (e.g., generalization in the use of vehicular transport) and the development of linear infrastructure. Suburbanization first characterized the larger cities of the United States (1920s-30s), reaching the countries of Western Europe after the Second World War. Following a significant phase delay, this took place in Eastern and Central Europe in the 1980s.

The suburbanization zone usually surrounds settlements within a 10 km – 20 km radius in cities and 40 km – 50 km in the case of larger cities.

Among other things, the policing relevance of suburbanization is that these suburbs “lose” their population during the day (dormitory settlements), as the residents go to the big cities to work, study, etc., so an ideal venue is provided for, for example, home burglaries. We can also mention that the surroundings of shopping centers and other commercial units established in suburban settlements can appear as hot spots in many cases (e.g., theft and car break-ins) (Vajda, 2024).

We can talk about suburbanization not only in terms of the population but also of industry because industrial plants were also moved to the agglomeration. As a result, the proportion of vulnerable values increased further in the settlements that surround the big cities, increasing the volume of crime.

3. DEURBANIZATION

In deurbanization, the population of not only cities but also agglomerations begins to decrease. Those who move out of the agglomeration move further away from the cities. One root cause is the further improvement in accessibility of the cities (it is possible to get to the city quickly even from further away), another is the increase in the role of remote working via the Internet (it is not necessary to go to a workplace every day of the week), and an appreciation that the rural environment offers better living conditions. The growing population also results in the emergence of plenty of services and commercial functions in these settlements, which then increases the number of vulnerable values. The process of deurbanization could already be observed in some European countries and North America in the 1970s.

4. REURBANIZATION

In the course of reurbanization, the population of cities begins to grow again, during which process it is mainly the previously neglected inner-city areas that are revitalized. The displaced population is usually moved to other parts of the settlement, which in many cases simply postpones social problems. The rehabilitated areas are physically renewed, and the old city centers are revived. Real estate prices rise; wealthy young intellectuals move into renovated apartments (gentrification). As purchasing power increases, services based on new residents appear (restaurants, entertainment venues,

etc.), and life returns to city centers. The number of crimes is significantly reduced in the socially and physically renewed area (Lees et al., 2010).

Regarding the particular stages of urbanization, it can be stated that, in many cases, they are not sharply separated from each other. This is especially true in the case of large cities, where several stages of urbanization sometimes take place at the same time.

Chapter 7.
CRIME GEOGRAPHY OF STATE BORDERS

The research of state borders can be viewed as one of the unique and particular subfields of crime geography. Still, unfortunately, even in comparison to the small number of crime geographers, very few people deal with this special area (Tóth, 2002). In recent years, the role of the border has been re-evaluated in Europe, which justifies a separate chapter for the description of legal violations related to state borders. With the large increase in irregular (illegal) migration (since 2015), illegal tent camps with hundreds, sometimes thousands of people have formed near the European borders (e.g., the Hungarian and Serbian border section). In these camps, and in the settlements along the border, the migrants commit numerous crimes against each other, against the local population and, in many cases, against the police forces protecting the border from illegal border crossings (URL 21, 22, 23). As a result of the above, the examination of border sections has gained new momentum, and it is to be expected that in the coming years, the geography of crime will also play a greater role in border-related research.

In the first two decades of the 21st century, the perception of the border has changed significantly, the border is seen decreasingly as something that separates countries and nations. People increasingly realize that borders do not separate but rather connect (Mátyás, 2007). In the spirit of the common European territorial ideology, partly thanks to regionalism and cross-border cooperation, creating border regions within the European area was also the start of a specific spatial organization (Nagy, 2011). It should be mentioned that not only the perception of borders have changed in recent decades, but also that of security and freedom. However, three concepts – border, sense

of security, and freedom – are intimately connected, and thus must be handled in a complex way because we cannot talk about the security or freedom of a state and its population if there is no adequate border protection (Ritecz, 2002).

The primary goal of this chapter is to provide a brief overview of the research opportunities offered by the geography of crime in the case of state borders. We also consider it important to determine the role that crime geography can play in border sciences.

Prior to the change of regime, border research in the former socialist countries was extremely limited, partly because statistical data was kept secret and inaccessible to researchers. After the change of the political system, however, representatives of many scientific fields showed interest in researching border areas. Today, the role of the border has been significantly enhanced, border traffic has increased many times over, and at the same time, the number of illegal acts committed at the state border has increased exponentially, and the criminal structure detected at the borders has changed significantly.

7.1. The importance and concept of borders

In addition to protecting the internal order of a given area, protecting the external borders has always played a prominent role, without which a state entity would not remain intact for very long. State borders are considered a priority research area in many social sciences, including political geography, international law, history, and so on. It is no coincidence that several disciplines pay a lot of attention to state borders since one of the keys to a country's sovereignty is the protection and control of its borders. If a country can no longer protect its borders, that state will soon cease to exist. The renowned geographer Géza Czirbusz said the following about the triple function of borders:

> *"Borders are a geographical phenomenon of countries, with which the states indicate their separate territory and independence. Politically, borders are the dividers of spheres of power; therefore, they depend on the political power of the peoples."* (Czirbusz, 1919, 10.)

In his opinion, the threefold purpose of demarcation is: a) the separation of the states' possessions, b) protection and c) traffic flow.

Many definitions have been created that describe what a border is. The field of social science that a given researcher represents will determine the aspect from which they approach the concept of the border. The geographer István Süli-Zakar defined it as follows:

> *"...the state border is a zone, strip or line that separates the territory of the states from each other. The state border limits the exercise of the state's territorial sovereignty. It is an important geopolitical element of neighborhood relations, with different contents in different historical eras."* (Süli-Zakar 1997, 7.)

We can say that the borders are not static lines but specifically dynamic formations that change relatively quickly, even when measured on a human scale. There are many reasons for borders to change, but usually it means acquiring territory that is useful for a given country in some way (e.g., due to population or territory growth, for military-strategic reasons). Friedrich Ratzel, the founder of political geography, compared states to living organisms. In his opinion, it is natural for a state that grows in strength to turn against its weaker neighbor.

7.2. Illegal migration and its crime geography projections

Before the change in regime, the concept of illegal migration was largely unknown in Eastern and Central European countries because the borders were hermetically sealed, so crossing them was also physically quite difficult (barbed wire, mined border sections, etc.) (Dobák, 2006). After the change of regime, the borders became relatively easy to cross, creating a situation in the region in which the organizations dealing with the border police were unprepared.

The increase in the number of illegal acts related to the border definitely justifies the need to place the technical achievements of the age at the disposal of social science to carry out security geography, crime geography, and migration geography analyses. As the author duo Kobolka and Kovácsics point out, crime geography analysis can help detect and prevent illegal acts related to illegal migration and the border. With map display, we can reveal connections and correlations related to crimes and the border that are not apparent or are difficult to notice in other ways. The spatial appearance of the expected migration pressure can also be delimited (Kobolka and Kovácsics, 2004a).

Crime geography is suited to the investigation of violations related to the border in order to:

- Examine the numerical characteristics of individual crimes
- Present the structure and dynamics of crime
- Define the tasks of law enforcement
- Set preventive goals
- Compare and represent criminal information with other data (Kobolka and Kovácsics, 2004b).

György Ritecz sees the role and place of geography in border-related research partly within migration geography. In Ritecz's interpretation and formulation,

> *"...migration geography is an applied, special element of geography that is an integral part of border control, which examines the physical geographical, economic and social, as well as border control factors of a given geographic location (territory, country or group of countries) and the impact mechanism, how they affect the migratory activity of a certain group of people."* (Ritecz 2002, 65.)

Ritecz suggests the following study areas of migration geography:

> *"Physical geography:*
>
> *- The general geographical features of the given country (border section) that affects illegal migration (geographical location, nature of the terrain, topography, hydrography, weather);*
>
> *- The border sections of the given country;*
>
> *- The description of the common border section, size and extent of factors hindering movement (illegal migration);*
>
> *- The (minimum) time needed to get through the country from the given border period, taking into account the established migration directions;*
>
> *- The main transport routes and options;*
>
> *- Objects located in the border area (on both sides) affecting illegal migration (major border crossings, traffic junctions, etc.).*
>
> *Social, economic:*
>
> *- The country's social structure and stability, the level and tendency to satisfy the security needs of a wide range of the population and certain groups;*

- The declared and "real" goals of the country with regard to illegal migration;

- The degree, orientation, and trend of social mobility;

- The extent and nature of corruption, affected groups;

- Demographic conditions and trends (age distribution, population density, population growth rate);

- The harmonization of visa policy, the involvement of countries of origin in terms of illegal migration;

- Assessment of the danger of illegal migration to society;

- Characteristics and factors of public administration and justice influencing illegal migration (alien police procedures, refugee and asylum treatment, procedural deadlines, efficiency of measures);

- Other factors endangering security (e.g., minorities), social tensions;

- The size and trend of GDP per capita, the current balance of payments deficit;

- The level and trend in inflation, the degree of economic freedom;

- Rate and trend in unemployment (analyzed separately for the border region);

- The given cross-border social and economic relations and conditions;

- Other (e.g., emotional) factors.

Border Police:

- International laws and treaties valid for the given border section;

- The involvement of the given country or border section by the main migration routes;

- The border guard forces performing tasks at the given border section:

- operating principle and system;

- Number of organizational units;

- Number of employees;

- The main forces and tools used;

- Distribution of force and equipment in proportion to km;

- Its border control system;

- The characteristics, training and efficiency of their activities;

- The development, characteristics and tendency of border traffic;

- The main characteristics of the activities of the border guard forces on the other side;

- Cooperation between the border guarding and migration management bodies operating on both sides of the given border section;

- The structure, trend, and methods of committing violations related to the state border of the given border section, the possible methods, procedures, and means of effective action against them;

- The extent and trend of violations committed in the border area, not related to the state border, and the possible methods of their effective prevention and detection." (Ritecz 2002, 66-69.)

When examining the border, we should also mention the time factor as a research aspect. In many cases, it is possible to determine in advance when a violation is most likely to be committed. The examination of the time dimension can be done according to the hours of the day, the days of the week, and the months of the year. In doing so, it can be determined at which hour of the day (time of day), on which day(s) of the week, and which month(s) of the year people commit a specific illegal act most frequently. The investigation of both major crimes and individual border sections (Figures 39 and 40) is recommended.

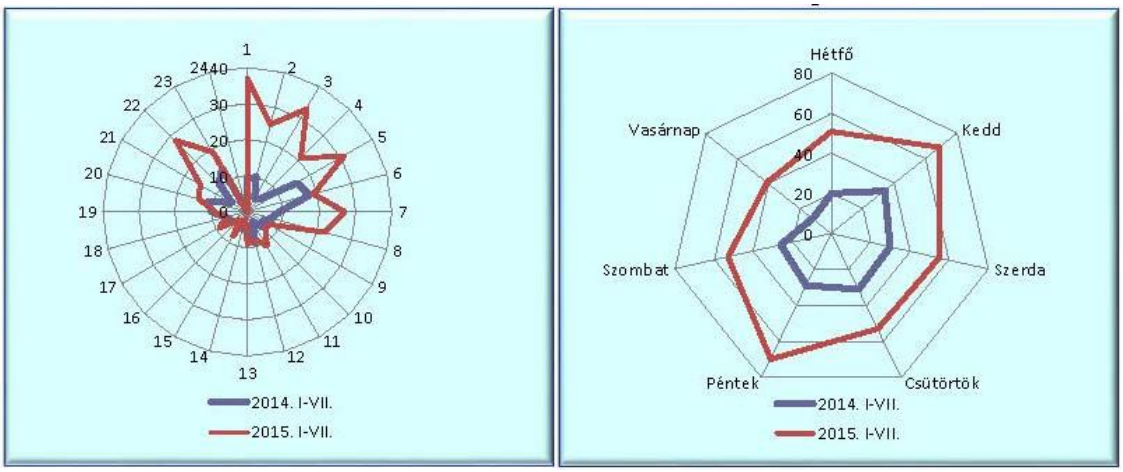


Figure 39. Human smuggling crimes by time of day (URL 24)
Figure 40. Human trafficking crimes by day of the week (URL 24)

Chapter 8.
CRIME MAPPING

8.1. Concept of map, types and content elements of maps

Proportionally reduced, two-dimensional map representations of a surface date back thousands of years. In order to facilitate orientation, maps were made thousands of years ago, carved on rock, drawn on papyrus, etc. Today's maps are made for the same reason that they were thousands of years ago: to facilitate orientation and record the current state and changes.

"A map is a scaled-down, generalized, explanatory representation of natural and social objects, phenomena, or processes found on Earth, other celestial bodies, or in outer space." (Unger, 1994, 5.)

Since the nineties, maps have been divided into two parts, analogue (paper) and digital. Prior to that, there was no such division, as all maps were paper-based.

Maps have mandatory content elements, which make the map clear and easy to read. Digital maps have many advantages over analogue ones, including that they can convey data more vividly, are not limited in content (can be expanded), are more accurate, etc. Of course, analogue maps cannot be dispensed with nowadays either; albeit in smaller numbers, they remain a part of our daily lives; and let's not forget that if we print out a digital map, it becomes analogue (Vincze, 2010).

In order to be clear and understandable, maps are accompanied by textual explanations. There is an expectation that all maps should be lucid and easy to interpret. This is helped by the LEGEND, which contains conventional signs and textual explanations. On maps, water is shown in blue, and hilly and mountainous areas in brown (Bartha and Havasi, 2011). If we produce a map,

in addition to the above, the name of the depicted area and the data content of the map (e.g., assaults in Debrecen city center) as well as the scale of the map must also be indicated.

The MAP'S SCALE can be specified as the ratio of the map length to the projection length. It shows how big the reduction ratio (amount) is compared to reality. Its designation: M. That is, if M=1:500, then what is 1 cm on the map is 500 cm in reality. The scale for maps may vary slightly for particular specialties (Table 2).

Table 2. Map scales

Map Type	Scale Limits	Representation
Small-scale map	1:1,000,000 or smaller	World maps, continents, large countries, or oceans
Medium-scale map	1:250,000 to 1:1,000,000	Countries, states, provinces, or large mountain ranges
Large-scale map	1:250,000 or larger	Cities, counties, municipalities, towns, parks, or campuses

Source: URL 25

A map requires a title to show the user what is visible on it. Orientation is also a vital map element. It shows the compass direction. While it is not obligatory, it is well worth including the name of the editor of the map.

Maps can be grouped according to many aspects. We can distinguish between surveying (geodetic), topographical and geographical maps according to scale. Crime maps can be classified as geographic maps, as this type of map is suitable for illustrating social phenomena, relationships, and changes over time, among other things (Monmonier, 1991).

For crime maps, it is also important to mark the direction of north, indicate the time interval depicted (e.g., 2014-2015, 03.20-22, 2015, 4:00 p.m. and

6:00 p.m., etc.), as well as to indicate the data source and the name of the creator of the map. In the case of other types of maps, additional accessories may be included, but these are usually no longer necessary for crime maps (e.g., projection system).

8.2. Map editing principals

When creating maps, we must keep the following principles in mind:

- Ethical communication of information (the map should not be misleading)
- Must be reproducible
- The data source must be cited (Medina and Solymosi, 2023).

It is also vital that the title is short and clear, and the name of the creator also be indicated (Medina and Solymosi, 2023). Another important map editing principle is that the class spaces are designed to represent reality. In the case of "quantile" class intervals, each category has the same number of elements (e.g., the same number of counties, settlements, and police stations). On the other hand, in the case of "natural breaks" (break: the grouping is adapted to the "breaks" in the data series), the elements are included in the individual categories in such a way that the slightest difference is between them, while the largest differences are between the individual categories. The software itself searches for such breaks in the data line (Tóth, 2014).

8.3. Thematic maps

According to their content, maps can be divided into two groups: general and thematic maps. However, before we familiarize ourselves with crime maps, it is worth defining the concept of a thematic map since it can also be classified as a thematic map.

> Thematic maps "*depict the non-landscape elements and phenomena of the natural and social environment, their quantitative and*

qualitative characteristics. The simplified versions of the general maps provide the background of the thematic maps. The group of thematic maps includes the natural environment, social and economic life, science, public administration, politics, history, etc. maps." (Unger 1994, 7.)

Types of thematic maps (based on János Unger with additions by the author) (Unger, 1994, 116.):

- QUALITATIVE: quality is represented (e.g., the structure of registered crimes).
- QUANTITATIVE: quantity is represented (size, mass, value) (e.g., the number of registered crimes).
- STATIC (or state map): they illustrate a specific time (e.g., the number of registered crimes in 2014).
- DYNAMIC: illustrates changes in space or time (e.g., the increase in the number of registered crimes between 1989 and 1998).

Types of thematic maps based on the number and relationship of the depicted topics (based on János Unger with additions by the author) (Unger, 1994, 116-117.):

- ANALYTICAL: represents a topic (e.g., the number of registered crimes).
- COMPLEX-ANALYTIC: depicts several topics, but there is no close connection between the topics (e.g., the number of registered crimes and the average life expectancy at birth).
- SYNTHETIC: depicts several topics that are closely related to each other (e.g., the number of registered crimes and below-average income levels).

8.4. The concept of the crime map

"A crime map is a thematic map on which the geographical location of a feature of crime can be depicted. Looking at the maps, we can notice connections and correlations between crime and criminogenic factors that would otherwise escape our attention." (Tóth, 2007, 27.)

The activity related to the preparation of a crime map (map representation), the recognition of the connections provided by the map, their evaluation and analysis, and their use is called crime mapping (Boda, 2019).

8.5. A sketchy overview of the history of crime mapping

The two-dimensional map display of crimes is as old as the area-based investigation of criminality. In his work, published in 1833, GUERRY depicted crimes against persons and property in France on a map. During his research, he established significant differences between the northern and southern parts of the country (see Figure 3). Crime maps have been used in the United States since the 1900s (first in the New York Police Department). In the beginning, there were pin maps: the areas affected by crime were marked with pins. However, pin maps have many shortcomings, such as, among other things, being static; it is difficult archive them and to keep them up-to-date and clear, and due to their size, they are not mobile (a wall map cannot be taken to a crime scene, for example).

Another drawback of pin maps is that sooner or later, they become unusable (due to the holes left on the map), and the marking of temporal succession is quite complicated (Tóth, 2007). A "generation change" in crime mapping occurred in the 1960s, when computer processing and visualization came into use in the USA (St. Louis). However, a significant change occurred with the advent of personal computers in the 1990s, when people had wider access to the hardware and the software needed for crime mapping (Piskóti-Kovács, 2011). In the United States, the Crime Mapping Research Center was

established as early as 1997 (renamed: Mapping and Analysis for Public Safety Program), which conducts research and disseminates knowledge related to crime maps. One result of this was that the American police began regularly to use crime maps in their daily practice. This was also demonstrated by a survey conducted in 1998, which determined that "13% of American police units used crime mapping in their daily practice" (Tóth 2007, 24.). Mention should also be made of the research carried out in Germany by SCHWIND, H. D., who created crime maps for Bochum (see Chapter 2.3).

8.6. Possibilities and limitations in the use of crime maps

As is generally the case for the fields of social science that carry out territorial research, the geography of crime makes extensive use of the additional information provided by maps since the visual display on the map provides much more data than any single statistical data series could provide. Moreover, in some cases, the statistical data can also create a false impression, as they do not show the reality (e.g., a county data series that masks territorial differences) (Nyitrai, 2021). Crime maps can be adapted in many areas in everyday police work, such as crime prevention, service organization, and analytical and evaluation work, as well as defining the area of criminal and public order actions, and planning patrol routes (Major et al., 2014). The map display also makes it possible to recognize the areas that are in different administrative districts but that are criminally related, and the territorial differences become much more dominantly perceptible (Pődör, 2005). In this regard, Ratcliffe very aptly points out that spatial patterns can be deciphered with crime maps, that is, specialists can pay attention to many phenomena that previously escaped our attention (Hlavacska, 2014).

Most crimes are not committed in a specific place by chance. A place is attractive to criminals, and criminals make rational decisions before

committing a crime (rational choice theory). We can discover crime patterns in space. By identifying these, an appropriate strategy to reduce the number of crimes can be developed.

Three additional areas of practical use are geographic profiling (in which the offender's "hunting grounds" are depicted), Crime Prevention Through Environmental Design (CPTED) and predictive policing. In the case of the latter, we can state that visual representation is an essential element of preventive policing.

In addition to police use, crime maps can be successfully used, among other things, in the development of regional development concepts and the preparation of plans for urban development (see: CPTED), as well as in choosing the optimal route for going to school and work.

8.7. Dilemmas in publishing crime maps

Different countries have different views on the publication of crime maps. In some countries (e.g., the USA), it is believed that citizens have the right to know the crime situation in their neighborhood ("freedom of information"). On the one hand, this protects the population (e.g., they can choose the safest route to work), and on the other hand, it contributes to more effective crime prevention. That being said, if residents are aware of the crime situation in their neighborhood, they can help prevent crime by paying more attention to their surroundings (see http://www.crimemapping.com, https://crimerate.co.uk/crime-map for more information).

According to those who argue in favor of limited publication of the maps, people can easily misinterpret crime maps and draw the wrong conclusions. As a result, real estate prices may decrease, and emigration may begin, which may initiate a self-stimulating process that is difficult to reverse (Tóth, 2007; Mátyás and Pődör, 2022).

8.8. Possibilities for the practical application of crime maps

(Based on Antal Tóth with additions by the author) (Tóth, 2007)

- Representation and analysis of the location, time, type and manner of committing crimes, the place of residence of the perpetrators and victims, and the spatial distribution of potential targets;
- Planning of patrol routes, service organization;
- Demonstration (e.g., public forums, law enforcement training);
- Detection of serial crimes (e.g., burglaries, robberies);
- The factors contributing to crime problems that increase the risk of their occurrence can be mapped, and high-risk neighborhoods can be identified through complex correlations and multivariate analyses;
- The changes in crime can be depicted: in addition to the geographical reorganization, there are also changes in the methods and time of the crimes;
- Crime prevention;
- In making strategic decisions for police leaders (e.g., determination of police density, location of district commissioner offices, location of police stations, etc.);
- Choosing a route to school and work (e.g., choosing transport routes with fewer traffic accidents or violent crimes);
- Area of justice (e.g., choosing the location of prisons).

8.9. Main types of crime maps

Everyone probably knows from their geography studies that many map types can be distinguished according to how the map is displayed. The different cartographic representations convey the data content to be communicated in map form as sensitively as possible (Figure 41). However, it should be mentioned that in many cases, several map types can be found on one map

in order to provide as complex data as possible. In the case of crime geography, the following map types are recommended for use.

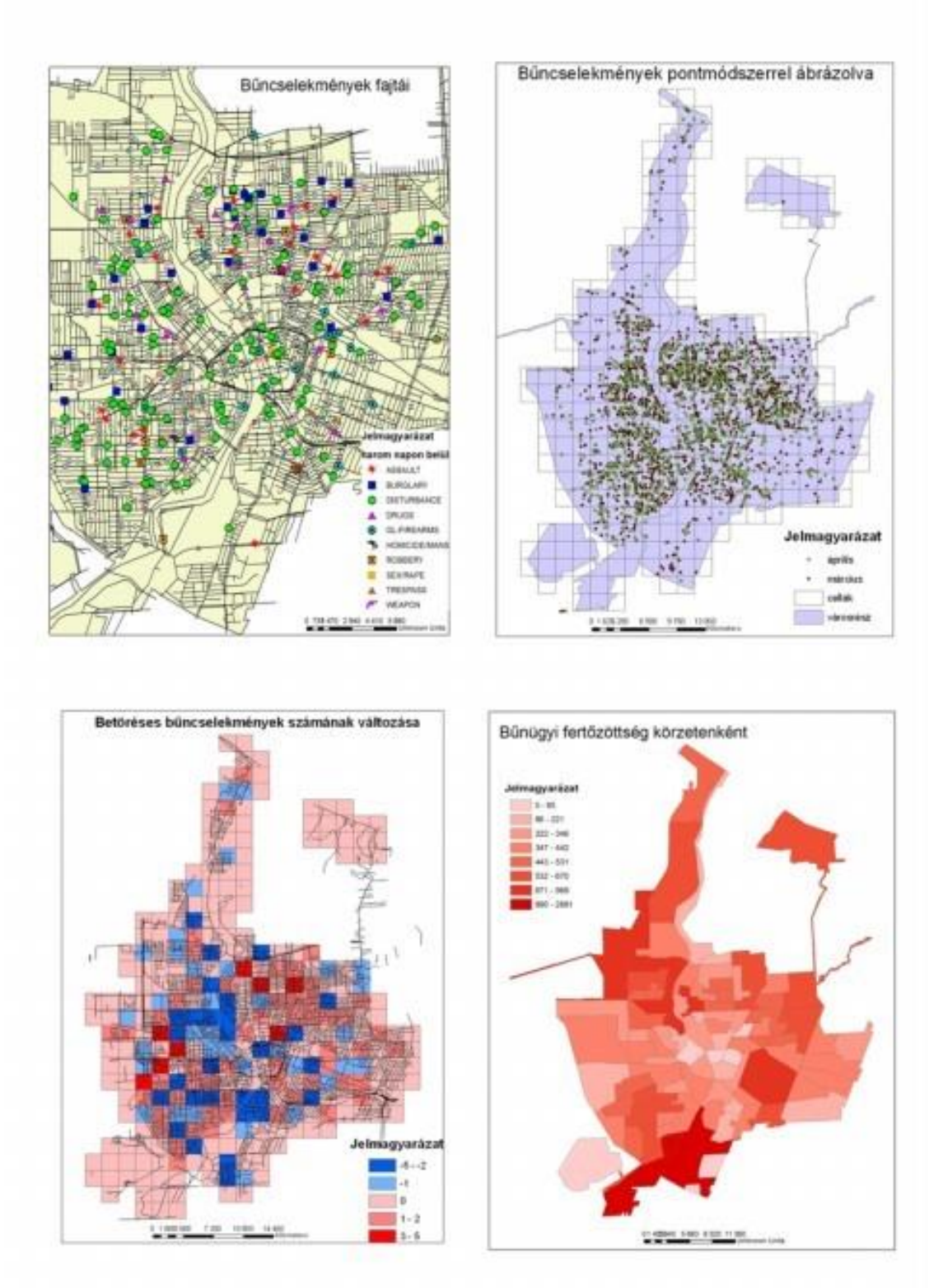


Figure 41. The same data content represented by different methods (Pődör, 2022, 108.)

- DOT MAP

If the elements to be represented occur in very large quantities, they cannot be represented individually with map symbols. It is worth switching to symbols with the smallest surface area, i.e., points. However, it is important to "find" the correct size for the points, as the map can otherwise be misleading. If the dot is too small, the map may appear empty. On the other hand, if the points are too large, the map will be oversaturated. The points cannot be allowed to overlap each other. The number (density) of points in a given area indicate the extent of regional concentration (e.g., accident and crime point map) (Figure 42) (Mátyás and Pődör, 2022).

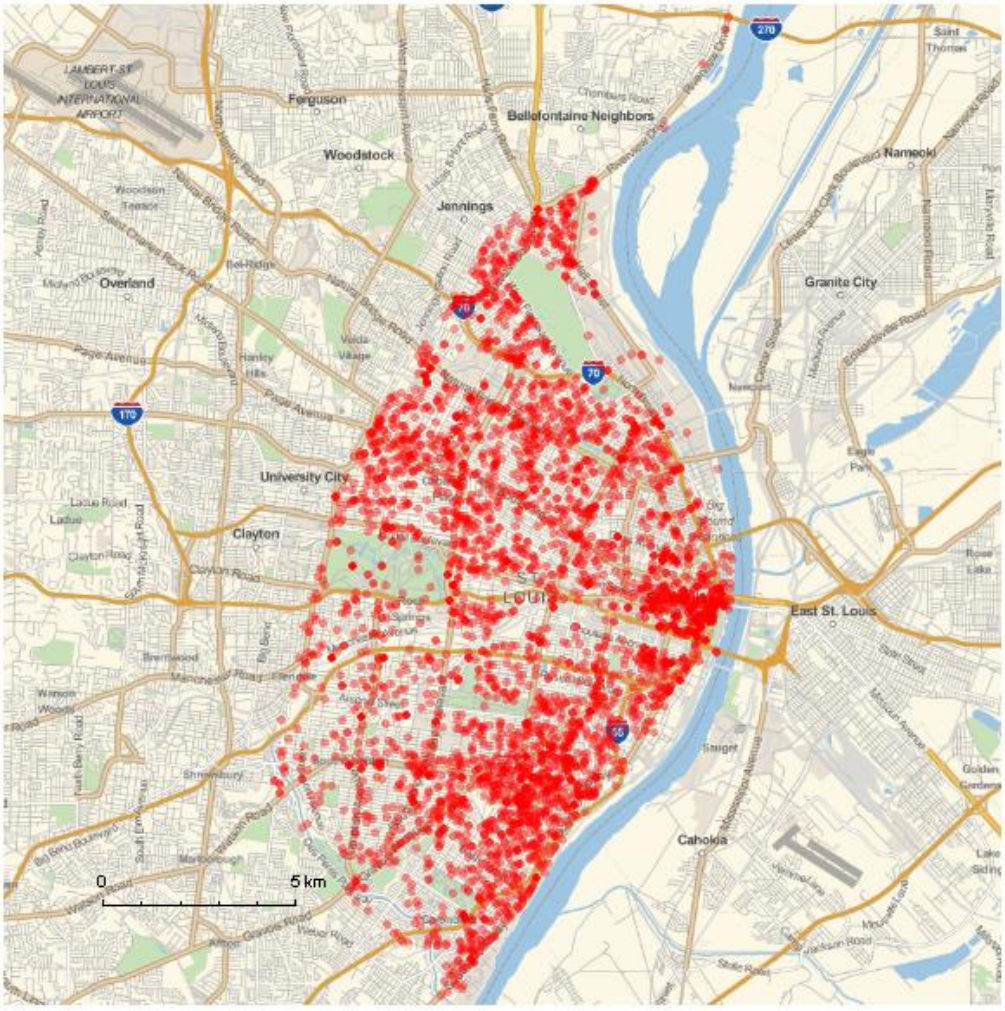


Figure 42. Dot map: Crimes in St. Louis (Buzing and Research, 2014)

- DIAGRAM MAP

The various data content is represented on the map in the form of various diagrams (column, circle, etc.) (Figure 43).

> *"It is a popular representation method for population geography and economic geography statistics. The space available on the map is very limited, so it is advisable to use the simplest small diagrams. If we can only represent the given topic with very complicated diagrams, it is better not to display it on a map because the map can become chaotic. The shape and structure of the diagram depend on the subject to be depicted and the space available on the map. Many types of diagram can be used on maps. There are diagrams specifically related to a topic (e.g., diagram showing age structure). Bar charts are often used because they are one of the most accurate forms of displaying statistical data. The color and hatching of the columns indicate quality, and their height indicates absolute quantity."* (Mátyás and Pődör, 2022, 135.)

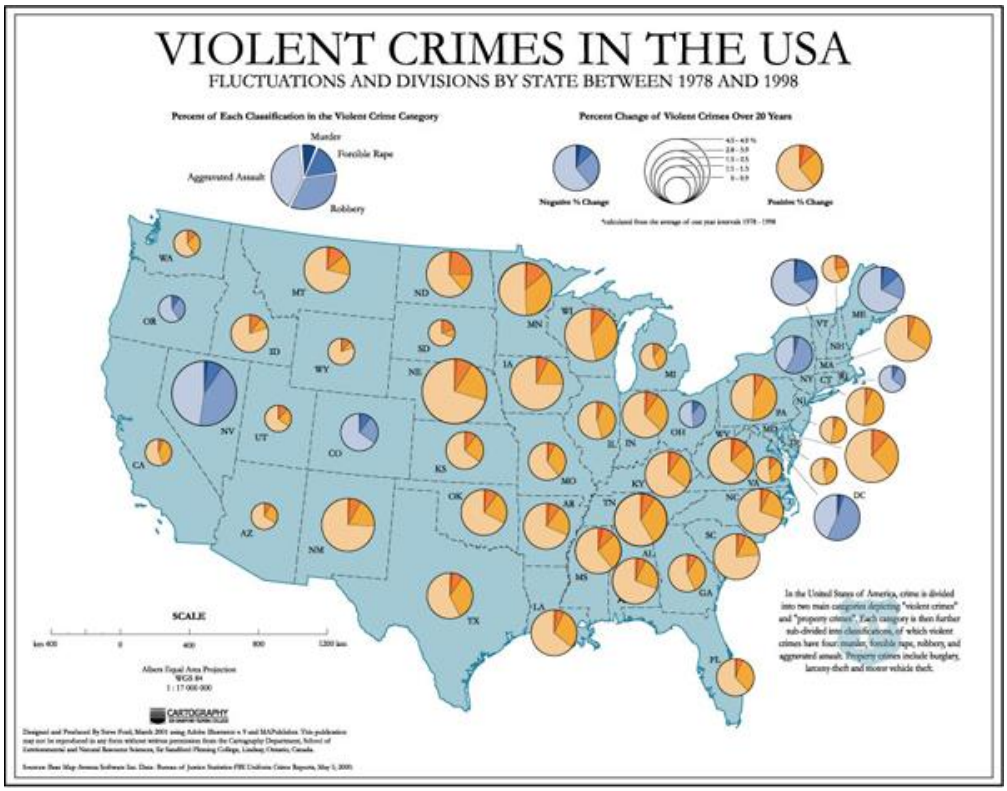


Figure 43. Diagram map: Violent crimes in the USA (1978-1998) (Norén, 2009)

- CHOROPLETH MAP

Shows the statistical data and metrics of a geographical area (e.g., population, registered crimes, and economic indicators). Places with various statistical values – according to the aspect specified in the legend – are represented with different colors or patterns (Figure 44) (Pődör, 2005).

Most geospatial software offers the option of using this method. Cartograms display statistical data (relative quantities) on the surface without an exact reference location (Mátyás and Pődör, 2022).

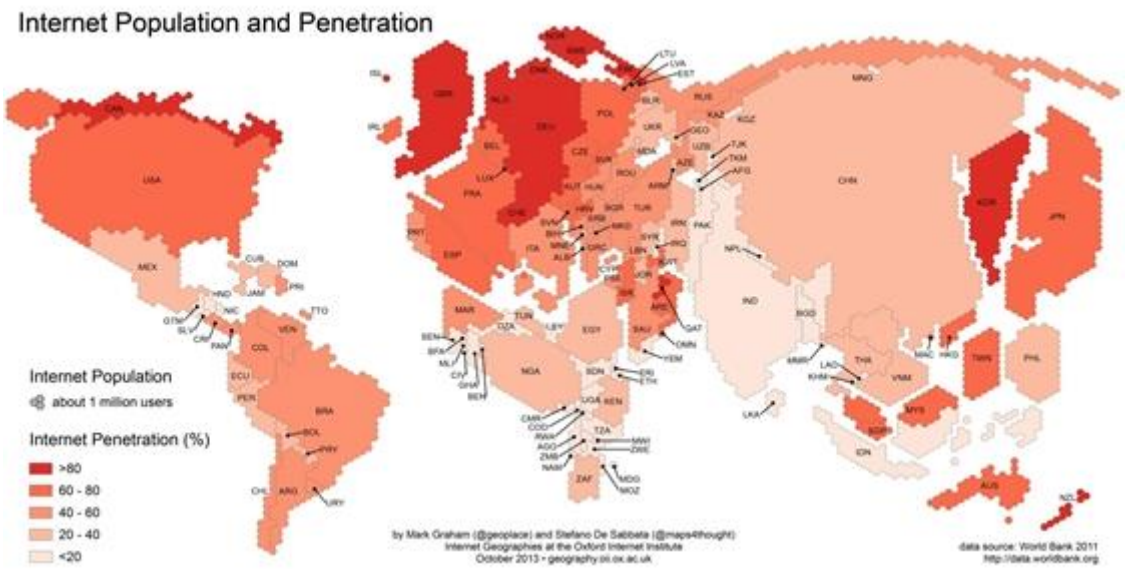


Figure 44. Choropleth map: Internet population and penetration (distorted choropleth map) (HVG, Oxford Internet Institute) (URL 26)

- ISOLINE MAP (iso=equal, word of Greek origin)

A map showing places with the same values. If we connect areas with the same value, we get isolines. Regional differences can be made more apparent if closed isolines running into each other are separated from the average value on the map using some coloring technique. This is called an isoline map (Figure 45).

Maps showing equal crime values do not have a special name in the literature. The term *isopleth* is used in *Mapping Crime: Principle and Practice* (Reno et al., 1999). However, this is a general name and can be used to represent any phenomenon or frequency on an isomap. In the author's opinion, places with the same criminal values are better expressed by the term *isocrime*. This term was coined by Szabolcs Mátyás in 2019.

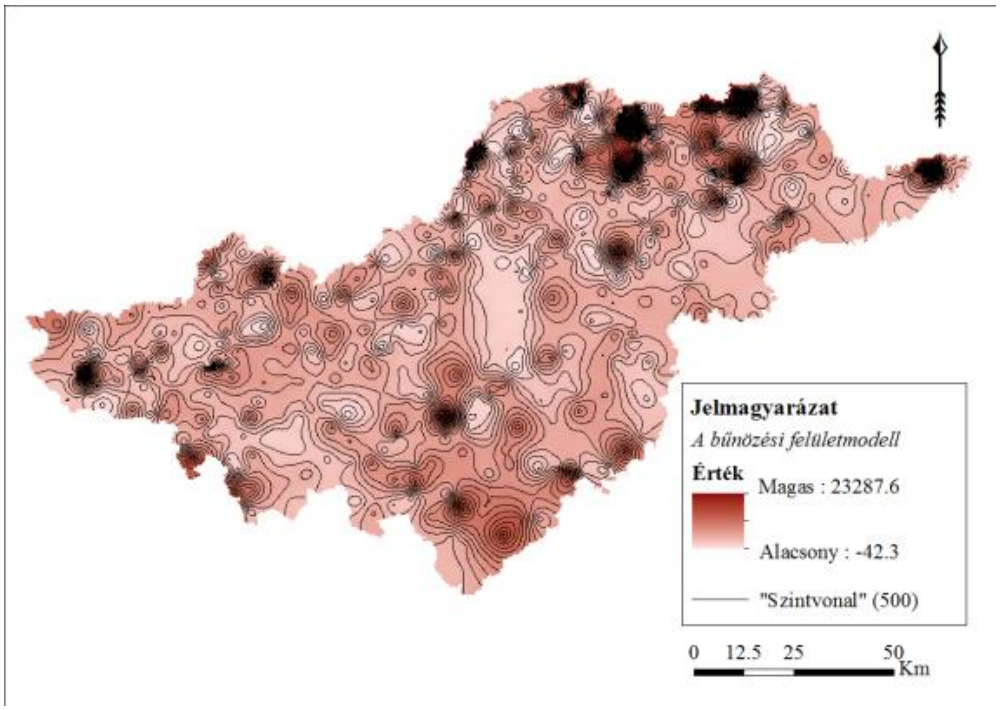


Figure 45. Isoline crime map (isocrime) of the Northern Hungary Region (Piskóti-Kovács 2014, 72)

- PROPORTIONAL SYMBOL MAP

This map type is used to represent absolute values. Most often a dot is used. The magnitude of the dot indicates the magnitude of the absolute value (the proportional symbol map is, therefore, often confused with a dot map). Apart from dots, circles, squares, columns, other geometric symbols can also be used, but dots are used most frequently. The area of the geometric symbol used is proportional to the numerical value it expresses (Ormeling, 2015-2016) (Figure 46).

Figure 46. Proportional symbol map: Depiction of hot spots areas for basement burglaries with size dependent icons
(Created by the Austrian police crime mapping system)

- FLOW MAP

A flow map is a combination of a flow diagram and map. The flow is indicated by arrows. The direction of the flow is indicated by the tip of the arrow and the width of the arrow indicates the volume. It can be used to represent a variety of things (e.g., animal migration, money flow, sea flow, flow of goods), including data related to crime (e.g. major routes and volumes of drug trafficking). There are three types of flow maps; network, radial, and distribution flow maps (Figure 47) (URL 27).

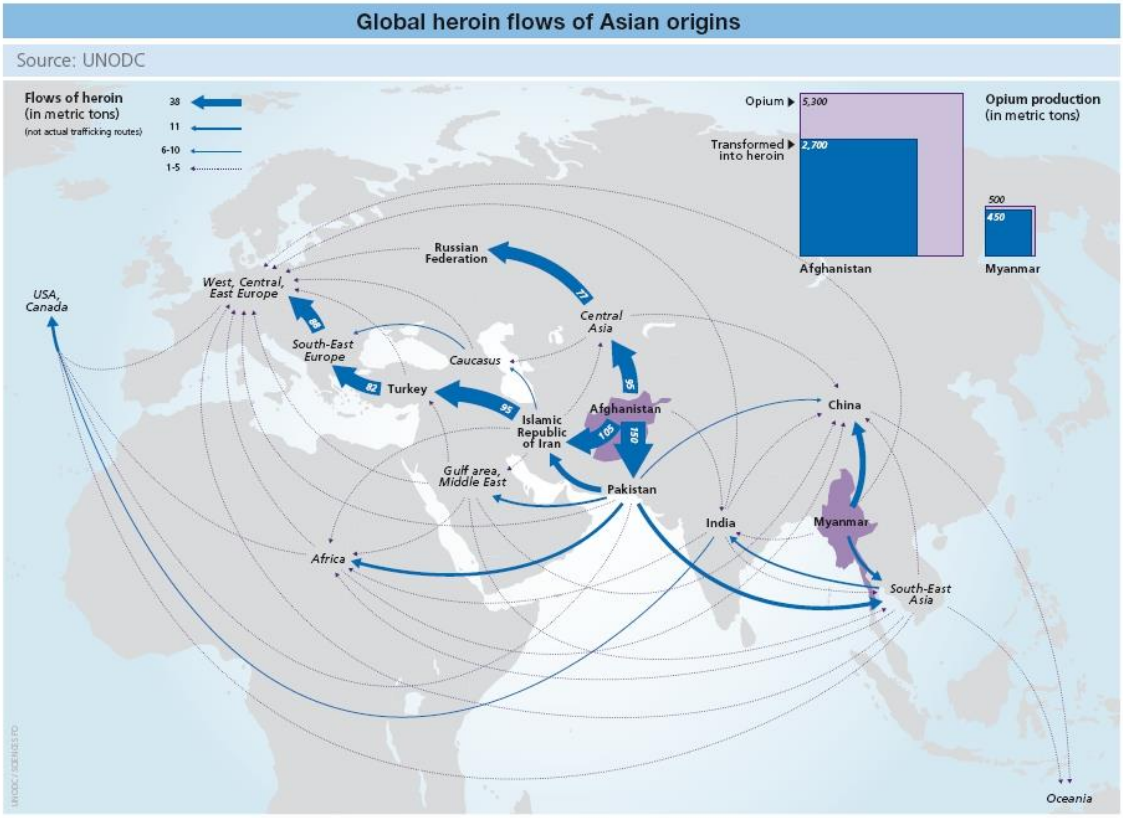


Figure 47. Flow map: Global heroin flows of Asian origin (UNODC, 2010, 45)

- CHOROCHROMATIC MAP

The word *chorochromatic* is a combination of two Greek words (*chora* = region, and *chroma* = color), thus literally *regions of color*. There are also several other names for this type of map (e.g., color-patch, area-class, qualitative area, mosaic map). Chorochromatic maps belong to the group of thematic maps and are widely used (e.g., soil groups, vegetation zones, lithological units or rock groups, and crop regions).

It is a map type that uses color to represent different spatial patterns within a given area, without using numerical data. Within chorochromatic maps two types can be differentiated; simple chorochromatic maps and compound chorochromatic maps (Sukamal, 2021) (Figure 48).

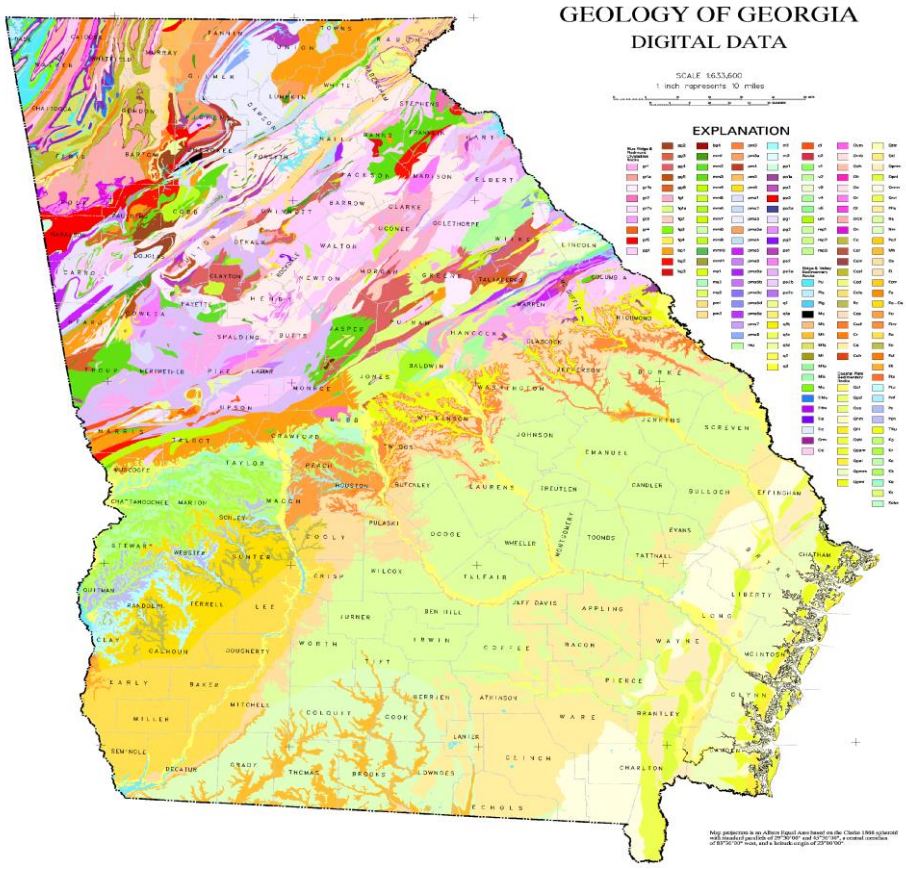


Figure 48. Chorochromatic map*: Geology of Georgia (URL 28)*

8.9.1. The Mátyás crime classification system

There are a number of problems that can arise in the spatial representation of crime. In the map representations currently used, it is possible to represent two factors separately: (1) the representation of total crime, and (2) the representation of individual crime types.

When plotting total crime, there are two options, either the absolute or the relative (calculated indicator) value is plotted on the map. Several authors have pointed out that absolute values do not represent the real crime situation, and that this can be very misleading (Patkós – Tóth, 2012). The real situation is better expressed by calculated indicators (e.g. a ratio of 10,000 or 100,000 inhabitants), but in the case of crime, this is not a good indicator of the real crime situation in most cases. One can think, for

example, of a situation in which a large number of crimes are committed in series, hundreds, sometimes thousands or tens of thousands of offences. These cases can be handled administratively (e.g. by calculating a cleaned crime value from the serial crime, so that only one crime will appear in the statistics), but even this representation does not reflect the real situation.

The representation of each type of crime better reflects spatial differences in crime, as the volume of total crime is a more accurate representation of spatial specificities for certain types of crime. It is primarily the socio-economic characteristics of an area that have a significant impact on crime trends (Sallai et al., 2016), but for some offences these factors have a larger than average impact on the number and structure of crimes (e.g. robbery, burglary). However, neither the representation of total crime nor the representation of individual crime types provides sufficient information on its own.

A set of indicators is needed that combines crime numbers and structural differences in crime. A system where, in addition to the total crime rate as a percentage of the population (base crime), a visual measure of the structural difference is also available. This can be illustrated by using the crime classification system developed by the author.

The basic idea of the new crime classification system is based on Köppen's meteorological classification system, therefore, in order to understand the concept of the crime classification system, it is necessary to outline the principles of Köppen's meteorological classification system.

Köppen used the first capital letters of the alphabet (A, B, C, D, E) to denote the major belts (tropical, arid, warm-temperate, continental-boreal, polar and high mountain). This five-letter division was also adopted by the author for the first letter. In Köppen's system, the second row of letters (W, s, f, s, w, m) indicates the amount of precipitation. The third row of letters (h, k, a, b,

c, d, F, T) indicates the climate thus formed, which in turn refers to the temperature.

The Köppen system has been very successful and is still in use. The reason for its success was that its alphabetic notation was a very 'visual expression of the characteristics of climates' (Dobosi and Felméry, 1994, 156). For the present classification system, the author uses a two-letter combination, as opposed to the Köppen three-letter combination (first letter code row: A, B, C, D, E; second letter code row: a, b, c, d, e). In Köppen's system, both the second and third letter codes represent more than five factors. In the author's view, it is sufficient to look at the five offences that most undermine the public's subjective sense of security, and it is therefore unnecessary to burden the transparency of the system with more offences.

In order to avoid chaos and to make the representation easy to understand, five categories are also displayed for total crime. Compared to the national average (91% – 100%), two categories are set up in both positive and negative directions, with equal divisions. Within a group, excluding the two extreme values, there is a 10% difference between the categories. The use of equal spacing is also common in traditional map plotting.

In the case of total crime, in order to avoid distortions from individual outlier years, it is advisable to use a so-called cleaned crime value and/or average over several years, as this better eliminates the extremes of individual years.

For the first letter code row, the following values are used:

A) 111% or more

B) 101%-110%

C) 91%-100%

D) 81%-90%

E) 80% or less

However, the first letter code can only be used to indicate the specific number of offences. It is not possible to plot "quantity" and "quality" together. In order to make this possible, it is necessary to show quality in addition to quantity. The quality is represented by each type of crime. Five types of crime are represented. Those crimes that have a major impact on the subjective perception of safety of the population (this is of course flexible).

The second letter code row is marked by the offences:

a. Homicide

b. Violent sexual offences

c. Robbery/armed robbery

d. Vehicle theft

e. House burglary

For both classifications, a "strength order" should be used, for logical reasons and for better traceability. In the case of the first set of letters (A→E), there is no difficulty in giving the values in ascending order, since the categorization is based on absolute values ("A" is the strongest). For each crime, the lower case letters of the alphabet indicate the "strength" (a→e) ("a" is the strongest). The letter "a" indicates the crime that most impairs the subjective sense of security, homicide. The other crimes (b, c, d, e) are decreasingly detrimental to the public's sense of security. The capital letter (A-D) is accompanied by the lower case letter (a-e), which is mostly above the national average. It is possible that several crimes are above the national average. In this case, the crime associated with the letter is the one with the largest percentage difference from the national average. However, it is also possible that all five crimes have a crime rate below 100 per cent of the national average. In this case, the letter of the crime with the highest value is

also placed next to the capital letter, but this letter must be indicated in some way, which is also mentioned in the textual assessment.

These letters are shown in circles to make it obvious at a glance that the value differs from the national average. The calculated crime rates can be displayed in several ways. The simplest way to display them relatively simple (Figure 49).

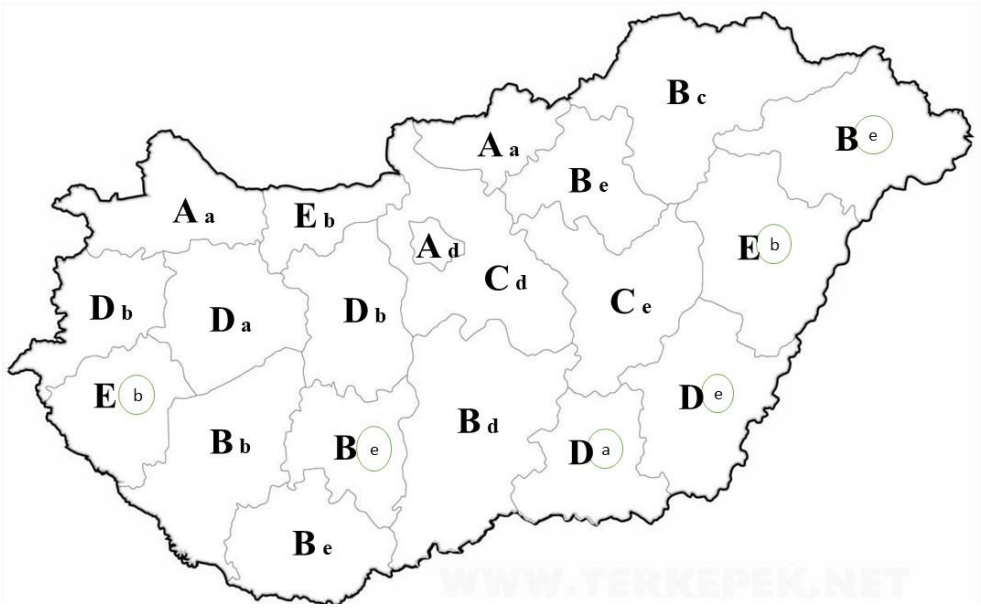


Figure 49: The Mátyás crime classification system for Hungary (2019) (own editing)

To make it even more visual, the representation can be done on a topological map, or even by thickening the boundary lines to show the difference between neighboring polygons.

A total of twenty-five variations can be selected from the two categories (quantity and quality).

The new crime classification system has several advantages over the previous maps.

- The advantages include the fact that the system can be applied in any country and is not limited to any one nation because of the specific legal environment.
- The two scales are flexible and can be adapted to local needs (e.g., different legal systems and offences)
- It can display several categories of offences at the same time, thus giving a good indication of which offences are the most problematic in a given place
- It is easy to see the system and the areas represented.

There are also limits to the system. In an analysis where a large number of settlements in close proximity to each other have to be plotted, the graphical representability is limited because the map will be less transparent. The system is suitable for analysis at the county level, but is only recommended for use at the municipality level if there is a filter, i.e. not all municipalities are shown.

8.10. Duration shown on a map

Depending on the goal of the map, different time intervals, from a few days to as much as several years, can be represented and displayed. Based on this, the following map types can be distinguished:
- DAILY: A map depicting any day of the week or a maximum of six days (e.g., to depict serial crimes).
- WEEKLY: Map type displaying a period of one, two or three weeks (e.g., representation of serial crimes).
- MONTHLY: A type of map depicting one or more months of the year (e.g., after a new road section has been handed over, the locations of accidents can be summarized in map form to decide, for example, on which part of the road section speed limit signs should be placed.

- ANNUAL: Map type displaying one or more years (e.g., to show crimes registered in a given year)

8.11. Hot and cold spots

A) CONCEPTUAL DEFINITION

The concept of the hot spot is closely related to crime mapping. There is no universally accepted concept. "Hot spot should be understood as a relatively small area where the concentration of crime is higher than that of the surrounding area, even for a longer period of time." (Mátyás, 2017b, 142.) There is also a hot spot in the geological sense. The terms *crime hot spot* and *geological hot spot* are also used for differentiation.

Why is it important to be able to separate and examine adjacent areas? Tobler's first law of geography gives the answer: "Everything is related to everything else, but near things are more related than distant things." (Tobler, 1970, 236.)

Why is it necessary to demarcate hot spots (that is, criminally infested areas)? Let us assume that there are seven cities with the same number of inhabitants and the same number of crimes. Despite the similarity, the same policing intervention should not be used because the distribution of crimes is different. To model this, let us look at five mosaics. Each of the five mosaics is 5x5, that is, consists of 25 individual squares. The individual mosaics (cities) are equally infested, but the distribution of crimes is different. In the first idealized case, A, the mosaic, is made up of identical elements; that is, the distribution of crimes is equal. In reality, this is obviously very rare, except when there is no territorial inequality. In the cases B and C, different configurations (arrangements) can be observed. In the case of D and E, we can speak of different heterogeneity (territorial inequality). Each square is characterized by different values.

If this is observed in reality, different police measures are required here than in the previous cases. Regional science can provide more by examining spatial shapes and distributions than studies of territorial inequality (Nemes Nagy, 1998).

The aforementioned *spatial mosaic model* examples clearly show that, despite the fact that we see a single administrative unit, its individual parts can have a variety of characteristics (e.g., crime, population, settlement structure). This results in the fact that we cannot consider any administrative unit to be a homogeneous space, which is partly why it is important to consider imaginary boundaries within a territorial unit when defining the boundaries of hot spots (Figure 50).

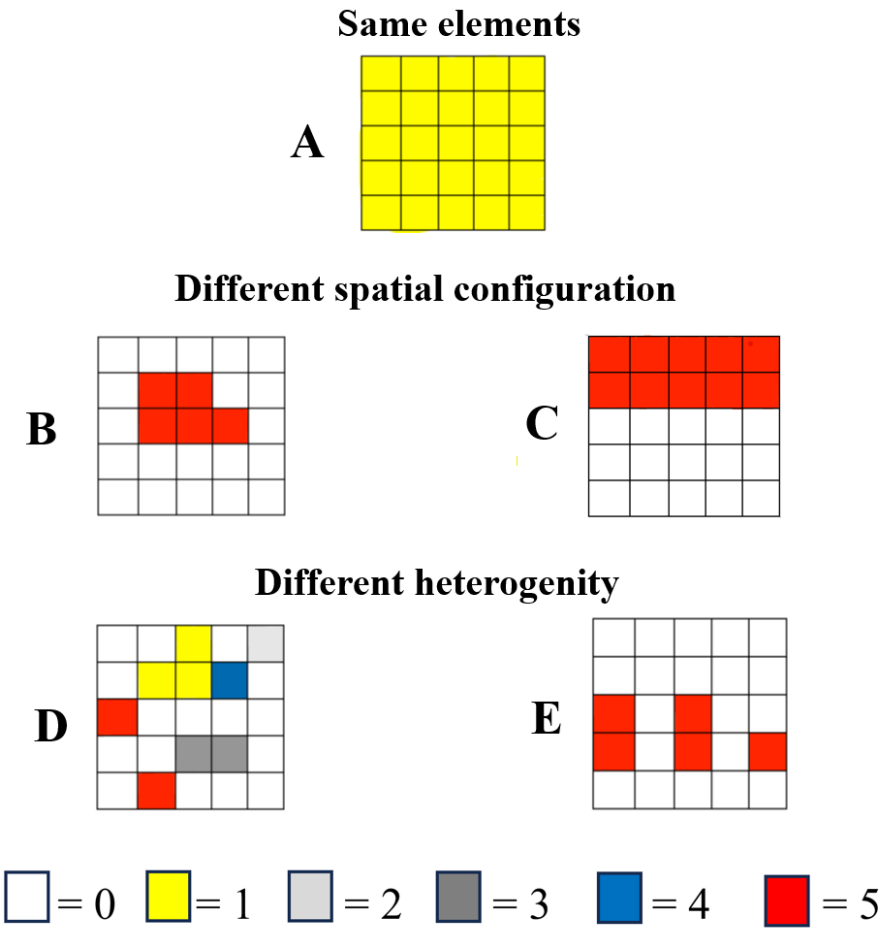


Figure 50. Spatial mosaic model (after Nemes Nagy /1998/ the author)

"Hot spots do not exist in reality, but are areas where there is sufficient clustering of certain activities (in this case, crime) such that they get labeled such. There is no border around these incidents, but a gradient where people draw an imaginary line to indicate the location at which the hot spot starts." (Levine, 2013, 1.)

Spatial organization can be observed in many areas of life, and it can also be adapted to the spatial distribution of crimes. Figure 51 shows the prevalence of the Mormon religion, based on which four sharply distinguishable zones can be observed (1. core, 2. domain, 3. sphere, 4. outliers) (after D.W. Meinting, Nemes Nagy, 1998).

Figure 51. Space divided by intensity zones (Nemes-Nagy, 1998, 20.)

For the hot spots, let us mention three theories regarding the depicted location:

- Place theories (place theories explain why a crime happened in that particular place. The lower level of committing crimes, specific addresses, places of police actions, etc.)
- street theories (street theories deal with data at a higher level than place theories [streets, blocks of houses, highway sections, road sections])

- Neighborhood theories (a higher level than the above two levels, they deal with connected areas, such as the area of a gang's operation) (Eck et al., 2004).

During hot spot analysis, it is possible to develop a new type of policing strategy, known as *hot spots policing*. The essence of this is that the law enforcement agency concentrates its measures on hot spots with high crime values, during which it carries out targeted actions across a smaller area (Borbíró et al., 2016). While the hot spot policing strategy is in place, infestation is reduced proactively through the increased demonstrative police presence (Boda, 2019).

With regard to the definition of hot spot, it is worth mentioning that most researchers do not define the *factual elements* included in it. In other words, how extensive the area of a hot spot (*small area*) might be is an open question, as is the length of the period that should be taken into account for its investigation. According to SHERMAN, one of the most respected researchers on the topic, a period of more than one year should be taken into account, and there should be a frequency difference of about six times between the hot spot and its immediate surroundings (Sherman, 1995). Hot spots are not static but dynamic formations that change continuously in space and time (Tóth, 2007). They are marked in red in the case of the map display. Regularity can be observed in the distribution of the temporal and territorial concentrations of crime, and they can even be typified (Figure 52).

Cold spots are the opposite of hot spots, indicating areas with a low attribute, and a lower crime rate than the average for the surroundings. In the case of map displays, they are usually marked in blue.

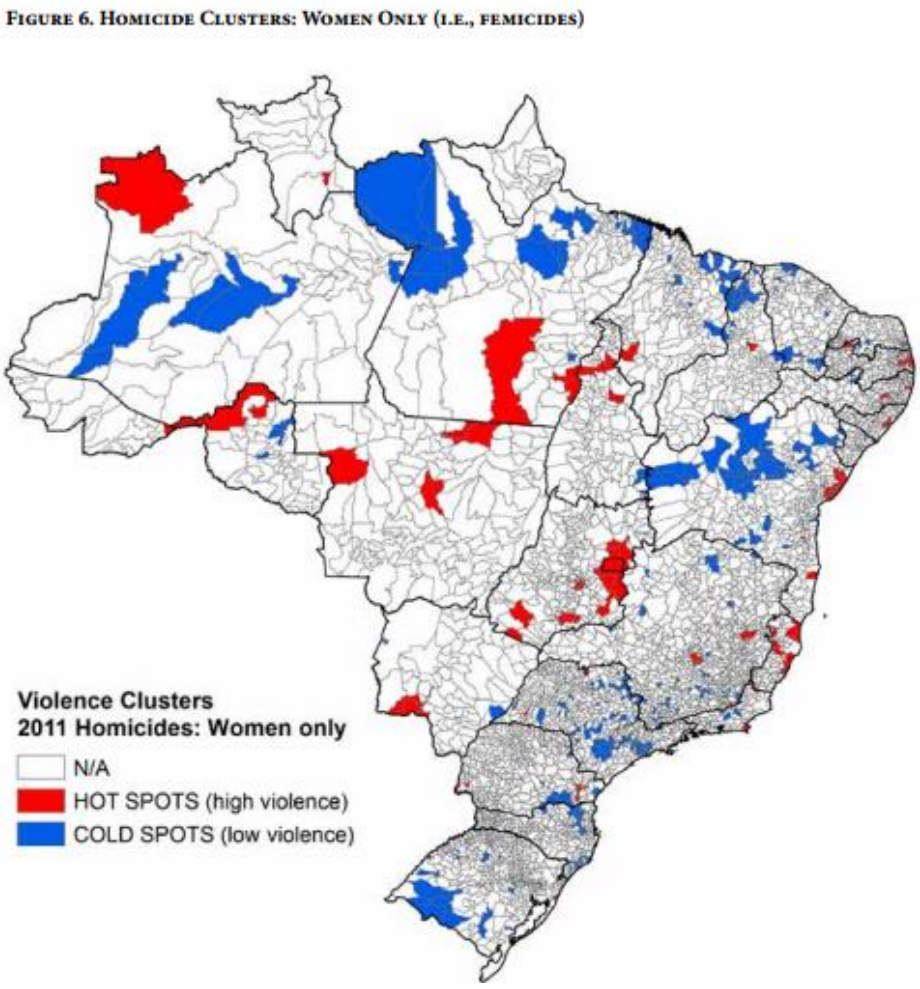


Figure 52. Homicide clusters in Brazil – Hot spots (red) and cold spots (blue) (Cawley, 2014)

In hot spot analysis, the Getis-Ord Gi* local statistical method is used to detect hot and cold spots. This makes it possible to detect clusters [Getis-Ord Gi* is a local indicator of spatial association (LISA), just like Moran I] (Figure 53).

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}} \quad (1)$$

where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - \left(\bar{X}\right)^2} \quad (3)$$

The G_i^* statistic is a z-score so no further calculations are required.

Figure 53. The Getis-Ord statistical formula (URL 29)

B) THE RESEARCH HISTORY OF HOT SPOTS

American researchers were the first to study hot spots. Based on more than 300,000 phone calls received by the police. SHERMAN, GARTIN, and BUERGER examined the magnitude of the territorial concentration. In Minneapolis, it was found that 50.4% of emergency calls came from 3.3% of the city area (Sherman et al. 1989); and SHERMAN L. W. and SPELMAN W. (1995) noted that hotspots have developmental cycles. Their formation is usually the consequence of some minor act being committed, for example, the graffiti on walls and broken windows, etc., of any neighborhood (see: *broken windows theory*). If further, more serious crimes occur in the crime-infested area, or crimes appear in neighboring areas, the hot spot continues to grow. If, on the other hand, it is possible to curb the further spread of crimes in the area, or if it is possible to suppress them, then the area of the hot spot will shrink and thus begin to decline (ideally, it might even

disappear). These hot spots exist in an amoeba-like form; their shape and extent can changing several times a year. Moreover, it is evident in some hot spots that their extent changes cyclically (e.g., in the case of seasonal tourist destinations). But, of course, there are also hot spots that have been a source of crime in a settlement over years and decades.

C) TYPIFICATION OF HOT SPOTS

There are many groupings and classifications of hot spots. One of the best known of these is the hot spot matrix created by JERRY H. RATCLIFFE (Figure 54). The main virtue of Ratcliffe's typology compared to earlier typification by others is that it already includes the time factor (temporal activity of the hot spot [time of day, day, week, month]). Previously, researchers had mainly investigated the size and spatial characteristics of hot spots. Ratcliffe displayed both the spatial and temporal planes in his table. Based on the temporal characteristics, he isolated three categories: *diffused*, *focused* and *acute*. A hot spot can be considered diffuse if the occurrence of crimes is more or less uniform over a given period. The hot spot is focused in terms of temporal characteristics, and if the temporal distribution of delicts is uneven, outliers can be discovered. Ratcliffe sees hot spots as acute, where the time interval of criminal activity can be very strongly limited. According to Ratcliffe, the spatial characteristics of hot spots can also be of three types: *scattered*, *clustered* and *point-like*. A hot spot is scattered if the distribution of crimes in the focal point can be considered almost uniform.

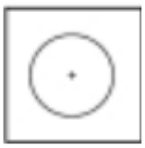
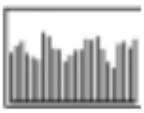
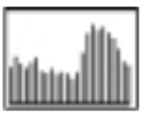
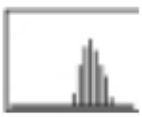
Policing Hotspot Matrix		Spatial		
		Dispersed 	Clustered 	Hotpoint 
Temporal	Diffused 	Uniform vehicle patrols, architectural changes, public education campaign	Random breath tests, foot patrols, architectural changes, publicity campaign	Roadblocks, plain clothes patrols, random breath tests, private security, CCTV
	Focused 	Uniform vehicle and foot patrols, improved lighting, public education campaign	Vehicle and foot patrols, random breath tests, private security, improved lighting	Surveillance units, plain clothes foot patrols, CCTV, surveillance of entry/exit points
	Acute 	Unmarked vehicle patrols, private security, improved lighting	Surveillance and plain clothes patrols, CCTV	Surveillance, arrest squads, CCTV, unmarked police units

Figure 54. Policing Hotspots Matrix (Ratcliffe, 2004, 17.)

A hot spot can be regarded as clustered if, even within a given focal point, there is an area where the frequency of crimes is above average. According to Ratcliffe, a hotspot is defined as a crime hot spot if the it was created due to only one source. The latter also strongly determines the size of the hot spot. Its diameter can be up to several hundred meters. In addition to the virtues of Ratcliffe's matrix, the fact that the author only thought in daily

cycles is seen as a flaw, which means that larger time intervals (week, month, and year) cannot be interpreted, including seasonality. In his table, Ratcliffe also includes, for each type of focal point, the forms of police action and procedural methods that, in his opinion, might be most effective for a specific kind of focal point (Hlavacska, 2014).

D) HOT SPOT CRIMES

Not all crimes automatically generate hotspots, so-called street crime is what can create hotspots. Primarily, those types of crimes that negatively affect the subjective sense of security of the population can be considered hotspots (e.g., theft, burglary, robbery, car break-ins). This does not include, among other things, internet crimes, white-collar crimes, etc. (URL 30) Therefore, an approach in which crime overall is represented as a hot spot is wrong.

Covering a hot spot

One of the most important issues when investigating hot spots and applying hot spot policing strategies is covering a hotspot, that is, the localization of the area to be investigated. Superficially, drawing the borders of a hot spot seems like a simple task, but in practice, it is far from simple. Demarcation of borders is complicated by, among other things, temporal and spatial changes in hot spots. A variety of geospatial software can be of great help in eliminating this. If the hot spot area is underestimated (that is, it appears smaller than it really is), then places where crimes can potentially be committed are left out of control during patrols. The probability of a crime being committed is higher where a violation has already been committed (Perry et al., 2014). If, on the other hand, the size of the demarcated area is too large, it will be more difficult to perform effective work since the control of the area will require more force and equipment (more police officers and police cars are needed).

The following four techniques are used to cover hot spots: 1. grid mapping; 2. covering with ellipses; 3. kernel density estimation; 4. heuristic modelling.

Grid mapping

> *"A method for resolving an unequal area in which a standard-sized grid is used for analysis. The analyst begins by placing an artificial grid (generated by GIS) on top of the area of interest and then uses graduated-color shading classifications to show a variety of levels of crime."* (Santos, 2017, 610.)

Grid mapping can be classified as one of the easiest hot spot covering techniques because the neuralgic areas are covered with square grids. On the other hand, the disadvantage is that the lines of the square grids usually do not follow the lines of the streets, so the covered area (the hot spot) can be smaller or even larger than in reality.

Covering with ellipses

During the process, the areas in question are covered with an elliptical flat, which can also be classified as a simple covering technique. The disadvantage of covering ellipses is similar to that of grid mapping (i.e., the covered areas do not always define the hotspot area precisely).

Kernel density estimation

Kernel density estimation requires more serious knowledge of GIS than in the abovementioned techniques. Kernel density estimation is not only used in crime sciences but can also be used in many areas of life, for example, market analysis in economics. In the case of crime, they try to identify the places where the crime infestation (density) is the highest, and then, moving away from this, we find decreasing values. Areas with decreasing infection

values may still be part of the hot spot, as their infection levels may still be above the environmental average (Figure 55).

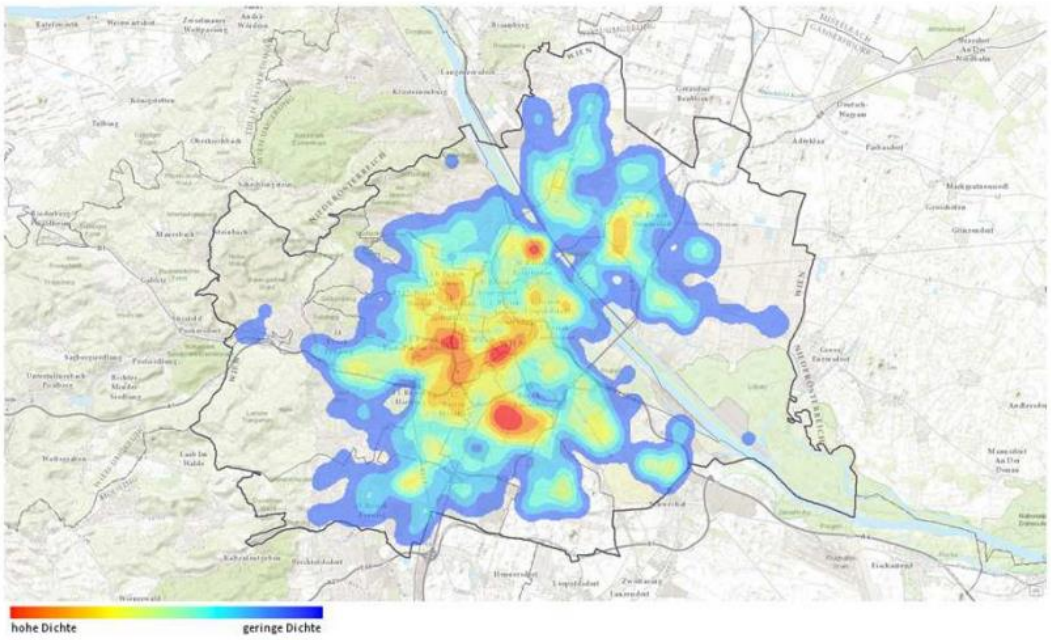


Figure 55. Heat map (Kernel Density Analysis) – Burglary in Vienna (Created by Austrian police crime mapping system)

Heuristic model

Among the hotspot coverage techniques, the most frequently used technique is the so-called heuristic model. The word is of Greek origin and means *to find, discover*. The police officer *finds out* the area of the hot spot and *leads themselves* to where they need to take action. After a few years of service, the officer will already have a good sense of the places where a crime is most likely to be committed. They will know and be familiar with the temporal and spatial characteristics of hot spots (e.g., riots and assaults are likely on certain streets on Friday and Saturday nights, and robberies are typical on other streets). Based on this, the hot spots can be identified without any kind of geospatial analysis, although a software analysis allows a more thorough identification.

E) HOT SPOTS POLICING

One common feature of the various policing strategies is that each of them – albeit in another way than the previous ones – is intended to achieve a crime reduction (Christián, 2015). Hot spot policing aims to reduce the number of crimes in a different way to previous policing strategies. Thanks to the spread of GIS software, the new kind of strategy has become a widely used method worldwide. Analysis programs have enabled more thorough analysis than before, and hot spots can be delineated much more precisely. The prominence of place-based research has facilitated the success of hotspot policing. In connection with this, two policing strategies and one criminological aspect should be mentioned that have significantly impacted this novel theory: rational choice theory, routine activity theory (Cohen and Felson, 1979), and environmental criminology (Cornish and Clarke, 1986; National Institute of Justice, 2013).

There have been many experiments on the effectiveness of hot spot policing, most notably in the United States. These experiments have sought to find the optimal patrol time that is sufficient to reduce the number of crimes (Braga and Bond, 2008). Among others, experiments in this direction were carried out in Minneapolis (Koper, 1995) and Sacramento (Braga and Bond, 2008). It has been determined that a minimum of ten minutes of patrol time is required in a given hot spot area; the optimal patrol time was found to be between 11 and 15 minutes. The basic principle of hot spot policing is place-based, as opposed to previously used person-based policing techniques. In other words, they do not monitor specific persons, but patrollers have to stay in clearly visible places for 11-15 minutes and communicate with the residents. Patrolling should be repeated randomly, which increases the subjective sense of security in the population (since they regularly see the police) and deters criminals from committing crimes (since they know that patrols can appear in the area of a given hot spot at any time).

We should mention here that hot spot policing is less popular in most countries, where instead of hot spot policing (based on hot spot knowledge), data-driven predictive policing has been used since early in the 21st century (Tompson, 2022).

8.12. Connection points of GIS and crime geography

Nowadays, the research opportunities provided by GIS are indispensable, including in law enforcement. In the United States, GIS-based systems appeared towards the end of the 1980s with the rise of GIS.

GIS in the English speaking area is known either as GIS (Geographical Information System) or as geoinformatics. Spatial informatics, developed on the border between geography and computer science, is "the summary name for the procedures for collecting, storing, organizing, analyzing and displaying spatial data in a database." (Sík, 2013, 25.) Geospatial informatics is also known as the science of spatial information due to its synthesizing characteristics.

The question may legitimately arise as to why the application of geospatial information might be helpful for law enforcement practitioners. By using GIS-based programs (e.g., ArcGIS, CrimeStat, QGIS, AutoCAD Map 3D), virtually any social process can be visualized and modelled, allowing us to perform spatial operations with geocoded[8] data (e.g., spatial data collection, management, processing, analysis, modelling, visualization) (Pődör, 2007). Geospatial information can be a tool in our hands to better understand the processes and phenomena of the environment and to be able to use spatial information as efficiently as possible (Márkus, 2002).

[8] Geocoding is the process of assigning a pair of geographic coordinates to an object with an address. This is important because it can connect external databases to the map and represent it in the appropriate place in space.

In many countries, websites were created where crime maps were available. Most of these were not public, they were prepared only for the police, the prosecutor's office, and researchers. Several websites were also completed that were open and accessible to the public. Examples include the American *http://www.crimemapping.com/* and the English *http://www.police.uk/* websites. Seeing the high level of interest, software developers have also developed several mapping software programs, e.g., ArcView: Crimeview; Levine: CrimeStat, ESRI: Crime Analyst for ArcGIS (Piskóti-Kovács, 2014).

Chapter 9.
THE RELATIONSHIP BETWEEN CRIME PREVENTION AND CRIME GEOGRAPHY

One of the main tasks of crime geography is to formulate crime prevention proposals based on the problems revealed during research. Pursuant to the decision of the Council of the European Union on May 28, 2001:

> *"Crime prevention is all measures and interventions whose purpose or result is to reduce the quantity of crime, to improve the quality of citizens' sense of security, be it by reducing the opportunities for crime, mitigating the impact of the causes that cause crime, or by preventing offending."*

After preparing a crime geography analysis, it becomes necessary to formulate a number of proposals and comments that may have a crime prevention role. Due to the limited scope, this publication cannot and does not wish to provide detailed information on crime prevention, but it would like to highlight one specific segment of crime prevention, namely, Crime Prevention through Environmental Design (CPTED) (Mátyás, 2013).

According to Endre Dallos, CPTED:

> *"Includes those architectural, settlement development, landscape and garden construction, traffic technology, light technology, psychological and communication methods, as well as their combined application, which, through the subsequent transformation of the built environment and the conscious planning and implementation of the*

environment to be created, the possibilities of committing a crime are reduced or eliminated." (Dallos, 2011, 124.)

In this case, the point of connection between crime prevention and geography is urban development, the knowledge of which can greatly help in the application of successful CPTED.

9.1. CPTED and situational crime prevention

The very broad concept of crime prevention also includes those precautions that make it physically impossible to commit a crime; that is, they contribute to reducing the number of crimes through architectural solutions (Pusztai, 1995). This segment of crime prevention is known as CPTED. The roots of CPTED can be traced back to the 1960s and 1970s, when crime geography investigations were already focused on the smallest architectural unit within the settlement, residential blocks. During these investigations, it was established that some architectural solutions increase, while others decrease, the frequency of crimes being committed (Dallos, 2008).

Perhaps the best-known representative and father of the topic is OSCAR NEWMAN, who investigated the relationships between the design of residential areas and the frequency of crimes in about 150,000 city-owned apartments in New York in the 1970s. The main findings of the research include the fact that the most endangered high-rise buildings are taller than seven floors and have a single entrance and common lobby. It was his view that it is worth creating residential units in which a maximum of 6-10 families can live (Dallos, 2008). During his research, DONALD APPLEYARD (1981) examined the relationship between residential blocks and the road next to them. He found that road traffic and community control are inversely proportional to each other.

CPTED is mainly dealt with in North America, Australia, Germany, Great Britain, the Netherlands and the Scandinavian countries (e.g., in the United Kingdom, every police station has a *design adviser* or an *architectural liaison officer*). The European Union has also noticed the problem, and its AGIS program supports, among other things, research related to CPTED aimed at preventing crime in housing estates within the framework of the CPC project. English, Dutch, Hungarian and Polish researchers participated in this [Crime Prevention Carousel (CPC)] (Irk, 2008).

In the United States, CPTED was introduced as a subject at the University of Louisville (Kentucky) in 1985. Between 1994 and 2002, the US government's largest CPTED program was launched, which was extended mainly to municipal rental apartments (Kara, 2017).

The initial CPTED techniques (CPTED 1.0) used almost exclusively architectural solutions, while nowadays other solutions are also used to reduce crime (e.g., the use of lights, scents, sounds, and colors). In addition to the above, there is an approach that no longer focuses exclusively on changing the built environment but also pays attention to the communities and their involvement (CPTED 2.0). Among other things, the second-generation principles define demands such as community culture, social cohesion, and the establishment of social relations (Molnár, 2018).

To reveal the areas at risk, crime maps are also prepared during CPTED, which sensitively show the parts of the settlement where architectural interventions are necessary.

In connection with CPTED, situational crime prevention is also often mentioned. These concepts are closely related; however, situational crime prevention has a much broader meaning, as it includes CPTED, as well. According to KATALIN GÖNCZÖL, the concept of situational crime prevention (or situational prevention) is "the totality of efforts aimed at reducing the number of occasions that facilitate the commission of a crime" (Gönczöl,

2006), and as Clarke, Ronald V. expressed it, it is "the totality of opportunity-reducing measures" (Clarke, 1995). One of the central concepts of situational crime prevention is *Defensible Space*, which is also a concept used in CPTED.

Therefore, every settlement needs to develop a complex crime prevention concept, including CPTED. Preparing these should be the joint task of the architects and developers of the local government and the crime prevention specialists of the police (Figure 56).

Figure 56. Fence built according to CPTED principles (Debrecen, Hungary) (Photo taken by the author)

Chapter 10.
THE RELATIONSHIP OF CRIME GEOGRAPHY WITH OTHER SCIENTIFIC FIELDS

In the following chapter, three areas are presented that are closely related to crime geography. In the case of each field, hundreds of scientific publications are published annually; however, one can hardly read about the connection between crime geography, predictive policing, geographic profiling, and settlements and urban development. This book does not mention the above areas in detail because the narrow limits in scope do not allow it. The goal is for the reader to see the connection between these disciplines and to look differently at the relationship between crime geography and the following areas.

1. Predictive policing

Nowadays, predictive policing is one of the areas that many people research, which is also shown by the fact that many studies have been published on the topic. The author of this book has also published numerous articles and a book on this topic. On the other hand, the authors do not sufficiently emphasize the relationship between predictive policing and geography. However, a close relationship between the factors used for forecasting and geography is evident.

The author is a geographer, and so looks for the geographical connection point in everything. In predictive policing it is relatively easy to find, as the field is closely related to geography.

All predictive software is equipped with GIS-based software that creates maps where future crime locations can be seen. This is the most spectacular point of connection between predictive policing and geography (cartography). The factors on which the software makes predictions are less familiar to the general public. Manufacturers mostly keep the algorithm secret (or formulate the operating principle vaguely), which is understandable since if the *secret* is revealed, anyone can make a clone of the software.

On the other hand, the factors taken into account by the software are mostly specified by the manufacturers, which causes the hearts of geographers to beat a little faster at the sight of the many important geographical factors here, too. It is well known that physical and human geographical factors play a role in the occurrence of crime.

Below, we look at some of the better-known predictive software packages in which geographical factors are used for forecasting (the name of the software is in parentheses).

- Geographic location of police stations, weather data, economic and demographic data (Hitachi Visualization Predictive Crime Analytics)
- Economic and demographic data (Crime Anticipation System)
- Weather data, temperature values (IBM)
- Weather data, socio-economic data, relief data (e.g., altitude, location of waters) (HunchLab®).

The above also shows that geographic factors also play a significant role in predicting crime. In the author's opinion, crime geography can play an essential role in expanding or clarifying the range of geographic factors needed for forecasting in the future, as there are certainly other geographic factors that have predictive value.

2. GEOGRAPHIC PROFILING

Geographic profiling (or in the UK, geographical profiling) is increasingly gaining ground in investigations around the world. According to one of the best-known representatives of the topic, Kim Rossmo:

> *"Geographic profiling is an investigative methodology that uses the locations of a connected series of crime to determine the most probable area of offender residence. It is applied in cases of serial murder, rape, arson, robbery, and bombing, though it can be used in single crimes that involve multiple scenes or other significant geographic characteristics. Developed from research conducted at Simon Fraser University's School of Criminology, the methodology is based on a model that describes the criminal hunt."* (Rossmo, 2000, 23.)

The creation of a geographical profile is primarily based on the perpetrators leaving behind a *geographical footprint*. These traces must be collected (spatial data collection) and represented on a mental map, and then the spatial patterns must be analyzed (the geographic profile created is more than just a map, as detectives incorporate strategies to begin their investigation). Editing these maps is one of the connections between crime geography and geographic profiling. During profiling, creating the offenders' buffer zone is essential, which is also a cartographic task (Figure 57).

In addition to collection, data cleaning, and analysis of crime data, it is also necessary to analyze the socio-geographical data of the hunting area, as these data can also lead to the arrest of the criminal. In doing so, the road network, settlement structure, environmental conditions, natural environment, etc., are examined, which also requires geographical thinking.

During profiling, researchers use three criminological theories: Crime Pattern Theory (Brantingham and Brantingham, 1984), Routine Activity

Theory (Cohen. and Felson, 1979), and Rational Choice Theory (Clarke and Cornish, 1987). Profiling is done with software (e.g., Rigel, Dragnet, Crimestat), but before using the software, spatial data that requires geographic knowledge is collected, so crime geography can also play a significant role in geographic profiling.

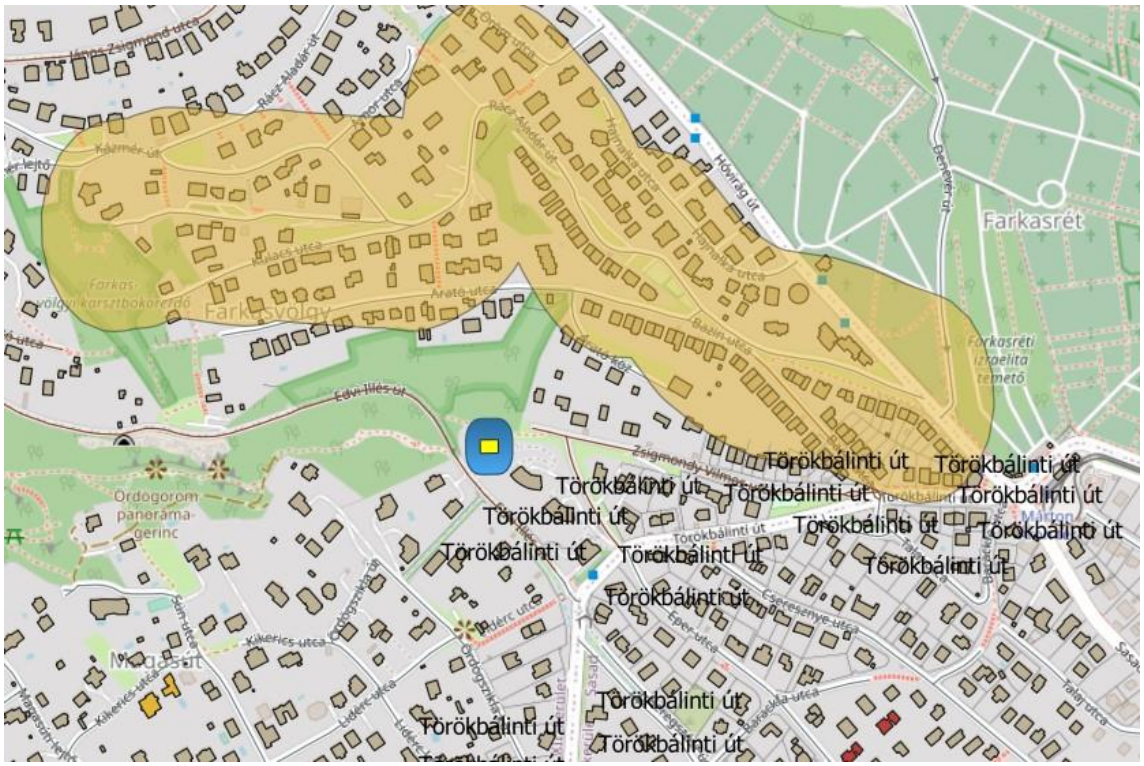


Figure 57. Buffer zone (Pődör, 2022, 64.)

A term often used in connection with geographic profiling is *mental map*. The introduction of this concept into social science can be attributed to Lynch, K. (1960). He was a prominent proponent of cognitive geography, who divided the components of cityscapes into five parts: paths, edges, districts, nodes, and landmarks. When creating his model, Lynch tried to find an identity between the spatial categories of mathematics and regional sciences. The term *mental space* (map) gained currency during the 1960s and 1970s. There are as many types of mental maps as there are people since

every person is different. A variety of mental maps characterize the young and the elderly, and the poor and the rich (Nemes Nagy, 1998).

Crime geography and criminology distinguish the places that are attractive to criminals, where crimes are committed. Also, there are the places where the perpetrators live. Investigating criminal mobility is especially important for geographic profiling, in which the perpetrator's place of residence must be identified, or the location of the next crime must be determined from the location of previous crimes.

The mobility of criminals can vary. It may depend on the offender's personality, the crime committed, the offender's nationality, the structure of the settlement, financial opportunities (does the offender have a car), etc. European offenders have less mobility than, for example, American offenders. This is also proven by data from Germany and Hungary, where 60% – 70% of offenders commit crimes near their place of residence (Clages and Zeitner, 2016).

3. Settlement and urban development

Crime geography can also play an essential role in settlement and urban development (Bói, 2024a). The connection between crime geography and settlement development is part of the CPTED method. When renovating and rehabilitating a part of a settlement, it is possible to use architectural solutions that do not cost more (or the extra costs are negligible) but have a significant crime prevention effect. Development concepts are advanced by settlement development specialists (who also have a degree in geography in many countries) who need to acquire CPTED knowledge, since it is possible to reduce the number of crimes.

Chapter 11.
CRIME GEOGRAPHICAL RESEARCH IN PRACTICE

11.1. Delimitation of the area, research hypotheses and methods

Before starting the analysis, it is necessary to precisely delimit the area being investigated since the administrative area of the territorial units included in the research (e.g., the city) is usually not the same as the jurisdiction of the police station (since the police station usually covers additional settlements). This problem obviously does not arise in county and national (international) level analyses. After the delimitation, it is worth selecting the tasks to be solved during the research and set up the hypotheses. Before starting any other research, it is recommended that the data used for the study be collected. It is necessary to assess what kind of databases can be worked from. From a practical point of view, before starting the research, the adequacy of the available data should be ascertained, and whether or not it is worth continuing the research. It is also worth considering the methods used for processing at the beginning of the research. For example, whether the necessary computer programs are available or whether the data processor has the necessary user knowledge, and so on.

11.2. Absolute values and calculated indicators

Crime, victim, or offender values obtained for research from various databases will usually be absolute numbers. Comparing them is relatively simple, with relatively few errors. However, research with absolute values does not allow us to compare two territorial units meaningfully. In order to

do this, we need to create calculated values. Such a calculated value is the frequency indicator. These are usually given for 10,000 or 100,000 people. If we calculate this frequency indicator for registered crimes, we get the CRIME FREQUENCY figure. A frequency value can be calculated for each crime, victim and perpetrator.

Examining the intensity of crime from a geographical aspect, that is, comparing the intensity of crime in individual areas, is also an important segment of practical law enforcement and crime prevention work. However, in addition to the quantitative comparison, a qualitative comparison (according to crimes, main groups of crimes) is also necessary, as this gives a realistic picture of the criminality of a given area (Heller, 1964). The change in the crime structure is best shown by the change in the ratio of the main criminal groups to each other, and the change in structure can be presented most sensitively based on this.

In the case of both absolute and calculated indicators, the values for leap years require close attention. One of the explanations for this could be a radically altered crime trend, but there could be other reasons for the extreme value. Among the various reasons that can be sought are changes in legislation and modification in the statistical procedure.

11.3. Examining the time factor

In addition to analyzing the territoriality of crime, it is important to examine the temporality (the role of the time factor was recognized by Guerry, who stated that in France, crimes against property are committed in greater numbers in winter). There are many types of crime in which the time dimension plays a prominent role, so their investigation is definitely justified (e.g., traffic accidents, disorder). When investigating tourism, it is also recommended spatial and temporal relationships be examined (Dávid et al., 2007).

11.4. The most common calculated values used in the analyses

11.4.1. Correlation and regression calculation

Many mathematical methods can be used to investigate crime. The two most common are regression (regression analysis) and correlation calculation. The author does not consider it necessary to describe these in detail, partly because this publication is primarily written for those involved in law enforcement and geography higher education and partly because nowadays, a variety of software practice performs the complicated mathematical operations completely on behalf of the users. Let us take a brief look at the two analysis methods mentioned above.

- CORRELATION CALCULATION

During the correlation calculation, we are interested in how two or more variables are related to each other (Are they related to each other at all?) and what the strength of the relationship is between the variables (How close are they?).

Below we look at the most important basic types of correlation. There may be no relationship between X and Y, meaning neither value affects the other. In such a case, the image of the function will be a horizontal line so that we can speak of a lack of correlation (no correlation). One example is the relationship between hair length and robbery frequency. We can state (although we do not have any relevant research but here assume it is so) that there is no correlation between the two factors. Those with longer hair do not commit a higher percentage of robberies. In other words, there is no correlation between hair length and the frequency of robberies (Figure 58-point e).

The opposite of *uncorrelation* is when there is a correlation between two values when two factors are functionally related to each other. Law

enforcement pays special attention to these factors, and so it tries to discover as many such connections between the individual factors as possible. Each X value has a Y value that fits the regression line in these cases. The correlation between the amount of alcohol consumed and the number of public nuisances can be cited as an example: if the amount of alcohol consumed increases, so does the number of public nuisance events.

If there is a relationship between two values, we must determine whether the correlation between the two values is positive or negative. The correlation is positive if the value of one factor increases as a result of the other (Figure 58-point a). If we want to examine the relationship between robbery and education, we can conclude that the frequency of robbery decreases with an increase in education. That is, there is a correlation between the two factors, and a negative correlation can be observed (Figure 58-point b). If, on the other hand, we examine the relationship between education and *white collar crime*, we can establish a positive correlation since the higher someone's education, the greater the chance of their committing that type of crime.

Suppose we want to represent the correlation on a scale from -1 to +1. In that case, the maximum value of the negative correlation will be -1, while the maximum value of the positive correlation will be +1. If there is no correlation, it takes the value 0 on the number line.

Based on the strength of the relationship, the following degrees of correlation can be distinguished (Table 3).

Table 3. The strength of correlation coefficients

Correlation Coefficient (r)	Description (Rough Guideline)
+1.0	Perfect positive + association
+0.8 to 1.0	Very strong + association
+0.6 to 0.8	Strong + association
+0.4 to 0.6	Moderate + association
+0.2 to 0.4	Weak + association
0.0 to +0.2	Very weak + or no association
0.0 to -0.2	Very weak - or no association
-0.2 to – 0.4	Weak – association
-0.4 to -0.6	Moderate – association
-0.6 to -0.8	Strong – association
-0.8 to -1.0	Very strong – association
-1.0	Perfect negative association

(LaMorte, 2021)

The three most commonly used correlation coefficients are Pearson's, Spearman's, and Kendall's coefficients.

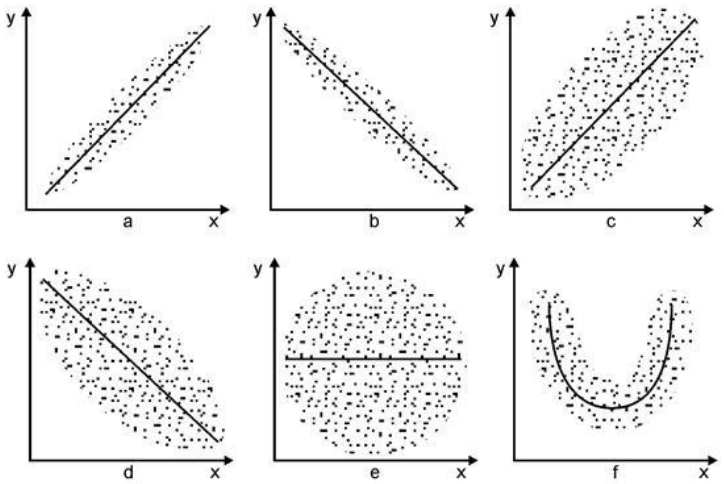


Figure 58. Degree of correlation (a - positive correlation /strong/, b - negative correlation /strong/, c - weak correlation /positive/, d - weak correlation /negative/, e - lack of correlation /no correlation/, f - non-linear correlation) *(Fidy and Makara, 2005)*

Among the correlation coefficients, we highlight the best-known and most frequently used: Pearson's. Let us also mention the *Moran's I* indicator. This is a territorial autocorrelation analysis that was developed in 1995. "Moran I is an indicator that shows how similar or different the value of the area under study is to its neighbor." (Tóth, 2003, 39.) With this indicator, we can examine clustering, i.e., whether the spatial pattern is the result of a random process or not (values are interpreted between -1 and +1) (Mátyás and Pődör, 2022) [Moran's I is a local indicator of spatial association (LISA), like Getis-Ord Gi*]

- REGRESSION CALCULATION (OR REGRESSION ANALYSIS)

When examining the correlation, we examined the relationship between the two factors (its presence or absence). However, even in the case of a correlation, we cannot predict one value from the other. During the regression calculation, however, we try to find a relationship between two or more variables that can be described by a mathematical function (Reiczigel, 2008). "If two variables are linearly related, one can be used to predict the value of the other. (…) The closer the relationship between two variables, the smaller the forecast error." (Balázs) The opposite of linear regression is non-linear regression. We can speak of non-linear regression if the relationship between the dependent and independent variables cannot be described with a linear function. In this case, a curved line best fits the points (Fidy and Makara, 2005) (Figure 59).

Let us also look at a two-variable model that can be considered ordinary in relation to regression! We want to investigate the increase in the price of firewood and the number of illegal wood thefts from the forest. There is a clear connection between the two factors. An increase in the price of firewood can predict by how much wood theft is expected to increase.

However, while it is clear that the two factors are related, many other factors also influence the development in the number of illegal acts: the weather, the rate of increase in wages or welfare benefit, etc. All of these must be taken into account in order for our forecast to be sufficiently accurate.

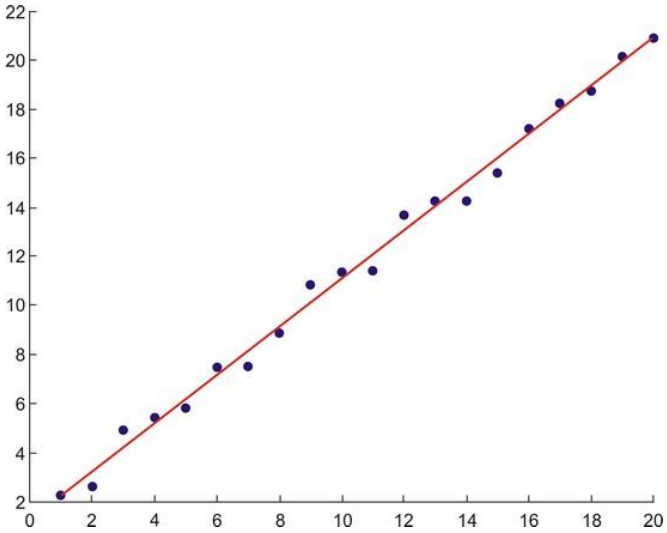


Figure 59. Linear regression (URL 31)

There are many spatial regression techniques, but the following three techniques are used most often in crime analysis:

- Spatial lag regression ("which considers the impact of the dependent variable in neighboring areas in the model alongside the influence of other explanatory variables")
- Spatial error regression ("which gives an indication that the clustering observed in the dependent variable reflects the influence of unmeasured explanatory variables")
- Geographically weighted regression (GWR) ("which performs local regression equations on each geographic unit in a study area") (Chainey, 2021).

Ordinary Least Squares (OLS) are used to establish the basis for spatial analyses.

Ordinary least squares (OLS) regression is an optimization strategy that helps you find a straight line as close as possible to your data points in a linear regression model. OLS is considered the most useful optimization strategy for linear regression models as it can help you find unbiased real value estimates for your alpha and beta. (Alto, 2023)

Chapter 11.4. Was written by adapting an earlier work by the author (Mátyás, 2020b)

11.4.2. Calculated values for police forces and crimes

- THE NUMBER OF RESIDENTS PER POLICE OFFICER

The ratio of the population of an area to the number of police forces can be calculated, but determining the number of police officers actually on duty is difficult. The data is certainly distorted by the fact that accurate data on the number of police officers actually on duty is not usually available. For each police unit, the calculated value is improved by those reassigned to ministries and other units, those performing service abroad, those on sick pay, etc. (see actual police density).[9]

Calculation method:

Population of the settlement: 10,000 people

Number of police officers on duty: 100 people

[9] "The actual police density shows how the actual number of police officers available at a given time in a given location and the ratio of the residents of the investigated settlement to each other develop. The actual police density can only be measured by the number of people per police officer." (Finszter, 2015, 75.)

The number of residents per police officer can be calculated as the quotient of 10,000 and 100; that is, based on the example, ten thousand is divided by one hundred, so there are 100 residents per 1 police officer ($\frac{10\,000}{100} = 100$).

- NUMBER OF POLICE OFFICERS PER 100,000 POPULATION

We often calculate the number of police officers per 100,000 inhabitants, which is actually a calculation of the above indicator (the number of inhabitants per one police officer) based on another possible, reversed idea. This is commonly known as *police density*, just like the number of residents per police officer.

Calculation method:
Population of the settlement: 200,000 people
Number of police officers on duty: 100 people

To calculate the number of police officers per 100,000 inhabitants, the first step is to calculate the ratio of the number of police forces to the population. Based on the values in the example, the number of police officers (100) must be divided by the population (200,000). Since we want to find out the value per hundred thousand people, the obtained value must be multiplied by 100,000 (If, for example, we want to calculate the above value for 10,000 people, the obtained quotient must be multiplied by 10,000). In this case, there are 50 police officers per 100,000 inhabitants

$(\frac{100}{200{,}000}\,x\,100{,}000 = 50)$.

With regard to police density, it can be stated that the desirable police density is different for each type of settlement and settlement structure. Taking into

account the data on the number of police officers in European countries, the potential police density is high if the number of police officers per 100,000 inhabitants exceeds 300, and the actual police density is high if the population per police officer on duty does not reach 400 (Finszter, 2015).

- THE AREA COVERED PER POLICE OFFICER

From the point of view of the ability to concentrate team strength and the defendability of an area, the size of the area per police officer is a highly critical point, which can be calculated as the ratio of the size of the area of jurisdiction and the number of police officers. Of course, the size of the area per police officer can be a highly *debatable* indicator in itself, but it is absolutely necessary to examine the linear infrastructure, topography, etc., of the studied area, as these can significantly modify the response time (both positively and negatively). Response time is one of the most important indicators of the effectiveness of police work.

Calculation method:

Size of the jurisdiction: 1000 km²

The number of police officers on duty is 100

To calculate the size of the area per police officer, we must divide the area of jurisdiction (1000 km²) by the number of police officers (100 people). Based on our example, 1 policeman has 10 km² of jurisdiction ($\frac{1000}{100} = 10$).

- NUMBER OF CRIMES PER POLICE OFFICER

The number of crimes per police officer can be calculated as the ratio of registered crimes to the number of police officers. When evaluating the indicator, it is recommended to examine the criminal structure as well, as

there may be significant differences in some cases (e.g., in the case of serial crimes).

Calculation method:

Number of registered crimes: 10,000

The number of police officers on duty is 100

When calculating the number of crimes per police officer, the number of registered crimes (10,000) is divided by the number of police officers (100). In the present case, 1 police officer is allocated 100 crimes ($\frac{10,000}{100} = 100$).

11.5. Summary of the main results of the research

After the analysis, it is advisable to summarize the results of the research in a few sentences. The questions of what the investigation results are, and of what can be applied in practice are often raised (after conducting research in any field of social science). It is, therefore, worthwhile formulating the main results in a few lines at the end of the research, summarized in outline points, and even in thesis form. Let us explore the possibilities and factors that can promote the improvement of the crime situation of any territorial unit at any level and lay the foundation for its development in this direction. In summary then, it is worth preparing a SWOT analysis of the area and drawing a goal pyramid in which strategic goals that can be regarded as guidelines are indicated. During the research, we should always strive not simply to follow the template analysis method used by many, but to include always something new that makes the research truly unique.

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CONTENTS

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In addition to creating a new way of representing crime, the 'Mátyás Crime Classification System', he coined the increasingly widely used terms 'isocrime'. Alongside crime geography, he is also a researcher of criminalistics, tourism security, and talent geography.