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CRIME FORENSICS

The Role of Geographical Factors in the Investigation

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Criminal geography in Hungary is a field of science that is researched by few people despite the fact that the research results can be used in practice. In Western Europe and North America, research results are widely used in everyday police work. Moreover, in Germany, all criminology books contain a chapter on criminal geography.

This paper aims to examine the impact of geographical factors on investigative processes, focusing on how location, terrain and accessibility influence crime scene investigations and evidence collection.

The author gathered factors that may influence investigations from both previous sources and his own research.

The present study not only presents the role of geographical factors in the investigation but also highlights their practical implications. It lists the physical and social geographical factors that can affect crime. When presenting the factors, specific criminal cases are described where geographic knowledge was necessary during the investigation. It was this specialised knowledge that led investigators to the perpetrator.

The author is confident that, based on the practical examples, more and more people in Hungary will recognise the importance and practical applicability of this field of science.

Keywords: criminal geography, law enforcement, crime, geography

Introduction

The spatial investigation of crime has a history of nearly two hundred years. André-Michael Guerry was the first to examine the spatial distribution of crimes in France

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in 1833. Since then, crime geography research has come a long way. In most countries, criminologists or geographers deal with this field.

In the opinion of the author, the examination of individual geographical factors is given little emphasis during crime geography investigations. This study aims to show how wide the range of geographical factors that can be examined is.

Even in the wars of antiquity, knowledge of geographical factors was important because certain elements could help or hinder a military operation.[2] 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 recognised 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 organisational performance evaluation). Moreover, in 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.[3]

In order to analyse 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 the 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).

The article is based on the author's *Crime Geography* book, as it may be said that it is an extended version of one of its chapters.[4]

[2] Kozma et al. 1993.
[3] SoundThinking s. a.
[4] Mátyás 2024.

Human geographical factors

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 analysed 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.[5] It is important to emphasise 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 emphasising 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).

Of course, more economic indicators affect crime, but these are the ones that have the greatest impact. The weight and role of individual indicators should be examined locally, within a specific area. Certain indicators may have a decisive role only in certain social conditions.

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 and 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.

[5] Piskóti-Kovács 2014; Vári 2015.

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.[6] 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.[7] 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).

Large differences can be observed between the individual tourism branches. For example, religious tourism attracts different people than party tourism. Based on this, it is not enough to examine the number of tourists but also look at what branch of tourism is typical in a given settlement.

Population of settlements

Settlements are also categorised 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. Still, it is not possible to compare crimes with each other in this way.[8]

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 × to a municipality with a population of 2×, 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 2× + 15%.[9]

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.

In addition to this, the examination of the structure of settlements is also a very important factor, as this also greatly influences the number, distribution and structure of crimes. It impacts not only crimes but also police measures and the philosophy of police measures. It is necessary to act differently in an inner-city area than in a rural environment.

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6 Ernszt et al. 2018.
7 Péter et al. 2018; Keller – Tóth-Kaszás 2021.
8 Tihanyi 2017.
9 Herke 2016.

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 the crime geographical analysis of settlements, as they can provide information that can explain some causes of crime. Demographically unstable settlements are generally characterised by higher crime rates.

Knowing the migration differential can be particularly important. If a settlement is characterised 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 (village 1), 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 village 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 village 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 village No. 1 as many residents have died. Crimes are much reduced in that village. Most of the children living in village 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. An essential indicator in the social disorganisation theory is family structure (e.g. the proportion of divorcees).[10] Children who grow up in a harmonious family environment with two parents (father and mother) are less likely to commit crime.

As with economic indicators, we can also state that, in case of demographic indicators, compared to the indicators described above, there are a larger number of indicators that can impact crime. However, these are either of minor importance or are only locally significant.

[10] Ceccato–Dolmen 2011; Vavró 1995; Piskóti-Kovács 2014.

Gender ratio

It is a criminological fact that men commit more crimes than women. Approximately 80% 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, 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.

In the author's opinion, this will be evident in some Hungarian cities in the future. In cities where significant industrial development is planned. Debrecen, for example, is expected to have a population of 250,000 by 2050. The extra 50,000 people are mainly foreign male workers who come to the city from abroad.

Transport geography features

Several studies have already highlighted that the transport infrastructure significantly determines the mobility of criminals.[11] 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" travelling 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 urbanisation axes, highway connections, etc.) be analysed. 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. 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).[12]

[11] Gabor–Gottheil 1984; Smith–Clarke 2000.
[12] Bói 2024.

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 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.

The role of geographical transport factors is obvious in the case of Attila Ambrus. The robber mainly targeted financial institutions that were not far from the highway and were close to tram or bus stops.

Function of settlements

The responsibilities of a municipality can also significantly influence the number, structure, temporal distribution, etc. of crime.[13] a settlement can be characterised 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. 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 centres, 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.

[13] Dürr 2023a.

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.

A common mistake is to compare two police stations with the same population or the same number of crimes. Two police stations can only be meaningfully compared if their size and settlement structure are similar.

Structure of settlements

Few people have investigated the relationship between the settlement's structure and crime. Representatives of the Chicago school first studied this. We should also mention Dennis Szabó, who wrote his doctoral dissertation on this topic.

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 urbanisation development.[14] It is essential to examine these as they largely determine the spatial distribution of crime.[15] With regard to the 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.

Education, presence of educational institutions

Numerous studies have demonstrated that education significantly influences criminality (quantity, structure). 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).[16]

At university centres 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

[14] Dürr 2023b.
[15] Mátyás 2024: 77–97.
[16] Piskóti-Kovács 2014.

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.

Anthropogenic landmarks

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.

Of course, knowledge of anthropogenic landmarks is important not only for the police, but also for the military. This is especially important for borders.

By understanding the layout and purpose of such structures, authorities can identify vulnerable areas where criminal activity is more likely to occur. Well-maintained and monitored spaces tend to discourage such activities, while neglected areas can attract illicit behaviour. Crime prevention through architectural design (CPTED) can enhance the safety of public and private spaces by eliminating opportunities for concealment. This may include better lighting, controlled access and regular inspections. Collaboration between law enforcement, urban planners and local communities can significantly reduce risks. Combining technology and human expertise can ensure that these sites are used safely and responsibly.

Ethnic and religious features

Examining ethnic and religious characteristics is sensitive, so many people do not deal with it. Struck politics does not solve anything. If we are to fight crime, we must deal with this issue as well as with several geographic features.

In relation to the population, it is worth examining the ethnic characteristics of an area, because in 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.[17] 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 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 characterised by

[17] Xiaobing–Huafu 2012.

higher levels of criminality. We can cite sad examples of this disharmonious coexistence. Organisations 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).[18]

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.[19]

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 emphasised 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),[20] but other researchers were unable to demonstrate this.[21]

In areas where a significant religious or ethnic minority lives, we have to reckon with a different type of criminal behaviour 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 the treatment of the problem.

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 deals with several areas, such as forensic text linguistics, forensic phonetics, language profiling, creating crime dictionaries, prison language tests and courtroom discourse analysis.[22]

[18] Vajda 2022.
[19] For example in 2016: Cologne, Hamburg, Stuttgart; in 2022: Milan.
[20] Ellis–Peterson 1996.
[21] Carneiro et al. 2005.
[22] Ránki 2019.

In 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 case 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.[23] The fundamental task of forensic linguistics is the analysis of linguistic evidence.[24] Considering the localisation of a perpetrator, the involvement of a forensic linguist is indispensable, one who can pick out stylistic and idiolect elements that characterise one particular region or a particular person's language use, or who perceives a certain dialect from the recorded sound that characterises a certain region as well.

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.[25] Predictive software plays an increasingly important role in predicting crimes at sports events (see HunchLab software).

Given that, in some cases, tens of thousands of people gather at a sports event, it can also be a target for terrorists. Preventing this is not only the task of the police but also of the secret services.

[23] Ürmösné Simon – Nyitrai 2021.
[24] Ürmösné Simon 2019.
[25] Tóth 2021.

Physical geographical factors

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. 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 waters 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).[26]

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.

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.

American researchers studied the relationship between crime and topography in San Francisco. Higher areas of the city were found to have less crime. This proves that criminals think logically; for example, it is more difficult to escape from an area that is more difficult to access.

[26] Lippai 2023.

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 do not 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.[27]

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.[28]

Tourist destinations that attract large crowds are mostly located in areas with pleasant weather. Consider the beaches, for example, where millions go. A close correlation can be observed between the climate, the number of tourists, the type of destination and the crimes committed.

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.[29] 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.

[27] Kozma et al. 1993.
[28] Kozma et al. 1993.
[29] Balláné Füszter 2019.

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.[30]

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.[31]

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).[32]

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 is not easy to walk on sandy soils in dry conditions, but they are easy to walk on when it rains.[33]

In many criminal cases, the soil led investigators to the perpetrator. Consider, for example, the Adeleine double murder, where a young man killed his mother and grandmother. However, the soil residue left on the shovel led the investigators to the mine where the man buried the bodies.

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 case of a homicide, for example, plant remains can help find the primary location, but pollen can also determine the approximate time of death.[34]

[30] Balláné Füszter 2019.
[31] Balláné Füszter 2019.
[32] Cselleng 2022.
[33] Kozma et al. 1993.
[34] 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.[35]

Regarding vegetation, let us mention that, for example, pollen analysis would have been of great importance in the O. J. Simpson case. The perpetrator hid in the flowering bush in front of the house. However, the court did not consider the pollen test necessary. If this had happened, it would have been possible to declare with 100% certainty that O. J. Simpson was guilty or not guilty.

Summary

The study looked at geographic factors that could aid the investigation. The author divided geographical factors into two: natural and social factors. Social factors are more numerous. Regarding both factors, they not only help the detectives during the investigation but can also impact the commission of the crime. Such a factor is, for example, the road network, which significantly impacts the mobility of criminals.

The research emphasises that understanding these factors is essential for improving law enforcement strategies. Geographic profiling, for instance, helps narrow down suspects based on spatial patterns of crimes. Practical examples highlighted in the study show that incorporating geographical knowledge can lead to breakthroughs in solving complex cases. Additionally, advancements in technology, like GIS (Geographic Information Systems), offer tools to analyse and visualise these factors effectively. The study underlines the necessity of integrating such tools into everyday police work. Moreover, raising awareness about the importance of criminal geography within police training programs could enhance investigative efficiency. Geographical factors provide a unique lens through which crime dynamics can be better understood and addressed.

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[35] Kozma et al. 1993.

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