

ENVIRONMENTAL DNA – eDNA

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INITIAL CONSIDERATIONS

Human right to a healthy and preserved environment in modern legislature is elevated to a level of right that is guaranteed both by the law and constitution. Although we may defend a point that it is a right which is a prerequisite for the survival of today's generations, as well as the future ones, we cannot ignore the impression that exercise as well as practice of such right is being neglected, mostly because it is taken for granted, since the profession fails to seek the importance of legislature and legal control of the right to a healthy environment. The right to a healthy environment has been facing modern challenges in recent decades, which leads to the conclusion that the absence of individual consciousness has made the necessity of including criminal law in the environmental protection system. Such criminal law pertaining to the environmental protection system can be seen as a formal social control, which states are seeking to reduce the level of environmental crime (Ignjatović, 2023: 49). In addition to the above, protection via criminal law norms must be seen as the ultimate mechanism of protection, mechanism that is to be used solely in the most drastic situations, where such criminal act is a result of a person's doing (Vuković, 2021: 74).

The main goal of criminal law is a purpose of protection, which is realized through the regulation of certain acts and doings as criminal acts, and the regulation of proper sanctions for such wrongful doings, as well as the realization of the conditions of the application of the sanctions to the perpetrator of the crime (Stojanović, 2010: 3). Jovanović shares the principle that criminal law regulates class expression of the will, which is transferred into a legal norm with a purpose to defend the collective interest, while the criminality is seen as a social accompanying phenomenon to a class society (Jovanović, 1963: 53). Jovanović also adds that criminality used to be seen as a low class behavior, which is unacceptable to the higher classes, and that the criminalization of illegal behavior followed changes in social phenomena. What is really specific for the criminality is that it is able to outlive the class society (Jovanović, 1963: 56), and it is persistent to survive in its basic form, with no regard to the social context. In terms of the above, the oldest criminal behavior related to the acts against the government and the reputation of the ruler, and today we are faced with modern forms of criminality, which include environmental crime, i.e. in the sense of criminal law, crimes against the environment.

Criminal acts against the environment are established with the goal to protect the right to the environment, while certain authors consider that its purpose is indirect protection of the environment (Joldžić & Jovašević, 2011: 17). In addition to the clear understanding of the goals, in the domestic literature the prevailing opinion pertains to the definition of protected objects, i.e. the entrenched opinion is that criminal acts against the environment do not protect the environment, but the human right to live in a healthy environment. The issue of determining criminal acts against the environment is somewhat toned down by the legal regulations used in Criminal Code (hereinafter: CC) where crimes against the environment have their own chapter (CC, Official Gazette RS no. 85/2005, 88/2005 - cor., 107/2005 - cor., 72/2009, 111/2009, 121/2012, 104/2013, 108/2014, 94/2016 and 35/2019).

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Unlike the issue of the definition of criminal acts against the environment, criminologists have come up with various definitions of ecological criminality. They can further be sorted into different groups - social, economic, criminological, political, legal, as well as those based on the compliance with or infringement of the law (Clifford, 1998: 5). More often than none, ecological criminality is determined as illegal action or inaction, which is against the law, and such is the subject of criminal prosecution and criminal sanction (Situ & Emmons, 2000: 3).

Criminal acts against the environment have made a long way from a simple undesirable incriminating behavior, reasoned because it was sought as a victimless crime or costs of doing business (Batričević, 2017: 251). Since the incrimination of such wrongful acts has evolved and expanded through social changes, it is without a doubt that new prohibited actions required adequate social reaction and appropriate repressive measure.

Criminal procedure is constructed in a way that criminal liability is proven criminal responsibility determined on the basis of the presented evidence, with little attention being paid to the issue of considering the consequences and understanding the person responsible for the consequences caused by his actions (Čopić, 2015: 56).

That being said, it is clear that criminal liability can be determined if based on the evidence presented, meaning that evidentiary actions must be formulated, so that their application can establish the existence of a criminal offense and criminal liability. What is equally important is that the evidentiary actions are the foundation to justified imposition of criminal sanctions, which always needs to be adjusted to the level of social harm.

Criminal acts against the environment are criminal acts with blanket characteristics, while the consequence is loosely defined, which is justified bearing in mind that in most cases consequence of these criminal acts fail to be proven in quantity and quality. Many international enquiries point out to the rise and further complication of ecological crime. Therefore, for the analysis purpose we will use discovery data related to criminal acts against the environment and court case practice of Serbia.

By analyzing the domestic court case practice in criminal proceedings for criminal acts against the environment², data have surfaced that evidentiary actions used in criminal acts against the environment are: eavesdropping of the accused, questioning of witnesses, expert examination of documents and temporary confiscation of cases, while the evidentiary actions that have not been introduced in any case include: reconstruction of events, taking samples and checking accounts and suspicious transactions (Blažić Pavićević, 2023: 435).

The conducted research also showed that out of a total of 18 criminal acts against the environment³, only 15 were prosecuted, of which 98.12% of the criminal proceedings were for the crimes of Killing

² The research was conducted for the purposes of the author's doctoral dissertation entitled "Specificities of criminal proceedings for criminal offenses against the environment", and included the judicial practice of all primary courts in the territory of the Republic of Serbia in the period from 1 January, 2006, i.e. 1 January, 2010. as the day of the establishment of certain basic courts until 20 October, 2021.

³ The current CC in Chapter 24 provides for 18 criminal offenses against the environment, namely: Pollution of the environment (Art. 260), Failure to take measures to protect the environment (Art. 261), Illegal construction and putting into operation of facilities and assets that pollute the environment (Art. 262), Damage to facilities and devices for environmental protection (Art. 263), Damage to the environment (Art. 264), Destruction, damage, export abroad and import into Serbia of protected natural goods (Art. 265), Introduction of dangerous material into Serbia and illegal processing, disposal and storage of dangerous substances (Art. 266), Illegal construction of nuclear facilities (Art. 267), Violation of the right to information about the state of the environment (Art. 268), Killing and torture of animals (Art. 296), Transmission of infectious diseases in animals (Art. 270), Negligent provision of veterinary assistance (Art. 271), Production of harmful means for the treatment of animals (Art. 272), Contamination of food and water for feeding, i.e. feeding animals (Art. 273), Devastation of forests (Art. 274), Forest theft (Art. 275), Illegal hunting (Art. 276), Illegal

and abusing animals (Art. 269 CC), Devastation of forests (Art. 274), Forest theft (Art. 275), Illegal hunting (Art. 276) and Illegal fishing (Art. 277).

Bearing in mind the results of the conducted research, i.e. the fact that the majority of criminal proceedings are conducted for only certain criminal acts, as well as that only certain acts of evidence are used to prove these criminal acts, the question arose whether there is theoretical doubt about the existence of dark crime figures, whether there are certain problems in detecting and proving these criminal acts, as well as whether there are any comparative legal solutions that can be applied in domestic legislation.

“DARK FIGURE OF ENVIRONMENTAL CRIME”

The phenomenon *Dark figure of environmental crime* can be defined as penalized behavior which has occurred, but not registered by a competent state body (Getoš Kolac & Pribisalić, 2020: 638). Problems that surround the dark figure of environmental crime can be approached from various angles, such as lack of repression, doubt about the existence of a criminal act; from the angle that presumptions about the existence of criminal acts cannot be detected, proven or no criminal charges could be established. On the other hand, there is scientific and research understanding of the dark figure of environmental crime, which boils down to incomplete knowledge of phenomenology and etymology of the crime, because of which most of criminological analyses are only fragmented and speculative (Getoš Kolac & Pribisalić, 2020: 638). In general, when we discuss the dark figure of environmental crime, it is without a doubt that it is only an imaginary and presumptive phenomenon for which we lack hard evidence to prove its existence. It is no wonder why the scientific theory is divided when discussing and explaining this phenomenon.

In the context of criminal acts against the environment, the main reason for analyzing the dark figure of environmental crime relies on the mentioned empirical research, which has proved that only certain criminal acts against the environment are being discovered in Serbia, and that the group represents a small percentage of all criminal acts endangering certain eco-mediums. Newly woken up curiosity about this issue is based on the fact that as a society we are well informed on various pollutions that strike different eco-mediums, while at the same time we lack any statistical data with regard to criminal acts against certain eco-mediums.

We must not neglect the stand that criminal persecution is of selective nature, and in most cases depends on the readiness of an individual to approach the authorities with a claim (Getoš Kolac & Pribisalić, 2020: 665). Conducted empiric research has proven that in most cases criminal charges would be raised by direct witnesses to the crime (Blažić Pavićević, 2023: 374-423), meaning that the discovery of such criminal acts mostly relies on direct witnesses, while other acts of evidence are not used to full capacity. In the context of criminal acts against the environment, it is of great importance to point out to the fact that the protective object in these criminal acts is a human, while often an individual does not need to experience the consequence of the pollution, while the consequence can be materialized much later compared to the original action that took place. In correlation to the previous statement, the detection of criminal acts against the environment must not depend exclusively on direct witnesses, for it needs to be possible for other means of evidence to be used with the goal to detect and prove these criminal acts.

fishing (Art. 277) CC.



Having in mind everything presented, and especially the fact that the mentioned pollutions are being created in individual eco-mediums, which could have negative effect on living in an environment, almost to make it impossible for people to live in a healthy environment, a new question arises in comparative systems regarding the act of proving via which we could discover and prove prohibited actions related to individual eco-mediums.

HARVESTING SAMPLES FROM THE ENVIRONMENT

Harvesting samples for a forensically-genetic analysis is also called the DNA analysis, meaning the analysis of deoxyribonucleic acid, which comes down to determining specific genetic code (Škulić, 2016: 238). DNA profiling was created with the idea that all individuals differ by one very specific mean of differentiation (Daeid et al., 2017: 7), while eDNA analysis originated from the idea of extraction of genetic material that organisms leave behind in the environment. The main difference between DNA and eDNA is that we extract from the samples with the former, while with the latter we harvest from the environment (Pawłowski et al, 2020: 4258). A point of divided opinion is the issue of what can be subsumed under the term sample from the environment, as the dominating aspect is that the term should be interpreted broadly, that it can encompass all organisms that are present in environmental samples.

A French criminologist Edmond Locard was one of the pioneer criminologist that pointed out to the possibility of using traces such as dust and ground (Allwood, Fierer & Dunn, 200: 1510), which is the reason why he is considered as the originator of extraction of genetic material of not human origin.

Environmental DNA – eDNA is DNA harvested from the environment (Lear et al., 2018, 8), and as such the term is used in the USA, Australia, Japan, Canada and New Zealand. eDNA originated for a purpose of solving problems of spawn and the return of the runaway salmon in the areas of Hokkaido and Sanrio in Japan (Minegishi et al., 2019: 1), as well as snail invasion in Canada (Ponce, Arismendi & Thomas, 2021: 1). It is important to point out the fact that in most cases eDNA is used in different biological researches, as well as forensic investigations.

DNA refers to the genetic material – nuclear, mitochondrial and chloroplast that is released by an organism to its environment, such as dead skin/plant cells, hair, feces, urine, saliva, mucous and gametes. Organisms in nature leave behind traces, which last for a certain time period and which can come in contact with water particles, sediments, earth or air. By using proper analysis, we could determine the presence of targeted organisms.

When analyzing DNA, it is required to separate cell materials and samples, which could contain different pollutions, mostly harvested from the ground or sediment material, as well as extracted from the grounds, sediments, leaves, fecal matter, water, ice, herbal tissue and animal tracks (Lear et al., 2018, 10).

There are different analysis via which one can analyze the composition of DNA, while some of them use plants, frequently pollen and mushrooms. Then, using microscopic techniques, we can compare samples from the certain area to the catalog of referenced material, as well as identifying geographical origin of people who left traces and tracks using microbe footprint trace (Allwood, Fierer & Dunn, 2000: 1505).

Technology used in environment testing is called metacarbonating and it includes the process of analyzing over hundred different samples. Most frequently metacarbonating is used in the process of con-



necting people with particular geo locations or in the process of identifying people who left microbe fingerprint traces (Alwood, Fierer & Dunn, 2000: 1505.)

There are certain opinions that the use of eDNA is useful with the aim of criminal acts discovery, because the perpetrator often carries some traces of the environment, without being aware of that, allowing the existence of forensic traces which are relatively present, stable and appropriate for placing the offenders at the crime scenes (Liu et al., 2022: 110828). An aggravating circumstance in this case is the fact that an ideal DNA code, suitable for every environmental trace and footprint does not exist.

There are opinions that eDNA analysis, even though it may seem as reliable, is still with its own faults, mostly because not every analysis is suitable for all climate changes. Sample contamination is always possible, the results of the analysis may not be sufficient for making a connection between people and crime scenes, as well as the cost and the fact that those analysis may be extremely time consuming⁴. Liu considers that not all DNA techniques are applicable to environmental samples, such as the Sangre's method, because it is difficult to obtain the adequate code for analysis of environmental samples. Liu suggests that the whole analysis may be broken down into five phases: soil DNA acquisition, amplicon preparation, amplicon sequencing, NGS data processing and a suspect's mud tracking.

DNA meta barcoding is NGS platform-based, correct extraction of sequences crucial for successful source tracking. There are several NGS data process pipelines – OUT, Dada2, COTU. The important issue concerning data analysis is also how soil samples can be reliably tracked back to the original place based on OTUs and their abundances. The Source Tracker and FEAST are two most popular software packages for allocating components in a microorganism community to the potential sources and the latter was claimed to be quicker and more accurate (Liu et al., 2022: 110835).

Having in mind that sample harvesting for forensic-genetic analysis is not a novelty, it is of great importance that it is considered an already familiar analysis used on other traces and tracks.

Most foreign authors dealing with this topic are of the opinion that environment sample harvesting is an evidentiary action subject to change by further development and upgrade, while results may be of great importance in criminal investigations.

In terms of the above, there is an opinion that areal reactions may be of great aid to forensic investigations, implying that it would be much easier to connect certain people to certain areas with the support of a data base of air harvested samples from various areas (Goray, et al., 2023: 926).

An environment sample analysis can be performed solely if prerequisite conditions are met, some of them being: securing proper lab reagents, expert hiring, ensuring adequate storage of samples, as well as proper sample storage. A database should also be organized, as it would be of great aid in the process of comparing the specimen to the previously inputted data.

The importance of such a laboratory should not be taken for granted, reason why we must call to mind the case which occurred in USA. In the federal state of Virginia, numerous analyses of environmental samples were performed, and some of the results were forged, the results related to water, air and earth pollution, and it all resulted in a public dismay as well as a court case (Moenssens, 1993: 5).

In Australia and New Zealand there are guidelines for designing and validation of eDNA tests, which regulate minimal requests of security and surveillance⁵. Those guidelines include the following steps: define the intended purpose of the assay; design and test the assay; validate and optimize the assay

4 <https://johndrogerslaw.com/what-are-the-faults-to-dna-evidence-in-criminal-cases/>, 14. Jun. 2024

5 <https://research.csiro.au/environomics/wp-content/uploads/sites/187/2022/08/Environmental-DNA-test-validation-guidelines.pdf>, 14. Jun 2024.



using reference samples; check analytical specificity; check analytical sensitivity; check repeatability; check reproducibility; determine thresholds (cut-offs).

Steps for metabarcoding assay development and validation are: define the intended purpose of the assay; design and test the assay (develop and test the associated bioinformatics pipeline for data analysis); validate and optimize the assay using reference samples; check reproducibility.

It is important to point out the fact that we do possess accredited laboratories which perform harvest samples from the environment, but with different goals in mind, such as soil testing, location testing, risk estimation, etc.

Of equal importance is the fact that environment sample harvesting is not an innovative evidentiary action, nor a method that requires special education of the forensic staff, yet it does require the setting of basic standards from which we must not deviate, and such standards are suitable for use in criminal matter.

USE OF eDNA IN PRACTICE

The use of environment samples as act of proving was registered in a couple of court cases in the USA, out of which the most famous would be mentioned.

Waterway system of Chicago was a great engineering project, which was a great leap forward in both commerce and industry. While works were being done, sewage was released into the lake, which further resulted in the change of direction of the waterway system of Lake Michigan. Water diversion has led to migration of Asian carp, which could slowly displace autochthonous species of fish. In a court case against the United States Army Corps of eng'rs⁶ e-DNA analysis of water samples was performed in a way that certain markers were tested, which showed the presence of carp in the tested waters. The mentioned analysis later allowed the determination whether the Asian carp had migrated beyond the original habitats and whether the water diversion had impacted the migrations of carp from the waters that were its primary habitat.

E-DNA analysis was used also during the process of water samples analysis, determining the presence of perch in the Blackwater River, i.e. that analysis as the one previously mentioned was used with the aim of proving the existence of perch in fresh waters. While explaining the verdict the court took the position that even though it was treated as direct evidence, harvesting of samples must not be treated as definitive, meaning it could not solve the case in black and white⁷. The important thing is explanation: "Though it sounds complex, e-DNA sampling is elegantly simple in design. Because fish continually release DNA molecules into the water via sloughed skin, scales, mucus and feces, scientists can capture and filter water from a stream and court it for specific species' DNA. These results can help corroborate or supplement existing information indicating the probable presence or absence of species in area."

⁶ Case State of Michigan et al, Plaintiffs-Appellants, and Grand Traverse Band of Ottawa and Chippewa Indians v. United States Army Corps of Engineers et al, and City of Chicago, et al, United States Court of Appeals, 667 F3d 765 (2011), No. 10-3891, decided August 24, 2011.

⁷ Case Wild Virginia; West Virginia Rivers Coalition; Preserve Giles County; Preserve Bent Mountain, a chapter of Blue Ridge Environmental Defense League; West Virginia Highlands Conservancy; Indian Creek Watershed Association; Sierra Club; Defenders of Wildlife; Chesapeake Climate Action Network; Center for Biological Diversity, Petitioners v. United States Department of the Interior; Deb Haaland, in her official capacity as Secretary of the U.S. Department of the Interior; United States Fish and Wildlife Service, an agency of the U.S. Department of the Interior; Aurelia Skip with, in her official capacity as Director of the U.S. Fish and Wildlife Service; Cindy Schulz, in her official capacity as Field Supervisor, Virginia Ecological Services, Responsible Official, 25 F.4th 259, United States Court of Appeals, Argued: October 29, 2021, Decided: February 3, 2022.



THE POSSIBILITY OF ENVIRONMENT SAMPLES COLLECTING IN THE PRACTICE OF DOMESTIC COURTS

Sample collecting is an evidentiary action that is introduced to the domestic legislature with Criminal Procedure Code (hereinafter: CPC) (Law of criminal procedure, Official Gazette RS, no. 72/2011, 101/2011, 121/2012, 32/2013, 45/2013, 55/2014, 35/2019, 27/2021 - decision CC and 62/2021 – decision CC) in 2001, and it includes harvesting of biometric samples, harvesting samples of biological origin and taking samples for forensic-genetic analysis. Biometric samples are constant physical characteristics of a person (Art. 140 CPC), samples of biological origin are real samples of human, animal and plant origin (Art. 141 CPC). Samples for forensic genetic analysis represent sampling by analysis of DNA reactions (Art. 142 CPC).

By the process of analyzing the domestic legislature and rules regarding e-DNA we approach a certain vagueness, meaning that certain norms of domestic legislature are based on the principle that biometrical samples and samples of biological origin could be collected exclusively from a human being. Although these samples may be of both herbal and animal origin, sample collecting may occur only once and be of human origin, meaning of people and animals. Contrary to the above, samples for forensic-genetic analysis may be harvested from a defendant, a victim, as well as other people; from either crime scene or other places containing traces of criminal acts. We must bear in mind that a crime scene or place that holds traces of criminal act needs to be understood in the contexts of a place where the defendant committed a certain action, or where the consequence occurred, as well as any other places where we could find items, objects and traces, may lead us to the conclusion that there is no limits to collecting samples of human nature (Ilić, Majić, Beljanski & Trešnjev, 2016: 400).

The above statement not only points out the fact that there is no limitation to harvesting samples for forensic-genetic analysis solely to samples of human nature, but also raises the question whether that capacity of modern forensics allows the analysis to be performed on the samples of biological origin. A possible problem to this is a fact that up to now a general opinion has been that only human originated samples can be taken into consideration in the process of harvesting samples, which does not imply that taking samples of biological origin are against the legal norms of current CPC.

If we consider the possibility of using these samples and the possibility of their suitability for discovery and proving of certain criminal acts, it is certain that harvesting samples from the environment could be used in correlation to eco-medium pollution, pollution of water, air, soil, and that such samples could be beneficial in the discovery of the following criminal acts: Environmental pollution (Art. 260), Failure to take measures to protect the environment (Art. 261), Illegal construction and putting into operation of facilities and assets that pollute the environment (Art. 262), Damage to facilities and devices for environmental protection (Art. 263), Damage to the environment (Art. 264), Destruction, damage, export abroad and import into Serbia of protected natural goods (Art. 265), Import of dangerous substances into Serbia and illegal processing, disposal and storage of dangerous substances (Art. 266), Unauthorized construction of nuclear facilities (Art. 267), Transmission of infectious diseases in animals (Art. 270), Contamination of food and water for consumption, i.e. feeding animals (Art. 273) CC.



CONCLUSION

Criminal acts against the environment are criminal acts which, considering the severity of a possible penalty, would not be considered to be in a group of criminal acts with insignificant social danger. In correlation to that, we may come back to the standpoint that strengthening of possible penalties is not the only method to fight crime. For punishments in middle ages, we can fairly say from modern point of view that they were draconian, and as such they did not result in lowering the criminality, but rather spread discontent to their disproportion and the way of enforcement (Konstantinović Vilić & Kostić, 2011:80). With that in mind, we consider that strengthening of criminal punishments may not always result in suppression of crime, and that vague limits of criminal area (Stojanović, 2016: 13), as well as issues surrounding the discovery and proving of criminal acts cause other problems.

When we talk about crimes against the environment, we can say that the regulation do not have too many shortcomings, i.e. that what is recognized as a problem is not the incrimination of the act and the amount of the threatened penalties, but that there is an insufficient and inadequate impact on the individual, as well as on society as a whole, which is the result of problems in detecting and proving these crimes. In this regard, one of the ways of improving the detection and proof of certain criminal acts against the environment polluting individual eco-media, i.e. reducing the dark figure of environmental crime, is based on the possibility of taking samples from the environment in such a way that the Criminal Code could be properly applied, and an appropriate criminal sanction could be imposed, and the purpose of punishment could be achieved, both in the context of influencing the individual not to repeat the criminal act, as well as influencing the entire society to realize that certain behaviours are not legally acceptable.

Namely, taking samples from the environment would be objective and immediate evidence that would certainly have to be valued both individually and together with all other evidence. What would complicate the position of the defendant in the criminal proceedings is the fact that the use of this evidentiary action would require to a certain extent the engagement of professional assistance - defense counsel in order to achieve the equality of the parties in the proceedings (Blažić Pavićević, 2018: 397). Namely, the use of this evidentiary act undoubtedly requires the expertise of both forensic experts and special knowledge of the prosecuting party, which could objectively put the defendant in a position of "arms inequality" (Blažić Pavićević, 2020: 359). The above does not mean that there are grounds for expanding the institution of mandatory defense, but only that the expansion of this evidentiary action could lead to the need to engage professional assistance in order to exercise the right to defend the accused.

What is also important is the fact that taking samples from the environment requires the existence of accredited laboratories, provision of conditions for conducting analyses, provision of appropriate reagents, training of laboratory workers, and provision of adequate sample storage.

REFERENCES

- Allwood, J. Fierer, N. & Dunn, R. (2000). The future of Environmental DNA in Forensic Science, *Applied and environmental microbiology*, 2, 1504-1519.
- Batrićević, A. (2017). Ekološka krivična dela i kriminalitet korporacija. In: I. Stevanović, V. Čolović (Ed.), *Privredna krivična dela* (pp 243-256), Beograd, Institut za kriminološka i sociološka istraživanja, Institut za uporedno pravo.



- Blažić Pavićević, M. (2018). Obavezna stručna odbrana u krivičnom postupku. *Zbornik Pravnog fakulteta u Novom Sadu*, 1, 395-410.
- Blažić Pavićević, M. (2020). Sporazum o priznanju krivičnog dela: pojam, pravna priroda i korišćenje sporazuma o priznanju krivičnog dela kao dokaza. *Crimen*, 3, 346-365.
- Blažić Pavićević, M. (2023). *Specifičnosti krivičnog postupka za krivična dela protiv životne sredine*. Doktorska disertacija, Univerzitet u Novom Sadu: Pravni fakultet.
- Vuković, I. (2012). Krivičnopravni pojam i funkcije radnje. *Crimen*, 1, 73-94.
- Getoš Kolac, A. & Pribisalić, D. (2020). Tamna i svetla strana tamne brojke kriminala: O izazovima istraživanja nepoznanica i blagoslovu neznanja. *Zbornik PFZ*, 4, 637-673.
- Goray, M. et al., (2023). Emerging use of air eDNA and its application to forensic investigation – A review, <https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/pdf/10.1002/elps.202300228>, 916-932.
- Daeid, N. et al., (2017). *Forensic DNA Analysis: A primer for courts*, London: RSE
- Ignjatović, Đ. (2023). Zelena kriminologija i kontrola kriminaliteta. *Crimen*, 1, 24-63.
- Ilić, G. Majić, M. Beljanski, S. Trešnjev, A. (2016). *Komentar Zakonika o krivičnom postupku*. Beograd: Službeni glasnik.
- Jovanović, LJ. (1963). Krivično pravo i njegova društvena uloga. *Zbornik radova Pravnog fakulteta u Nišu*, 53, 53-60.
- Joldžić, V. & Jovašević, D. (2011). *Ekološko krivično pravo, međunarodni i ustavni osnovi, stvarnosti i mogućnosti*. Beograd: Institut za kriminološka i sociološka istraživanja.
- Konstantinović Vilić, S. & Kostić, M. (2011). *Penologija*. Niš: SVEN.
- Lear, G. et al. (2018). Methods for the extraction, storage, amplification and sequencing DNA from environmental samples, *New Zealand Journal of Ecology*, 42, 2-100.
- Liu, Y. et al., (2022). Determination of a criminal suspect using environmental plant DNA metabarcoding technology, *Forensic Science International*, 324, 110828-110838.
- Minegishi, Y. et al., (2019). Spatiotemporal distribution of juvenile chum salmon in Otsuchi Bay, Iwate, Japan, inferred from Japan, <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0222052>
- Moenssens, A. (1993). Novel Scientific Evidence in Criminal Cases: Some Words of Caution, *Journal of Criminal Law and Criminology* 84, 1-22.
- Pawlowski, J. et al., (2020). Environmental DNA: What's behind the term? Clarifying the terminology and recommendations for its future use in biomonitoring, *Molecular ecology*, 29, 4258-4264.
- Ponce, J. Arismendi, I. & Thomas, A. (2021), Using in-situ environmental DNA sampling to detect the invasive New Zealand Mud Snail (*Potamopyrgus antipodarum*) in freshwater, *PubMed Central*, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8359795/>
- Situ, Y. & Emmons, D. (2000) *Environmental crime: The Criminal Justice System's Role in Protecting the Environment*. London: SAGE Publications.
- Stojanović, Z. (2010). *Krivično pravo – opšti deo*. Beograd: Pravna knjiga.
- Stojanović, Z. (2016). Essays. In: Đ. Ignjatović (Ed.) *Kaznena reakcija u Srbiji* (pp.2-15), Beograd, Univerzitet u Beogradu -Pravni fakultet.

- Ćopić, S. (2015). *Restorativna pravda i krivičnopravni sistem: teorija, zakonodavstvo i praksa*. Beograd: Institut za kriminološka i sociološka istraživanja.
- Clifford, M. (1998). *Environmental Crime: Enforcement, Policy and Social Responsibility*. Gaithersburg: AN ASPEN PUBLICATION.
- Škulić, M. (2016). *Krivično procesno pravo*. Beograd: Univerzitet u Beogradu Pravni fakultet.
- Criminal Code, *Official Gazette RS* no. 85/2005, 88/2005 - cor., 107/2005 - cor., 72/2009, 111/2009, 121/2012, 104/2013, 108/2014, 94/2016 and 35/2019.
- Law if criminal procedure, *Official Gazette RS* no. 72/2011, 101/2011, 121/2012, 32/2013, 45/2013, 55/2014, 35/2019, 27/2021 - decision CC i 62/2021 – decision CC.
- Case State of Michigan et al, Plaintiffs-Appellants, and Grand Traverse Band of Ottawa and Chippewa Indians v. United States Army Corps of Engineers et al, and City of Chicago, et al, United States Court of Appeals, 667 F3d 765 (2011), No. 10-3891, decided August 24, 2011.
- Case Wild Virginia; West Virginia Rivers Coalition; Preserve Giles County; Preserve Bent Mountain, a chapter of Blue Ridge Environmental Defense League; West Virginia Highlands Conservancy; Indian Creek Watershed Association; Sierra Club; Defenders of Wildlife; Chesapeake Climate Action Network; Center for Biological Diversity, Petitioners v. United States Department of the Interior; Deb Haaland, in her official capacity as Secretary of the U.S. Department of the Interior; United States Fish and Wildlife Service, an agency of the U.S. Department of the Interior; Aurelia Skip with, in her official capacity as Director of the U.S. Fish and Wildlife Service; Cindy Schulz, in her official capacity as Field Supervisor, Virginia Ecological Services, Responsible Official, 25 F.4th 259, United States Court of Appeals, Argued: October 29, 2021, Decided: February 3, 2022.
- <https://research.csiro.au/environomics/wp-content/uploads/sites/187/2022/08/Environmental-DNA-test-validation-guidelines.pdf>,
- <https://johndrogerslaw.com/what-are-the-faults-to-dna-evidence-in-criminal-cases/>