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Introduction by Prof. Michael Faure

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Content

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Dear readers,

Environmental crime knows no borders, and neither should our efforts to combat it. With this in mind, I am pleased to present to you our special edition of the European Law Enforcement Research Bulletin dedicated entirely to the pressing issue of environmental crime, a multifaceted threat that endangers not only human health and safety, but also the ecosystems that sustain life on our planet.

Since environmental crime transcends national boundaries, collaborative initiatives both within the EU and with non-EU countries are essential to disrupt criminal networks, share intelligence and enhance enforcement capabilities. One of the key highlights of this edition is the emphasis on cross-sectoral and cross-border cooperation. Furthermore, the integration of research outcomes into our training modules will directly increase the impact and efficiency of law enforcement operations, ensuring that our officials are well prepared to face these evolving threats.

Since our previous edition, CEPOL has undergone significant transformations. One of the most notable changes is our new strategic approach to publishing thematic research editions of our bulletin. This special edition marks the beginning of a series of publications focused on addressing specific areas of criminal activity.

This strategic shift underscores our commitment to producing high-quality, relevant research that directly contributes to the professional development of law enforcement practitioners while supporting the broader objectives of a safer Europe. Our editorial board members' dedication and vision have been instrumental in shaping this thematic approach, ensuring that our publications are of the highest scientific quality, while also being directly relevant to the specific needs of law enforcement practitioners. Their contributions are invaluable to our mission of fostering a safer Europe through enhanced law enforcement training and research.

I am also pleased to announce the appointment of our new editor-in-chief, Dr. Maria João Guia, our CEPOL research & knowledge management officer. Holding a PhD in Law, Justice and Citizenship in the 21st Century and four master's degrees, she is a highly quoted academic and an experienced inspector of Portugal's Polícia Judiciária – former inspector of the Serviço de Estrangeiros e Fronteiras. Dr. Maria João Guia brings a wealth of knowledge and expertise to this role. Her leadership will be instrumental for the bulletin, ensuring that it remains a vital resource for both law enforcement practitioners and the academic community.

I am also grateful to Dr. Matteo Arru, Giacomo Florio and André Pires da Silva, editorial assistants of this thematic edition, and to all the members of the editorial board for their dedication and hard work in bringing this edition to fruition. Additionally, I would like to acknowledge the valuable contribution of Professor Michael Faure, who wrote the introduction to this special edition. His expertise and insights have provided high-level value, setting the stage for the in-depth discussions and analyses contained within this bulletin.

In conclusion, I would like to thank all the contributors. Their research, insights and recommendations are vital for advancing our understanding of environmental crime and developing effective strategies to combat it.

I also thank you, our readers, for your support and engagement with our publications. I hope you will find this edition both informative and inspiring. Together, we can make significant strides towards a safer, more secure Europe.

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The *European Law Enforcement Research Bulletin* has conquered a very particular space in the academic community and among law enforcement practitioners because of its innovative way of approaching law enforcement subjects. Taking on this new challenge, we realised we needed to progress and step forward in law enforcement research, creating digital object identifiers (DOIs) for all our articles and editions while continuing to follow the policy of the European Union Agency for Law Enforcement Training (CEPOL) for this bulletin of keeping up with new technologies and advancing efforts to ensure open access. While continuing to publish our general editions, for which we welcome all submissions, and ensuring the timely availability of the research findings turning it into an online publication with a rapid publication policy, maintaining the conference editions and starting the new approach of publishing thematic editions is sure to benefit both readers and authors by highlighting and improving research into the very relevant topics covered by our training portfolio.

Adopting a thematic focus for our research bulletins represents a considerable evolution from our past editions. By concentrating on specific crime areas or evolving security topics, we aim to provide in-depth analysis, foster a deeper understanding of emerging threats and offer practical solutions that can be readily implemented in the field. Integrating focused research into our training programmes ensures that law enforcement officials are equipped with the latest knowledge and best practices to tackle contemporary challenges effectively.

A distinctive aspect of this edition is the inclusion of practice-oriented essays developed to follow up on CEPOL training activities. These contributions from law enforcement practitioners offer valuable insights and practical perspectives that complement the scientific articles. By bridging the gap between theory and practice, we aim to foster a more dynamic exchange of knowledge that benefits both researchers and practitioners. This unique feature of our new thematic editions highlights the collaborative spirit of our community and underscores the importance of integrating practical experience with academic research. It ensures that our publications remain grounded in real-world applications, making them highly relevant and useful to the law enforcement community.

The new editorial strategy of the *European Law Enforcement Research Bulletin* aims to bridge the gap between practice and science, addressing the need for high-quality, impactful research, while also meeting the demands of the scientific community. This approach is designed to ensure that our publications not only serve as valuable resources for practitioners but also contribute to the academic discourse on law enforcement and public safety. By encouraging a closer relationship between researchers and practitioners, we can facilitate the development of innovative solutions to the complex challenges facing our societies today.

This first thematic edition will touch on environmental crime from diverse, kaleidoscopic perspectives. The European Union has recognised the critical importance of combating environmental crime, as reflected in the environmental crime directive (Directive (EU) 2024/1203 of 11 April 2024 ([1])) and the 2022–2025 European multidisciplinary platform against criminal threats (Empact) ([2]). These frameworks highlight the necessity of a concerted, cross-border approach to addressing the complex and transnational nature of environmental crime.

The first part of this first thematic edition, on integrating academic research, starts with a brilliant introductory chapter by Professor Michael Faure, which discusses in detail the new environmental crime directive of the European Commission.

Following many detailed discussions, Professor Faure concludes that the enforcement of environmental law in the EU has been problematic for a long time. Environmental crime is, according to the United Nations, one of the most prevalent crimes worldwide and within the EU. According to Professor Faure, the European legislator has to be applauded for having produced an excellent piece of forward-looking, progressive legislation that, including by international standards, stands out.

Pernille Marie Agerholm Moesborg, author of the first article, 'Reflections on some of the everyday challenges due to the complexity of waste crime legislation', continues the discussion around legislation, presenting an astonishing case study from everyday life, with the Danish prosecutor showing that the complexity of legislation can have a fundamental impact on court rulings. The case study concerns a criminal case on the cross-border transport of waste, namely from Sweden through Denmark to Germany. The main regulation relevant to this criminal case was an EU one – Regulation (EC) No 1013/2006. An aluminium skimmings' shipment from Sweden to Germany smelled strongly of ammonia. Danish authorities found that the shipment was not compliant with the 'Annex VII procedure'. The prosecutor's office filed charges against the dispatching company. The judge acquitted the defendant due to the wording of the indictment. The author concludes by remarking that making the legislation more transparent is crucial to ensuring that the main principles of that legislation can be followed in the courtroom.

The next article, authored by Ragnhild Sollund and Daan van Uhm, with the title 'The reptile trade and law enforcement in Norway and the Netherlands: time for a ban?', brings our attention to reptiles. More than one in five reptile species is threatened with extinction. Research on the reptile trade in Norway and the Netherlands was analysed to unravel overlapping themes and synthesise empirical findings. According to the authors, Meso-America is the largest reptile-exporting region, closely followed by sub-Saharan Africa. Traders declare reptiles as captive bred, even when they have been caught in the wild. Reptile laundering occurs through countries that are not members of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

([1]) Directive (EU) 2024/1203 of the European Parliament and of the Council of 11 April 2024 on the protection of the environment through criminal law and replacing Directives 2008/99/EC and 2009/123/EC (OJ L, 2024/1203, 30.4.2024).

([2]) https://www.europol.europa.eu/crime-areas-and-statistics/empact.

Ragnhild Sollund and Daan van Uhm show us in the article that, worldwide, 36 % of reptile species are being traded, and many of them come from wild populations. Europe is one of the biggest markets for illegally traded reptiles. In this article, issues related to law enforcement associated with the reptile trade are discussed, showing that the Netherlands is considered both a transit and a destination country in the international trade of Horsfield's tortoises. Many reptile traders in the Netherlands are unaware of trade restrictions and reptile-laundering practices, particularly when it concerns non-CITES species. In addition, uncovering laundered reptiles presents a major challenge for Dutch and Norwegian law enforcement agencies. At the same time, the article finds that wildlife trade on the dark web is not as prevalent as the trade that goes on in open internet channels, such as through social media.

In the next article, 'Combating environmental crime: illegal cross-border waste transport and utilising modern technologies', Michal Cikhart shows that environmental crime is one of the world's fastest-growing security problems. The Basel Convention plays a crucial role in the international regulation of cross-border movement of hazardous waste. In 2021, the author refers that EU Member States exported almost 15 million tonnes of non-hazardous waste. Updating and strengthening legislation related to illegal waste transport could deter potential offenders.

This contribution provides a comprehensive introduction to the issue of environmental crime and illegal cross-border waste trafficking, with a focus on the use of EU legislation to combat these phenomena. Within the EU, these issues are systematically addressed through Directive 2008/99/EC. Tackling environmental crime is crucial for preserving a healthy environment for future generations. Success in this area is inextricably linked to the effective detection and investigation of crimes. The Basel Convention plays a crucial role in the international regulation of cross-border movement of hazardous waste, while EU legislation regulates waste categorisation, disposal and recycling processes. The Basel Convention categorises hazardous waste and establishes rules for its export, import and transport. Since the enlargement of the Schengen area in 2007, cross-border waste transport within the EU has increased.

Illegal waste transport has become a global issue that requires coordinated efforts from multiple countries. The use of modern technologies (drones, 3D scanners, etc.) by law enforcement agencies in the field of illegal cross-border waste transport appears to be a necessity. Updating and strengthening legislation related to illegal waste transport, including the introduction of strict sanctions, could deter potential offenders.

In the next article, Michal Phillip William Screen and his co-authors present an excellent overview of the EU-funded Emeritus project, which aims to improve the effectiveness of law enforcement agencies in identifying, locating and collecting evidence about environmental crimes. A lack of capacity across the entire enforcement chain, involving investigators, prosecutors and judges, inhibits the work of frontline forces. Common concerns include the requirement for permits, uncertainties about data storage and the centralisation of deployment decisions.

The Emeritus training needs assessment, involving both internal and external practitioners, was conducted through focus groups in five European countries. Interviews were conducted with the law enforcement and border guard authorities involved in Emeritus to identify the main factors hampering the uptake of cyber-physical technologies such as drones, satellites and sensors. The most significant gaps in responding to environmental crime were identified.

Researchers developed a library of state-of-the-art super-resolution models that were tested in different scenarios relevant to the study of waste. The 18 models were trained using a vast dataset of medium-resolution images (Sentinel-2), together with very high-resolution imagery (SPOT), to generate their high-resolution equivalents. The training methodologies employed were cutting edge, involving adversarial training that pits two networks against each other to improve image quality.

The next article, 'Applying remote sensing and data science techniques to enhance the monitoring and detection of environmental crime: examples from the NarcoView project', is authored by Tatjana Kuznecova, Nilay Swarge & Jaap Knotter. The Netherlands has gained an international reputation as a centre for the production and export of synthetic drugs such as MDMA and amphetamine, according to the authors. Dumping and discharge of synthetic drug waste is a serious environmental crime. The main regions of the EU facing problems related to drug waste dumping are the southern part of the Netherlands and the northern part of Belgium.

The research presented in this article was conducted within the framework as part of the NarcoView project, funded by the police component of the Internal Security Fund (ISF Police). The concept involves combining data from various sources and utilising data-driven algorithms that enable the prioritisation and/or inspection of larger areas in a shorter time. Three scenarios were tested for feasibility, of which two were selected for further research.

Dumping of drug waste is a serious environmental crime. Dumped chemicals penetrate the soil, groundwater and sewers, contaminating the environment. Disrupting this form of organised crime is one of the priorities of the European agenda on security. The NarcoView project aims to develop a platform for monitoring and detecting environmental crime for end users such as law enforcement authorities.

In the sixth and final article of the first part of this thematic edition, entitled 'Tackling environmental crime and harm by large industrial facilities: lessons learned based on two Dutch case studies', Lieselot Bisschop, Karin van Wingerde & Sammie Verbeek present Hoogovens/Tata Steel and DuPont de Nemours/Chemours as examples of large industrial facilities that have been polluting the environment in the Netherlands. Both companies are liable for the consequences of per- and polyfluoroalkyl substance (PFAS) contamination. Large class-action lawsuits have now been filed against both companies. Criminal investigations are being conducted into whether the companies and their executives have endangered public health.

Concerns about PFAS contamination by Chemours emerged in the Netherlands in 2015. Fragmented supervision and enforcement of environmental laws and regulations has led to a lack of coordination and citizens feeling overlooked. Countering fragmentation requires good information exchange between the different actors responsible for supervision and enforcement. The case of DuPont de Nemours/Chemours shows the consequences of this fragmentation.

A lack of high-quality data on environmental crime hinders environmental law enforcement. Data can be missing or incorrect, and in some cases, it is not possible to identify individual companies. The most frequently mentioned criticism of environmental law enforcement is the long-term failure to take action against – or the tolerance of – environmental law violations.

In the second part of our thematic edition, 'Essays of practice', the first article is written by Volodymyr Veretiannikov, one of the participants of the environmental crime workshop held at CEPOL Budapest in 2023. The article, 'Legal measures to combat and prevent forest fires in the EU and Ukraine', presents us with the case of forest fires, which are a widespread and dangerous natural phenomenon in EU Member States and Ukraine. Fires often occur due to people violating the rules of safe behaviour in the forest. In 2020, the Verkhovna Rada of Ukraine adopted Law 556-IX, which increased the fine for offenders by 10–15 times. According to official data of the Head of the State Forest Resources Agency of Ukraine, 569 fires were extinguished in forests in 2021.

For EU Member States and Ukraine, the main negative impact of forest fires is the death of a vast number of individuals of various species of fauna and flora. Forest protection in Member States is regulated by internal administrative, land and forest legislation. The pace of harmonisation of Ukraine's national laws with EU legislation has been very slow, with Ukraine still facing serious environmental problems that pose a high risk to ecosystems and the health of the population.

Ukraine uses traditional methods that involve outdated approaches to preventing and containing the spread of forest fires. However, recent advances in society have had an impact on the development of the national forest fire prevention system. The State Forest Guard of Ukraine, a law enforcement agency, needs to be reformed and given the authority to investigate environmental crime.

The next article is authored by Pedro Alexandre Maia Ribeiro, another participant of the very successful workshop held in Budapest. In this article, 'Europe Latin America programme of assistance against transnational organised crime (El PAcCTO): the Jaguar Network', the author writes about Portugal having participated in Operation Madeira de Lei, which aimed to combat the illegal trade of and crimes committed against wildlife. More than 350 enforcement actions took place during the days of joint action in September 2022. Investigators detected many irregularities in 17 companies: 1 in Italy, 1 in the Netherlands, 3 in Spain and 12 in Portugal. The author concludes that collaborating with a network facilitates the harmonisation of legal frameworks, extradition agreements and mutual assistance treaties between countries. This streamlines legal processes and enables the more effective pursuit and prosecution of criminals across borders. By working together, law enforcement agencies can send a strong message of deterrence to potential offenders.

The final article, 'A well-functioning organisation for detecting and investigating environmental crimes: what is needed and how to get there? Experiences from Sweden', was written by Henrik Forssblad. He closes our thematic edition by saying that environmental crime is a relatively new area for law enforcement authorities to handle in many European countries. Investigating environmental crime is complicated and requires new investigation methods and competences, and a multidisciplinary approach that is different from what police organisations are used to. The most serious concern with environmental crimes is that the large majority of them remain undetected.

There are often no individual victims or plaintiffs in environmental crimes, the author argues. These factors have an impact on how environmental crimes are detected and investigated. When applied to environmental crimes, intelligence can be very effective in detecting more serious offences at an early stage. The strict legislation regarding confidentiality in Sweden, and probably in other countries as well, is regarded as a major obstacle. The Swedish Environmental Act is now being revised for the second time.

As can be seen from this very brief overview of the edition, the societal impact of environmental crime cannot be overstated. From illegal waste dumping and wildlife trafficking to air and water pollution, these crimes have far-reaching consequences. They undermine sustainable development, exacerbate climate change and pose significant risks to public health and biodiversity. Moreover, the effects of environmental crime endanger the future of current and subsequent generations, threatening the very fabric of our ecosystems and the health of our planet. The illicit profits generated from environmental crimes often fund other forms of organised crime, further destabilising societies and economies.

Thematic research is crucial for the development of effective law enforcement practices and policies, as demonstrated in this edition. By focusing on specific issues such as environmental crime, we can provide targeted training and resources that address the unique challenges posed by these threats. This approach not only enhances the effectiveness of our law enforcement agencies but also contributes to the broader goal of creating a safer and more resilient society.

We hope that you enjoy reading the articles; we also very much hope that they stimulate your critical thinking and encourage you to make proposals, participate in our workshops, training and courses, and take advantage of all CEPOL offers, enabling you to increase your contribution to a better society.

We want to end with a word of gratitude to all the authors, reviewers and editorial board members, our management team at CEPOL and all our colleagues who have helped us succeed with this project. We really hope you enjoy reading this bulletin and that it helps to increase your engagement with us at CEPOL.

Better protection of the environment through criminal law in the EU

Michael Faure

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Introduction

For many years, attempts have been made in Europe to in some way harmonise environmental criminal law. A first important step was taken by the Council of Europe, which created a convention on the protection of the environment through criminal law in 1998. The goal of that convention was to provide minimum standards for the decent protection of the environment using criminal law. It covered, inter alia, abstract endangerment crimes (mostly sanctioning the violation of administrative obligations), concrete endangerment crimes (sanctioning unlawful emissions into the environment) and truly autonomous crimes. The only problem was that, unfortunately, this convention never entered into force ([3]).

At the EU level, since the beginning of this century, initiatives have been developed to intervene in the domain of environmental criminal law. The goal of this EU intervention was different: criminal law was to be used mostly as an instrument to solve the implementation deficit. It was indeed established that the environmental laws of the EU (regulations and directives) were often not adequately implemented by the EU Member States or, in cases where they had been formally implemented, the domestic legislation implementing the environmental *acquis* was not properly enforced. The EU, therefore, wished to force Member States to impose criminal sanctions on the violation of domestic legislation implementing the EU environmental *acquis*. Originally, there was a debate about whether the EU legislator would have the competence to force Member States to issue rules with respect to criminal law. An institutional conflict in that respect between the European Commission and the Council of the European Union was settled in a judgment of the Court of Justice of the European Union of 13 September 2005 ([4]) (later referred to as the judgment of 13 September 2005). In that judgment, the Court made clear that, when the application of effective, proportionate and dissuasive criminal penalties by the competent national authorities is an essential measure for combating serious environmental offences, the Community legislator can take measures

([3]) For further details, see Faure (2020a).

([4]) Judgment of the Court of Justice of 13 September 2005, *European Commission* v *Council of the European Union*, C-176/03, ECLI:EU:C:2005:542.

relating to the criminal law of the Member States that it considers necessary to ensure that the rules it lays down on environmental protection are fully effective. However, in a subsequent judgment, the Court also made clear that this did not entail a competence to prescribe the nature or the size of the sanctions.

After the judgment of 13 September 2005 paved the way for (environmental) criminal legislation on 19 November 2008, a directive was promulgated on the environment through criminal law ([5]).

There were quite a few problems with this 2008 environmental crime directive (ECD). The directive did not include autonomous environmental crime. Rather, it covered only criminal liability in the case of unlawfulness, which was defined as the violation of legislation adopted pursuant to the Treaty establishing the European Community and listed in Annex A; legislation adopted pursuant to the Treaty establishing the European Atomic Energy Community (Euratom) and listed in Annex B; or domestic (usually administrative) environmental law implementing these ([6]). This omission of any autonomous environmental crime has been criticised in the literature ([7]). There was a further criticism of the 2008 ECD: it relied completely on criminal law alone and did not refer to any other enforcement mechanism, such as, notably, administrative law. That was striking, as, in the years preceding the 2008 ECD, many Member States had followed suggestions in the literature to introduce a so-called toolbox approach, providing a wide variety of (both criminal and administrative law) instruments for the enforcing authorities ([8]). Moreover, it was also clear that the 2008 ECD might not be able to reach its objective of solving the implementation deficit. A Member State could, in theory, transpose all EU environmental legislation and follow the duty of the 2008 ECD to impose criminal sanctions, and, still, very little would have been done concerning the effective enforcement of the domestic legislation implementing the environmental *acquis*. The main problem was that the 2008 ECD did not impose any obligation on Member States to provide information on how environmental law was enforced (Faure, 2020a, pp. 260–261). An evaluation of the 2008 ECD led by the European Commission also showed that there were serious problems with the enforcement of environmental law within Member States ([9]). These problems led to several calls for a revision of the 2008 ECD. One such study, commissioned by the European Commission, was labelled 'European Union action to fight environmental crime' (Efface) ([10]). Efface made important recommendations, including to reconsider the relationship between environmental criminal law and administrative law, and to pay attention to data collection and sufficient resources for the enforcement of environmental crime. In addition, the European Parliament's Committee on Legal Affairs (JURI) demanded that the European Commission reform the 2008 ECD ([11]). This suggestion was made following two reports commissioned by the European Parliament that both called for a revision of the 2008 ECD. One dealt with the liability of companies for environmental damage ([12]); the other dealt with the liability of companies in the context of corporate mergers and acquisitions ([13]).

([5]) Directive 2008/99/EC of the European Parliament and of the Council of 19 November 2008 on the protection of the environment through criminal law (OJ L 328/28, 6.12.2008, p. 28).

([6]) Art. 2(a) of the 2008 ECD.

([7]) See, inter alia, Vagliasindi (2017, p. 41) and Di Landro (2022, pp. 283–284).

([8]) See in that respect Ogus and Abbot (2002).

([9]) Commission Staff Working Document – Evaluation of the Directive 2008/99/EC of the European Parliament and of the Council of 19 November 2008 on the protection of the environment through criminal law (environmental crime directive), SWD(2020) 259 final of 28 October 2020, https://commission.europa.eu/document/download/e9bc5c87-f34d-47da-b56e-4b65874093dd_en?filename=environmental_crime_evaluation_report.pdf.

([10]) https://efface.eu/index/index.html.

([11]) As a result, in its 2021 work programme, the European Commission announced a revision of Directive 2008/99/EC on the protection of the environment through criminal law (see Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Commission work programme 2021: A union of vitality in a world of fragility, COM(2020) 690 final of 19 October 2020), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0690.

([12]) Study requested by the European Parliament's Committee on Legal Affairs (see Faure, 2020b).

([13]) Study requested by the European Parliament's Committee on Legal Affairs (see Faure, 2021).

After the Commission presented a first proposal for a new ECD on 15 December 2021 ([14]), an intensive exchange of ideas took place between the European Commission, the Council and the Parliament, eventually leading to the new ECD, Directive (EU) 2024/1203 of 11 April 2024 ([15]).

In this contribution, some of the most important innovations of the 2024 ECD will be highlighted.

A new definition of unlawfulness

The 2024 ECD has taken an innovative, one may even say revolutionary, approach with respect to unlawfulness. First of all, unlawfulness is defined in Article 1 as breaching:

> (a) Union law which contributes to the pursuit of one of the objectives of the Union policy on the environment as set out in Article 191(1) TFEU; or
>
> (b) a law, regulation or administrative provision of a Member State, or a decision taken by a competent authority of a Member State, which gives effect to the Union law referred to in point (a).

This is already an important step forward. In the 2008 ECD, unlawfulness was defined by reference to EU legislation contained in an annex to the directive, which was, of course, more complicated and cumbersome. The current formulation is substantially broader.

However, the EU legislator saw that it may be important to be able to impose criminal liability, even when the conditions of a permit are fulfilled. Therefore, Article 3(1) continues:

> Such conduct shall be unlawful even where it is carried out under an authorisation issued by a competent authority of such a Member State if such authorisation was obtained fraudulently or by corruption, extortion or coercion.

It is obviously to be welcomed that it is made clear that an authorisation that was obtained in an unlawful manner cannot be excused from criminal liability. On the other hand, one could argue that this is not very revolutionary, as fraud should normally remove the validity of the authorisation anyway. Moreover, it may be extremely difficult for the public prosecutor to prove that the authorisation was obtained fraudulently or through corruption, extortion or coercion. The practical importance of this passage may, therefore, not be that significant, but the symbolic value is certainly important.

However, Article 3(1) continues that the conduct shall also be unlawful when it is carried out under an authorisation 'if such authorisation is in manifest breach of relevant substantive legal requirements'. That can certainly be considered revolutionary. Indeed, the European legislator has introduced here nothing less than an autonomous environmental crime. The practical importance of this sentence cannot be underestimated. It practically means that even if an operator follows the conditions of an authorisation, criminal liability should still be possible 'if such

([14]) Proposal for a directive of the European Parliament and of the Council on the protection of the environment through criminal law and replacing Directive 2008/99/EC, COM(2021) 851 final of 15 December 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52021PC0851.

([15]) Directive 2024/1203 of the European Parliament and of the Council of 11 April 2024 on the protection of the environment through criminal law and replacing Directives 2008/99/EC and 2009/123/EC (OJ L, 2024/1203, 30.4.2024).

authorisation is in manifest breach of relevant substantive legal requirements'. This could, for example, be the case when the authorisation would allow emissions that de facto lead to a concrete danger to human health.

Such a provision was included in Article 2(1)(a) of the previously mentioned 1998 Council of Europe convention. That imposed criminal liability in case of a:

> discharge, emission or introduction of a quantity of substances or ionising radiation into air, soil or water, which: (i) causes death or serious injury to any person, or (ii) creates a significant risk of causing death or serious injury to any person.

However, as mentioned, this convention never entered into force, and such a truly independent environmental crime was, in fact, rare in Member States ([16]). Of course, it still has to be seen how national legislators will transpose this provision into domestic law, but the intention of the European legislator is clear: when an authorisation is in manifest breach of relevant substantive legal requirements (e.g. human rights), the operator can no longer hide behind the authorisation.

Ecocide

There has, for a while, been intense debate on the need to criminalise ecocide ([17]). A renowned independent international expert panel defined ecocide as 'unlawful or wanton acts committed with knowledge that there is a substantial likelihood of severe and either widespread or long-term damage to the environment being caused by those acts'. A similar definition can (with a few changes) also be found in the ECD. Article 3(3) of the 2024 ECD states that:

> Member States shall ensure that criminal offences relating to conduct listed in paragraph 2 constitute qualified criminal offences if such conduct causes:
>
> (a) the destruction of, or widespread and substantial damage which is either irreversible or long-lasting to, an ecosystem of considerable size or environmental value or a habitat within a protected site, or
>
> (b) widespread and substantial damage which is either irreversible or long-lasting to the quality of air, soil or water.

This provision clearly obliges Member States to directly criminalise ecocide as a qualified offence. Even though this particular provision does not mention the word 'ecocide', Recital 21 makes clear that 'those qualified criminal offences can encompass conduct comparable to 'ecocide', which is already covered by the law of certain Member States and which is being discussed in international fora'. This is also undoubtedly a revolutionary aspect of the 2024 ECD.

([16]) For other examples, see Di Landro (2022, pp. 292–297).

([17]) This is supported by, inter alia, the non-governmental organisation Stop Ecocide International, which is lobbying for a legal initiative to criminalise ecocide at the international level, more particularly to include it as a war crime in the Rome Statute (see https://www.stopecocide.earth, accessed 18 September 2024).

A reference to ecocide can also be found in Article 8, which contains the obligation on Member States to take the necessary measures to ensure that particular circumstances should, in accordance with national law, be regarded as aggravating circumstances:

> The offence caused the destruction of, or irreversible or long-lasting substantial damage to, an ecosystem.

The ecosystem is defined in Article 2(2)(c) as 'a dynamic complex of plant, animal, fungi and micro-organism communities and their non-living environment, interacting as a functional unit, and includes habitat types, habitat of species and species' populations'.

Although ecocide is not explicitly mentioned in the text of the directive, it clearly plays a crucial role, as, first, Member States are obliged to create a separate qualified offence of ecocide if any of the other criminal offences listed in the directive have been committed, and, second, ecocide should equally be considered as an aggravating circumstance, potentially leading to a more severe penalty.

New crimes

Being so enthusiastic about the introduction of autonomous environmental crimes and the sanctioning of ecocide, one could almost forget that the 2024 ECD includes many other important innovations. An important one is that the number of offences has substantially increased. While the 2008 ECD contained only 9 offences, the 2024 ECD contains 20, and some of them 'worth nothing'. The following are just a few:

- Article 3(2)(g): the shipment of waste where such conduct concerns a non-negligible quantity, whether executed in a single shipment or in several shipments which appeared to be linked;
- Article 3(2)(h): the recycling of ships falling into the scope of Regulation (EU) No 1257/2013;
- Article 3(2)(k): the construction, operation and dismantling of an installation, where such conduct and such an installation fall within the scope of Directive 2013/30/EU (on safety of offshore oil and gas operations) and such conduct causes or is likely to cause the death of, or serious injury to, any person or substantial damage to the quality of air, soil or water, or substantial damage to an ecosystem, animals or plants;
- Article 3(2)(s): the production, placing on the market, import, export, use or relief of ozone-depleting substances;
- Article 3(2)(t): the production, placing on the market, import, export, use or relief of fluorinated greenhouse gases.

It is clear that many of these specific provisions are currently not yet subject to criminal penalties in Member States' law. This will, therefore, require substantive legislative work within the Member States.

Minimum sanctions

Under the regime of the 2008 ECD, there was, given the case law of the ECJ ([18]), no scope to force Member States to introduce a particular type of sanction nor to issue rules with respect to the magnitude of the sanctions. That changed with the Treaty of Lisbon, with Article 83(2) of the Treaty on the Functioning of the EU providing a legal basis for the harmonisation of sanctions (Fajardo, 2017, pp. 6–7). The condition for the competence in Article 83(2) of the treaty is that the approximation proves essential 'to ensure the effective implementation of a Union policy in an area which has been subject to harmonisation measures' (Grasso, 2017, pp. 19–21).

In Recital 30 preceding the 2024 ECD, the EU legislator held that 'penalties for the criminal offences defined in this Directive should be effective, dissuasive and proportionate ([19]).' To that end, the legislator sets minimum levels for the maximum term of imprisonment for natural persons and maximum levels of fines for fines to be imposed on legal entities.

Article 5 defines the penalties for natural persons, making a distinction between various types of offences. The most serious ones should be punished according to Article 5(2)(a) by a maximum term of imprisonment of at least 10 years if they cause the death of any person. The qualified offence of ecocide should be punishable by a maximum term of imprisonment of at least eight years. However, other offences are punishable by a maximum term of imprisonment of at least five years if they cause the death of any person ([20]). Other offences are punishable by a maximum term of imprisonment of at least five and three years, respectively.

As far as legal entities are concerned, Article 7 provides the obligation to impose 'criminal or non-criminal fines, the amount of which shall be proportionate to the gravity of the conduct and to the individual, financial and other circumstances of the legal person concerned ([21]).' For particular offences committed by legal persons, the sanction should be 5 % of the total worldwide turnover of the legal person or an amount corresponding to EUR 40 million; for other offences the fine should be 3 % of the worldwide turnover or an amount corresponding to EUR 24 million.

The idea of the EU legislator is obviously to apply the highest level of fines to the most serious forms of criminal offences. Member States are also invited to regularly review the fine levels set with regard to rates of inflation and other fluctuations in monetary value ([22]).

The idea of introducing a maximum level for imprisonment and fines is that the EU legislator wishes to express that environmental crime is a serious crime. These relatively high fines and prison sanctions should, therefore, send an important signal to potential perpetrators. Obviously, judges in individual cases are still at liberty to take into account all the circumstances of the case in order to determine an appropriate sanction for a particular perpetrator and specific conduct ([23]).

([18]) In a second judgment (Judgment of the Court of Justice of 23 October 2007, *European Commission v Council of the European Union*, C-440/05, ECLI:EU:C:2007:625), the Court reaffirmed the conclusions of the earlier judgement of 13 September 2005, but decided that 'the determination of the type and level of the criminal penalties to be applied does not fall within the Community's sphere of competence'. For further details, see Vagliasindi (2017, pp. 38–39).

([19]) This is also repeated in Art. 5(1) with respect to the penalties for natural persons and Art. 7(1) with respect to the penalties for legal persons.

([20]) Art. 5(2)(c).

([21]) Art. 5(3) of the 2024 ECD.

([22]) Recital 35 preceding the 2024 ECD.

([23]) The EU legislator recognises the discretion of judges in Recital 36 preceding the directive: 'The establishment of the maximum level of fines is without prejudice to the discretion of judges or courts in criminal proceedings to impose appropriate penalties in individual cases. As this Directive does not establish any minimum

The idea of imposing minimum levels of sanctions was considered important to remedy the implementation deficit, but also to avoid a 'race to the bottom'. If in one Member State a violation of domestic legislation implementing EU environmental law was punishable with very high sanctions, whereas much lower sanctions applied in another Member State, this could obviously jeopardise the level playing field between those Member States and potentially lead to a race to the bottom (i.e. towards lower sanctions).

Obviously, simply imposing minimum sanctions in legislation does not completely remedy the problem, as there is no guarantee that a judge will apply a specific sanction in practice. Holding perpetrators criminality liable depends not only on the statutory sanctions available but also on the probability of detection, which is often a function of the capacity available for enforcement. However, assuming that all Member States have sufficient resources at their disposition and qualified staff to enforce domestic law implementing the environmental *acquis* (see the section 'Capacity building and enforcement' below), minimum sanctions can at least in theory contribute to creating a level playing field and thus avoid the danger of a race to the bottom.

A toolbox approach

In the literature, it has been stressed that an efficient enforcement system for environmental crimes needs a wide variety of instruments. Increasingly, administrative penalties are important, not just for prevention and reparation but also for sanctioning in a punitive manner via administrative fines. Administrative fines are very well suited to less serious offences (e.g. violation of administrative obligations). Many legal systems in the EU have recently moved to the introduction of administrative fines for environmental violations; as a result, there are fewer dismissals. Therefore, more environmental violations are provoking a reaction, at least ([24]). The previous 2008 ECD had too strong a focus on criminal law. There was even a sentence in the preamble that made it clear that only criminal law could provide a deterrent effect, which sanctions under private law or administrative law could not ([25]). As a result, there was no mention whatsoever in the 2008 ECD of administrative fines, which was strange to say the least, as this was contrary to the tendency of Member States to introduce administrative fines. It was also for this reason that the 2008 ECD was criticised (Faure, 2017, pp. 344–349).

The 2024 ECD clearly refers to the importance of administrative penalties in the preamble. For example, Recital 45 states that 'the obligation provided for in this Directive to provide for criminal penalties should not exempt Member States from the obligation to provide for administrative penalties and other measures in national law for breaches of Union environmental law.' Recital 46 also mentions that Member States should define the scope of administrative and criminal law enforcement clearly with regard to environmental offences in accordance with their national law. The toolbox approach is represented most clearly in Recital 47, which states that 'Judicial and administrative authorities in the Member States should have at their disposal a range of criminal and non-criminal penalties and other measures, including preventive measures, to address different types of criminal conduct in a tailored, timely, proportionate and effective manner.'

levels of fines, the judges or courts should, in any case, impose appropriate penalties taking into account the individual, financial and other circumstances of the legal person concerned and the gravity of the conduct.'

([24]) For an overview, see Faure and Svatikova (2012).

([25]) Recital 3 preceding Directive 2008/99/EC reads: 'Such compliance can and should be strengthened by the availability of criminal penalties, which demonstrate a social disapproval of a qualitatively different nature compared to administrative penalties or a compensation mechanism under civil law.'

This is also exactly what has been done in terms of penalties. For example, Article 5 (penalties for natural persons) provides a list of possible penalties going beyond the traditional fines and imprisonment, such as:

— an obligation to restore the environment within a given period;

— an exclusion from access to public funding;

— withdrawal of permits and authorisations;

— temporary bans on running for public office.

Similarly, Article 7 (penalties for legal persons) provides for a wide variety of penalties, which may be either criminal or non-criminal (again referring to the possibility of administrative penalties).

It provides, for example, for:

— an exclusion from entitlement to public benefits or aid;

— the temporary or permanent disqualification from the practice of business activities;

— the withdrawal of permits and authorisations to pursue activities that resulted in the relevant criminal offence;

— placing under judicial supervision;

— judicial winding up;

— closure of the establishment used for committing the offence.

This clearly shows that there is now a wide variety of criminal and administrative measures that can be imposed as a reaction to environmental crime, or in other words, a real toolbox with many instruments.

Capacity building and enforcement

Crucially, the ECD also makes explicit mention of the need to have sufficient resources for environmental law enforcement. Article 17 of the 2024 ECD holds that Member States shall ensure that national authorities that detect, investigate, prosecute or adjudicate environmental criminal offences have a sufficient number of qualified staff and sufficient financial, technical and technological resources for the effective performance of their functions related to the implementation of this directive. Obviously, it may be difficult to implement this notion very precisely or verify whether Member States have met this condition. However, the symbolic value of this provision is significant. It shows that the EU legislator is aware that merely providing for criminal sanctions does not solve the problem. If serious deterrence of environmental crime is to be achieved, it is equally necessary to have sufficient human capacity in the monitoring, investigation, prosecution and adjudication of environmental crime. Article 18 continues that it is equally necessary that specialised, regular training is provided to judges, prosecutors, police and judicial staff and to competent authorities with regard to the objectives of this directive. To the best of my knowledge, it is unique

in European criminal law that the EU legislator provides in such a detailed manner an obligation for Member States to take care of appropriate training and capacity building for the judiciary with respect to environmental crime.

The EU legislator is also aware of the fact that the entire 2024 ECD, of course, ultimately has the goal of achieving compliance with the environmental *acquis*, as implemented in domestic environmental law ([26]). In that respect, compliance assurance is also stimulated through Article 16, aimed at prevention. It holds that Member States shall take appropriate measures, such as information and awareness-raising campaigns targeting relevant stakeholders in the public and private sectors, as well as research and education programmes, that aim to reduce environmental crime and the risk of environmental crime. In the light of the empirical findings, this is a very wise strategy. After all, criminological research has indicated that a large percentage of environmental crime is not committed in an intentional, wilful, calculating manner but rather out of negligence and lack of information (Faure, 2012, p. 328; Huisman and Van de Bunt, 1997). Since, at the end of the day, compliance should be the goal of the entire enforcement exercise, it does make sense to aim for compliance assurance via the type of prevention campaigns mentioned in Article 16.

Access to justice and protection of whistle-blowers

The 2024 ECD also sees an important mention for victims affected by environmental crime and for non-governmental organisations (NGOs), who can be active in detecting and reporting crime. Article 15 mentions that victims, as well as NGOs, should have appropriate procedural rights in the case that those rights for the public concerned do exist in the Member State, for instance as a civil party. Article 15 also mentions that Member States shall ensure that the information on the progress of the proceedings is shared with the public concerned. The directive mentions explicitly that the public concerned should be informed of the results concerning a particular criminal offence.

Traditionally, it was often frustrating for victims or NGOs who, for example, reported an environmental crime and then would either not be involved in the proceedings that followed or would not be informed about them. Article 15 of the 2024 ECD aims to remedy that problem.

A specific provision also aims to protect so-called whistle-blowers, or, more generally, persons reporting criminal offences – in this case, the ones mentioned in the 2024 ECD. Article 14 is aimed specifically at the protection of persons who report environmental criminal offences or assist in the investigation thereof. The article holds that Member States shall take the necessary measures to ensure that those persons have access to support and assistance measures in accordance with national law.

Data collection

Probably one of the most important provisions (in addition to the new unlawfulness provision and the qualified offence of ecocide) is Article 22, imposing an obligation on Member States to put in place a system for the recording, production and provision of anonymised statistical data. Recall that one of the important criticisms of the 2008 ECD was that it largely failed to provide a level playing field because, basically, EU authorities had no idea what was going on as far as the monitoring and enforcement of environmental crime within the Member States were concerned.

([26]) It is for this reason that the European Commission has been strongly focusing on supporting operators and authorities in Member States to achieve environmental compliance assurance. See, inter alia, the guidance document concerning environmental compliance assurance to prevent environmental crime that has been developed by the European Commission (European Commission: Directorate-General for Environment, 2021).

Collecting this information is crucial for at least two reasons. First of all, a so-called smart enforcement strategy (Blanc and Faure, 2018, 2020) supposes that monitoring, inspection and investigation take place in an evidence-based manner. That supposes that authorities have information on the incidence of, for example, violations in a particular sector or by a particular enterprise so that they can concentrate further enforcement efforts on that particular sector or enterprise. Scarce enforcement resources should be used in an effective manner to make evidence-based enforcement possible. Secondly, an important goal of the ECD is to make sure that violations of domestic legislation implementing the environmental *acquis* are appropriately sanctioned. This is obviously necessary to establish a level playing field among the Member States and avoid a race to the bottom. This can only be verified if the EU authorities (particularly the European Commission) have at least some idea of the incidence of environmental crime within the Member State concerned and of the response to environmental crime.

There was, incidentally, an interesting EU document that already provided for such a duty, more particularly the recommendation concerning minimum criteria for inspections of environmental crime ([27]). However, the problem was that, as this was merely a recommendation, there was hardly any follow-up. The recommendation contained indications on how environmental inspections should be organised and carried out. The recommendation also included an obligation on the part of Member States to report to the Commission on their experience of the recommendation in operation, but that seldom happened. In addition, there was some sectoral legislation imposing an obligation on Member States to conduct inspections at regular intervals and report on inspections to the Commission. Such a duty to organise a system of inspections by competent authorities and report on these was, inter alia, provided for in the so-called Seveso directive ([28]). In addition, the directive on integrated pollution prevention and control (now referred to as the industrial emissions directive) contains monitoring obligations for the competent authorities and set up an effective compliance monitoring system for environmental inspections ([29]). However, these obligations were limited to the particular sectors to which they applied. The 2024 ECD now provides for a much more general obligation upon Member States to collect statistical data on, inter alia:

— the number of criminal offences registered and adjudicated by the Member States;

— the number of dismissed court cases;

— the number of natural persons who are prosecuted and who are convicted;

— the number of legal persons who are prosecuted and who are convicted or fined;

— the types and levels of penalties imposed.

Member States shall annually transmit the statistical data to the Commission according to a standard format that is further described in Article 23 of the directive. Moreover, Member States shall ensure that a consolidated review of the statistics is published at least every three years (Article 22(3)). The Commission shall, on the basis of the

([27]) Recommendation of the European Parliament and of the Council of 4 April 2001 providing for minimum criteria for environmental inspections in the Member States (2001/331/EC) (OJ L 118, 27.4.2001, p. 41).

([28]) Art. 20 of Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances (OJ L 197, 24.7.2012, p. 1) (referred to as Seveso III). For further details, see Jans and Vedder (2012, pp. 357–359).

([29]) See, inter alia, Art. 70(f) of the industrial emissions directive (Directive 2010/75/EU) as most recently amended by Directive (EU) 2024/1785 of 24 April 2024 (OJ L, 2024/1785, 15.7.2024). For further details on the integrated pollution prevention and control and industrial emissions directives, see Jans and Vedder (2012, pp. 359–368).

statistical data transmitted by the Member States, publish a report at least every three years, again according to the format described in Article 23. Article 23 holds that this format should comprise:

— a classification of environmental criminal offences;

— counting units;

— a reporting format.

Obviously, this will have to be worked out in further detail.

The statistical data referred to in Article 22 can be extremely useful for a critical analysis of the effectiveness of an enforcement policy within a Member State. However, ideally, if one really wants to know the probability of detection (and thus the exposure to enforcement), one also needs to know:

— the number of installations/enterprises that have to be inspected, for example on a yearly basis;

— the number of staff (expressed in full-time equivalent) available to exercise these inspections.

On that basis, one would at least be assured that a particular entreprise would be inspected within a certain time period. Obviously, within the framework of smart enforcement, it is logical that particular enterprises (especially when prescribed by EU law, for example, with the so-called Seveso installations) will receive more frequent inspections than others ([30]).

However, as Article 22(2) prescribes that the statistical data shall 'at a minimum' contain the prescribed data, Member States could provide further information that would equally enable an assessment of the probability of detection.

Conclusion

The enforcement of environmental law in the EU has been problematic for a long time. Environmental crime is, according to the United Nations, one of the most prevalent environmental crimes worldwide and within the EU. Reports mention that environmental crimes create large losses within the EU ([31]) and also lead to substantial benefits for the perpetrators ([32]). These facts alone would be important reasons for EU legislators to address this issue. Moreover, harmonising the approach applied in the case of a violation of domestic law by implementing EU environmental law also makes sense if one wants to guarantee a level playing field for industry in Europe and prevent a so-called race to the bottom.

That was only partially achieved with the 2008 ECD. Many criticisms of that prior directive were voiced in the literature, and these criticisms have been addressed in the new directive. The EU legislator has to be applauded

([30]) For example, Art. 20(4) of Directive 2012/18/EU (Seveso III) provides that the competent authorities shall regularly draw up programmes for routine inspections and that the period between two consecutive site visits shall not exceed one year for upper tier establishments and three years for lower tier establishments.

([31]) See data reported by the United Nations Environment Programme in Faure and Kindji (2022, pp. 30–31).

([32]) For a summary of the gains made from environmental crime in the EU, see Faure and Kindji (2022, p. 32).

for having produced an excellent piece of forward-looking, progressive legislation that, including by international standards, stands out. Not that many jurisdictions have introduced autonomous environmental crime in the way that the 2024 ECD has done, nor have many domestic jurisdictions introduced a qualified offence of ecocide. Furthermore, the duty to provide statistical information on the enforcement of environmental crime is a very important step, as it can lead to a more effective evidence-based enforcement mechanism.

Obviously, the proof of the pudding is in the eating. There is an excellent piece of legislation that now has to be transposed by the Member States, and by 21 May 2026 at the latest, according to Article 28 of the 2024 ECD. It will be important to see how the Member States deal with, for example, the interpretation of autonomous environmental crime. It can be expected that the European Commission will assist Member States with guidelines and workshops to facilitate the implementation process. At the same time, implementing the directive will, unavoidably, also entail adapting its provisions to the local culture of the individual Member State.

Provided that Member States take up the spirit of the 2024 ECD and implement the directive in the same progressive spirit, one can optimistically argue that the EU legislator has now provided a legal framework for effective enforcement of environmental criminal law for the coming decades.

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Part I
Academic research

Reflections on some of the everyday challenges due to the complexity of waste crime legislation

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Summary

The legislation relevant to waste crime is very complex.

A case study from everyday life as a Danish prosecutor shows that the complexity of the legislation can have a fundamental impact on court rulings.

The case study concerns a criminal case regarding the cross-border transport of waste. The waste was transported from Sweden through Denmark to Germany. During the investigation of the case – and even during the trial itself – the competent authority changed its mind about which articles in the relevant regulation the indictment should refer to.

Only the international legislation relevant to the specific criminal case is commented on in the following.

The analysis of the case study shows that the legislation is based on reference upon reference upon reference. Although the main regulation in the criminal case is a European one – Regulation (EC) No 1013/2006 – this regulation does not state the relevant definitions or procedures within the regulation itself but through references to EU directives, the Basel Convention, etc.

The complexity of the legislation makes it difficult for authorities to navigate the legislation – even so difficult that it means criminal cases are sometimes lost in court.

Keywords: waste crime, complexity, legislation.

Transport of waste – the two procedures

Transport of waste across borders has to follow one of two procedures laid out in Regulation (EC) No 1013/2006 ([33]).

The procedure of prior written notification and consent

The main rule is that the transport of waste across borders must follow the procedure of prior written notification and consent.

In simple terms, this means that prior to the transport/shipment, the notifier has to submit a written notification to and through the competent authority of the dispatch country; there has to be a contract between the notifier and the consignee; and there has to be established a financial guarantee or equivalent insurance.

The competent authority sends the notification to the competent authority of the destination country, with copies to any competent authority/authorities of the transit country. Only when all relevant parties have agreed to the transport it can take place ([34]).

This procedure takes resources and time.

Annex VII procedure

In recognition of the high demands of the procedure of prior written notification and consent, the regulation includes an exception to this procedure.

Waste listed in Annex III or IIIB can be transported without the procedure of prior written notification and consent, and simply accompanied by the document contained in Annex VII ([35]).

This is considered sufficient. Thus, the waste listed in Annex III is so-called green-listed waste ([36]).

The criminal case:

— The criminal case involved transporting aluminium skimmings from Sweden through Denmark to Germany.

— In Denmark, the competent authority is the Environmental Protection Agency.

In a criminal case, the Environmental Protection Agency makes a recommendation to the police regarding investigation work that is still needed, the right legislation, etc., and, of course, the categorisation of the waste.

([33]) Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).
([34]) Chapter 1 of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).
([35]) Art. 18 of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).
([36]) Annex III to Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).

The specific inspection took place in the south of Denmark. On that day, both the police and the Environmental Protection Agency were present during the inspection.

The shipment was accompanied by an Annex VII document ([37]). The Annex VII document stated that it was being transported from Sweden to Germany and that it was aluminium skimmings.

What caught the attention of both the police and the Environmental Protection Agency was the fact that the aluminium skimmings smelled strongly of ammonia. In fact, the entire area where the inspection took place had to be shut down so that the public could not use it, and the Emergency Management Agency was called to take samples, etc.

The conclusion was that the aluminium skimmings, due to contact with water, were giving off gases.

The Danish authorities found that the shipment was not compliant with the Annex VII procedure; therefore, the shipment was to be sent back to Sweden ([38]).

Extraordinarily, it was decided that it could continue the rest of the way to its destination in Germany. As the inspection took place in the south of Denmark, the destination was much closer than the place of dispatch, and the Danish authorities did not want the shipment being driven across Denmark and giving off gases.

Based on the categorisation of the waste, the test results and the recommendation from the Environmental Protection Agency, the prosecutor's office filed charges against the dispatching company. The charges were that the waste was 'not listed', instead of being covered by Annex III (green-listed waste); thus, the shipment was not compliant with the Annex VII procedure, and should have been subject to the procedure of prior written notification and consent ([39]).

During the trial, everybody agreed that:

— the correct company was facing charges;

— the transport of aluminium skimmings could have been compliant with the Annex VII procedure if the skimmings had stopped giving off gases.

During the trial, there were different opinions on whether the shipment was compliant with the Annex VII procedure or whether it should have been subject to the procedure of prior written notification and consent.

The Swedish authorities did not take any samples or did any tests regarding the shipment. They made a statement that aluminium skimmings' in general were covered by Annex III and, therefore, the transport was compliant with the "Annex VII procedure".

([37]) Annex VII to Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).
([38]) Art. 22 of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).
([39]) Chapter 1 of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).

Denmark (country of transit) tested the shipment, showing that there was a dangerous level of gases present. The tests showed that the aluminium skimmings produced these gases when put in contact with water. Once the chemical reaction was complete, it would not start up again should the aluminium skimmings get wet once more.

Germany (country of destination) tested the shipment, and this test showed that gases were not present. The German tests were conducted several days after the Danish tests. Thus, the chemical reaction had stopped and gases were no longer present.

In cases of disagreement about the waste categorisation, the environmental legislation is clear. If the competent authorities of the dispatch and destination countries cannot agree on whether the notified waste is listed in Annex III, IIIA, IIIB or IV, the waste shall be regarded as listed in Annex IV ([40]).

The twist in this case was that the authorities of the dispatch and destination countries agreed that the waste was listed in Annex III.

Denmark was the only country of transit; however, it was documented that there was a dangerous level of gases present in the shipment when it was in Denmark.

The Environmental Protection Agency had, prior to the trial, concluded that the shipment was to be regarded as listed in Annex IV ('not listed'), and the references to the legislation in the indictment were made according to this conclusion.

Just before the end of the trial, the Environmental Protection Agency changed its mind. Thus, Denmark was neither the country of dispatch nor destination, the Environmental Protection Agency now speculated that Denmark could not state that the shipment was to be regarded as listed in Annex IV, when both the country of dispatch and destination agreed on the waste of the shipment was listed in Annex III.

The Environmental Protection Agency now stated that it was a shipment of waste listed in Annex III, as it displayed the hazardous characteristics listed in Annex III to Directive 91/689/EEC ([41]).

The bottom line was the same as before. The shipment should have been subject to the procedure of prior written notification and consent.

However, since the reference to the legislation was different, namely that the shipment was not being categorised as listed in Annex IV but instead in Annex III with the presence of dangerous levels of gases, and the indictment did not reflect this, the judge acquitted the defendant.

([40]) Art. 28 of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).
([41]) Council Directive 91/689/EEC of 12 December 1991 on hazardous waste (OJ L 377, 31.12.1991, p. 20).

Legislation

The legislation on environmental crime is complex. It is an area of legislation where there is not one set of rules but national legislation combined with EU regulations that refer to EU directives, conventions, etc.

In addition to the complexity of the legislation, there are two opposing principles regarding environmental crime in criminal cases:

1. the legislation regarding environmental crime has the main purpose of putting the environment first;
2. in criminal cases, any reasonable doubt must benefit the accused.

In the following, only the international legislation relevant to the criminal case mentioned above will be analysed and commented upon, and some challenges will be highlighted. In the criminal case, it was not an issue whether the waste was contaminated or mixed. Therefore, this issue will not be a topic for exploration or discussion.

The main legislation relevant to the criminal case was Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste ([42]). This regulation incorporates the Basel Convention and the Organisation for Economic Co-operation and Development (OECD) decision into Community legislation.

Therefore, in this regulation, there are references to directives, conventions, the OECD decision, etc.

Even terms used in the regulation are not defined within the regulation but by reference to other legislation.

For example, Article 2 states the following:

For the purposes of this Regulation:

1. 'waste' is as defined in Article 1(1)(a) of Directive 2006/12/EC;

2. 'hazardous waste' is as defined in Article 1(4) of Council Directive 91/689/EEC of 12 December 1991 on hazardous waste.

Article 3 describes the method used for waste transport across borders. The method depends on which annex the waste is listed in.

In the case referred to, it was relevant whether the aluminium skimmings should have been sent accompanied by an Annex VII document – under the Annex VII procedure – or if the shipment should have been subject to the procedure of prior written notification and consent.

In order to determine the right procedure, the waste had to be categorised.

([42]) Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1), Preambles 3–5.

The shipment was transported following the Annex VII procedure; therefore, it was relevant to determine whether Annex III to Regulation (EC) No 1013/2006 covered aluminium skimmings.

Annex III to the regulation provides the reader with the same challenge as previously mentioned. It does not list the wastes subject to the general information requirements laid down in Article 18 (green-listed waste) as the title states – it refers to the Basel Convention.

Part I of Annex III states:

> The following wastes will be subject to the general information requirements laid down in Article 18:

Wastes listed in Annex IX to the Basel Convention.

In order to determine whether the shipment is covered under Annex III to Regulation (EC) No 1013/2006, the reader has to refer not to Annex III to the regulation but to Annex IX to the Basel Convention.

Aluminium skimmings are mentioned in Annex IX to the Basel Convention as 'B1100: Aluminium skimmings (or skims) excluding salt slag'.

So far, it can be concluded that aluminium skimmings are covered by Annex IX to the Basel Convention and, therefore, by Annex III to Regulation (EC) No 1013/2006. They can therefore be transported, accompanied by an Annex VII document.

The question in the criminal case was whether that conclusion was enough to conclude that the specific shipment was compliant with the Annex VII procedure or not.

As mentioned, the answer to that question can be found in Article 3 of Regulation (EC) No 1013/2006.

The main rule – the procedure of prior written notification and consent – is listed in Article 3, paragraph 1.

The exception is found in Article 3, paragraph 2, which states:

> Shipments of the following wastes destined for recovery shall be subject to the general information requirements laid down in Article 18 if the amount of waste shipped exceeds 20 kg:
>
> (a) waste listed in Annex III or IIIB …

Article 18, paragraph 1, states:

> Waste as referred to in Article 3(2) and (4) that is intended to be shipped shall be subject to the following procedural requirements …

The references are circular. Therefore, it can be difficult to decide which is the correct order to mention the articles when formulating an indictment. The meaning is pretty clear, though, and the issue of the correct order in which to mention the articles is more of an academic discussion that will be taken no further here.

The main rule is stated in Article 3, paragraph 1. The exception is stated in Article 3, paragraph 2.

An exception to the exception is made in Article 3, paragraph 3, which states:

> For wastes listed in Annex III, in exceptional cases, the relevant provisions shall apply as if they had been listed in Annex IV if they display any of the hazardous characteristics listed in Annex III to Directive 91/689/EEC. These cases shall be treated in accordance with Article 58.

Again, it is not possible to find what these exceptional cases are by reading Regulation (EC) No 1013/2006. A new reference is made, as the paragraph refers to Directive 91/689/ECC. Directive 91/689/ECC is no longer in force.

The new directive, Directive 2008/98/EC of the European Parliament and the Council of 19 November 2008 on waste and repealing certain directives, repeals Directive 91/689/ECC but states in Article 41 that 'References to the repealed Directives shall be construed as references to this Directive and shall be read in accordance with the correlation table set out in Annex V.'

H12 substances in Annex III to the directive are essentially the same as before, as in Regulation (EC) No 1013/2006 H12 describes 'Substances and preparations which release toxic or very toxic gases in contact with water, air or an acid', while Directive 2008/98/EC says: 'Waste which releases toxic or very toxic gases in contact with water, air or an acid'.

The conclusion, as far as the regulation goes, is that the shipment, under the special circumstances that were present in Denmark, should have been transported according to the procedure of prior written notification and consent because the waste was categorised as listed in Annex III, as it displayed the hazardous characteristics listed in Annex III to Directive 91/689/EEC and was therefore covered by the exception in Regulation (EC) No 1013/2006, Article 3, paragraph 3.

Discussion

In order to find the correct legal references in just one simple criminal case regarding one cross-border shipment of waste, it was necessary to find the appropriate legal provisions in the following:

- Regulation (EC) No 1013/2006;
- Directive 2006/12/EC;
- Directive 91/689/ECC, which is no longer in force, so also Directive 2008/98/EC;
- the Basel Convention, as it has been amended over the years.

As a special prosecutor, I am used to work with European regulations, directives, etc. I was startled to find how difficult it was to find Annex IX to the Basel Convention.

Finding the latest consolidated version of the legislation is an extra challenge that has to be overcome in everyday work life.

The very first preamble of Regulation (EC) No 1013/2006 states that 'The main and predominant objective and component of this regulation is the protection of the environment, its effects on international trade being only incidental.'

Nevertheless, the complexity of the legislation resulted, in this specific criminal case, in the principle that any reasonable doubt must benefit the accused winning against the principle of putting the environment first.

Even though it was documented that the shipment in Denmark gave off a dangerous level of gases and that the result of this was that the shipment should have been subject to the procedure of prior written notification and consent, the Environmental Protection Agency in Denmark – and thereby the prosecutor's office – had such difficulty finding the appropriate references in the legislation that the judge saw no other option but to acquit the defendant of the charges.

It must be acknowledged that, by making the legislation the way it is, by building it up with one reference after another, by making it impossible to know what to do by reading only the regulation itself, it is a very difficult tool to use – not only for the competent authority or public prosecutor – but certainly also for the transporting business and the notifier.

There are still many illegal shipments of waste within the EU. The European Commission is aware of this, and the problems controlling shipments are one of the reasons for proposing a revision of the regulation ([43]).

However, after reading the proposal, I realised that transparency is not the goal of the revision. It seems that it is not even a minor goal or a side effect of the revision. Reading through the main findings of the *ex post* evaluation of the current regulation, illegal shipments and control thereof is the last point mentioned ([44]).

Four political options are mentioned in the proposal ([45]). None of them seems to acknowledge that the complexity of the legislation in using references instead of stating rules within the regulation is part of the problem.

It goes against the sense of justice that companies can get away with violations only because the rules are so complex that they cannot always lead to the right indictment and therefor conviction.

([43]) 2021/0367 (COD) Proposal for a Regulation of the European Parliament and of the Council on shipments of waste and amending Regulations (EU) No 1257/2013 and (EU) No 2020/1056, Section 1.

([44]) 2021/0367 (COD) Proposal for a Regulation of the European Parliament and of the Council on shipments of waste and amending Regulations (EU) No 1257/2013 and (EU) No 2020/1056, Section 3.

([45]) 2021/0367 (COD) Proposal for a Regulation of the European Parliament and of the Council on shipments of waste and amending Regulations (EU) No 1257/2013 and (EU) No 2020/1056, Section 3.

Making the legislation more transparent is crucial to making sure that the main principles of the legislation can be employed in the courtroom and that the environment can be put first.

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Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).

2021/0367 (COD) Proposal for a Regulation of the European Parliament and of the Council on shipments of waste and amending Regulations (EU) No 1257/2013 and (EU) No 2020/1056.

The reptile trade and law enforcement in Norway and the Netherlands: time for a ban?

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Abstract

This article presents research on wildlife trafficking, more specifically the illegal trade in live reptiles and its enforcement in two countries: Norway and the Netherlands. Based on broad datasets that cover more than a decade and semi-structured interviews with police, customs, environmental authorities, food safety authorities and experts, the implications of the current regulation regime of wildlife trade through the Convention on International Trade in Endangered Species of Wild Fauna and flora (CITES) are discussed. A specific problem connected to CITES is the emergence and persistence of parallel legal and illegal markets. The empirical findings of this study show that the regulatory framework invites the laundering of illegal, wild-caught reptiles into the legal trade, increasing the risk of extinction for many species. The laundering issues will be discussed in the Norwegian context, where a reptile ban was lifted recently, and in the Dutch setting, historically known as a reptile trade hub. An important question is, therefore, whether the existing regulation actually serves to protect species from extinction or whether it rather legitimises and encourages trade, leading to extinction. A ban on the trade of live reptiles is discussed, since research data suggest a ban would be easier to enforce than the current regulation regime.

Keywords: reptile trafficking, laundering, wildlife ban, green criminology, enforcement.

Introduction: the global reptile trade

The wildlife trade is devastating to exotic species across the world. Large trade flows of endangered species have become embedded in the global economy for a wide variety of purposes. Products derived from wildlife species are used as medicines, meat and eggs are served as food, skins are used for leather products, and live animals are bought, sold and kept as domestic pets, including mammals, birds and reptiles (Pires and Clarke, 2012; Sollund,

2019; Van Uhm, 2016a; Wyatt, 2022). The trade of wildlife species contributes to a severe global defaunation that has extensive consequences (Dirzo et al., 2014; Hooper et al., 2012; IPBES, 2019).

Reptiles are one of the most heavily traded taxa of exotic animals in the world. They are traded for the 'pet' industry, and this threatens many reptile species (Warwick, 2014). Marshall et al. (2020) found that 35 % of reptile species are traded online and that much of this trade in reptiles is unsustainable and endangers many species' survival. Three quarters of this trade is in species that are not (yet) covered by CITES ([46]). The reptile trade involves numerous endangered or range-restricted species, especially from hotspots within Asia; approximately 90 % of traded reptile species and half of traded individual reptiles are abducted from the wild. Exploitation can occur immediately after scientific description, leaving newly discovered endemic species especially vulnerable (Marshall et al., 2020, p. 1).

A consequence of the reptile trade is species loss, but also the destruction of ecosystems, as reptiles and amphibians are vital in sustaining ecosystems through plant pollination (Schlaepfer et al., 2005; Valencia-Aguilar et al., 2013). The International Union for Conservation of Nature's (IUCN) Red List has assessed 45 % of the 10 272 currently recognised reptile species: 180 reptile species are critically endangered; 361 reptile species are threatened; and 403 reptile species are vulnerable (Puritz and Weller, 2018). More than one in five reptile species is threatened with extinction (Böhm et al., 2013). Cox et al. (2022) conducted a comprehensive extinction risk assessment of reptiles and showed that at least 1 829 out of 10 196 species (17,9 %) are threatened. Auliya et al. (2016) conducted case studies in a whole range of countries, including Australia, Indonesia, Japan and New Zealand, and countries in Central America, the EU, Europe and West Africa. They found that many species are threatened because there is no monitoring of the number of animals that are subjected to trade or their populations.

Worldwide, 36 % of reptile species are being traded, and many of them come from wild populations (Marshall et al., 2020). The countries that export the largest number of reptiles are in Meso-America, which is the largest exporting region, closely followed by sub-Saharan Africa. South America is the third largest exporting region, followed by southern Asia and South-East Asia and western and central Asia (Robinson et al., 2015). The EU is a major importer of reptiles (Van Uhm, 2016a): between 2004 and 2014, 20 788 747 live reptiles were imported to EU Member States, including reptiles that are protected by CITES regulations and species that are not. However, a minimum of 79 % of traded reptile species are not subject to CITES regulations (Auliya et al., 2016; Marshall et al., 2020, p. 6).

The greatest importers of live reptiles to the EU in 2004–2014 were Germany, with roughly 6 million imported, the United Kingdom, with almost 3 million, Czechia, with almost 2 million, and Italy, with almost 1.8 million reptiles imported. Germany and the Netherlands have been the main players in the transnational reptile trade for decades (Dominguez et al., 2024; Stefes, 2024). The value of the import of live reptiles to the EU was EUR 7 million in 2005. While the EU has a large reptile market, the United States' is even larger, accounting for 56.1 % of the total market in the import of live reptiles compared with the EU's 18.2 % (Auliya et al., 2016). Norway is a newcomer in the legal reptile market, as, since a partial lift of a ban on exotic reptiles in 2017, trade in 19 species has been permitted (Sollund, 2019, 2021).

Europe is also one of the biggest markets for illegal reptiles. Most live exotic animal seizures are reptiles, with more than 30 000 live reptiles confiscated between 2001 and 2010 in the European Union. Based on information from

([46]) CITES is a multilateral treaty to regulate the trade in endangered plant and animal species.

CITES reports, it has been determined that, between 2010 and 2014, 95 % of the live wild vertebrates seized were reptiles (D'Cruze and Macdonald, 2016). The confiscated reptiles included mainly tortoises, followed by chameleons and turtles (Van Uhm, 2016b). While some of the seizures concern reptile species from Europe, the majority are first imported from outside Europe (Gussow, 2009; Sollund and Maher, 2015; Mărginean et al., 2018).

In this article, we discuss issues related to law enforcement associated with the reptile trade using two countries as case studies, Norway and the Netherlands, and discuss the risks of reptile laundering, the challenge of enforcement and the advantages and disadvantages of a ban on trade in live reptiles.

Methodology

In this article, empirical data from research on the reptile trade in Norway and the Netherlands were analysed to unravel overlapping themes and synthesise the findings. The data collection in Norway was conducted in two stages between 2010 and 2020. The first stage of the data collection took place between 2010–2013, the second part took place between 2019–2021. The data consist of 42 interviews with people working for the authorities involved in the enforcement of CITES: police, customs, the managing authority of CITES, the Norwegian Environmental Agency and the Food Safety Authority (FSA), whose veterinarians often carry out the first control of wildlife in transit at borders. In addition, 340 penal case files dated up to 2017 were subject to analyses (Sollund, 2019, 2021, 2025). In addition, informants who had kept and trafficked reptiles illegally were interviewed. These data were triangulated with seizure reports from customs between 2008 and 2020, with the most recent data from 2017 to 2020.

The research in the Netherlands was conducted between 2013 and 2020, based on empirical data collected for three research projects (Dominguez et al., 2024; Van Uhm, 2016a). In these research projects, police files were analysed, experts were interviewed, seizures were analysed, reptile traders were interviewed, and network analysis was conducted. The 34 experts interviewed included police officials, specialists from the Dutch Food and Consumer Product Safety Authority (NVWA), customs officials, biologists and employees of conservation organisations, including the RAVON Foundation, Herpetofauna Foundation, IUCN, International Fund for Animal Welfare, the Wildlife Justice Commission and CITES Netherlands.

The research is situated within the field of green criminology. Green criminology focuses on environmental harms and crimes against humans and non-human species (e.g. Sollund, 2015; Van Uhm, 2024; White, 2013), including studies on wildlife crimes and harms (e.g. Sollund, 2019; Van Uhm, 2016b; Wyatt, 2013). Justice concepts are central in such studies, such as those connected to environmental (human) rights, animal rights and species justice, and ecosystem sustainability and eco-justice (Benton, 1998; White, 2013).

Findings: the problem with parallel legal and illegal markets

The reptile trade is characterised as trend-sensitive; it is influenced by social media and film releases that cause new reptile species to become popular. The existence of parallel legal and illegal markets entails the risk of laundering illegal goods/products/animals into the legal market (Lyons and Natusch, 2011; Sollund, 2019; Sosnowski and Petrossian, 2020; Van Uhm, 2018). In the wildlife trade, the problem of verifying an animal or animal product is

generally connected to the documentation, such as export and import permits ([47]) issued by the exporting country and the importing country's CITES managing authorities. The CITES documents may be subject to fraud and loopholes, and the lack of control provides opportunities for wildlife laundering (e.g. Sollund, 2019; Warchol et al., 2003).

During the process of laundering wildlife, the illegal origin of an animal is concealed. For instance, the animal is declared as being bred in captivity instead of abducted from nature. Thus, a wildlife trader or breeder may order illegal wildlife from a poacher. The poacher provides the illegal wildlife, and then the dealer declares that the wildlife is captive bred and thus mixes it with the legal wildlife trade. Subsequently, the wildlife is laundered and can enter the legal economy (Figure 2.1).

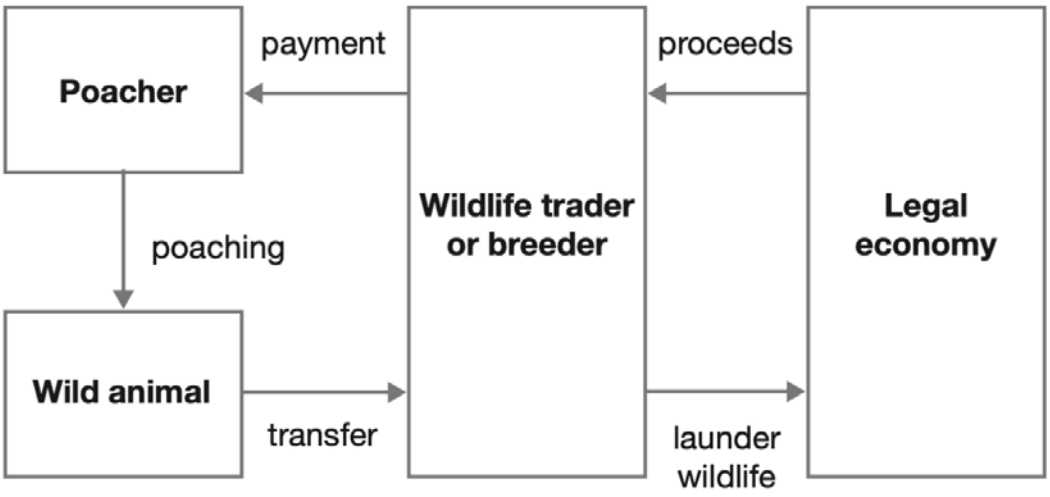

Figure 2.1. Wildlife laundering.

Numerous examples demonstrate the involvement of commercial wildlife traders in fraudulent activities, including the use of forged documentation and other deceptive practices to misrepresent wild-caught animals as captive-bred (Nijman et al., 2012; Nowell, 2009; Wong, 2017). In addition, breeding farms for endangered wildlife have been promoted to aid biodiversity conservation by alleviating the pressure on wild populations. However, they also provide a perfect cover for obtaining illegally caught wildlife and the appropriate documents (Lyons and Natusch, 2011; Nijman and Shepherd, 2009; Van Uhm and Zhang, 2022). Furthermore, zoos have a special position in that they are able to import wildlife easily for conservation or education purposes. However, this role also allows illegal entrepreneurs to launder wildlife and use breeding programmes to explain the appearance of new (illegally obtained) animals (Stiles et al., 2013). Zoos are also beneficiaries when wildlife is seized, since they can pick and choose the animals they are willing to rehome and reject others (Sollund, 2019).

Laundering reptiles and lifting the ban in Norway

With the lift of the ban on trading exotic reptiles in Norway, opportunities for laundering illegal reptiles have surged; however, the justifications put forward as the basis for this decision need some elaboration. The FSA argued for a lift of the general ban on exotic reptiles, since it was estimated that there were already more than 100 000 reptiles

([47]) This may become less of a problem with the introduction of digitalised documentation.

kept illegally in the country (Sunde, 2010). The FSA worried about salmonella and the welfare of these animals, as it suspected that owners would not take their reptiles to the vet due to the ban, and that they could suffer harm. The Norwegian positive list includes species that the FSA regards as fit to be held in captivity. Of the 19 reptile species, 15 are either listed in the CITES II appendix (requiring export and import permits) or listed by the IUCN as vulnerable. However, with the reverse of the 40-year-old ban on reptiles as pets and the introduction of the positive list for reptiles, other issues have arisen.

One requirement is that the animals should not be caught in the wild, and, thus, the person selling the animal should provide the buyer with a document stating that the animal had been bred in captivity. Rather than customs officers, who are usually responsible for controlling goods that enter the country, in the case of live animals this has become the responsibility of the border veterinarians of the FSA, who are not CITES experts. Consequently, reptiles (and other animals) may enter the country without being subject to proper CITES controls (Sollund, 2019). The FSA border veterinarians underline that the documents that reptile owners produce to prove the legality of their animals are easily subject to fraud, and can take the form of all sorts of hand-scribbled auto declarations. This means that illegal wild-caught animals may be laundered into the legal reptile trade in Norway and elsewhere.

Another issue concerns non-EU countries. The interview data showed that cardboard boxes with reptiles inside arrived in Norway from the Netherlands or Germany; however, it appears they did not embark on their journey from either of these countries, but from China, since the packages were marked with Chinese script. Once a package has arrived in an EU Member State, it can legally cross borders within the EU and the European Economic Area without being subject to further control, thus facilitating the illegal wildlife trade. This is also an animal welfare issue. On several occasions, the border veterinarians have unpacked boxes containing dead fish and reptiles. This reflects the extremely high mortality rates in wildlife trafficking generally (e.g. Maher and Sollund, 2016).

Laundering reptiles in the Netherlands

Reptile species that are in high demand or reptiles that are difficult or expensive to breed in captivity risk becoming part of laundering schemes in the Netherlands (Janssen and Chng, 2018; Lyons and Natusch, 2011; Nijman and Shepherd, 2015). One example is the African spurred tortoise (*Centrochelys sulcata*), since breeding this turtle to a significant size takes several years, which makes it unprofitable for traders. Dutch inspectors revealed that a large shipment of African spurred tortoises was reported as being captive bred, but the animals' physical appearance proved otherwise. These African spurred tortoises had a much larger carapace than would have been plausible for captive-bred African spur tortoises; it takes the tortoises many years to grow a shell of such a large size. This illustrates how traders declare reptiles as captive bred, while in reality they have been caught in the wild.

Reptile laundering also occurs through countries that are not members of CITES. A reptile expert in the Netherlands explained that many are suspicious that reptiles from the wild are being passed of as captive bred by using a non-EU country as a stopover. For instance, several Horsfield's tortoise (*Testudo horsfieldii*) range states are not a party to CITES, which probably adds to the illegal trade in the species by complicating the differentiation between legal and illegal trade streams (Smith and Porsch, 2015). This facilitates laundering practices in source countries that are a party to CITES. The Netherlands is considered both a transit and a destination country in the international trade of Horsfield's tortoises trade; they account for 91 % of the wild-caught reptiles imported by the Netherlands and about 12 % of all CITES-listed reptiles that are exported from the Netherlands (Janssen and Leupen, 2019).

Finally, in many cases authorities have no idea what reptile species they are dealing with, so they write down everything the trader in question says. According to our respondents, reptiles from Indonesia destined for the United States make a detour via the Netherlands, after which they are indicated as captive-bred reptile species and offered for sale online. However, although traders' knowledge of reptile species may provide opportunities for laundering, many reptile traders in the Netherlands are unaware of trade restrictions and reptile-laundering practices, in particular when it concerns non-CITES species. Therefore, trade in laundered reptile species also occurs due to a lack of awareness.

Problematic law enforcement

Since both Norway and the Netherlands are part of the Schengen area and the EU single market, which allows goods to be moved freely among Member States, reptiles can be traded completely legally in Europe. As soon as the reptiles have been illegally smuggled from the country of origin into Europe, this poses significant challenges for law enforcement agencies. According to law enforcement officials, this makes tackling the illegal reptile trade in Norway and the Netherlands very difficult.

In addition, uncovering laundered reptiles presents a major challenge for Dutch and Norwegian law enforcement agencies. In the Netherlands, law enforcement officials explained that it can be a challenge to identify illegal reptile species, particularly when the appropriate paperwork has been submitted, and to distinguish between the legal and illegal reptile trade. This is confirmed by law enforcers in Norway. While FSA vets may be trained to distinguish the 19 legal species from illegal species, customs inspectors and police officers often do not have such skills. Therefore, according to the interviews, they will desist from establishing the species of a reptile when they are found during house searches and take offenders' claims that the reptiles are on the positive list at face value. It has become too complicated to enforce CITES, since it requires skills that are lacking in law enforcement agencies (LEAs).

If an illegal reptile is detected on the border of Norway or the Netherlands and the offender is duly reported to the police, customs may impose an administrative sanction, which means that if such cases are not simply dismissed by the police, which happens frequently, they often result in rather insignificant fines. This means that the punishment for illegal reptile trade has little deterrent effect, both on an individual level and as a general preventative measure. The fact that such punishment is seldom made public also means that the general public assumes that reptiles for sale in Norway and the Netherlands have a legal origin and are unaware of the risks of reptile species brought into the EU illegally with false, forged or no paperwork.

A ban on the trade of live reptiles?

Generally, reptile trafficking offences are under-enforced and punishments are lenient, and, given the rate of extinction we are currently witnessing, with more than one out of five reptile species threatened (IPBES, 2019), this gives rise to concerns about the effectiveness of the regulations in their current form, since they do not appear to be protecting reptiles from going extinct (Dickson, 2003; Sollund, 2023; Wyatt 2019). Whether a ban on the trade of live reptiles would stop the trade is doubtful, according to our respondents, since high profits may attract illegal entrepreneurs, even when it is banned, such as in the case of the Adelaide pygmy blue-tongue skink (*Tiliqua*

adelaidensis) ([48]). The effect of a ban also depends on the risk of being detected and the severity of the punishment that would be imposed should offenders get caught. Currently, in both Norway and the Netherlands, punishment for involvement in reptile trafficking is lenient, if any punishment is imposed at all (Sollund 2019, 2025; Dominguez et al., 2024); reptile trafficking is still a crime that involves low risk and high pay (Van Uhm, 2023) ([49]).

A ban could also have the undesired effect of making live reptiles even more attractive. In the Netherlands, several drug traffickers became involved in the illegal reptile trade in the 1990s, and, in Norway, much of the illegal reptile trade was linked to offenders involved in multiple types of crimes who had a fetishist relationship with the then illegal reptiles (Collard, 2020; Sollund, 2019; Van Uhm, 2016b). It is possible they held an attraction not only because they looked scary (Janovcová et al., 2019) but also because they were illegal, thus adding to the status of the offender in their social subgroups.

Research also suggests that when CITES introduces a ban on a species, in the interval between when the proposal is made and when it comes into effect, there may be an increase in trade (Rivalan et al., 2007). Currently, roughly 6 610 species of animal and 34 310 species of plant are listed in the CITES appendices. The number of species is constantly increasing because more species become endangered, due to the increase in climate change and the nature crisis generally, but also because more species are offered protection or stricter protection ([50]). When a potential CITES listing or uplisting is announced, traders try to obtain as many animals as possible, illegally or not, before the stricter regulations come into effect (Dominguez et al., 2024; Rivalan et al., 2007). However, this argument would probably be less valid if all trade in live reptiles was banned, since law enforcement would probably increase.

Some respondents argued that a ban on trade in live reptiles would affect the livelihoods of local people in poor source countries. Many rural households in economically developing countries depend heavily on wildlife resources (Duffy, 2010; Roe, 2002). However, hunting reptiles is often part-time work, undertaken by poorer members of the community, and is perceived as opportunistic, risky and financially unreliable (Robinson et al., 2018). Therefore, the implications of regulations and bans on reptiles for local livelihoods should be better contextualised to understand the real effects.

Finally, if the trade of live reptiles was banned, respondents argued that more of it would go underground and take place on the internet – so-called crime displacement. Should LEAs start monitoring the internet and social media properly, perhaps crime groups would turn to the dark web. At the same time, those who constitute the largest part of the market – ordinary citizens – will abstain from participating in the reptile trade because it is no longer openly available and is more complicated, and thus less tempting. However, research focusing on wildlife trade on the dark web has found that it is not as prevalent as the trade that goes on in open internet channels, such as through social media (Stringham et al., 2023; see also Harrison et al., 2016).

It is important to note that, due to the complications of enforcing the trade regulations, several respondents from law enforcement agencies in Norway and the Netherlands argued that a ban would make it easier to react to

([48]) At the 19th meeting of the Conference of the Parties (COP 19) to CITES in Panama, the reptile *Tiliqua adelaidensis* (Adelaide pygmy blue-tongue skink) was listed under Appendix I as threatened after being heavily commercialised for the pet trade (CITES, 2022).

([49]) An important requirement for a potential punishment to have a deterrent effect, is not only its severity and certainty, but also that these aspects of the potential punishment become generally known among potential offenders. As mentioned, these circumstances lack in the case of Norway and the Netherlands.

([50]) An example of this was the uplisting from Appendix II to Appendix I of the African grey parrot in 2016 as a consequence of unsustainable trade (CITES, 2016). It was estimated that this trade involved more than 1.3 million birds prior to the ban (IFAW, 2022).

illegal reptile trade. For instance, the findings from the Norwegian study clearly show that enforcement agencies, customs, police and border vets regard a ban as far easier to enforce than the partial legislation that exists today, and that the introduction of the positive list has entailed difficulties in the enforcement of CITES (Sollund, 2019; 2021).

In addition to the complications implicit in enforcing a regulation rather than a ban is the issue of animal welfare and the role of reptiles in their ecosystem. Undoubtedly, millions of animals suffer in the wildlife trade, whether this is legal or illegal (Sollund, 2011, 2019, 2025; Van Uhm, 2016a; Wyatt et al., 2022). With the increase in aetiological, psychological and biological studies of animals (e.g. Ackerman, 2017; Bekoff, 2006; Pepperberg, 2000), more insights into the cognitive and other abilities of reptiles will be provided in the future. From a biocentric perspective, reptiles that are abducted from their habitat and traded so that they must live the rest of their lives in captivity should they survive would benefit from a ban on the trade. Several respondents added, from an ecocentric perspective, that the intrinsic value of reptiles, as well as the role of reptiles in their ecosystems, should be considered by CITES, rather than their trade value and objectification (Sollund, 2023, 2025). CITES can be accused of being an outdated convention based on econocentric values (Goyes, 2023). It has been suggested that it legitimises and encourages wildlife trade, which, consequently, harms wildlife and contributes to animal harm and species extinction (Sollund, 2019; 2023; 2025).

Our empirical findings highlight the importance of reconsidering the effectiveness of the regulation of the reptile trade and taking into account biocentric and ecocentric approaches when considering a general ban on the trade in live reptiles.

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Combating environmental crime: illegal cross-border waste transport and utilising modern technologies

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Abstract

This contribution provides a comprehensive introduction to the issue of environmental crime and illegal cross-border waste trafficking, with a focus on the EU legislation to combat these phenomena. The article begins by presenting a wide range of challenges associated with environmental crime and its impact on the environment and public health. It includes a definition of the scientific methods used in the creation of this contribution.

The article describes the EU tools available, such as the Serious and Organised Crime Threat Assessment (SOCTA), European multidisciplinary platform against criminal threats (Empact) and Secure Information Exchange Network Application (SIENA), which are key instruments used to monitor and suppress criminal threats in the realm of organised crime, of which environmental crime is a part. The article analyses their utilisation and effectiveness in identifying, monitoring and penalising actors engaged in environmental crime and their illegal activities within the EU.

Another section is dedicated to illegal cross-border waste trafficking, encompassing the global scope of waste production, definitions of key terms, and statistical data collected by Eurostat, which illustrate the extent and severity of this problem. In the section focused on combating this issue, the contribution examines the use of modern technologies, particularly unmanned vehicles and methods such as lidar and photogrammetry, as effective tools for detecting and investigating illegal activities related to cross-border waste transport, providing specific examples of their use. There is a focus on the experiences of the Slovak police using these tools in real-world conditions and their contribution to combating illegal waste transport.

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In the concluding section of the contribution, current challenges and future prospects in the fight against illegal waste transport are identified, with an emphasis on the need for further action, cooperation and innovation in this field.

Keywords: environmental crime, transboundary shipment of waste, drones.

Environmental crime and illegal cross-border waste transport

Introduction to the issue of environmental crime and illegal cross-border waste transport

Environmental crime currently represents one of the world's fastest-growing security problems. Given the increasing occurrence and severe consequences of these crimes, greater attention needs to be given to the relevant regulations and sanctions. Within the EU, this issue is systematically addressed through Directive 2008/99/EC on the protection of the environment through criminal law, as amended ([2]). This directive responds to the rise in environmental crimes with international implications. The preamble of Articles 2 and 3 of this directive clearly expresses the EU's concern about the growing number of crimes that transcend national borders. These acts, posing serious threats to the environment, require not only an adequate response but also effective legislation. Over the past decade, it has become evident that existing punitive provisions are often insufficient to achieve the desired compliance with environmental protection laws. The low number of successfully investigated environmental crimes underscored the need for a comprehensive review of Directive 2008/99/EC. The reasons for the revision are apparent – new information and scientific evidence on the harmful environmental and economic impacts of these crimes compel us to re-evaluate the issue. The dynamics of this process clearly indicate the need for the revision and improvement of legislation in this area. New legislation should address not only existing shortcomings but also current challenges in tackling environmental crime. We witness how the negative effects of these crimes extend beyond the environment, impacting the economy, social stability and public health (Kern, 2023a). The above statements are directly addressed by Directive (EU) 2024/1203 on environmental protection through criminal law, replacing Directives 2008/99/EC and 2009/123/EC ([3]). In this directive, the European Parliament and the Council of the European Union unequivocally express the view that the sanction rules under Directive 2008/99/EC of the European Parliament and of the Council and under Union sectoral law in the field of environmental protection are not sufficient to ensure compliance with Union law on environmental protection. Such compliance could and should be increased by the availability of effective, proportionate and deterrent criminal sanctions that correspond to the seriousness of the offences and can express greater societal disapproval than the use of administrative sanctions alone. The complementarity of criminal and administrative law is of fundamental importance for the prevention and deterrence of unlawful actions that harm the environment.

With the increasing trend of environmental crime, financial motivation for its commission is particularly associated, serving as the key driving force behind this form of illegal activity. The waste trade sector in particular has reaped illegal profits amounting to tens and even hundreds of millions of euro in recent years. These revenues not only fund other forms of criminality but also serve as sources of corruption that undermine societal integrity. Throughout the world, waste trafficking is increasingly recognised as a serious criminal offence with close ties to corruption, organised crime and money laundering (Isarin et al., 2023).

In addition to the economic consequences, environmental crime is linked to irreversible damage. The creation of illegal waste dump sites and other crimes related to unauthorised waste disposal can lead, among other things, to

the endangerment of biodiversity and the extinction of certain plant and animal species. This results in biological imbalance, disrupting ecosystems and causing serious consequences for the entire environment.

Detection and investigation of environmental crime is a key aspect of law enforcement efforts to combat the consequences of this criminal activity successfully. The first step in addressing this problem is identifying the perpetrators and determining the extent of their actions. A thorough investigation is essential for the fair punishment of offenders and the removal of the harmful consequences of their actions. Detecting and investigating environmental crime not only serves to repress and punish offenders but also plays a key role in restoring damaged ecosystems and preventing further offenses, especially when potential perpetrators are aware of the high likelihood of detection and severe penalties. This creates an environment that deters potential offenders. The fight against environmental crime is, therefore, crucial for preserving a healthy environment for future generations. Success in this area is inextricably linked to the effective detection and investigation of crimes, supported by relevant legal tools, including European legislation.

Methodology

This contribution is based on the analysis of the issue from the perspective of international legislation and available EU tools. The foundation of the contribution is a multidisciplinary approach. The common methodology comprises five main research steps: initial theoretical research of international legislation, analysis of available EU tools in combating organised crime, analysis of available statistical data, the current state of using unmanned vehicles in forensic activities from a global perspective, and the incorporation of authors' own experiences of investigating environmental criminal activity.

EU tools to combat criminal threats in the field of environmental crime

In an effort to strengthen security and enhance cooperation in the fight against criminality, the EU operates the SOCTA and Empact systems. These tools play a crucial role in identifying, assessing and monitoring threats associated with criminality in the EU.

SOCTA is a comprehensive report prepared by the European Union Agency for Law Enforcement Cooperation (Europol) that analyses organised crime in the EU over a specific period. It focuses on identifying major trends, patterns and new threats, providing Member States and LEAs with strategic information essential for effectively combating organised crime, shaping legislation and fostering joint activities (Europol, 2017).

Empact coordinates and integrates the actions of EU Member States in priority areas. It identifies key areas of criminality that require special efforts and collaboration. Environmental crime was one of the 10 priorities of this platform within the EU's 2018–2021 political cycle and remains a priority in the 2022–2025 cycle, and specific measures have been created to combat particular illegal practices threatening the environment (Europol, 2022a).

That environmental crime is a priority of Empact emphasises the importance of environmental protection and sustainable development. The main goal is to suppress illegal activities such as illegal waste transport, illegal trade in endangered species, illegal logging and other forms of environmental pollution. Making this a priority seeks to prevent not only ecological damage but also potential consequences for public health (Europol, 2022a).

Within Empact, joint operations and operational teams focused on environmental crime are created and implemented, bringing together experts in law, science and technology from Member States. Their role is not only to identify and expose perpetrators but also to improve preventive measures and operational police cooperation in the fight against environmental crime.

Illegal cross-border transport of waste

The development of industrial activities and increased consumption since the 1970s has led to an exponential increase in waste production worldwide: in 2022, the size of the waste management market was estimated at USD 1 052.58 billion, and it is expected to reach approximately USD 1 985.06 billion by 2032 (Precedence Research, 2024). Looking at the statistical data over time, it can clearly be stated that the waste trading market is a multibillion-dollar industry that requires special attention from law enforcement authorities. Demand is not only stable but also sharply increasing. Challenges related to waste management in rapidly growing urban areas affect not only low-income countries but also cities in developed economies. However, the rapidly growing volume of waste has exceeded the capacities of states for legal and economically viable waste management. This phenomenon has prompted a push for ecological solutions and environmentally friendly practices, simultaneously driving entrepreneurs to dispose of waste, often through illegal transport outside the country of origin. In an attempt to reverse this trend, international, European and national legal regulations have been enacted to govern the management of waste, especially hazardous waste.

The Basel Convention plays a crucial role in the international regulation of cross-border movement of hazardous waste and its disposal. It categorises hazardous waste and establishes rules for its export, import and transport. The convention emphasises the obligation of contracting parties to prohibit the import of hazardous waste for disposal purposes. Legitimate import, export and transport of hazardous waste are permitted only with the consent of all contracting countries, and each country has the right to ban the import of hazardous waste into its territory completely. With the establishment of the Schengen area after 2007, the number of cross-border waste shipments within the EU increased, including those involving non-EU countries. This trend further intensified after China, the leading country in plastic recycling, restricted the import of plastic waste (Kern, 2023b).

EU Member States are bound by the obligation, under the Basel Convention, to dispose of or recycle their waste primarily within their own territories. The ban on the export of plastic waste to China, known as the China ban, significantly affected cross-border waste shipments. EU legislation regulates waste categorisation, disposal and recycling processes, and defines the responsibilities of waste producers, taking into account transport conditions within the Schengen area and relationships with non-EU countries.

Illegal cross-border transport of waste poses a serious threat to the environment, human health and the economy, and is often driven by the pursuit of illegal profits, with perpetrators ignoring existing environmental standards and regulations. Waste is illicitly transported from its origin to other areas, often to countries outside the EU, where it is processed more affordably or without adherence to relevant environmental legislation. This creates a global problem, as illegal waste transport transcends borders and causes harm not only in the country of origin but also in the countries to which the waste is sent.

The aforementioned Basel Convention provides a comprehensive legal tool for regulating cross-border waste transport to minimise its environmental impact and protect public health. Since illegal waste transport occurs across borders, the Basel Convention offers an essential framework for international cooperation in this field. Signatories to the Basel Convention have committed to treating any illegal cross-border transport of waste as a violation of the law and a criminal offence (Secretariat of the Basel Convention, n.d.).

The EU pays special attention to waste transport regulation and the prevention of illegal waste transport. Regulation (EC) No 1013/2006 of the European Parliament and of the Council on shipments of waste, as amended (hereinafter 'the regulation') ([52]), constitutes a fundamental and binding framework for waste transport regulation in the EU. It defines terms such as waste, specifies the relevant authorities and people involved in cross-border waste shipments, and, notably, in Article 2, paragraph 35 defines illegal cross-border waste transport itself as any shipment of waste affected:

> (a) without notification to all competent authorities concerned pursuant to this Regulation;
>
> (b) without the consent of the competent authorities concerned pursuant to this Regulation;
>
> (c) with consent obtained from the competent authorities concerned through falsification, misrepresentation or fraud;
>
> (d) in a way which is not specified materially in the notification or movement documents;
>
> (e) in a way that results in recovery or disposal in contravention of Community or international rules;
>
> (f) contrary to Articles 34, 36, 39, 40, 41 and 43;
>
> (g) which, in relation to shipments of waste as referred to in Article 3(2) and (4), has resulted from:
>
> (i) the waste being discovered not to be listed in Annexes III, IIIA or IIIB;
>
> (ii) non-compliance with Article 3(4);
>
> (iii) the shipment being affected in a way that is not specified materially in the document set out in Annex VII.

At the same time, this regulation introduces the categorisation of waste according to its hazardousness and economic usability into three main categories: 'green-listed' waste, 'amber-listed' waste and other waste.

Green-listed waste includes environmentally acceptable and recyclable waste with a high level of recyclability. Examples include waste suitable for producing new products or extracting economically valuable substances that are not inherently hazardous. The regulation allows the transport of such waste across internal and external borders for recycling purposes. Shipments of green-listed waste must be accompanied by information in accordance with Annex VII of the regulation, requiring details about the transport organiser, waste producer, transport company and facilities authorised to receive and utilise the waste. Information about the type and quantity of transported waste is also required. Transport of green-listed waste is permitted only if the waste is correctly sorted from other components, catalogued according to the waste catalogue, not excessively contaminated, and transported directly

([52]) Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (OJ L 190, 12.7.2006, p. 1).

from the producer to the recycling facility. In this context, a contract is also concluded between the exporter and the importer of green-listed waste, in which the exporter commits to supplying a certain type and quality of waste, and the importer demonstrates the ability to receive and utilise such waste. Conversely, amber-listed waste includes waste that is hazardous according to the Basel Convention or is contaminated, and its recycling mainly involves energy utilisation, cement production or obtaining economically relevant components or substances with high technological and safety standards. Due to the higher level of hazard and processing complexity of this waste, its transport is strictly regulated within the EU and the non-EU countries concerned. Regulation of its transport primarily involves prior written notification and consent from all countries involved. The consent of the destination country is contingent on, among other things, receiving mandatory data that specify precisely the quantity and type of waste, as well as the relevant waste processing method, which must meet the conditions of the country allowing the recycling of that specific waste. Such consent is time-limited and allows the import of waste into a specific facility in the destination country. The regulation also defines conditions for providing guarantees to cover costs in cases where an authorised shipment fails to meet the conditions set out in the regulation. In the event that a person responsible for illegal waste transport is identified, it is possible to impose an obligation on them to take back the waste at their own expense or at the expense of another obligated entity, such as the exporting state. Affected states are not entitled to oppose or object the return of the waste or the process of its disposal or utilisation at the location where the illegal waste transport is detected (Regulation (EC) No 1013/2006).

When assessing the legality of actions by individuals or legal entities regarding cross-border waste transport, it is necessary to consider other international legal regulations governing specific waste streams. In addition, other directives and acts must be taken into account. Examples include Directive (EU) 2018/849 of the European Parliament and of the Council of 30 May 2018 amending Directive 2000/53/EC on end-of-life vehicles, Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and Directive 2012/19/EU on waste electrical and electronic equipment; Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment; and the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).

For a better understanding of the issue of waste export, especially its quantity, it is necessary to look at the available statistical data for the year 2021 on waste transport between Member States and non-EU countries. The data are publicly available on the Eurostat website. In 2021, Member States exported almost 15.0 million tonnes of non-hazardous waste, while 8.8 million tonnes of hazardous waste were exported from one Member State to another. From 2010 to 2021, the amount of hazardous waste exported from Member States significantly increased from 6.1 to 9.6 million tonnes. From 2016 to 2017, there was a sharp increase in exports, which increased by more than one fifth, from 6.1 to 7.4 million tonnes (+ 22 %). In 2021, the Member States with the highest amount of exported hazardous waste were France (2.8 million tonnes), Italy (1.3 million tonnes), Germany and the Netherlands (both 1.1 million tonnes). The export of hazardous waste from Member States to countries of the European Free Trade Association, especially Switzerland and Norway, decreased from 568,000 tonnes in 2019 to 450,000 tonnes in 2021. Hazardous waste exports to OECD countries outside the EU and countries of the European Free Trade Association amounted to 399 000 tonnes in 2021. This accounted for 4 % of the total amount exported. The main destinations among these countries were the United Kingdom and Türkiye. The amount of hazardous waste exported from Member States for disposal in the destination country was 1.7 million tonnes in 2021. Over the same period, 2010–2021, the amount exported for recovery increased from 4.3 million to 7.9 million tonnes (Eurostat, 2024).

Combating illegal cross-border waste transport and utilising modern technologies

The production of waste that can no longer be reused exceeds the capacity for storage/disposal, especially in advanced economies. Organised criminal groups, therefore, seek economically advantageous solutions to dispose of such waste in countries where the costs of disposal are significantly lower and where action to combat such illegal activities is negligible. These factors contribute to the increasing number of illegal waste shipments within and outside the EU. Combating illegal cross-border waste transport effectively, therefore, requires a global perspective and close cooperation between Member States. International collaboration is a key tool in detecting and investigating criminal activities related to illegal cross-border waste transport. Mechanisms for exchanging information between countries utilised thus far enable the rapid identification of illicit activities and the efficient coordination of actions taken. The EU has established platforms and systems that allow Member States to share information about illegal waste transport. In this context, Europol plays a crucial role, especially in coordinating the fight against environmental crime, including illegal cross-border waste transport. Europol has developed an information exchange system called SIENA. SIENA enables relevant authorities from Member States to quickly and securely share real-time information about crimes. In the case of illegal cross-border waste transport, Europol can coordinate joint operations through this system, provide analytical and technical support, facilitate cooperation and information exchange between individual Member States, and support the formation of operational groups and joint investigative teams (Europol, 2022b).

Rapid technological progress provides new tools for detecting and investigating environmental crime, including illegal cross-border waste shipments. Satellite technologies, geographic information systems and software applications enable detailed tracking of waste movement and the identification of potential illegal activities. These tools provide investigators with valuable data and analytical means to establish patterns and suspicious routes of waste movement.

One such tool is unmanned aerial vehicles (UAVs), commonly known as drones. These are any autonomous or remotely controlled vehicle operated via pre-programmed computer software or a ground-based remote pilot (D'Andrea, 2014). Drones are often associated with the ability to perform '3D' (dirty, dull and dangerous) missions, leading to their widespread use and in-depth exploration in various fields. Drones enable procedures to be carried out quickly and efficiently and with fewer risks than manned operations (Naidoo et al., 2011), such as delivering essential supplies to individuals affected by disasters in situations where traditional routes are inaccessible. Although drones have been widely adopted in many forensic procedures, the evidence regarding the categorisation of drone applications in forensic science is still limited and unclear, highlighting the need for further research in this area (Mohd Sabri et al., 2023).

Despite continuous advancements in this field, drones have become invaluable aids in crime scene detection and documentation. Their use allows for rapid and efficient monitoring of the extent of illegal cross-border waste transport and provides investigators with detailed visual information about crime scenes. Of course, drones primarily serve as a means of flight, carrying other technology or detectors. One such technology is lidar, which is a specialised type of sensor that uses laser beams to measure distances and create accurate 3D surface models. When used with drones, lidar allows precise mapping of terrain, including illegal waste dump sites. This technology can identify dump sites hidden under vegetation or in hard-to-reach areas, significantly simplifying the localisation and documentation of criminal activities (Rango et al., 2006). Photogrammetry, which combines

photographs obtained using drones, also plays a crucial role in documenting crime scenes. This method enables the creation of high-quality 3D models of terrain and objects, including locations with illegally deposited waste. Analysing these models can accurately determine the volume and extent of illegal dump sites. Collaboration with experts in geoinformatics and photogrammetry is essential for the effective use of these technologies. Creating 3D models and mapping terrain not only assists in detecting illegal activities but also provides evidence in criminal proceedings. Law enforcement agencies within the EU, in addition to direct collaboration with experts in the field, have recently been developing their own capacities and specialists capable of utilising unmanned means to document crime scenes. The use of in-house capacities significantly reduces the time and financial requirements of collaborating with external expert organisations.

In conclusion, it can be stated that modern technologies, especially the use of drones with lidar and photogrammetry, have had a revolutionary impact on the ability to detect and document illegal waste transport. Their precise and rapid data acquisition helps LEAs create the necessary evidence for the effective prosecution of perpetrators.

Slovak overview

In Slovakia, the specialised unit responsible for detecting and investigating crimes related to unauthorised waste handling, including those associated with illegal cross-border waste transport, is the Hazardous Materials and Environmental Crime Detection Division of the police forces' National Centre for Specialised Crime. Established on 1 February 2022, this dedicated unit ensures the detection, clarification and investigation of environmental crime and crimes related to the illegal handling of chemical, biological, radiological, nuclear and explosive (CBRNe) materials throughout the territory of Slovakia. In the documentation of environmental criminal activities linked to illegal cross-border waste shipments, this unit collaborates intensively with customs officers from Slovakia's Financial Administration, experts from the Ministry of Environment and inspectors from the Environment Inspectorate.

In 2019–2021, hundreds of cases of illegal waste transport into the territory of Slovakia were identified and documented by the Slovak police. In 2022, thanks to very effective collaboration with the Slovak Financial Administration and Ministry of Environment, only five cases were documented. The decline in these criminal activities is attributed to direct and decisive measures taken by the Slovak police against companies organising illegal cross-border waste shipments, receiving waste from these shipments, operating waste processing facilities or using fuel made from waste from these shipments. Key to improving the situation were the specialised training of the police and the utilisation of specialised technical devices designed to monitor the content and quantity of waste transported by freight vehicles.

It is important to note that the fight against criminal activities related to illegal cross-border waste shipments and illegal waste trade is annually prioritised within the framework of Empact. This topic was also an area of cooperation during Slovakia's presidency of the 'Visegrád Four', established in 1993 as a community of four central European states: the Czech Republic (now Czechia), Hungary, Poland and Slovakia. These states are currently the most vulnerable to illegal waste imports, primarily due to rising disposal and recycling costs in western European countries and the predominant use of waste disposal processes in central European countries. Effective cooperation among all states in Europe in the fight against such serious criminality is key to its eradication and ensuring a responsible, ecological and economically sustainable approach by individual Member States in the field of waste management at the national level (Kern, 2023b).

Figure 3.1 and 3.2. Illegal waste disposal sites. Source: The author.

In the fight against environmental crime, specialised units within the Slovak police employ various methods and technical means to detect and document such activities. During operational activities aimed at gathering initial information about environmental crime, UAVs are utilised for observing objects, individuals and items, especially in inaccessible terrain or areas where the discovery of covert operations is a concern. In the process of documenting crime scenes, UAVs are employed for photogrammetric or lidar scanning, with the goal of creating a 3D model of the crime scene, its geodetic surveying and, most importantly, determining its volume. Figures 3.1 to 3.3 show waste disposal sites resulting from illegal transboundary waste transport, where the photogrammetry method was used.

Figure 3.3 and 3.4. Illegal waste disposal site and data processing output. Source: The author.

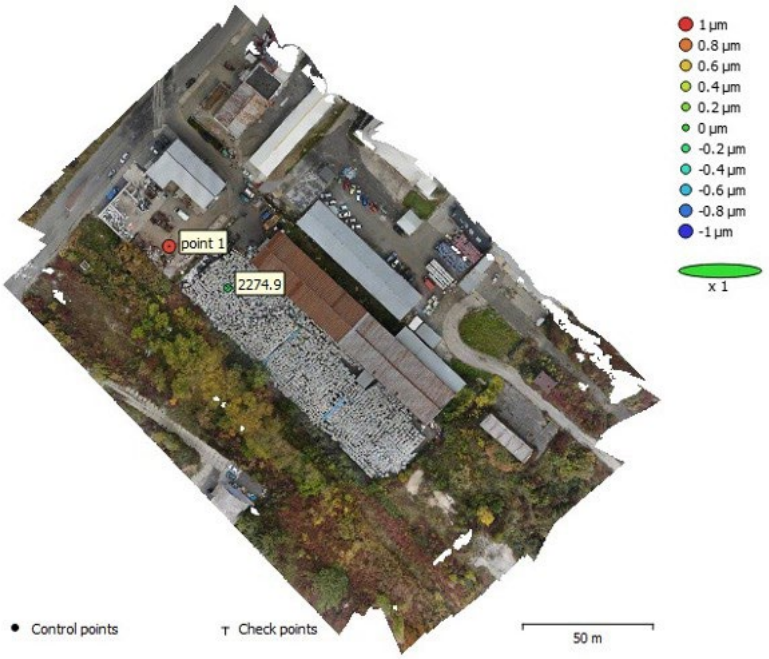

Figure 3.5. Data processing output. Source: The author.

Figures 3.4 to 3.5. represent the form of data processing output obtained by capturing the crime scene using UAV and the photogrammetry method.

In conjunction with other scientific methods, volumes of waste stored underground were identified as part of the investigation using the geophysical method of dipole magnetic profiling, which is used to examine underground structures and rock properties based on their magnetic properties. It is frequently utilised in geological and geophysical surveys to locate various geological formations, explore mineral deposits or investigate underground water (Frankovská et al., 2010). Given its ability to detect changes in magnetic properties, dipole magnetic profiling can be a valuable tool for mapping and characterising underground structures. This method has a depth range of up to several tens of metres, making it applicable for mapping shallow structures (SÚRAO, 2024). In Slovakia, police officers are capable of modelling the waste deposition, determining the volume of buried waste up to a depth of 70 metres. Combined with surface surveying using UAVs, extensive evidential material is generated for criminal proceedings, presenting various layers, as depicted in the illustrations below.

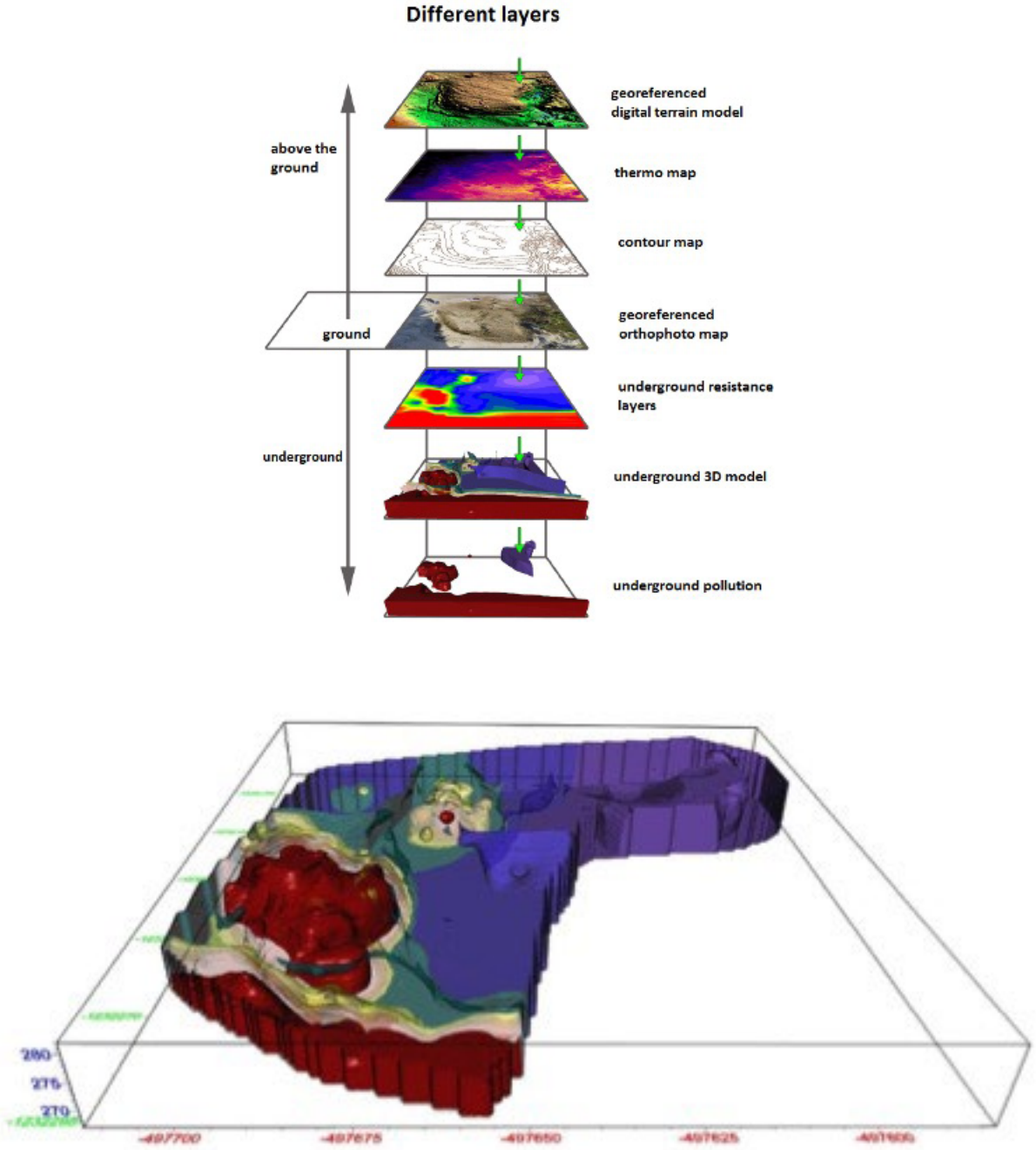

Figure 3.6. Generated various layers. Source: The author.

Another indispensable use of UAVs, especially in the context of illegal cross-border waste transport, is the monitoring of shipments directly at the site of their inspection. This involves verifying whether the declared waste being transported is indeed the subject of the controlled shipment. The modus operandi of illegal cross-border waste transport also includes the falsification of documentation, in particular altering the type of waste to align with existing legislation. For example, waste may be declared under catalogue number 19 12 04, which is a mix of plastics and rubber of a single polymer, and is on the green list. However, underneath the plastic waste in the cargo vehicle's storage area, municipal waste with catalogue number 20 may be found. The cross-border transport of this waste for disposal requires prior permitting. Visual inspection is sometimes insufficient to detect hidden and illegally transported municipal waste placed beneath a layer of plastic waste or mixed with waste declared in

accompanying documentation. It is important to note that, as waste classified under catalogue number 19 12 04 is on the green list, no prior approval from relevant authorities of the country of origin, transit or destination is required for its cross-border transport. By employing modern technologies, especially UAVs equipped with thermography, it is possible to directly identify, during on-site inspections, whether municipal waste is mixed or concealed in the declared shipment of plastics and rubber. This is because municipal waste generates heat, resulting from its biological decomposition or ongoing chemical reactions. In contrast, pure plastic waste does not induce such processes and, therefore, does not produce heat (Tansel, 2023).

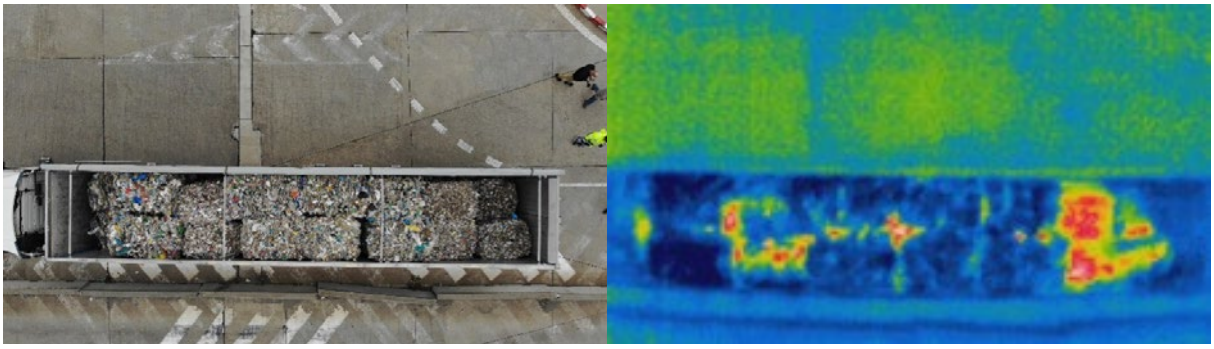

Figure 3.7 and 3.8. Waste shipment – using thermography. Source: The author.

In the thermal image above, the red areas can be identified as places where heat is being produced.

Challenges and perspectives in combating illegal waste transport

Illegal waste transport has become a global issue that requires coordinated efforts from multiple countries. Complications in investigating these cases arise from the different legal systems and diverse approaches to addressing environmental crimes. Increasing advances in technology provide offenders with new opportunities for covert waste transport and minimising the traces left behind. The solution lies in new challenges for authorities responsible for detection and investigation, who should invest in the development and implementation of new technologies such as artificial intelligence (AI), big data analytics and enhanced sensory systems. These tools offer new means of identifying and tracking illegal waste transport.

An ongoing project serves as an example of these efforts – a collaboration based on a memorandum of understanding signed between the United Nations Office on Drugs and Crime and the Vittorio Occorsio Foundation in Italy. The project aims to improve the understanding of using AI and other new technologies to prevent and combat international organised crime, including identifying the most effective and suitable procedures and developing legal frameworks. A specific focus is on utilising AI and other new technologies to combat crimes affecting the environment, including international waste trade associated with international organised crime and other types of criminal activities such as economic crimes, corruption and money laundering. One of the activities carried out under the memorandum was an AI learning project focused on identifying waste types based on UAV footage (Fondazione Vittorio Occorsio, 2021).

Another prospective activity is raising public awareness of environmental crimes, which could motivate citizens to cooperate with law enforcement authorities. Education about the dangers and consequences of illegal waste

transport can lead to increased public engagement. Updating and strengthening legislation related to illegal waste transport, including the introduction of strict sanctions, could deter potential offenders. With specific measures and adjustments in legal, technological and social domains, the international community can make progress in combating illegal waste transport and contribute to environmental protection on a global scale.

Conclusion

The use of modern technologies (drones, 3D scanners, etc.) by LEAs in the field of illegal cross-border waste transport appears to be a necessity, given the rapid technological progress. From the experience of the Slovak police, it can be concluded that these are very effective tools, even in the phase of detecting this illegal activity. Of course, these are financially demanding operations, as the acquisition of the appropriate technology and the training of operators represent a one-off higher investment from a financial perspective, the return of which, however, can be expected in a very short time. By quickly detecting illegal waste shipments, subsequent environmental damage or the costs of removing waste from an improper storage location, which would have to be borne by the destination country of the illegal cross-border waste shipment, can be avoided. Ensuring adequate technical equipment as well as training and specialisation of domestic authorities that detect, investigate and prosecute environmental crimes or make decisions about them requires the new Directive (EU) 2024/1203 of the European Parliament and of the Council of 11 April 2024 on the protection of the environment through criminal law, replacing Directives 2008/99/EC and 2009/123/EC. The specialisation of LEAs, their expertise and quality technical equipment are, therefore, key tools in the fight against environmental crime.

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Harnessing technologies to combat environmental crimes: the potential of satellites, drones, water sensors and super-resolution imaging

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Abstract

Preventing and tackling environmental crime is a global priority. The multiple risks this phenomenon poses, the high-profit margins, the low risk of detection and prosecution, and the notable lack of empirical research on specific investigative practices call for innovative approaches to evidence gathering and analysis to ultimately increase the effectiveness of the fight against waste-related environmental crime.

This article investigates the use of co-creation approaches to identify practitioners' needs in the field of waste-related environmental crimes, and it attempts to shed light on the range of solutions that technology can offer to improve environmental crime detection, investigation and prosecution. These include satellite, drone and sensor technology, as well as the integration of remote sensing (RS) technologies enhanced with machine learning (ML). The article concludes by arguing that the further employment of available super-resolution (SR) techniques can unlock the potential for more detailed environmental monitoring and analysis and is valuable for both image classification and segmentation tasks.

Keywords: waste crime, river pollution, police investigations, law enforcement agencies, Earth observation.

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Introduction

'Waste crime', a term encompassing a spectrum of illegal activities within the waste management cycle, poses significant environmental and public health risks (Walters and Loureiro, 2020). These activities range from the production of waste materials to their storage, transport, disposal and reuse (Baird et al., 2014). Common forms of waste crime include trafficking, dumping, mismanagement of waste and water, and air pollution (Buczma, 2020). The motivations behind waste crime are typically lucrative profits and the perceived low risk of detection or prosecution (Interpol, 2022).

Technological advancements offer promising avenues for improving waste crime detection, investigation and prosecution. Drones and satellites, for instance, enable efficient surveillance and data collection over large areas, aiding in identifying illegal waste disposal sites and monitoring environmental violations. However, despite recognition of this in the literature (Alderuccio et al., 2019; Di Fiore et al., 2017; Lega and Teta, 2016; Mager and Blass, 2022), the integration of these technologies into law enforcement practices remains limited.

This article presents an approach implemented with practitioners in the field of waste-related environmental crimes to identify their operative needs and skills gaps. It explores how technological solutions can bolster practitioners' efforts against waste crimes by supporting the investigation, forensic practices and detection of waste crimes.

Following an extensive literature review, the article firstly presents the results of gaps and needs analysis conducted within the scope of the EU-funded project Environmental crimes' intelligence and investigation protocol based on multiple data sources (Emeritus) ([2]), with a representative sample of law enforcement agencies (LEAs) and other operators involved in waste-related environmental crimes. The information collected during this phase is then used to tailor relevant technological solutions to support investigative practice. In this regard, the article presents the case of using SR techniques to enhance satellite images, thus facilitating the identification of illegal waste dumping and/or storage sites.

Literature review and current state of the art

Criminal activities related to waste often involve organised criminal groups, particularly in cases of transnational trafficking (Andreatta and Favarin, 2020). Despite its detrimental effects, waste crime remains a low-risk venture, largely due to deficiencies in law enforcement capabilities and prioritisation (Europol, 2013). Moreover, environmental investigative teams in LEAs lack specialised resources, while multilateral LEAs' operations to tackle waste crime are perceived as lower priority vis-à-vis those to combat 'mainstream' crimes (Eurojust, 2014).

Technological advancements can help improve investigative practices in several ways. For instance, the advancement of Earth observation (EO) technology can transform environmental monitoring. Indeed, satellite and aerial images offer wide-scale perspectives unattainable by ground methods, thus offering great potential for detecting and combating illegal waste disposal.

Aerial imagery, the initial application of which dates back 40 years, when it was employed to estimate waste in neighbourhoods in Tampa, Florida (Garofolo and Wobber, 1974), can also better and more efficiently identify waste

deposits. Despite the increasing applications of these methods over time, challenges arose due to the high costs and infrequent revisit intervals associated with aerial photogrammetric flights.

The field saw a significant shift in digital photogrammetry that enabled the creation of high-resolution (HR) digital terrain models to assess changes in waste deposits over time (Vincent, 1994). As technology progressed, satellite imagery began to supplement aerial imagery, offering wider coverage and better frequency. A notable example was the use of QuickBird images to identify illegal waste activities in the United Kingdom (Purdy et al., 2017). The success of segmentation algorithms in change detection relies on the spatial and spectral resolution of satellite imagery, which ensures detailed ground feature representation and the capture of unique material properties.

Projects such as the Life Smart Waste project ([3]), AI Visions' AI for Good – Landfills project ([4]) and the European Space Agency's Wastemon Project ([5]) highlight the growing trend of integrating satellite data with ML to enhance waste dump detection and monitoring. Recent studies have emphasised the importance of segmenting very high-resolution (VHR) imagery for waste detection. Advances in deep learning (DL) have notably enhanced satellite image segmentation methods. Techniques like convolutional neural networks (CNNs), which use multiple non-linear layers for feature extraction and transformation, are now key in both supervised and unsupervised learning scenarios (Chen et al., 2021). These models, which integrate DL with computer vision, were effective in solid waste management applications (Ganci et al., 2021). Advancements in satellite sensors brought an influx of HR images, which are crucial for detecting illegal waste dump sites (Notarnicola and Anguilli, 2004). CNNs, particularly those using Edge Boxes and multilayered neural networks, demonstrated effectiveness in detecting targets in satellite images of varying sizes and orientations (Kattenborn et al., 2021).

While VHR imaging shows great promise in monitoring waste dumping, challenges remain, mainly due to the high costs of commercial data. Additionally, end users have repeatedly noted the need to detect illegal waste sites as large as 0.5 hectares, a task not feasible with only medium-resolution imagery. Applying SR algorithms to Sentinel-2 data, a freely accessible medium-resolution imagery source, is an emerging solution that allows the enhancement of images capped at a 10 m resolution, aiding in monitoring dynamic features, environmental changes and disaster response. The super-resolution convolutional neural network is a DL model that has improved the spatial resolution of satellite images (Müller et al., 2020). Moreover, the enhancement of older and current datasets can offer more detailed insights, improving long-term environmental assessment accuracy.

In addition, satellite technology, equipped with high- to medium-resolution optical and thermal imagery, revolutionised the monitoring of environmental crimes. Thermal satellite imagery can detect elevated land surface temperatures, revealing illegal waste sites and waste burning. Additionally, synthetic aperture radar (SAR) satellite imagery can detect changes in land topography, sewage and chemical spills, indicating illegal waste disposal.

Finally, drones have enabled significant progress in waste management by complementing satellite technology. They provide HR and multiband imagery and can be remotely controlled or autonomously perform pre-programmed routes. Furthermore, several drones can work collaboratively, sharing tasks and data to scan an area, hence reducing monitoring time.

Overview of Emeritus technologies to fight environmental crime

The combination of several of the technologies mentioned above is one of the core aims of the EU-funded Emeritus project, which is to ultimately improve LEAs' effectiveness in the identification, location and collection of evidence about environmental crimes.

Indeed, satellite and drone technology is integrated with ML, enabling systems to learn and adapt without explicit instructions to automatically detect and classify different environmental violations, further enhancing LEAs' capabilities to identify offenders. Emeritus also employs DL models, particularly CNNs, that have been a game changer in image processing, being able to learn and excel at visual tasks like object detection, image fusion, scene classification, and land use and land cover classification in RS image analysis (Youme et al., 2021).

In addition, optical cameras and/or satellite monitoring, along with computer vision algorithms, are combined to tackle river pollution, which endangers the environment and human health. Determining river contaminant sources is crucial for investigations, but, when released into a river, contaminants swiftly disperse due to turbulent mixing and molecular diffusion (Wang et al., 2023). To limit the related damage, it is vital to quickly identify contaminant sources (Kwon et al., 2021). Emeritus goes one step further by enhancing the development of more powerful detection tools using water quality sensors that can detect variables, including pH levels and changes in chemical composition, extending beyond basic monitoring to identify pollution sources.

Methodology

Within the framework of Emeritus, a design-thinking inspired methodology has been used to co-create, with LEAs and border guard (BG) authorities involved in the project's consortium, a set of tools to improve efforts to tackle waste-related environmental crimes. Design thinking is an iterative process for human-centred innovative design of products and solutions, with the most well-known version defined by the Hasso Plattner Institute of Design at Stanford University[6]. This approach seeks to understand users' perspectives and needs to challenge typical assumptions and define original human-centred solutions.

This methodology encompasses five (non-linear and iterative) steps, namely: (1) empathise, (2) design, (3) ideate, (4) prototype and (5) test. The present section provides an overview of the approaches implemented to cover all the stages of this process, from understanding needs and challenges (corresponding to steps 1 and 2) to ideation, prototyping and testing of new solutions (corresponding to steps 3, 4 and 5). In particular, it presents the methodologies used to (1) identify the main factors hampering the uptake of cyber-physical technologies by practitioners in the field of environmental crime, (2) define the most significant gaps and needs in responding to environmental crime and (3) ideate and prototype SR models for enhancing the detection of waste dumping.

Procedural challenges and barriers

Interviews were conducted with the LEAs and BGs authorities involved in Emeritus to identify the main factors hampering the uptake of cyber-physical technologies such as drones, satellites and sensors by practitioners in the field of environmental crime. LEAs and BGs authorities (from Greece, Italy, Moldova, Romania and Spain) identified three main factors, which are presented in the section 'Procedural challenges and barriers' below, under 'Results and discussion'.

Training needs assessment

The Emeritus training needs assessment (TNA), involving both internal and external practitioners, was conducted through focus groups in five European countries (Greece, Italy, Moldova, Romania and Spain), following a dedicated methodology designed by the project's partner CIFAL Malaga to gather information on training needs in the area of environmental crime. This involved identifying six main questions and presenting these to focus group participants using Google Forms', as shown in Figure 4.1.

1. Please indicate the institutions or organizations the members of this focus group belong to.
2. Do you think a project of this type is necessary? Do you think it is beneficial for our region and for your institution? Why?
3. Do you regularly attend training on this subject? If so, who gives them (your own institution, university, etc.)?
4. What are your training needs on this topic? Which topics, within the field of environmental crime, are of interest to you?
5. Is there currently a coordination body or system among all the institutions engaged into environmental crime?
6. Is there any other organization/institution with responsibility or interest in environmental crime that has not been invited to this focus group today?

Figure 4.1. List of questions for Emeritus TNA. Source: The author.

The proposed agenda for the focus groups included an introduction to the project for the participants, their possible role in it, the benefits of the project and proposed training, which was planned to be delivered based on the identified needs. CIFAL Malaga suggested each focus group last at least 4–5 hours and be attended by a heterogeneous group of national stakeholders (police, non-governmental organisations, academia, environmental agents, coastal guards, etc.).

Super-resolution techniques for image classification

Illegal landfills are a pressing issue with significant environmental, economic and public health implications. Despite AI and computer vision advancements, it is still challenging to train robust ML methods for waste detection because they need abundant aerial images of potential illegal landfills. Existing aerial landfill datasets are scarce and typically lack location information due to confidentiality agreements (Torres and Fraternali, 2023). Additionally, open-access satellite image banks like Sentinel-2 and Landsat via Copernicus ([54]) typically provide low-resolution images with no information about potential illegal landfills.

To address the quality issue, this article proposes to use SR techniques to generate an HR version of a given low-resolution image (Kim et al., 2016 a, b). Consequently, this study undertakes a thorough assessment of waste detection algorithms, representing the first exploration of SR enhancement and cross-domain evaluation within the Emeritus project. The methodology applied uses the HR dataset for image classification, assessing its performance across various resolutions. The goal is to evaluate how a model trained on HR images performs when applied to downscaled samples.

([54]) The EU's Earth observation programme (https://scihub.copernicus.eu/).

Super-resolution techniques for image segmentation

To overcome the low spatial resolution of freely available imagery, this article proposes to exploit enhanced Sentinel-2 imagery in waste analysis. The advancements in SR techniques, with current techniques that can reconstruct HR details from low-resolution images, unlock the potential for more detailed environmental monitoring and analysis (Fernandez-Beltran et al., 2017). The integration of SR models with existing segmentation models, notably the combination of DeepLabV3+ and a ResNeSt101 encoder, has led to a significant improvement in identifying waste dump sites from Sentinel-2 imagery.

This approach is particularly valuable due to the limited availability of HR imagery and labelled datasets specifically designed for waste dump identification. While previous studies often relied on VHR imagery, this may not always be feasible or cost-effective. The successful use of SR techniques with Sentinel-2 data, a freely accessible medium-resolution imagery source, offers a more accessible and scalable solution for waste dump identification.

Results and discussion

Procedural challenges and barriers

Following the methodology presented in the section 'Procedural challenges and barriers' above (under 'Methodology'), practitioners in the field of environmental crime identified three main factors as major constraints to the uptake of cyber-physical technologies: procurement-related factors, administrative/procedural aspects and resource shortage.

Regarding procurement-related factors, two critical elements were highlighted: technology cost and the administrative burden of procurement. While the first is expected to decrease over time due to technology consolidation, the latter poses a challenge. Being public entities, LEAs and BGs are subject to the procurement rules dictated by EU regulations and national authorities to guarantee the transparency and legitimacy of the public acquisition process. However, such rules hamper or even prevent the use of such technologies within investigation procedures. Common concerns include the requirement for permits, uncertainties about data storage, and the centralisation of the deployment decision. For instance, drone usage in the European urban environment is regulated by European Union Aviation Safety Agency (EASA) rules implemented by Member States, requiring a case-by-case assessment. Specific authorisations of deviations from standard aeronautical scenarios or limitations on overflying people may impede drone usage, especially among organisations lacking the internal expertise to evaluate aeronautical rules comprehensively.

In addition, procedural concerns arise regarding the admissibility of digital or cyber-physical evidence in court, as well as their collection and secure storage. Satellite and drone data brought to court cannot stand alone but require supporting metadata (i.e. acquisition data and time, location, source, etc.), and, given the rise of generative AI, it is vital to protect collected digital evidence against alteration and corruption.

Finally, resource shortage is a baseline common issue entailing limited experienced drone operators and the availability of drones and/or other relevant digital devices.

Training needs assessment

Environmental crime is complex in terms of definition, scope, legal framework, impacts, drivers and connections with other serious offences. Identifying and understanding the current barriers is critical to addressing such crimes. The most significant gaps in responding to environmental crime, identified through the United Nations Environment Programme's expert process (UNEP, 2018) and reinforced by the Emeritus project, relate to four issues.

The first is a lack of data, knowledge and awareness: the paucity of publicly available data on environmental crimes and related issues causes difficulties for governments and public organisations attempting to develop effective policies to combat such crimes.

The second issue is the insufficient and restricted application of legislation, primarily due to limited legal and administrative knowledge among LEAs. This results in personnel not being fully aware of their enforcement authority, the legal responsibilities related to evidence collection, the use of complementary laws, and how and to what extent information should be shared internationally.

The third issue is the lack of capacity across the entire enforcement chain of investigators, prosecutors and judges, which inhibits frontline forces responsible for combating environmental crime. This is marked by deficiencies in the necessary knowledge, training and equipment to prevent environmental crimes and the need for more sophisticated law enforcement capacity.

The fourth issue is insufficient national and international cooperation and information sharing among authorities. This limitation stems from factors such as competition, mistrust and the absence of clear institutional frameworks, hindering effective resource utilisation for combating environmental crime.

Furthermore, the Emeritus TNA revealed that countries have different levels of training in environmental crime: many provide training, but this is mostly general or theoretical. Many participants declared interest in receiving training in legislative matters – for example definitions of environmental crimes, codification of legislation, and damage calculations – and on the uses and applications of cyber-physical technologies in their daily activities. A frequency-based graph (Figure 4.2) presents the most prominent training needs across the following categories:

- legal: environmental crime identification, contaminating levels, cadastre legislation, environmental legal framework;
- ecosystemic services: measuring environmental damage to flora, fauna, water, air and soil; effluent sampling, dumping waste, forest fire prevention and control;
- procedure: capping co-competent institutions, environmental crime reporting protocol, geo-profiling;
- tech: drone handling, satellite analysis, early fire detection, forest video surveillance, sensors, new tech (AI, big data, etc.).

Figure 4.2. Emeritus TNA results. Source: The author.

Figure 4.2 shows that, according to Emeritus TNA participants, the tech domain, that is, technological tools to prevent, detect or mitigate potential environmental crimes and their associated impacts, is the most prominent one in terms of training needs. The legal domain, namely environmental crime identification, the EU legal framework and cadastre legislation, also scored highly in the Emeritus TNA, suggesting the need for participants to acquire more specialised legal and administrative knowledge in the field of environmental crime.

Finally, the Emeritus TNA revealed that participants are, on average, aware of the procedures to be followed when a potential environmental crime is detected (procedure domain), as well as the procedures for sampling, data analysis and assessment of environmental damage to an ecosystem (ecosystemic services).

Super-resolution techniques for image classification

Following the approach detailed in the section 'Super-resolution techniques for image classification' under 'Methodology', we outline a comprehensive evaluation protocol in the field of waste detection via image classification that, to the best of our knowledge, represents a novel and unexplored avenue. Our initial results indicate the possibility of improving performance classification in a cross-domain setting with SR enhancement. Furthermore, we conduct a thorough analysis of various metrics to gain a comprehensive understanding of how these models can be tailored to specific domains.

Figure 4.3. Examples of images (from left to right) showing our SR enhancement: the input image, before SR enhancement (low resolution), the output image (following SR enhancement) and the ground-truth (HR) image. Source: The author.

Figure 4.3 shows an example of applying SR techniques to a sample from the AerialWaste dataset (Torres and Fraternali, 2023), comparing the original HR sample (right) with the result of applying SR techniques (middle) to the low-resolution version (left).

Super-resolution techniques for image segmentation

The author's contribution to this evolving field has so far consisted of developing a library of 18 state-of-the-art SR models that were tested in different scenarios relevant to the study of waste (Selea et al., 2023). This library, illustrated in Figure 4.4, encompasses a diverse array of neural network architectures, including sophisticated generative adversarial networks (GANs), known for their ability to generate high-quality, detailed images (Saxena and Cao, 2021); CNNs, which excel in capturing spatial hierarchies in image data (Chen et al., 2016); and residual networks (ResNets), which address the vanishing gradient problem effectively and allow for deeper and more accurate networks (He et al., 2016).

These models were trained using a vast dataset of medium-resolution images (Sentinel-2), together with VHR imagery (SPOT), to systematically upscale medium-resolution data to generate their HR equivalents. The training methodologies employed were cutting edge, involving adversarial training that pits two networks against each other to improve generated image quality, feature extraction that captures essential details from low-resolution images, and residual learning that helps construct the HR output by learning from the residuals of the low-resolution input.

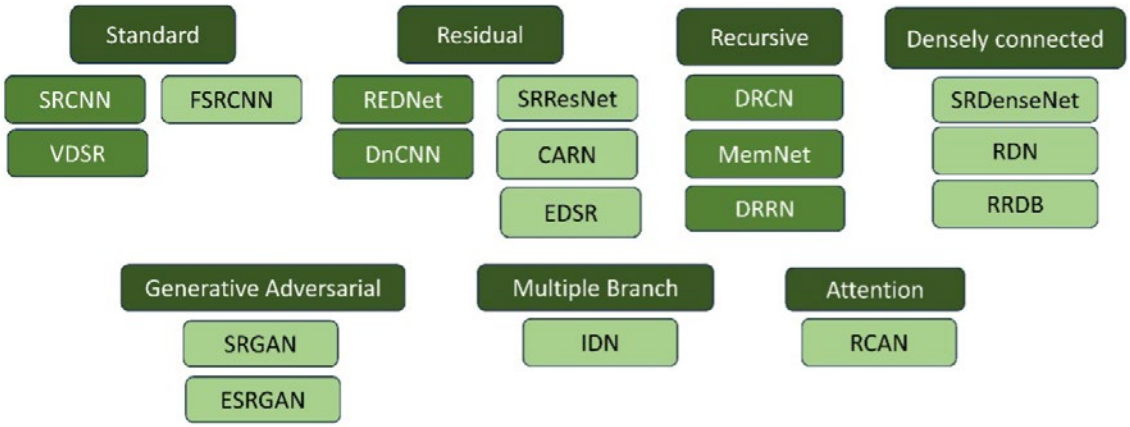

Figure 4.4. Overview of the library of SR models implemented for SR. Source: The author.
NB: CARN, convolutional anchored regression network; DnCNN, denoising convolutional neural network; DRCN, deeply recursive convolutional network; DRRN, deep recursive residual network; EDSR, enhanced deep super-resolution; ESRGAN, enhanced super-resolution generative adversarial network; FSRCNN, fast super-resolution convolutional neural network; MemNet, very deep persistent memory network; RDN, residual dense network; RRDB, residual in residual dense block; SRCNN, super-resolution convolutional neural network; SRGAN, super-resolution generative adversarial network; VDSR, very deep super-resolution. RedNet, residual encoder-decoder network. SRResNet, super-resolution residual network. SRDenseNet, super-resolution dense convolutional network.

This library represents a technical achievement while also serving as a resource for enhancing Sentinel-2 data. By applying these SR models to Sentinel-2 imagery, we can significantly improve resolution, making it possible to discern finer details and enhance the detection and differentiation of illegal waste sites.

In our activities associated with the Emeritus project, we have taken the first steps in integrating our own pre-existing SR libraries with segmentation models. We focused on applying DL-based segmentation directly to Sentinel-2 data to identify waste dump sites. This task required the segmentation models to differentiate between various land covers and to outline the areas of interest precisely. To train these models, we created a unique dataset with manually labelled masks, a necessary step due to the lack of suitable open-source datasets for this specific application.

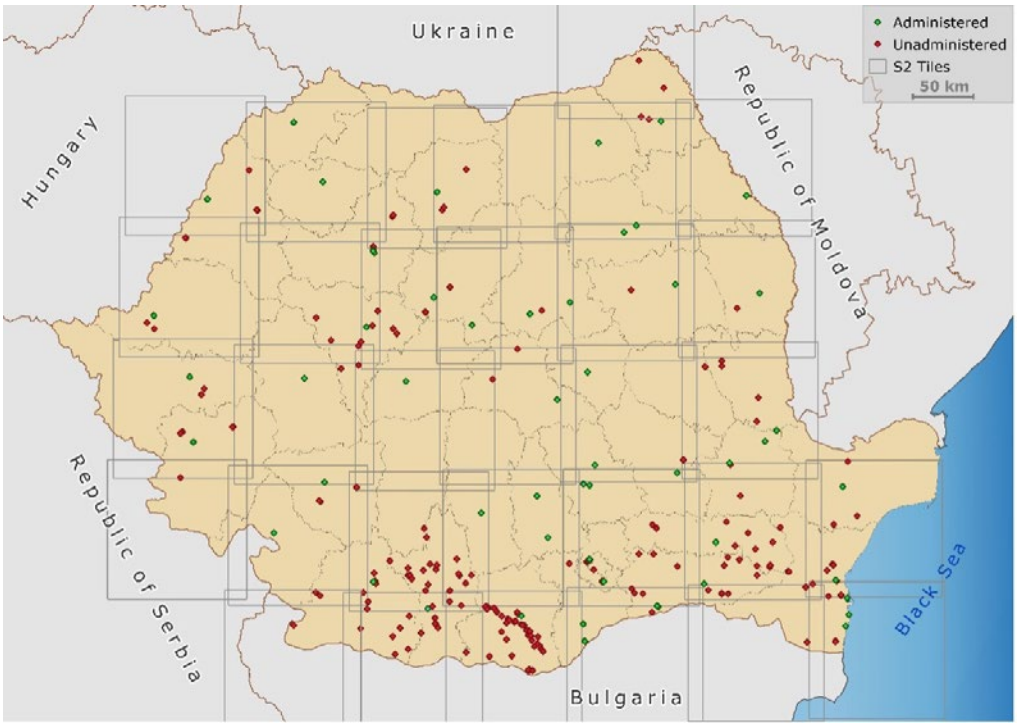

Figure 4.5. The training dataset for segmentation encompasses a total of 159 administered and 495 unadministered sites from 2020 to 2022. Source: The author.

Through extensive experimentation and optimisation, including hyperparameter tuning facilitated by the Optuna framework (Akiba et al., 2019), we determined the most effective combinations of models and encoders for our segmentation task. The standout combination was the DeepLabV3+ (Du et al., 2021) model paired with the ResNeSt101 (Zhang et al., 2021) encoder. When applied to Sentinel-2 data, this pairing achieved a validation intersection over union score of 0.6, signifying a 60 % accuracy in matching the predicted masks with the actual waste dump locations. The testing dataset yielded an intersection over union score of 0.5 and a precision rate of 0.8, confirming the model's capability to generalise well to unseen data.

Figure 4.6. Inference results on different dates from a Sentinel-2 tile in Romania, showing false positive (red) and true positive results (yellow). Source: The author.
NB: FP, false positive; TP, true positive.

These findings highlight the potential of SR techniques in addressing the limitations of medium-resolution imagery for waste dump identification. By enhancing the resolution of Sentinel-2 data, finer details become discernible, leading to improved differentiation of waste dump sites from other land cover types. This not only contributes to the advancement of waste management practices but also aligns with the broader objective of leveraging EO data for environmental monitoring and sustainable development.

Further development and refinement of SR techniques hold the promise of even more precise identification of smaller and less regular waste dump sites, which are currently challenging to detect due to the limitations in spatial resolution. By continuously improving these techniques and expanding their application to diverse geographical contexts, the capacity to monitor and address in a less costly manner the global issue of waste management can be significantly enhanced, contributing to a more sustainable and environmentally conscious future.

Conclusion and outlook

This article attempted to shed light on the range of solutions that technologies can offer for enhancing the detection, investigation and prosecution of waste crimes, a serious global issue with significant environmental, economic and public health implications.

The article first provided an overview of the technologies and techniques Emeritus employs in fighting environmental crime. These include satellite, drone and sensor technology, as well as the integration of RS technologies with ML, which enables systems to learn and adapt without explicit instructions to detect and classify different environmental violations automatically.

The article then presented the main procedural challenges and barriers limiting the uptake of cyber-physical technologies by practitioners and the most significant gaps in responding to environmental crime identified through the United Nations Environment Programme's expert process and reinforced by the outcomes of the Emeritus TNA. The article then demonstrated that EO technology advancement, including better satellite and aerial imaging, can transform environmental monitoring by offering wide-scale perspectives unattainable by ground methods.

We concluded by suggesting that the further employment of available SR techniques able to reconstruct HR details from low-resolution images can unlock the potential for more detailed environmental monitoring and analysis, and is valuable for both image classification and segmentation tasks.

As we look to the future, we are poised to take the following step: apply the described SR models to Sentinel-2 data to further enhance image resolution and, consequently, the accuracy of waste dump identification. This will involve transferring the segmentation methodology to the super-resolved imagery. By doing so, it is expected to achieve even more precise identification of smaller and less regular waste dump sites, which are currently challenging to detect due to the limitations in spatial resolution of Sentinel-2 data.

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Applying remote sensing and data science techniques to enhance the monitoring and detection of environmental crime: examples from the NarcoView project

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Abstract

The Netherlands has gained an international reputation as a centre for the production and export of synthetic drugs such as MDMA and amphetamine. The number of synthetic drug production laboratories and chemical waste dump sites discovered in recent years is a cause for concern. Dumping and discharging synthetic drug waste is a serious environmental crime, since synthetic drug waste contains various harmful chemicals. Such waste is being disposed of unsafely, in a number of illicit ways, causing environmental harm and risking public health and safety. This was highlighted as a growing problem by reports published in 2016 and 2019 by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), now the European Union Drugs Agency (EUDA), and Europol. The main regions in the EU facing the drug waste dumping problem are the southern part of the Netherlands and the northern part of Belgium.

The research presented in this article was conducted in the framework of the project NarcoView, with the main objective being to enhance the monitoring and detection of the environmental crime of illegal dumping of chemical waste from synthetic drug production. This is accomplished by gathering and processing intelligence through the use of RS, data science and ML algorithms. This article thus presents the results from formulating and testing methodologies for selected use cases with the aim of more efficiently and effectively detecting locations used for waste dumping. The main scenarios outlined here include (1) the detection of 'classic' dump sites and (2) the detection of chemically treated crop fields. The methods and resulting analytical products developed for

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the two aforementioned scenarios will be further integrated into a web-based platform for end users, such as law enforcement and other state agencies.

Keywords: remote sensing, data science, artificial intelligence, environmental crime, synthetic drug waste.

Introduction

The Netherlands is known to be a producer (and exporter) of cannabis and synthetic drugs and a transit country for cocaine and heroin. The number of synthetic drug production laboratories discovered and dismantled has increased in recent years, with a significant number of synthetic drug waste dump sites having also been discovered (Politie, 2018, 2021; Schoenmakers and Mehlbaum, 2017). Most of the laboratories discovered were involved in the production of amphetamine and MDMA/ecstasy and methamphetamine. The dumping of chemical waste resulting from drug production was highlighted as a large and growing problem in reports published by EMCDDA and Europol in 2016 and 2019 (EMCDDA and Europol, 2016, 2019), supported by the Dutch national police data presented in Figure 5.1 (Politie, 2018, 2021). Figure 5.2 clearly shows that the drug waste dumping problem concerns mostly the southern part of the Netherlands and the northern part of Belgium, adding a transborder element to this issue (Claessens et al., 2019; EMCDDA and Europol, 2019).

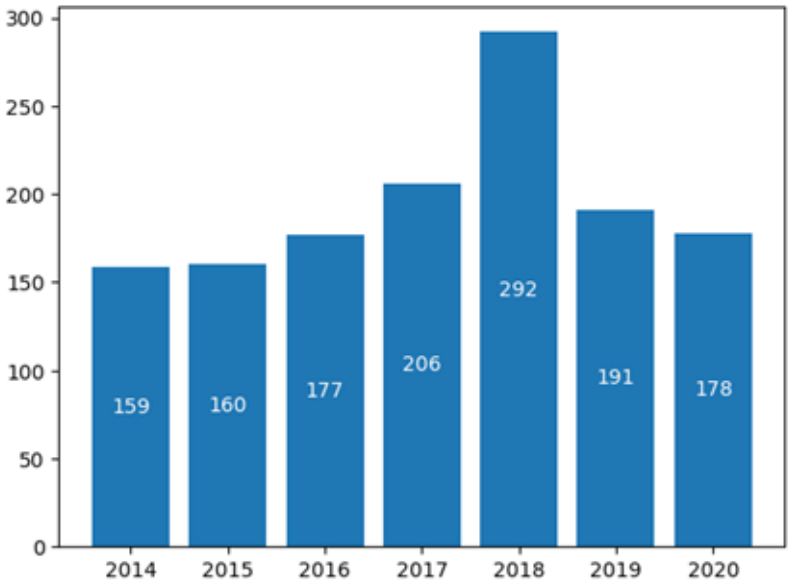

Figure 5.1. Numbers of synthetic drug dump sites discovered in 2014–2020. Source: Based on data from reports of Police Netherlands (Politie, 2018, 2021).

The waste generated from the production of synthetic drugs is usually disposed of unsafely, causing environmental harm and risking public health and safety. It is estimated that the production of 1 kg of MDMA (ecstasy) or amphetamine (speed) results in many more kilograms of waste: 6–10 kg for MDMA and 20–30 kg for amphetamine or methamphetamine (EMCDDA and Europol, 2019).

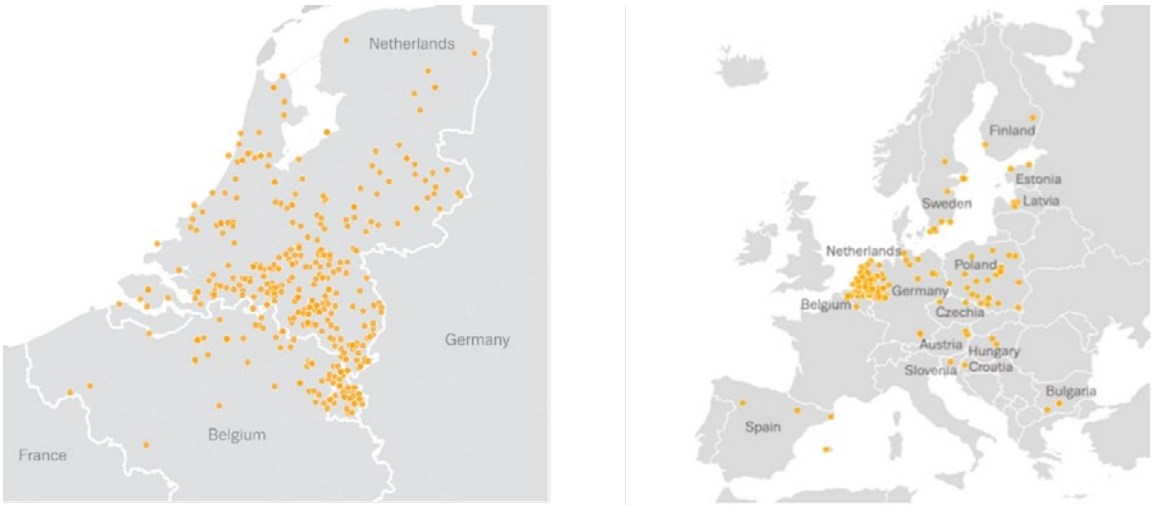

Figure 5.2. Locations of synthetic drug waste dump sites in the Netherlands and Belgium in 2015–2017 (left) and amphetamine production sites in the EU (right). Source: EMCDDA and Europol (2019), under the European Commission reuse policy.

According to Schoenmakers and Mehlbaum (2017), dumping drug waste is a serious environmental crime, with drug waste being considered a hazardous waste on the basis of its composition, as it usually contains acids, solvents and other substances that may be toxic (van Leerdam et al., 2022). Containers containing chemical waste products are often dumped in remote and secluded areas like forests and fields, and sometimes waste is spilled directly into the environment or buried underground. Dumped chemicals penetrate soil, groundwater and sewers, contaminating the environment (EMCDDA and Europol, 2019). Environmental health is strongly linked to human health and well-being, and contamination of the environment can lead to health problems via the consumption of contaminated agricultural produce or water. Contamination of water with chemical waste may lead to the disruption of water treatment plants, which has an impact on (safe) water supply (Ter Laak and Emke, 2023). The cost of cleaning areas where chemicals have been dumped is high, and it poses high safety risks for the personnel involved. Specialised professionals with protective gear are usually needed to clean up affected sites.

Disrupting these forms of organised crime is one of the priorities of the European agenda on security, and the fight against drug waste crime is in line with the European Commission's nine-point action plan on environmental compliance assurance (European Commission: Directorate-General for Environment, 2016). It was also a priority of the 2018–2021 EU policy cycle for organised and serious international crime (EMPACT) (Council of the European Union, 2018).

Geodata science comes under the domain of data science, as it uses statistics, data mining and predictive modelling to study spatial relationships and patterns. It often takes advantage of modern computational techniques and big data technologies (Zuo and Xiong, 2020).

In recent times, Remote Sensing (RS) technology has gained traction in various fields of study and application due to its ability to collect data without the need for direct contact with the subject. To achieve this, it utilises sensors to measure signals, such as electromagnetic radiation, emitted, reflected or scattered by the object under scrutiny (Campbell and Wynne, 2011). Two types of sensors can be used: passive sensors that capture naturally occurring

energy like sunlight that is reflected by objects (e.g. multispectral and hyperspectral sensors) and active sensors that emit and then measure reflected signals (e.g. lidar and radar sensors). These sensors enable data collection using satellites for global coverage, aircraft for finer details and drones for localised information (Janga et al., 2023).

RS data are used to calculate spectral indices, which are derived from combining values from multiple spectral bands of a multispectral image. Such indices, for instance the Normalized Difference Vegetation Index (NDVI), are instrumental in the early detection of stress in vegetation (Dash et al., 2017) or other phenomena, depending on the index used.

The integration of Artificial Intelligence (AI) techniques with RS technology presents a groundbreaking opportunity in data analysis across diverse domains (Dash et al., 2017; Hameed, 2024; Rashidiyan and Rahimzadegan, 2024). Traditional Machine Learning (ML) methods have been extensively utilised in RS tasks like classification, object detection and change detection. Deep Learning (DL), a subset of ML, utilises complex neural networks to discern patterns and extract intricate features from large datasets, revolutionising RS applications.

Combining data science or ML techniques with RS approaches presents various opportunities in many application domains and could be instrumental in monitoring and detecting environmental crime. For instance, change detection is a widely used RS task that aims to detect and analyse gradual or abrupt changes occurring in the same area or object over time (Bai et al., 2023; de Bem et al., 2020). Anomaly or outlier detection is considered one of the vital applications of data mining, which deals with identifying data points that are dramatically different from the rest of the observations (Samariya and Thakkar, 2023). Object detection is a common problem in aerial and satellite image analysis, and RS enables the detection of various objects of interest visible from space or air (Cheng and Han, 2016). Such techniques, separately or in combination, may help uncover the signs of an illegal activity or crime by surveying or monitoring a region of interest.

RS technology also has the potential to revolutionise the identification of pollution or chemical stress in soils and vegetation by offering efficient monitoring solutions. By utilising spectral imaging sensors on Unmanned Aerial Vehicles (UAV's) or satellites, RS technology can identify plant distress caused by toxic substances and enable early detection, even before visible symptoms appear. Therefore, it is interesting to explore the applicability of such techniques for detecting or monitoring discharges of synthetic drug waste into the environment.

Several interesting studies conducted so far include those related to the use of herbicides in the context of agricultural crop production, in particular glyphosate (Kouakou et al., 2017; Nehurai et al., 2023; Suarez, 2018; Yao et al., 2012); to the monitoring of brownfield sites and oil-contaminated soils (Adamu et al., 2018; Lassalle et al., 2019); to heavy metal and metalloid pollution (Kooistra et al., 2004; Saha et al., 2022; Sobura et al., 2022); and to a chemical spill where toluene was a pollutant (Kim et al., 2021). Many of the experiments described in these peer-reviewed studies were conducted in the laboratory or under controlled conditions, and most utilised UAV-based or proximity sensing. To date, we are not aware of comparable studies that consider the effects of pollution from synthetic drug waste. A small pilot project was conducted in the Netherlands on chemical spills from drug production as part of an initiative by the national police, but the results were not conclusive.

This research explores the applicability of several data science and ML techniques in combination with RS and other geospatial data for enhancing the detection of synthetic drug waste dump or discharge sites based on formulated scenarios. The article was developed as part of the NarcoView project funded by ISF Police. The NarcoView project aims to develop a platform for monitoring and detecting environmental crime for end users such as law enforcement and other state agencies. The concept is based on combining data from various sources and utilising data-driven algorithms that enable the prioritisation and/or inspection of larger areas in a shorter time.

The objectives of the research presented in this article are as follows:

- to pre-evaluate the feasibility and relevance of using RS technology in combination with data science and ML approaches for selected scenarios;
- to develop approaches and test techniques for enhancing the detection and monitoring of synthetic drug waste dump or discharge sites using (geo)data science and ML for selected scenarios.

The most promising methods and resulting analytical products will be further integrated into the NarcoView platform.

Methodology

At the start of the project, a list of various scenarios was compiled based on a survey and discussions with the relevant experts of the partner organisations (the Dutch national police, Belgian Federal Police and NVWA). The scenarios were later prioritised based on data availability, relevance, technical feasibility potential and other considerations. Several types of synthetic drug waste dumping were considered.

While many of these scenarios carry great relevance in terms of environmental protection and human health impact, the research team was confronted with limited data availability. In view of this limitation, three scenarios were tested for feasibility, of which two were selected for further research.

Various types of data were necessary to conduct the research in accordance with the specified objectives. An overview of the most important datasets for different scenarios is given in Table 5.1.

Table 5.1. Overview of dumping scenarios and datasets used

No	Scenario of waste disposal	RS data	Ground-truth data	Other data
1	'Classic' dumping (use of jerrycans, barrels, intermediate bulk containers (IBC))	Satellite images, aerial images, drone images	Historical locations of dump sites for 2016–2021 in the Netherlands supplied by the Dutch police (approx. 1 000 cases)	Geographical, socioeconomic data (we used public data portals, such as PDOK (Publieke Dienstverlening Op de Kaart) – a platform for geodatasets from the Dutch government (https://www.pdok.nl/))
2	Waste dumped in manure pits / applied to crop fields	Satellite images, drone images	NVWA records: drug waste pollution (1 case) and use of other chemicals (< 10 cases of glyphosate exposure)	—
3	Chemical waste discharged into the soil/vegetation	Satellite images, drone images	Police records (3 cases)	—
4	Waste abandoned in cars/trucks	Excluded (lack of data)		
5	Waste discharged into open waterbodies/ waterways	Excluded (lack of data)		
6	Waste buried underground	Excluded (lack of data)		
7	Waste discharged into a sewer system	Excluded (lack of data)		

The research on the preselected scenarios started with a feasibility evaluation for the detection of dump sites using satellite data. The availability of satellite data (both public and commercial) was assessed, and potential sources/ providers were identified. Initial testing of satellite data processing and analysis was performed to estimate the potential for detection. Where satellite data were proven to be ineffective, aerial or drone data were also considered. After the feasibility assessment, two final scenarios were chosen for more in-depth research, with the aim of developing detection approaches for:

— the detection of 'classic' dump sites, that is, the detection of sites used for the dumping of synthetic drug waste by utilising storage containers such as IBCs, barrels or jerrycans;

— the detection of chemically polluted crop fields, that is, the detection of fields polluted by synthetic drug waste (this study included other chemical stressors due to the shortage of ground-truth data on drug pollution).

Scenario 1–Detection of 'classic' dump sites

For detection of 'classic' dump sites, two components were formulated: (1) a risk map for assessing which areas have a higher or lower risk of being used as a dump site, based on geodata science; and (2) a detection approach based on RS imagery and AI for object recognition. Eventually, the two components could be used in synergy – with the risk map being used to prioritise or narrow down areas for monitoring and inspection and object detection being used to pinpoint suspicious objects from satellite, aerial or UAV data.

Risk map development

Risk map development was based on historical data on synthetic drug dump site locations for 2016–2021 (source: Dutch national police – confidential data) and various complementary spatial data layers, such as roads network data, a land use/land cover map and data on characteristics of neighbourhoods, and other (Figure 5.3). The objective of data modelling was to identify meaningful spatial patterns in the locations of the dump sites and extrapolate this information to other (yet unused) locations. With limited studies available on this type of crime (examples include Schoenmakers et al. (2016) and Schoenmakers and Mehlbaum (2017)), we started by exploring a broader range of potential explanatory variables and then narrowed these down to a smaller subset that was used in the risk modelling.

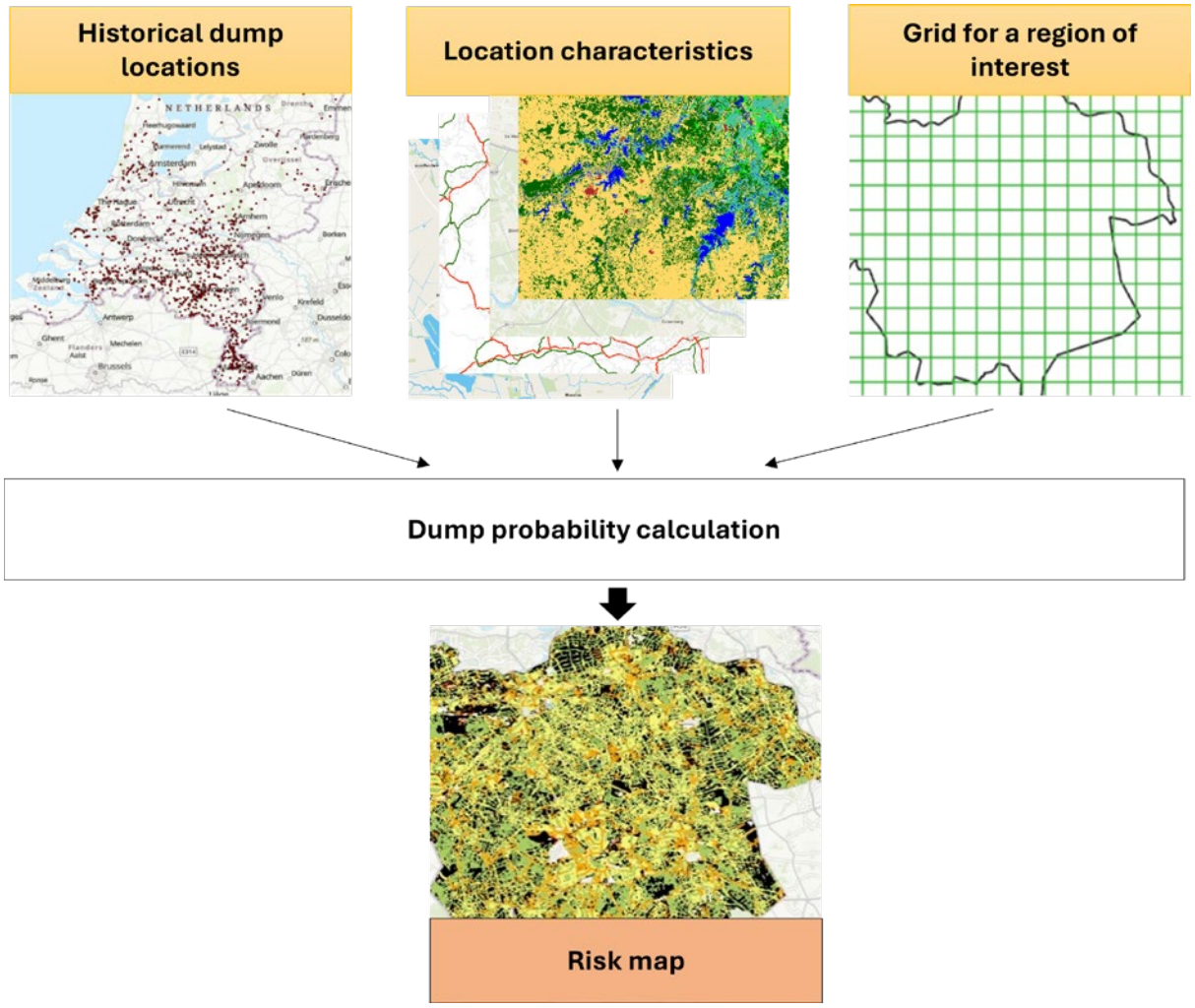

Figure 5.3. Conceptualisation of risk map development. Source: The authors.

The general workflow consisted of the following eight steps.

1. Identify a set of potential explanatory variables, using information from available literature/reports and discussions with experts from the partner organisations.
2. Split a region of interest into a grid of cells (we used 100 × 100 metre squared cells).
3. Preprocess the spatial data and assign variable values to the grid cells (using cell centre location).
4. Test potential explanatory variables for association with the presence of dump sites and select variables with statistically significant association ([56]).
5. Test variables for collinearity (when possible). For continuous variables, we used a maximum collinearity threshold of 0.7 (based on Pearson's coefficient for normal or transformed (e.g. log-normal) variables).
6. Discretise continuous variables.

([56]) We utilised a range of different statistical techniques to analyse the association. Before discretising continuous variables, we conducted analysis of mean and variance of exposed (with dump sites) and unexposed (without dump sites) groups of area cells. For normally distributed variables or normally transformed variables, an analysis of variance (ANOVA) test was used; otherwise, a non-parametric alternative was used, such as the Mann–Whitney *U* test. After discretising variables and with categorical variables, Fisher's exact test and odds ratio estimation were conducted.

7. Calculate dump site probability based on a conditional probability approach, using identified significant explanatory variables (we used a naive assumption that explanatory variables are independent). Conditional probability formula in a general form and in the form of a Bayes theorem is presented in Equation 1 (Bayes and Price, 1763).

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{P(B|A)P(A)}{P(B)} \qquad \text{(Equation 1)}$$

8. Visualise computed probabilities on a map.

Before performing the calculations, various geo-processing techniques were applied to the original input datasets (step 3), such as distance calculations, the selection of features and the aggregation of values. The preliminary spatial processing was executed using the ModelBuilder tool of the ESRI software ArcGIS. ArcGIS was also used for final map visualisation. Statistical tests and probability computations were executed in the Python programming environment, using a variety of analytical libraries.

Object detection

We evaluated the potential to use satellite, aerial or drone imagery for detecting objects typically associated with synthetic drug waste dump sites. Publicly available aerial and satellite data and commercial VHR satellite imagery were considered first. Additional drone images were collected by the project team at a training facility of the Belgian Federal Police near Antwerp (Figure 5.4).

Figure 5.4. Drone images of objects tested for detection with DL algorithms: several barrels and jerrycans on the left and two IBCs on the right. Source: The authors in collaboration with Belgian federal Police.

For testing purposes, IBCs, barrels and jerrycans were selected as the most typical objects used for dumping chemical waste. DL object recognition algorithms, such as YOLOv8, were tested by the subcontracted company using the drone imagery collected.

Scenario 2 - Detection of anomalous crop parcels

For analysis and detection of chemical discharge spots and polluted crop fields, vegetation health was used as a proxy. The analysis is based on the use of spectral indices, such as the NDVI, calculated from RS data for the area(s) of interest.

The NDVI, which is calculated using red (*R*) and near-infrared (*NIR*) band reflectance values, quantifies vegetation health, density and seasonal changes (Gandhi et al., 2015; Townshend et al., 1985), with values ranging from – 1.0 to + 1.0 (Equation 2). Values close to 1 correspond to healthier and more dense vegetation, and values close to 0 correspond to little vegetation, early stages of cultivation or bare soil. Negative values are generally associated with water, artificial/built-up surfaces and snow.

$NDVI = (NIR - R) / (NIR + R)$ (Equation 2)

The basic feasibility analysis of chemical discharge spots in soil/vegetation based on the imagery from the Superview and Triplesat satellites showed that automated detection of such cases would not be very likely in practice, at least based on a small number of known cases. This was partly because the affected area was too small. Therefore, we continued with developing an approach for the detection of anomalous crop fields.

Figure 5.5 shows a global conceptual workflow of an approach for the detection of anomalous fields. Due to the shortage of confirmed examples of crop fields polluted by chemical drug waste, the concept was tested on examples of exposure to another type of chemicals - the herbicide glyphosate.

Our test area covered a region of about 80 km^2 south of the city of Zwolle in the Netherlands, partly in the Overijssel province and partly in the Gelderland province. This area was selected because several glyphosate treated crop parcels were confirmed to be located here (exact locations are confidential; data from NVWA). Preprocessing of the data included retrieving available satellite imagery (Sentinel-2 multispectral instrument) in the Google Earth Engine environment. Google Earth Engine combines a multi-petabyte catalogue of satellite imagery and geospatial datasets with planetary-scale analysis capabilities, therefore enabling easy processing of large-scale datasets ([57]). From satellite imagery, NDVI values were computed for the selected region and aggregated at a crop-field level using a crop-parcel dataset for the Netherlands (Basisregistratie Gewaspercelen (BRP)). NDVI values were computed for various points in time spanning 2018–2022 (the temporal interval between data points varied depending on satellite imagery availability).

([57]) https://earthengine.google.com/.

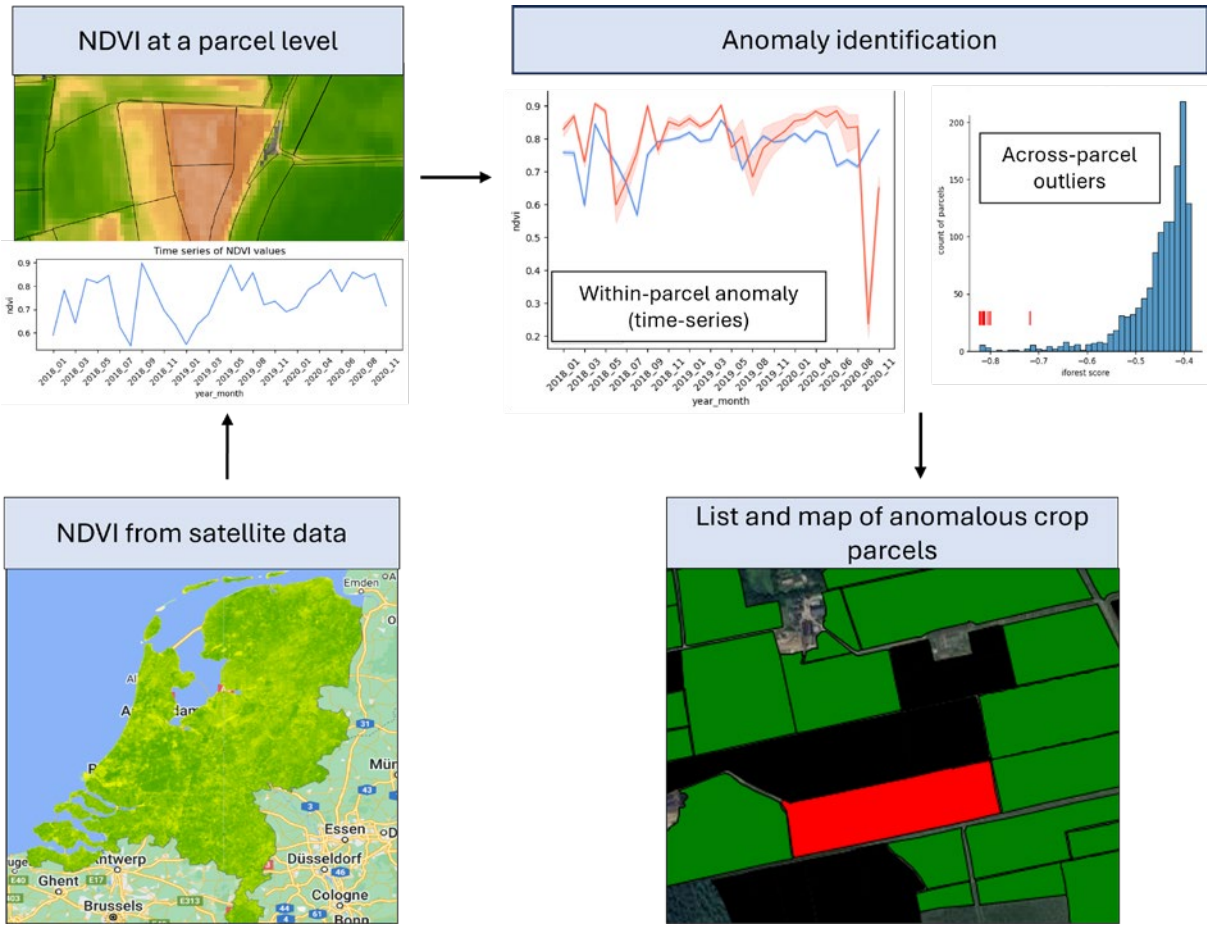

Figure 5.5. Conceptual workflow for detection of anomalous crop fields. Source: The authors.

As spectral reflectance of vegetation may depend on the crop type, as well as various environmental and climatic conditions, certain filters and constraints were applied prior to analysis as follows:

— only parcels within a certain area of interest were included (in our case, we used an area of around 80 km^2, but the sensitivity to different area sizes could be tested in the future) due to possible variations in growing conditions for the crop;

— only parcels with the same crop type were analysed together;

— other filters were used to reduce the noise in the data, such as excluding NDVI values that were uncharacteristic for the vegetation (e.g. negative NDVI values).

For identification of anomalous crop parcels, two approaches were identified:

— outlier parcels were identified in a snapshot in time (e.g. specific month) from the NDVI distribution across parcels in the selected region;

— anomalies were detected in the time series of NDVI values for a specific crop parcel.

For the first approach, two types of techniques were considered: (1) statistical outlier detection (e.g. using *z*-values) and (2) ML techniques, such as isolation forest. Isolation forest is an unsupervised ML technique that is based on the use of decision trees to isolate outlier data points in a dataset (Liu et al., 2008). After the initial testing, preference was given to the isolation forest technique, as it allows to include multiple variables in the analysis and it does not depend on the input data distribution (unlike the *z*-value-based technique), thus providing more flexibility in its application.

For the second approach, the techniques for detecting breakpoints or other pattern changes within the time series of values were tested. Work to develop and test the exact methodology based on time series analysis is still in progress.

Results

This section presents the results achieved with the development and testing of the approaches for enhancing detection of synthetic drug dump sites based on the two formulated scenarios.

Scenario 1–Approach for the monitoring and detection of 'classic' dump sites

The results for use case 1 include the proof of concept of the risk map for prioritising monitoring and detection areas, and a preliminary assessment of the feasibility of dump detection using RS data.

Risk map evaluation

We explored the possibility of generating a risk map at the level of a whole province. A proof of concept for the North Brabant province in the Netherlands was developed (Figure 5.6). This province was chosen due to the high concentration of illegal drugs production in the area (close to the Dutch–Belgian border) and, as a result, the highest number of chemical drug waste dump sites among all Dutch provinces.

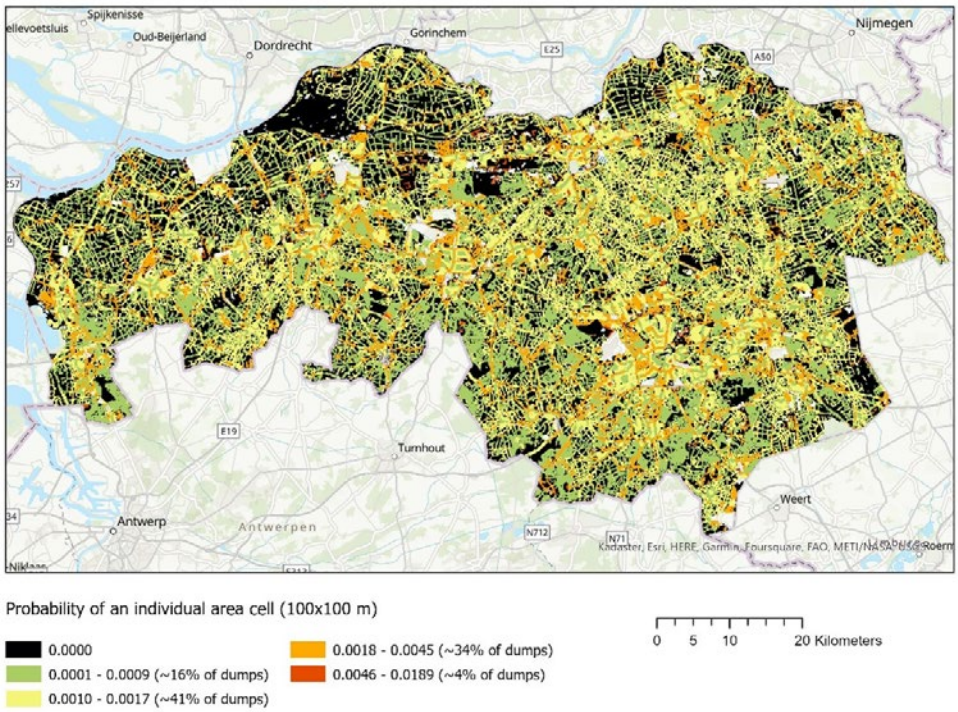

Figure 5.6. Risk map for North Brabant province in the Netherlands based on data for 2016–2021. Source: The authors.

A number of variables that characterise a location were initially explored for the risk modelling, such as variables reflecting accessibility, land use type, urbanisation and various socioeconomic factors, as well as various preprocessing approaches. Based on statistical tests, several variables were selected for inclusion in the model. Some variables were rejected due to a large number of missing values in a dataset. Including many variables in one model also caused a complication: the large number of possible unique combinations of characteristics and relatively small number of dump records could have led to unreliable conditional probability distributions. Therefore, five variables were left in the model: distance to roads, distance to high significance roads (eg. highways or arterial roads), distance to built-up areas, land use type and population density. We also introduced a threshold for the minimum number of cells required with the same characteristics (100 cells ([58])) in order to avoid inflation of the conditional probability range due to a random chance in small groups of cells.

Conditional probabilities were further calculated for each area cell of 100 × 100 metres for the whole province. Resulting values were classified for visualisation using the natural breaks method and displayed with the proportion of the total dump site count covered by the respective area.

([58]) We recommend experimenting with different thresholds to evaluate their influence on the risk map.

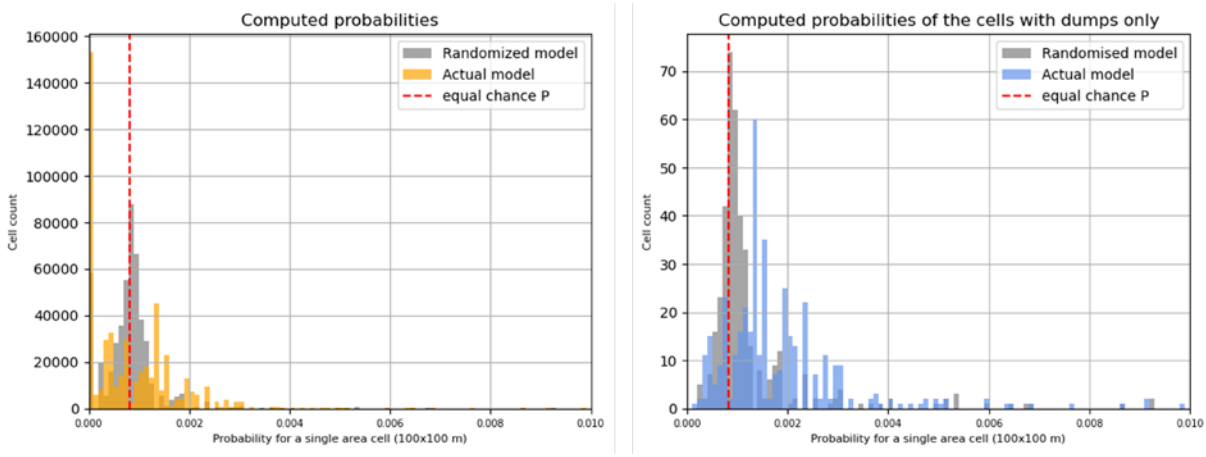

Figure 5.7. Distribution of probabilities of map cells – comparison of the model with the real data and one of randomised experiments (the *x* axis is limited to 0.01 for better visualisation). Source: The authors.

A large portion of cells had an estimated probability of 0 or very close to 0. After splitting the resulting probability range into classes, almost 80 % of the known dump sites occurred in less than 40 % of the total area (yellow, orange and red areas on the map in Figure 5.6), while almost 40 % of all dump sites occurred in only about 12 % of the total area (orange and red areas on the map). In a practical application, such knowledge could enable the exclusion of certain areas from monitoring or inspection routines and narrow down the search areas.

The results of the model using the actual data were compared with a number of experiments using simulated randomised sets of dump locations (Figure 5.7) in order to exclude the possibility that the results we obtained could easily have occurred by chance.

Object detection

Based on the initial feasibility assessment, using satellite data for detecting chemical storage containers was shown to be impractical for several reasons, such as the very narrow window of opportunity (in the Netherlands and Belgium, suspicious objects are quickly found by citizens and reported to the police), difficulty in finding suitable imagery for the specific locations and time / time frames, the resolution of the imagery necessary for detection of small objects and the high costs of VHR satellite imagery. Based on these considerations, it was decided to further test the applicability of aerial and drone-based imagery. Training and testing algorithms for this task is still a work in progress (being undertaken by an external company).

Scenario 2 – Detection of anomalous crop fields

We introduced two approaches to the analysis of potentially chemically treated crop parcels. The first approach investigated patterns at a given point in time across comparable parcels. To control for factors such as soil type and weather circumstances, parcels from the surrounding area of known treated fields were used for comparison. All parcels were filtered down to preserve only one crop type (in this case, permanent grassland) in a specific year and month (e.g. September 2020). The NDVI score was used as an input variable for the isolation forest algorithm, and, later, the difference from the previous month was added as another input. Based on a number of iterations, each value of a variable was assigned a score indicating its 'outlierness' given the full set of values (Figure 5.8). The number of estimators (or number of times the isolation forest algorithm was performed and used for computing

the isolation forest scores) was also tested. From 10 iterations and higher, the results stabilised to a constant pattern. However, even with 5 iterations, the distribution of isolation forest scores showed a similar pattern. In each case, known treated fields were classified as outliers.

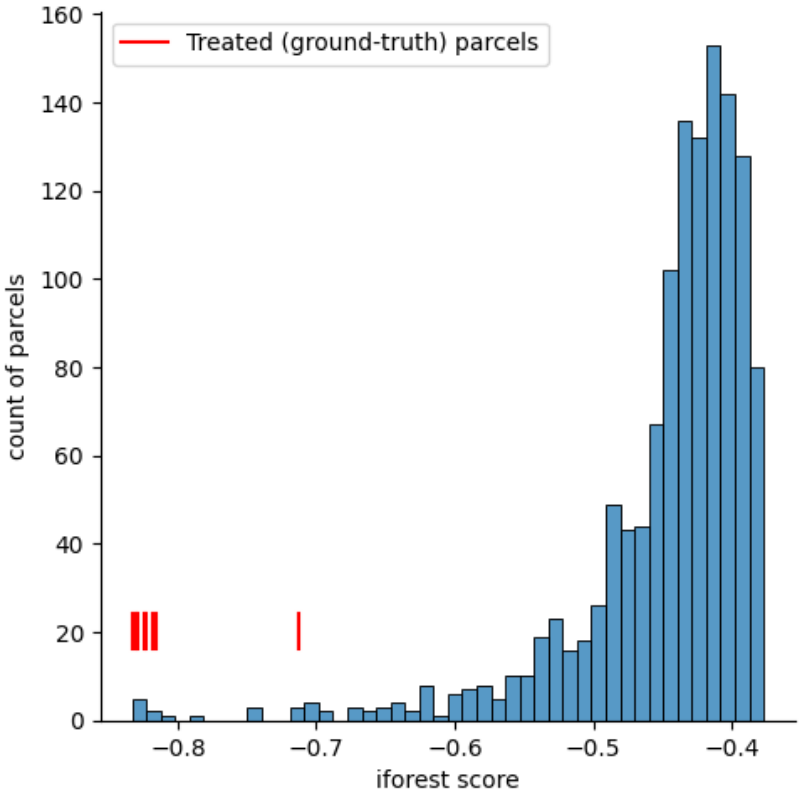

Figure 5.8. Results of outlier detection with isolation forest for September 2020. Source: The authors.

The filter-based approach to finding outliers was shown to be consistent in classifying the known treated fields as such. An example of applying filters to the combined dataset is provided in Table 5.2.

Table 5.2. Example of filtering crop parcels using NDVI values for the month of interest and difference from the previous month as inputs for the isolation forest algorithm

Filter step	Action	Total records remaining	Individual plots remaining
—	Starting state	71 762	2 057
1	Filter crop type (permanent grassland)	43 340	1 318
2	Filter out plots with bare soil (maximum yearly NDVI threshold of 0.2)	43 340	1 318
3	Take out parcels with changed crop type compared with the previous year	43 340	1 318
4	Select the data from September 2020 (slice in time)	1 265	1 265
5	Apply isolation forest algorithm and select the parcels classified as outliers (isolation forest score < – 0.5)	185	185
6	Select parcels classified as stronger outliers (isolation forest score < – 0.7)	21	21
7	Validation	known parcels under exposure (ground-truth) classified as outliers: 8 out of 8	

For the second approach – time series analysis – we first focused on visual inspection. The NDVI values were plotted chronologically. For the treated plots, the months in which the treatment occurred showed drastic differences compared with the non-treated parcels (Figure 5.9).

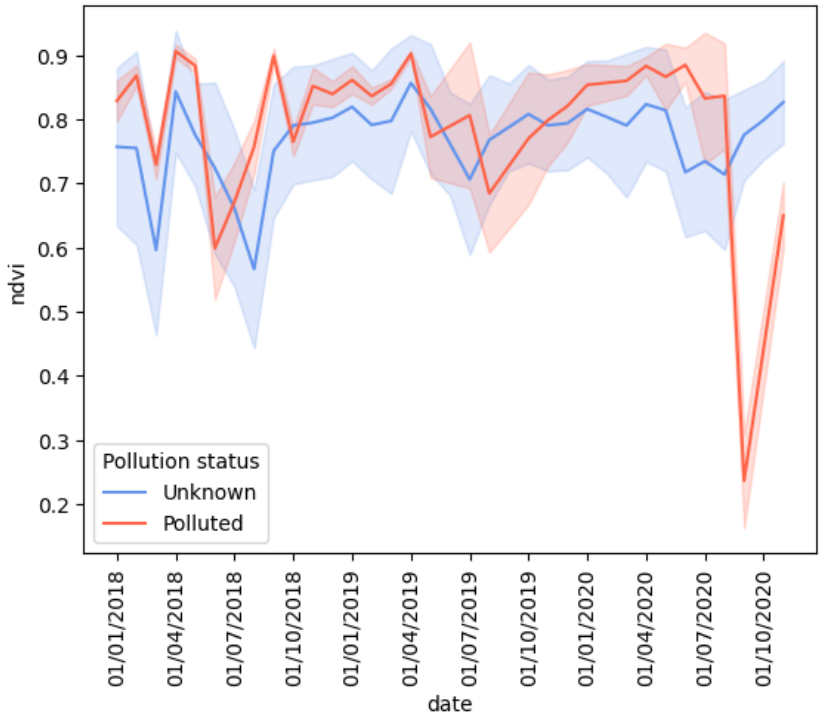

Figure 5.9. Comparison of average NDVI values of normal and affected grass fields. Source: The authors.

For this acute drop, the difference from the previous month was tested as an additional input parameter for applying the isolation forest algorithm (Table 5.2). At this stage, adding the change compared with the previous month did not add a lot to the isolation forest outcome for stronger anomalies, but it slightly reduced the overall number of detected outliers (isolation forest score < – 0.5). By further investigating the possibility of change detection in the time series of spectral data, there is potential to develop a proper detection method suitable for multiple applications in the domain of monitoring crop growth and vegetation stress detection.

Discussion

RS imagery and other types of geospatial data, alongside data science and ML techniques, offer unique possibilities for the monitoring and detection of illegal activities, and assessing the consequences of these. In the context of the illicit dumping of chemical waste from synthetic drug production, the body of knowledge is limited and insufficient data are available. In light of this, our objective was to assess the feasibility of and develop proofs of concept for the two scenarios outlined for detecting synthetic drug waste dump sites, considering the aforementioned constraints. During the process, various limitations and opportunities for future improvement were identified.

Risk map

In the risk map development, several limitations were related to data availability and quality. For example, most socioeconomic variables were available only at a neighbourhood level as the finest level of detail. Uncertainty about the locations of historical drug waste dump sites was also a serious concern. Police records contained specific GPS coordinates for only the year 2021, while other records had only a partial address. Our team used OpenStreetMap ([6]) to convert recorded addresses or postal codes into approximate coordinates; however, the error in location in this case is difficult to estimate. The availability of other potentially interesting information was also a limitation – for instance information on abandoned industrial or agricultural businesses or those no longer operating. Furthermore, it could be beneficial to analyse different subgroups of dump sites separately (e.g. based on the manner of dumping); however, this was not done in this case due to the absence of dump site descriptions in a significant portion of police records.

Further refining the set of input variables would be beneficial. However, including more variables at this stage was not feasible with the currently available dump site records and the method used. Including more variables would lead to an overly large number of possible combinations of characteristics that each area cell could have, and therefore a reliable conditional probability distribution for each of these combinations could not be ensured.

Our current risk map model makes use of the conditional probability concept and could be presented as a very simple Bayesian network in the future. Further risk map development could explore Bayesian network modelling with spatial data in more depth (e.g. the possibilities outlined in Krapu et al., 2023) and more thorough testing of model structure and robustness.

Remote sensing and image recognition

Tasks like object detection are widely used in combination with RS data, based on satellite and/or UAV imagery. Existing algorithms, such as YOLOv8, are well developed and enable the easy implementation of the detection workflows. However, data availability and quality still represent serious limitations. Based on a preliminary analysis,

various limitations to the use of satellite data were identified in our application context. Among them were a lack of suitable imagery for the required locations and dates, the specific image resolution requirements for the detection of small objects or features and, consequently, the high costs of VHR imagery that would accommodate such requirements on demand. Our team resorted to the use of aerial and UAV data instead. This approach, however, is not in line with the original idea of a detection workflow, since UAVs cover a smaller area than satellites and require an operator. Aerial imagery, meanwhile, is collected only about once a year by the Dutch government, and therefore would not be suitable for the timely detection of crime.

Availability of labelled examples for training object detection algorithms and examples of ground-truth data for testing and validating the techniques still represent serious limitations. For several interesting scenarios, only a few recorded examples of ground-truth data could be provided by law enforcement partners. This is in line with the observations of Schoenmakers et al. (2016), who pointed out the lack of records, especially on chemical discharge cases. For applications with rather uniform objects (e.g. containers or barrels), the new opportunities that modern generative AI tools (e.g. DALL-E/ChatGPT) can offer should be explored, for example the generation of an artificial training sample for the image classification algorithms.

Detection of anomalous crop fields/parcels

Our approach was based on detecting anomalies in the spectral vegetation index of the crop fields from satellite data. Any observation that is inconsistent with the rest of the dataset would be highlighted, thus reducing the need to account for all possible effects of each specific chemical substance or their combinations. However, anomalies in crops may be caused by various factors, including natural factors (drought, pests, etc.) and anthropogenic factors (mechanical disturbance, use of phytosanitary products, etc.), and, with the approach presented, the distinction between various potential stressors cannot be determined. Overall, the research on sensing the effects of chemical stressors is still limited and does not deliver a full picture of the theoretical body of knowledge (e.g. the response of different crop types to different chemical stressors and the best techniques to sense these responses) or how such techniques can be used in practice in the context of real application scenarios of the stakeholders concerned and in real-world conditions. Other indices are available in addition to the NDVI (e.g. the Optimised Soil-adjusted Vegetation Index (OSAVI)) that may be potentially effective for this application (Rondeaux et al., 1996). Furthermore, with the rapid development of sensing techniques, hyperspectral data may provide additional opportunities for the detection of chemical pollution, using either satellite or UAV platforms.

Another important point of discussion is the availability of ground-truth data. In this research, only a few confirmed cases of affected crop fields were known, with most of these cases being due to glyphosate exposure and only one case being related to drug waste pollution (that could not be used). Identifying and adding more ground-truth data (on both confirmed exposed and unexposed fields) would add robustness to the eventual analysis and hopefully help establish some baselines in the differences between the two groups.

The time series analysis approach showed some promise, but also posed challenges. The cyclical character of seasonal growth patterns is sometimes hard to capture for a few reasons. Firstly, parcels themselves can change in size and be split up or merged with another parcel. Secondly, the type of crop can change over time. Lastly, other factors such as the weather and other environmental factors can vary over the years. Moreover, the analysis may

consider other factors, such as the variability of spectral information within the parcel, soil type variations and finer moisture scores.

Conclusions

This article presents the results achieved so far in the context of the NarcoView project, where approaches for improving the detection of synthetic drug waste dump sites were explored using RS and data-driven techniques. Two main use cases were outlined: (1) the detection of 'classic' synthetic drug waste dump sites with the help of a risk map and object detection algorithms; and (2) the detection of polluted crop fields.

For the risk map, we used a small number of variables (five) to define a risk model. It is possible that the model could be further improved through the inclusion of other variables, as well as the use of more and better quality records on cases of dump sites over time. The evaluation of the risk map showed that, even at the proof-of-concept level, it is possible to narrow down or prioritise inspection areas, compared with a purely randomised approach. Eventually, a risk map could be used in synergy with object detection approaches for the more efficient surveying of areas.

The utilisation of VHR satellite imagery was found to be impractical for the detection of containers and small chemical discharge spots due to high costs and limited temporal and spatial coverage and resolution of the imagery. As an alternative, we started testing the applicability of UAV imagery. The initial tests with container detection showed promise; however, employing the latest drone technology equipped with higher resolution cameras is recommended when the detection of smaller objects (e.g. jerrycans) is of interest.

For the detection of anomalous crop fields, two approaches were used. Firstly, crop fields with the same crop type (grass) were compared at a selected point in time (month of interest). Using different statistical and ML methods, as described above, parcels were filtered to obtain a list of parcels labelled 'anomalous'. The use of the isolation forest approach to isolate anomalous crop parcels shows promise for the further development of this method.

As for the time series analysis approach, there are some interesting starting points, such as the acute drops in the NDVI values of some of the affected crop fields. However, further work and more ground-truth data are required to develop a method for the automated detection of time series changes in polluted crop fields. As of now, the testing had to be conducted using data on other chemical stressors (such as glyphosate). Furthermore, to improve the methodological approach, more theoretical knowledge on the response of vegetation to chemical stressors and the best techniques to sense such a response will be crucial before continuing with pattern analysis.

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Tackling environmental crime and harm by large industrial facilities: lessons learned based on two Dutch case studies ([59])

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Abstract

How is it possible that some large industrial facilities cause pollution for decades while enforcement of environmental laws and regulations stays largely ineffective? In this contribution, this question is answered by analysing the historical development of environmental law enforcement in the Netherlands, drawing on evaluation reports and an explorative case study of two industrial facilities in the Netherlands that are currently in the public eye because of their impact on the environment and public health: Hoogovens/Tata Steel in IJmuiden and Chemours in Dordrecht. Three elements emerge as key challenges in tackling environmental crime by large industrial facilities: fragmented enforcement of environmental laws and regulations, the information asymmetry between businesses and government, and the interconnectedness of legitimate and illegitimate business activities. Although these conclusions are drawn based on Dutch evaluations of environmental law enforcement practice and illustrated using Dutch cases, they are more broadly relevant to how Europe deals with industrial pollution.

Keywords: environmental crime, pollution, environmental enforcement, industry, PFAS.

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Introduction

On 22 September 2023, the Dutch National Institute for Public Health and the Environment concluded that the residents of the IJmond region are particularly likely to become ill due to the contemporary emissions of the Hoogovens/Tata Steel site' (Geelen, 2023). For the first time in Dutch history, the health authority concluded that there was a direct relationship between emissions from industrial activity and health risks for residents and the environment. A few days after the report was published, on 27 September 2023, the District Court of Rotterdam rendered a similarly historic ruling in a civil case brought by the municipalities of Dordrecht, Papendrecht, Sliedrecht and Molenlanden against the company DuPont de Nemours/Chemours. In this intermediate ruling, the district court found that Chemours and its legal predecessor, DuPont de Nemours, were liable for the damage they caused between 1984 and 1998 ([61]) by emitting perfluorooctanoic acid (PFOA) ([62]), one type of the more than 10 000 Per- and polyfluoralkyl substances (PFAS), which are chemical compounds based on a chain of fluorine and carbon atoms, infamously known as 'forever chemicals' due to their high persistence in the environment and human body ([63]). The judge ruled that the company acted unlawfully because it had not sufficiently informed the licensing authority and municipalities during this period about the possible risks of PFOA pollution and about internal concerns about PFOA, and did not reduce emissions ([64]). Moreover, the district court ruled that both companies were liable for the consequences of the PFAS contamination, even if they had permits to emit PFAS.

Hoogovens/Tata Steel and DuPont de Nemours/Chemours are Dutch examples of large industrial facilities that have been polluting the environment and have caused public concern for decades, but which have presented very challenging cases in terms of environmental law enforcement. In the case of Hoogovens/Tata Steel, the first concerns about the public health consequences of its coal-fired steel mill date back to 1918, two years before the construction of the first furnace of Koninklijke Hoogovens, the original name of the company, which literally translates to Royal Blast Furnaces (Van Wingerde, 2022). The various lawsuits surrounding the production of PFOA both in the United States and in the Netherlands show that the chemical industry – in this case PFOA producer 3M and user DuPont – had already raised concerns about its toxicity as far back as the 1960s. (Arenson 1961; Gaber et al. 2023.). In the Netherlands, the use of PFOA started in 1967, five years after the opening of the Dordrecht Works site. In a 1984 US corporate document, DuPont's executives discussed the potential phasing out of the chemical compound and stated that they were liable for the past 32 years of emissions ([65]). Nevertheless, the production of Teflon based on PFOA continued in Dordrecht until 2012, and the factory in Dordrecht was the second largest user of PFOA in the world ([66]) ([67]).

In recent years, health and environmental concerns about both industrial facilities have risen to the top of the Dutch political and societal agenda following more and better knowledge about the harmfulness of emissions, increased media attention and heightened societal concern. Large class action lawsuits have now been filed against both

([61]) For the period from 1 March 1998 to 2012 (PFOA phaseout), the civil proceedings were to continue and to be part of the final verdict. No final verdict has been rendered at the moment of writing (October 2025).

([62]) Also known as ammonium perfluorooctanoate, C8 or FC-143.

([63]) https://www.niehs.nih.gov/health/topics/agents/pfc.

([64]) www.rechtspraak.nl/Organisatie-en-contact/Organisatie/Rechtbanken/Rechtbank-Rotterdam/Nieuws/Paginas/Chemours-handelde-onrechtmatig-met-uitstoot-van-PFOA.aspx.

([65]) https://static.ewg.org/files/dupont_elim_PFOA_1984.pdf?_gl=1*1oapee8*_gcl_au*MjExMTU2MTc5LjE2OTU4MTQ3MTk.*_ga*NDg0ODQ5Njk1LjE2OTU4MTQ3MTk.*_ga_CS21GC49KT*MTY5NzAwODIwNi4yLjEuMTY5NzAwODQ5MC4wLjAuMA..&_ga=2.144866742.365754225.1697008207-484849695.1695814719.

([66]) https://resolver.kb.nl/resolve?urn=KBNRC01:000034663:mpeg21:a0176.

([67]) www.ftm.nl/artikelen/pfas-onzekerheid-regeert.

companies, and criminal investigations are being conducted into whether the companies and their executives have criminally endangered public health ([68]) ([69]).

The problems related to harmful pollution by the chemical and steel industries are not limited to the Netherlands. A cross-border collective of investigative journalists found 23 000 sites of PFAS pollution in Europe ([70]). These problems are not bound by contamination sites: for instance, a Belgian company caused high concentrations of PFAS in the French rivers Arias and Avène ([71]). In Italy, from the 1990s onwards, several epidemiological studies have found a link between the steel factory Arcelor Mittal Italia – formerly named Ilva – and environmental damage and public health problems (WHO, 2023). What these and other cases have in common is that these large industrial facilities continued to cause pollution for decades despite (public) awareness of the harmful impact and while environmental law enforcement stayed largely ineffective. By analysing the historical development of environmental law enforcement in the EU and specifically the Netherlands, this article aims to discuss the key challenges in the enforcement of environmental laws and regulations. While illustrating our arguments with cases from the Netherlands, the relevance of these challenges goes beyond national borders. The next section provides a rudimentary history of the Dutch approach to environmental crime and harm by large industrial facilities. It draws on evaluation reports (both government-commissioned and independent evaluations) that focus on Dutch environmental law enforcement. After that, three key challenges in tackling environmental crime are discussed: the fragmentation of supervision, the lack of balance in information provided by companies and government, and the interconnectedness of pollution and legal business activities. These challenges are illustrated based on concrete examples of environmental crime from the past and present, based on our two case studies. The conclusion discusses a couple of future implications of these Dutch cases, which are more broadly relevant to how Europe deals with industrial pollution.

Historical development of environmental law enforcement in the Netherlands

For a long time, attention to the environment was largely limited to 'urban hygiene' topics such as odour nuisance, risk of contamination, contaminated drinking water and fire safety (Siraa et al., 1995, p. 231). From the late 1960s onwards, it gradually became clear that post-war economic growth, expanding industrial activity and technological progress were bringing serious risks to the environment and public health. In 1972, this realisation was reinforced when the Club of Rome published its report *The Limits to Growth* (Meadows et al., 1972), concluding that the planetary boundaries would be reached within a hundred years unless we changed our behaviour. The report coincided with a number of incidents that affected the environment. In July 1976, a reactor of a chemical company near Seveso, Italy, exploded. The explosion caused a dioxin cloud that immediately killed many animals, and people in the wider area suffered permanent health damage. On 16 March 1978, the Liberian oil tanker Amoco Cadiz ran aground off the French coast. More than 200 000 tonnes of crude oil spread over the sea and the French coastline. That same year, a truck loaded with liquefied gas exploded at the Spanish campsite Los Alfaques, as a result of which 216 people died. In 1978, both in the Netherlands (Lekkerkerk) and the United States (Love Canal), people were shocked by the discovery of residential areas that were built on chemical waste.

([68]) https://nos.nl/artikel/2487766-massaclaim-tegen-tata-steel-omwonenden-willen-schadevergoeding.
([69]) https://nos.nl/artikel/2494623-omwonenden-chemours-blij-met-onderzoek-van-om-enige-juiste-om-te-doen.
([70]) https://foreverpollution.eu/.
([71]) https://www.europarl.europa.eu/doceo/document/E-9-2024-000485_EN.html.

As a consequence, several (international) environmental laws and regulations were drafted and ratified, such as the first environment action programme by the European Commission. In the 1980s, more than 200 legislative measures were passed by the European Commission regarding environmental protection. However, the effectiveness of the implementation of these laws by Member States was questioned, leading to a shift from public to private actors in the enforcement of environmental legislation (Abbot and Lee, 2015; Macrory, 1992; Orlando, 2014).

In the Netherlands, enforcement of these laws and regulations only started in the 1980s. Dutch evaluations of environmental law enforcement characterised it as reactive and coincidental (Aalders, 1984, p. 301) and as lacking coordination, and found that sanctions were hardly ever imposed (e.g. Blomberg and Michiels, 1997; Committee on Administrative and Private Law Enforcement, 1998; Committee for the Revision of the Enforcement System for the Environment, Spatial Planning and the Environment Regulations, 2008; Van den Anker and Hoogenboom, 1996; Van Vugt and Boet,1994; Van den Berg, 1995a,b). In February 1982, the lack of environmental compliance became obvious when the District Court of Breda sentenced three former directors and several employees of Uniser Holding BV to unconditional prison sentences ranging from seven months to two-and-a-half years for, among other things, the illegal discharge of hazardous waste. The Uniser case was the Netherlands' first encounter with serious environmental crime. Several similar large-scale and long-lasting corporate environmental crimes followed, with Booy Clean, Kemp and Zegwaard and Tank Cleaning Rotterdam (TCR). Each company illegally discharged or dumped hazardous (waste) substances and led clients and enforcement authorities to believe they had properly treated them. Moreover, each of these companies had a long history of non-compliance. For example, between 1985 and 1994, enforcement authorities carried out 408 inspection visits to TCR under the Surface Water Pollution Control Act, resulting in 55 official reports about 134 violations (Court of Audit, 1996, p. 66–67). Sanctions were regularly imposed, yet the enforcement authority was ineffective in making the companies compliant. These cases instigated important developments in environmental law enforcement. The fact that these companies made large profits at the expense of the environment led to considerable public outcry, as well as several follow-up investigations into the companies (Court of Audit, 1996; Eshuis and Van den Berg, 1996; Gosewehr and Maas, 1984; Ten Heuvelhof et al., 1996; Uniser Committee, 1983).

In the early 1990s, as a consequence of these cases, the concept of 'environmental crime' came into vogue, and various studies followed about the nature and scale of, and explanations for, this phenomenon (e.g. Van den Anker and Hoogenboom (1997); Van den Berg (1995a,b)). Moreover, there was growing awareness about environmental law enforcement being in the public interest. Several evaluations showed serious environmental law enforcement deficits, and a myriad of environmental enforcement projects, programmes and policy adjustments followed at the national (Blomberg and Michiels, 1997; Committee for the Review of Law Enforcement Instruments, 1995; Committee on Administrative and Private Enforcement, 1998) and international levels (OECD, 2002, 2014, 2018). The role of European legislation increased: in 2003, 80 % of Dutch environmental legislation was either directly or indirectly imposed by the EU (Wesselink and van Wijk, 2003). In the EU itself, international cooperation became more important as well. It took a leading role in a number of multilateral agreements, such as the 1989 Basel Convention and the 1997 Kyoto Protocol on climate change (Orlando, 2014). Within the EU itself, two directives were adopted, the ECD in 2008 and the environmental liability directive in 2004, showing a shift in priorities from 'the internal market to more genuine environmental concerns' (Orlando, 2014, p. 19).

In the 2019 European Green Deal, the European Commission stated: 'In addition to launching new initiatives, the Commission will work with the Member States to step up the EU's efforts to ensure that current legislation and policies relevant to the Green Deal are enforced and effectively implemented' ([72]). Yet the recent mid-term review of the eighth environment action programme by the EU concluded that effective enforcement of EU environmental legislation and policies by Member States remains a concern (European Commission, 2024). Recent Dutch evaluation reports with telling titles such as *The Time Is Ripe* (Committee for the Revision of the Enforcement System for the Environment, Spatial Planning and the Environment Regulations, 2008), *The Market in Charge* (CCV, 2019), *An Invisible Problem* (Court of Audit, 2021a) and *Enforcement in the Dark* (Court of Audit, 2021b) have drawn attention to several recurring challenges in the enforcement of environmental laws and regulations: fragmented law enforcement, information asymmetry between government and industries, and the interconnectedness of legitimate and harmful activities. In what follows, these three challenges are explained and illustrated based on the cases of Hoogovens/Tata Steel in IJmuiden and DuPont de Nemours/Chemours in Dordrecht.

Fragmentation of environmental law enforcement

The environmental law enforcement deficit is often attributed to a high degree of fragmentation in the supervision and enforcement of environmental laws and regulations. Many different legal authorities – both administrative and criminal – are involved, and each focuses on a specific part of the environmental domain. Cooperation and exchange of information between these organisations have regularly proven to be inadequate. One of the first observations of these inadequacies was made in the 1998 report *Qualitative Enforcement* (*Handhaving op niveau*) of the Committee on Administrative and Private Law Enforcement. This so-called Michiels Committee concluded that administrative enforcement needed to be professionalised across the board, making several recommendations for improvement (p. 59 *et seq.*). In line with earlier reports, the committee recommended separating the functions of permit granting and enforcement, improving task division between administrative and judicial enforcement authorities, improving cooperation and information exchange between enforcement agencies and creating distance between environmental authorities and local politics by creating regional (instead of local) environmental services (pp. 96–97). The recommendations resulted in several programmes aimed at developing best practices to stimulate compliance with environmental regulations. Despite the efforts invested in improving environmental enforcement, a 2008 evaluation report concluded that the changes were insufficient. A major bottleneck remained the high degree of fragmentation between over *500 environmental agencies, whose 'enforcement strategies in many cases did not meet the requirements of being effective, efficient, and least burdensome for citizens and businesses'* (Committee for the Revision of the Enforcement System for the Environment, Spatial Planning and the Environment, 2008, pp. 6–7, translated from Dutch). This so-called Mans Committee report resulted in the creation of (then) 29 regional environmental authorities responsible for issuing permits and enforcement across various municipalities and provinces in their region ([73]). The idea was that a larger working area would allow for specialist knowledge building and improved interagency cooperation (pp. 41–48). Although this improved the structure of the so-called permit, oversight and enforcement (vergunningverlening, toezicht en handhaving (VTH)) system, major concerns remained about its effectiveness. In 2021, the Van Aartsen Committee – set up by the Secretary of State for Infrastructure and Water Management to improve the VTH system – concluded that it had observed the performance of the VTH system with 'increasing surprise and concern' (VTH Advisory Committee, 2021, p. 50, translated from Dutch). It deemed environmental authorities ineffective due to their fragmentation, small-scale organisational structures, insufficient information exchange and knowledge development, and insufficient

([72]) https://environment.ec.europa.eu/law-and-governance/legal-enforcement_en.
([73]) https://www.omgevingsdienst.nl.

professional distance from local government administrators. Yet another programme – the intergovernmental programme strengthening VTH – followed. Its December 2023 intermediate report mentioned noticeable yet slow improvements in organisational structure, reconfirmed insufficient information exchange and fragmentation of expertise and knowledge, and added that criminal enforcement should be used more frequently than is currently happening in cases of repeat and/or severe non-compliance (IBP VTH, 2023).

The challenges these reports identified and reiterated can be illustrated using the Hoogovens/Tata Steel and DuPont de Nemours/Chemours cases. In 2015, concerns about Chemours' PFAS contamination emerged in the Netherlands ([74]). Fragmented supervision has led to a lack of coordination and citizens feeling overlooked (IJzermans et al., 2017). In a 2023 report by the Dutch Safety Board (OvV, 2023) that looked at three key industrial facilities in the Netherlands, the actors that are currently involved in the supervision of Chemours are listed (p. 87): the EU, the Ministry of Infrastructure and Water Management, the Environment and Transport Inspectorate, the National Institute for Public Health and the Environment, Public Works (Rijkswaterstaat), the province of South Holland's parliament and government, the Regional Environmental Authority, the South Holland South Environmental Authority, the South Holland South Health Authority, and the municipalities of Dordrecht, Sliedrecht and Papendrecht. Given the long time frame in which the pollution occurred, the competent authorities changed over time. In 2017, for example, the implementation of the supervision of Seveso companies ([75]) was transferred from the local South Holland South Environmental Authority to the Regional Environmental Authority ([76]). The fragmentation of supervision and responsibilities, therefore, also refers to fragmentation over time. Limited knowledge sharing and coordination resulted in insufficient insight into the full extent and multifaceted nature of PFAS pollution. Given the persistence and mobility of PFAS, such an overarching picture is essential: the exposure route of PFAS is not limited to direct pollution points. PFAS emissions in the air, groundwater and surface water find their way to citizens through, for instance, open water swimming, vegetable and dairy products, playground soil and drinking water. The case of DuPont de Nemours/Chemours, therefore, clearly shows the shortcomings of a fragmented VTH system. Due to the specialisation among and, in some cases, even within different regulatory bodies, an overall picture of environmental pollution and its associated health and environmental consequences was missing.

That same Dutch Safety Board report (OvV, 2023) concluded that supervision is similarly fragmentation in the Hoogovens/Tata Steel case (p. 44), with the following actors listed: the EU, the Ministry of Infrastructure and Water Management, the Environment and Transport Inspectorate, the National Institute for Public Health and the Environment, the Province of North Holland, the Regional Environmental Authority North Sea Channel, the Regional Environmental Authority IJmond, the Regional Health Authority Kennemerland, and the municipalities of Velsen, Heemskerk and Beverwijk. Although the various actors have increasingly sought cooperation since the graphite rains in 2018 and 2019, fragmentation continues to cause problems. For example, both the Province of North Holland and the Ministry of Infrastructure and Water Management continued to see each other as primarily responsible for taking action (p. 74). As a result, stricter emission standards were not included in Tata's permit, despite both parties having the authority to do so under the VTH system (pp. 75–76).

([74]) www.ftm.nl/artikelen/hoe-dupont-met-teflon-een-ongekende-milieuramp-veroorzaakte.

([75]) Brzo is an acronym for Besluit Risico's Zware Ongevallen, which translates as 'major accident risks decree', the Dutch interpretation of the EU directive on occupational safety, external safety and disaster management. This refers to companies that work with large quantities of hazardous substances, so that these risks are mapped out in order to prevent and control major accidents.

([76]) www.zuid-holland.nl/@17503/wijziging/.

The information asymmetry between businesses and governments

Countering fragmentation requires good information exchange between different actors responsible for supervision and enforcement; however, in practice, information exchange is often lacking. In its reports *An Invisible Problem* (2021a) and *Enforcement in the Dark* (2021b), the Court of Audit concluded that the lack of high-quality data on environmental crime causes environmental law enforcement to be deficient. Data turned out to be missing or incorrect, and it was not possible to identify individual companies in the absence of unique identifiers for legal entities (Court of Audit, 2021b). In addition, the severity of the punishment did not appear to take into account whether the company in question had previously committed the same offence. It shows that environmental enforcement authorities often have too limited insight into companies' (non-)compliance histories (Court of Audit, 2021b), which – if included in the decision-making process – could lead to faster enforcement. For example, a historical analysis of the problems surrounding Hoogovens/Tata Steel shows that the company was frequently reprimanded by regulators in the 1970s and 1990s for, among other things, the illegal discharge of zinc and lead into surface water (Van Wingerde, 2022). These problems with the registration of data and the lack of historical awareness of enforcement authorities are not new. In her PhD research on the supervision of Seveso companies, Kluin (2014) showed that inspectors are often unaware of the compliance and enforcement history of the companies they inspect, resulting in recidivism staying unnoticed.

In addition to inadequate internal and longitudinal information management, information exchange between agencies, for example between criminal and administrative law authorities, also proved to be insufficient (Court of Audit, 2021b), both between government agencies and within government agencies. For example, until 2017, the South Holland South Environmental Authority was responsible for regulating DuPont/Chemours' air, surface water and soil pollution. However, there was limited communication between the inspectors responsible for these different domains, which meant that the cumulative nature of the pollution came into focus too late.

In addition to limited information exchange between government agencies, the Dutch Safety Board (OvV, 2023) also mentions the lack of information sharing between industry and government. Due to budget cuts and decentralisation, the latter has fallen behind in terms of capacity, resources and knowledge. This has created an imbalance in the information about business processes, causing the government to become dependent on the industry itself (OvV, 2023). The case of DuPont/Chemours shows the problematic consequences of this position of dependence. Previous studies have analysed how US parent company DuPont de Nemours maintained an information monopoly and situation of 'selective ignorance' by not sharing internal studies on the health effects of PFOA (Richter et al. 2021; Shapira and Zingales, 2017). As a result, the responsible public authorities could not adequately address the risks posed by this chemical pollution (Richter et al., 2021). In the Dutch case, a similar backlog of information contributed to the continuation of PFOA contamination until 2012, while most uses of the substance in the United States had been phased out in the mid-2000s (Bisschop, 2023). The issue of information asymmetry between business and government brings us to a final challenge: the interconnectedness of environmental pollution and legitimate business activities.

Interconnectedness of pollution and legitimate business activities

The most frequently mentioned criticism of environmental law enforcement is the long-term failure to take action against – or tolerance of – environmental violations by companies that have a permit for certain business activities.

In the case of Uniser, it is clear that, despite complaints and reports about suspected contamination of surface water, abnormal fish mortality and tar-like substances on the water dating back to the 1980s, there was no oversight of Uniser's activities (Uniser Committee, 1983, p. 52). In the case of Booy Clean, dozens of violations were identified over 10 years, but no sanctions were imposed (Gosewehr and Maas, 1984, pp. 25–27). In addition, despite clear indications that TCR was systematically violating environmental regulations, there was insufficient supervision and hardly any enforcement action, by neither administrative nor criminal law authorities (Court of Audit, 1996, pp. 16–23). This limited application of criminal law, even for companies with multiple violations, is also reflected in the Court of Audit's more recent report, *Enforcement in the Dark* (2021b). In the cases involving Hoogovens/Tata Steel and DuPont/Chemours, we also see – as described above – that there had been signs of exceedances of the permit for illegal discharges of hazardous substances for a long time, but that, until recently, little or no action was taken against them.

In the scientific literature, these situations are largely attributed to the interconnectedness of environmental pollution and legal activity. Environmental crime is not so much the result of isolated illegal acts but takes place in the context of legal and licensed business activities. This means, first and foremost, that environmental non-compliance is often not called environmental *crime*. After all, these are often business activities that are, in principle, permitted and might exceed certain thresholds. This implies that it often takes a long time to understand the seriousness of the situation, especially when threshold values are adjusted based on new information about health risks. Therefore, the entirety of the environmental problem comes into focus too late.

In addition, this interconnectedness with legal activity means that the public interest in a healthy environment must also be weighed against other public interests, such as employment, the stability and continuity of the processing of hazardous substances and the competitive position of national economies. History teaches us that, especially when it comes to large industrial companies, these economic interests regularly take precedence over human and environmental health. When the Uniser, Booy Clean and TCR cases happened, the Dutch government struggled with a major (hazardous) waste problem and was heavily dependent on these companies for the continuity of waste disposal (Houtsma and van der Schot, 1992; Knoop, 1991). As a result, the government also had (economic) interests in maintaining the – de facto illegal – situation. The reports of the Dutch Safety Board about the fire at Chemie-Pack in Moerdijk (OvV, 2012a), the safety situation around Odfjell in the port of Rotterdam (OvV, 2012b) and gas extraction in Groningen (OvV, 2015) also showed that years of safety concerns did not result in regulatory enforcement, because other interests prevailed. This is most evident in the history surrounding Hoogovens/Tata Steel. Koninklijke Hoogovens was founded in the aftermath of World War I. Driven by the conviction that the Netherlands needed a strong industry to recover and by the quest for a destination for coal, a coal-fired steel mill seemed ideal. However, according to some, Hoogovens has never been a profitable company (Schoorl and Kreling, 2021): after World War II, the company received financial aid from the Marshall Plan; after a failed merger in the 1970s, it received massive state funding to stay afloat; and a few years ago Indian owner Tata Steel put the plant up for sale because making a 100-year-old coal-fired steel mill more sustainable would be too expensive. Despite the long-standing public concern about a safe living environment, the steel market was deemed too important for the Dutch economy; Hoogovens – later Corus and now Hoogovens/Tata Steel – was deemed too important an employer; and locally produced steel was deemed to make the Netherlands less dependent on other countries (Van Wingerde, 2022).

For DuPont/Chemours, economic interests prevailed internally over judicial and health interests, as evident from a 1984 (Schmid, 1984) meeting at the DuPont headquarters, which is also at the heart of the civil lawsuit in the Netherlands. During this meeting, the company discussed the future of PFOA, which, from a legal and medical point of view, would be its 'total elimination', but, from a business perspective, was about reducing it as much as possible 'in a way that does not hurt economically' (p. 2). However, economic and environmental interests are not only weighed by the company but also by the Dutch government. In the 1980s, it granted subsidies to DuPont to make additional investments in the Dordrecht plant more attractive (Dalmijn, 1981). As a result, non-economic public interests were insufficiently safeguarded. The Dutch Safety Board concluded (OvV, 2023) that the VTH system does not take sufficient account of public health concerns. The Dutch environmental authorities have stressed that this framework currently impedes them from tightening permits (Environmental Service Nijmegen Region, Environmental Service North Sea Canal Area and DCMR Environmental Service Rijnmond, 2023). In short, the strong interconnectedness with economic and political interests means that it is not always possible to take effective action against environmental crime. Indeed, as Caelesta Braun (2022, p. 4, translated from Dutch) argued: 'The (inter)national public administration seems to be blind and deaf to a broad spectrum of social interests and at the same time irresponsibly open to a narrow part of them.'

Conclusion

This article has speeded through the history of environmental law enforcement in the Netherlands, a history characterised by continuous concerns about its effectiveness due to fragmented supervision, poor coordination and cooperation, an inadequate information position and the interconnectedness of pollution and legal business activities. This rather gloomy picture allows us to draw a couple of conclusions about future approaches to environmental crime and harm by large industrial facilities. Although this contribution focused mainly on the developments of environmental law enforcement in the Netherlands, industrial activity takes place on an international playing field, and many of the industrial polluters work within several countries. Regulatory authorities can learn from other countries' experiences in regulating – or failing to regulate – these companies. Although these conclusions are drawn from Dutch evaluations of historical environmental law enforcement practice and are illustrated using longstanding Dutch cases of industrial pollution, they are more broadly relevant to how Europe deals with industrial pollution.

Firstly, looking at the past 40 years of reports and analyses on the state of environmental law enforcement, a key challenge is how to give environmental harm and victimisation a more independent stake in the enforcement of environmental legislation. In 2008, the EU adopted Directive 2008/99/EC: the ECD. Although this directive was considered to be a progressive step in promoting the role of criminal law in the enforcement of environmental legislation, it lacked regard to the rights of victims (Cardwell et al., 2011). An evaluation in 2020 concluded that due to inconsistencies in the material definitions of environmental crimes, the absence of legal violations prohibited the prosecution of 'substantive ecological damage'([77]). Thus, the aforementioned problems of interconnectedness of legitimate activities and environmental pollution and an inherent lack of regard to victims and harms prevented opportunities for criminal prosecutions. This is particularly important when economic and political interests coincide in causing harm. In many cases, governments were not only aware of what was going on but also facilitated these activities for a long time out of concern for their economy and innovation potential by applying more lenient standards for emissions or safety margins or by failing to act altogether. In the literature on state corporate crime, it

([77]) https://commission.europa.eu/news/evaluation-environmental-crime-directive-2020-11-05_en.

has been pointed out for a long time that it is precisely where economic and political interests align that it is much more complicated to characterise the behaviour of companies as crime (Michalowksi and Kramer, 2007). Focusing on environmental harm and victimisation can break that pattern. This would also allow us to consider other harms faced by non-human victims. Since pollution affects the health of other living organisms, maybe nature could be given a more prominent legal position in environmental policy enforcement. In 2023, the European Council and European Parliament agreed to replace the ECD, creating the foundation for an autonomous environmental offence. This would imply that the 'permit defence' no longer stands in court in cases like that of DuPont/Chemours, where a company was aware of the harmful impact of their legally permitted pollution. Moreover, the new directive also emphasises the importance of preventing that the tightening of environmental regulation and enforcement for industrial facilities in Europe leads to displacement effects to other regions. It is therefore important to align the regulations internationally as much as possible, as well as to regulate the entire supply chain to avoid a waterbed effect. A sole focus on improving national environmental law enforcement risks exporting the environmental and health harm to other regions while preventing environmental harm in our own backyard.

Secondly, these issues show the importance of including societal actors in the decision-making processes in environmental governance. For example, the PFAS issue is regulated mainly at the European and international levels by REACH – a European regulation on the registration, evaluation, authorisation and restriction of chemicals – and, in the case of specific PFAS such as PFOA and perfluorooctanesulfonic acid, by the Stockholm Convention ([78]) ([79]).Together with Denmark, Germany, Sweden and Norway, the Netherlands submitted a universal restriction proposal for all PFAS compounds to the European Chemicals Agency ([80]). During the public consultation phase, no fewer than 4 400 organisations, companies and individuals commented on the proposal. One of the OECD guiding principles of regulatory enforcement and inspections is the theory of responsive regulation, introduced by Ayres and Braithwaite (1992). In *Responsive Regulation,* Ayres and Braithwaite proposed the idea of 'tripartism'. In regulating corporations and industries, governments should be responsive not only to business behaviour but also to the needs and views of societal actors, including citizens and interest groups. While the public consultation phase, in theory, provides a table for these three parties to meet, 68.5 % of comments are made by either companies or other industry representatives. Furthermore, only those comments that are not indicated as 'confidential' are published and accessible by the public ([81]). Tripartism would require an equal seat at the table and equal access to information. However, the consultation on the PFAS ban shows that the interaction between these three parties is hard to balance. At the time of writing, the European Chemicals Agency's scientific committees are considering these submitted comments to advise the European Commission ([82]). It is, therefore, still uncertain whether the European Commission will implement the restriction proposal and how environmental, health and economic interests will be weighed. Of course, any constructive dialogue between government, businesses and civil society in the cases of Hoogovens/Tata Steel and Chemours is at present stymied by a legal dispute that is likely to continue for years. Nonetheless, including civil society in the environmental governance of industrial activities early on can prevent environmental harm in the future. Initiatives to develop new ammonia terminals near residential areas could provide an interesting test case. As ammonia is necessary for the energy transition, many companies across Europe plan to increase their facilities to store ammonia. However, exposure to ammonia

([78]) https://echa.europa.eu/regulations/reach/understanding-reach.
([79]) https://echa.europa.eu/hot-topics/perfluoroalkyl-chemicals-pfas.
([80]) www.rivm.nl/en/news/proposed-european-pfas-ban-officially-submitted.
([81]) https://echa.europa.eu/-/echa-receives-5-600-comments-on-pfas-restriction-proposal.
([82]) https://echa.europa.eu/-/echa-receives-5-600-comments-on-pfas-restriction-proposal.

can cause severe health problems. Including civil society early on in the decision-making about these terminals could prevent environmental and health harm in the future.

Lastly, these case studies show the importance of reflexivity in the relationship between governments and companies. Responsive regulation inherently focuses on the short and medium term, not on the long term (Braithwaite, 2020, 2022; Van Wingerde, 2022). It thereby forgets to consider the political, economic and historical context and long-term trends of harmful behaviour. This is even more important when it comes to environmental harm, where there is a temporal gap between behaviour and consequences. As responsive regulation looks at recent behaviour by a company, it does not take into account the historical trends in the regulation of the company. In the case of enforcement of environmental law in the Netherlands, Kluin (2014) concluded that inspection agencies did not sufficiently look at their own records on company behaviour to incorporate past violations and recidivism into their sanctioning. For example, the case of Hoogovens/Tata Steel shows a long history of a lenient stance by the government in response to environmental violations. In this case, it leads to the question of what the regulatory responses to violations would have looked like if they had included past behaviour in the decision-making process. The historical analysis in this article shows the importance of such reflexivity. It invites other scholars and practitioners to include historical perspectives in their understanding of, and thereby effective response to, cases of industrial pollution.

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Part II
Essays of practice

Legal measures to combat and prevent forest fires in the EU and Ukraine

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Abstract

Forest fires are a widespread and dangerous natural phenomenon in EU Member States and Ukraine. Fires often occur due to people violating the rules of safe behaviour in the forest, and these fires are identified as environmental crimes. These environmental crimes often have severe consequences over large areas. The search for effective technical means of detecting and stopping forest fires, fire prevention methods, and creating effective rules and laws to combat forest fires are important issues for Member States and Ukraine. In this article, the author provides statistical data on the number of recorded fires, reviews the legal mechanism for combating forest fires in Member States and Ukraine, and reviews the means of forest fire monitoring and prevention. The author also provides statistical data on the number of administrative and criminal offences recorded in Ukraine and compares the severity of punishment for arson and forest fires with the criminal laws of Member States. The article presents conclusions based on the results of an analysis of the shortcomings of the national legal system for combating violations of forest fire safety rules and forest fire prevention, as well as recommendations for positive changes in the environmental laws of Ukraine and for solving problems related to forest fire prevention.

Keywords: criminal code, environmental legislation, fine, forest protection, forest fires, offence, wildfires.

Introduction

Wildfires and forest fires can have a significant impact on people's mortality and morbidity. Smoke and wildfire ash can significantly affect those with pre-existing respiratory diseases or heart disease. Firefighters and emergency response workers are also significantly impacted by injuries, burns and smoke inhalation. Wildfires release significant amounts of mercury into the air, leading to impaired speech, hearing and walking, muscle weakness and vision problems among people of all ages.

The European Forest Fire Information System (EFFIS) ([83]) observed fires in 45 countries in 2022. These countries suffered 16 941 fires that burned 1 624 381 hectares (ha), about the size of Montenegro (due to methodological differences, the Ukraine totals are excluded). Records show a 4 % increase in burned area and a 48 % increase in the number of fires between 2021 and 2022. Excluding Ukraine, Spain was the most affected by wildfires, with 315 705 ha burned. Romania (162 518 ha), Portugal (112 063 ha), Bosnia and Herzegovina (76 473 ha) and France (74 654 ha) were also among the countries that were most affected ([84]).

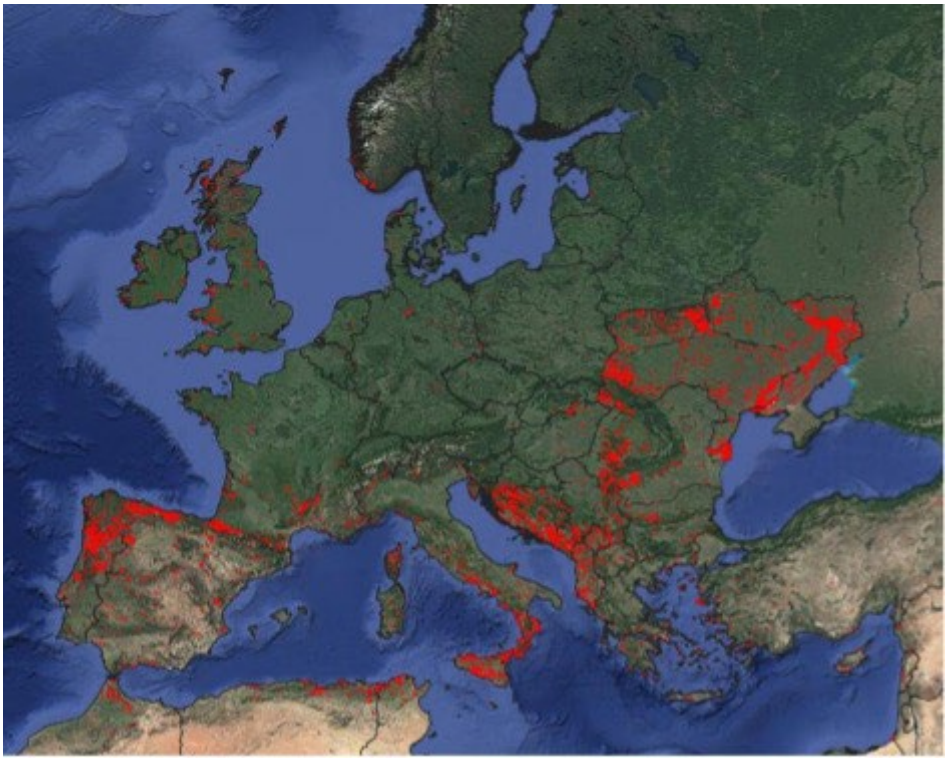


Figure 7.1. Natura 2000 protected sites were hit particularly hard.

Since the beginning of the Russian war of aggression against Ukraine, a significant increase in the number of fires has been recorded. Not the most extensive and evident among them is the spread of landscape fires caused by ammunition explosions in relatively dry weather. According to Serhii Zibtsev, Director of the Regional Eastern Europe Fire Monitoring Center, by autumn 2022 fires covered about 2.4 million ha, of which 330 000 ha were forested. In particular, thousands of hectares of forest burned in the national parks in the east of Ukraine: Kremin Forests and Holy Mountains, Biloberezhya Svyatoslav and Chornobyl Biosphere Reserve (Zhuravel, 2022).

For Member States and Ukraine, the main negative impacts of fires are the death of a vast number of individuals of various species of fauna and flora; atmospheric air pollution with sulfur compounds, nitrogen and unburned hydrocarbons; heavy metals accumulating in biomass; and emissions of large volumes of carbon dioxide (CO_2).

The data show that forest fires are a severe problem for Member States and Ukraine. According to the World Health Organization, forest fires are often caused by human activity or natural phenomena such as lightning, and they can happen anytime, anywhere. In 50 % of recorded forest fires, it is not known how they started (WHO, 2019).

([83]) https://forest-fire.emergency.copernicus.eu.
([84]) https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/eu-2022-wildfire-season-was-second-worst-record-2023-05-02_en.

According to the Confederation of Fire Protection Associations Europe, fires are often intentionally lit in places where people typically spend time: in homes, gardens, parks and on streets. Wildfires are often lit near populated areas or roads (CFPA Europe, 2022, p. 11).

Very often, careless handling of fire leads to significant losses. A clear example of the careless handling of fire occurred in south-west France in the summer of 2022. The Bordeaux public prosecutor said a man was taken into police custody in connection with a probe into a fire in the Landiras area, where 12 800 hectares were burned (Vidalon, 2022).

Reports about arson are often found in the press. For example, the Associated Press reported in March 2023 that there were 100 wildfires in northern Spain and that officials said arson was behind most of them (Associated Press, 2023).

According to information from the Ukrainian Nature Conservation Group, in the first four months of 2022, 43 % of fires (30 205 fires in total) occurred in other regions of Ukraine. According to several local cases of Russian missiles hitting oil depots, all these fires occurred in the area under the control of the Ukrainian authorities. In addition, during the war, Ukraine had the highest number of dry vegetation fires in Europe. Many natural territories were damaged, including areas covered by the Nature Reserve Fund (Tatana, 2022).

In the spring of 2022, 86 fires were extinguished in the forests of Ukraine, covering an area of 438 ha, which is 11 times higher than the number of fires and an area 7 times larger than recorded in the same period of 2021. The Head of the State Agency of Forest Resources of Ukraine, Yurii Bolokhovets, noted that among the reasons for this was people burning dry matter in fields and on their property, as well russian army shelling and sabotage ([85]).

Legal background (national and European regulations)

Forest protection in the Member States is regulated by internal administrative, land and forest legislation, taking into account the fact that the legal acts of the EU establish common standards in the field of environmental protection, which directly relate to the processes of forest use and protection. The EU has developed a unified environmental policy, which is the basis for harmonised pan-European legislation on protecting the natural environment and the rational use of natural resources. The range of EU legal acts regulating forest protection includes the forest Strategy[86] and accompanying multiannual implementation plan[87], the bioeconomy strategy[88] and the strategy on adaptation to climate change[89].

Most of the environmental legislation of the EU is in the form of directives addressed to the governments of the Member States. According to Article 249 of the EU Treaty, a directive 'shall be binding on each Member State to which it is addressed, regarding the result to be achieved, but leaves to the national authorities the choice of the form and implementation methods. The Member State is obliged to transpose the directive into national legislation. Some EU environmental legislation takes the form of a regulation, which, according to Article 249 of the

([85]) Ukrainian Forest. [State Forest Resources Agency of Ukraine]. Facebook, 29 march 2022, https://www.facebook.com/forestUKR/posts/305587291680646.
([86]) Forest strategy–European Commission https://environment.ec.europa.eu/strategy/forest-strategy_en.
([87]) Multi-annual Implementation Plan of the new EU Forest Strategy https://ec.europa.eu/transparency/regdoc/rep/10102/2015/EN/10102-2015-164-EN-F1-1.PDF.
([88]) Bioeconomy for Europe 2012 A sustainable bioeconomy for Europe–Publications Office of the EU.
([89]) EUR-Lex–52021DC0082–EN–EUR-Lex https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN.

treaty, is legally binding and applicable to all Member States. Obligations may be imposed directly on any natural or legal person subject to the jurisdiction of a Member State. Lastly, some EU environmental standards, such as recommendations, reference notes and technical instructions, are set out in non-binding forms. Depending on the context and purpose, such documents are issued jointly by the European Commission, the Council and the European Parliament or by EU agencies ([90]).

The author conducted an analysis of data on the types of punishment for arson set out in the environmental legislation of the EU. The results of the analysis show that committing arson is defined as a crime regulated mainly by criminal law. An analysis of the criminal legislation of the Member States shows that, among the 27 Member States, responsibility for arson or forest fires is established in only 13 countries: Bulgaria (Art. 330, Criminal Code of Bulgaria), Estonia (Sect. 352, Penal Code of Estonia), Cyprus (Art. 316, Criminal Code of Republic of Cyprus), Germany (Sect. 306, 306f, Criminal Code of Germany), Greece (Art. 265, Penal Code of Greece), Spain (Art. 351, Criminal Code of Spain), France (Art. 322-5–322-9, Criminal Code of France), Latvia (Sect. 107, Criminal Code of Latvia), Luxembourg (Art. 519, Penal Code of Luxembourg), Netherlands (Art. 157, Penal Code of Netherlands), Austria (Sect. 306, Criminal Code of Austria), Portugal (Art. 274, Criminal Code of Portugal), Finland (Sect. 22, Criminal Code of Finland).

The criminal laws of these countries provide severe punishments for committing arson or starting forest fires, often imprisonment for a term of between 1 and 10 years or a fine. In France, offenders are fined up to EUR 200 000.

In Ukraine, forest protection, following the example of the Member States, is governed by internal forest land, administrative and criminal laws. Forest protection laws are one area undergoing law reform and adaptation, to bring national laws in line with legislation of the EU. However, despite ongoing reforms, the national legislation of Ukraine has yet to meet the criteria for states that intend to join the EU. Since the signing of the association agreement between Ukraine and the EU in 2014, the harmonisation of national environmental laws with European standards has been very slow. According to a report of the Legislation Institute of the Verkhovna Rada of Ukraine (2021), the slow pace of harmonisation is due to national environmental problems that pose a high risk to natural ecosystems and the health of the population, finding a solution to which is a priority.

In Ukraine, offences that cause a forest fire are regulated by administrative and criminal laws. According to Article 77 of the Code of Ukraine on Administrative Offences, citizens can be fined from UAH 1 530 to 4 590 (EUR 39–115) and officials can be fined from UAH 4 590 to 15 300(EUR 115–382) for violating fire safety requirements in forests. The fine for destruction of or damage to a forest due to careless handling of fire, as well as for the violation of fire safety requirements in forests that lead to the occurrence of a forest fire or its spread over a large area, is from UAH 4 590 to 15 300 (EUR 115–382) for citizens and UAH 10 710 – 30 600 (EU 267–765) for officials. Criminal responsibility is also provided for the destruction of or damage by fire or other generally dangerous means to forests and green areas around settlements and along railways, as well as stubble, dry wild grasses, vegetation or its remains on agricultural lands (Article 245 of the Criminal Code of Ukraine). The committing of such an offence is punishable by a fine of UAH 91 800 to 153 000 (EUR 2 295–3 825) or imprisonment for a term of 2–5 years. If the offence results in the death of people, the mass death of animals or other serious consequences, it is punishable by imprisonment

([90]) Treaty establishing the European Community (Nice consolidated version) (OJ C 325, 24.12.2002, p. 132), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex-%3A12002E249.

for a term of 5–10 years. Under public pressure, in 2020 the Verkhovna Rada of Ukraine adopted Law 556-IX, which increased responsibility for forest fires by 10–15 times. Following Russia's unprovoked invasion of Ukraine, Decision No 0015525-22 of the National Security and Defence Council of Ukraine was enacted by Decree No 675/2022 of the President of Ukraine, dated 29 September 2022, and instructed the Cabinet of Ministers of Ukraine to develop draft laws regarding:

— the strengthening of administrative responsibility for failure to comply with legal orders or prescriptions of officials of bodies that exercise state control in the field of environmental protection;

— the revision of the size of the areas for forest planting and sanitary felling of the forest in the context of the application of environmental impact assessments ([91]).

This decision was enacted based on an analysis of threats to the national security of Ukraine in the sphere of the protection, use and reproduction of the forests of Ukraine due to the inadequacies of the regulatory and legal framework, and insufficient financial and logistical support for the functioning of the forest industry during the Russian war of aggression against Ukraine.

Data – experiences in investigations concerning this subtopic

Currently, the search for effective ways to investigate offences that cause forest fires and prevent them from being committed is essential for the EU and Ukraine. Countering forest fires is particularly important for Ukraine because of declining forest stock.

According to Article 89 of the Forest Code of Ukraine, the protection of forests in the territory of Ukraine is carried out by the state forest protection State Forest Guard of Ukraine and protection of other forest users. The State Forest Service has the status of a law enforcement body. However, it is not an independent state body or division, but only a list of forestry officials who are part of the staff of forestry enterprises, associations, forest seed inspections, regional forestry and hunting departments, and the State Forest Resources Agency of Ukraine.

Employees of the State Forest Guard of Ukraine protect forests from fires, illegal felling and pests and diseases, within the limits of current legislation. State forest protection workers' main tasks and powers are defined by Articles 90–92 of the Forest Code of Ukraine and the Regulation on State Forest Protection, approved by Resolution No 976 of the Cabinet of Ministers of Ukraine of 16 September 2009.

According to official data of the Head of the State Forest Resources Agency of Ukraine, 569 fires were extinguished in forests in 2021 (State Forest Resources Agency of Ukraine, n.d.). The cause of forest fires, in the majority of cases, was careless handling of fire by the population. In addition, in 2021 a total of 233 administrative protocols were drawn up for fire safety violators for a total of UAH 369 000 (around EUR 9 266) ([92]).

([91]) Decision of the Council of National Security and Defence of Ukraine of 22 September 2022 'On the protection, protection, use and reproduction of forests of Ukraine in a special period' (https://zakon.rada.gov.ua/laws/show/n0015525-22?lang=en#Text).

([92]) See the official website, Minfin (https://index.minfin.com.ua/ua/exchange/archive/ua/2023-05-15/).

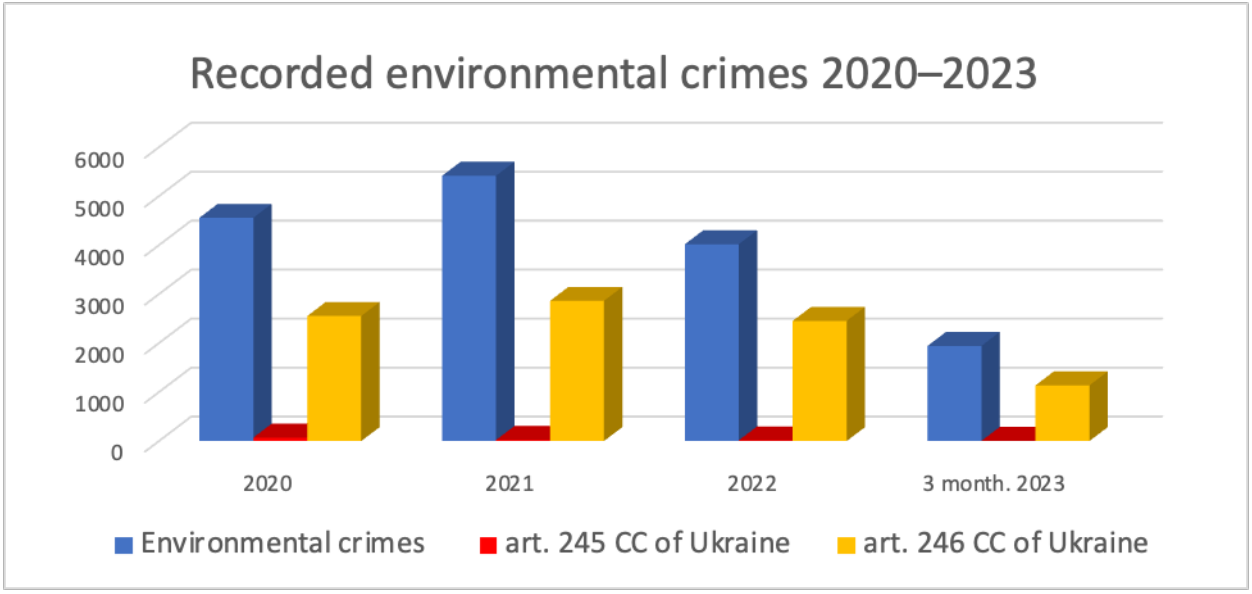
According to the Office of the General Prosecutor, in 2020, of the total number of environmental crimes recorded, more than 50 % involved the illegal felling or illegal transport, storage or sale of forest, under Article 246 of the Criminal Code of Ukraine (Office of the General Prosecutor, n.d.). The share of criminal offences related to the destruction of vegetation, including by setting fire to forest, did not exceed 1.6 % (Table 7.1).

Official reports indicate that, in 2021, 569 forest fires were recorded; officials of State Forest Protection of Ukraine drew up 233 administrative offence protocols for violations of fire safety requirements in forests (Article 77 of the Code of Ukraine on Administrative Offences); and 22 criminal offences were registered under Article 245 the Criminal Code of Ukraine. The data show that, for the vast majority of forest fires recorded, LEAs did not take legal response measures. Environmental crimes, such as illegal logging and forest fires, are widespread in Ukraine. The official environmental crime statistics for 2020–2023 show that more than 50 % of violations recorded were for illegal felling or the illegal transport, storage or sale of forest (Article 246 of the Criminal Code of Ukraine) (Table 7.1).

Table 7.1. Numbers of environmental crimes recorded in 2020–2023 (official data from the Office of the General Prosecutor).

Year	Environmental crimes	Crimes under Art. 245 of the Criminal Code (destruction or damage to vegetation, including wildfires)	Crimes under Art. 246 of the Criminal Code (illegal felling or illegal transport, storage or sale of forest)
2020	4 558	71 (1.6 %)	2 553 (56.0 %)
2021	5 416	22 (0.4 %)	2 862 (52.8 %)
2022	4 018	15 (0.4 %)	2 454 (61.1 %)
Three months of 2023	1 943	4 (0.2 %)	1 136 (58.5 %)

However, the number of offences recorded that led to forest fires is very low. Next, we will try to understand the reasons behind this by analysing the working methods of LEAs and existing obstacles.



Officials of State Forest Protection of Ukraine record fire safety violations in forests by conducting surprise inspections of forestry enterprises and other organisations and patrolling the service areas. In some cases, inspectors from State Forest Protection of Ukraine conduct inspections with the involvement of the National Police of Ukraine. According to official data from the Head of the State Agency of Forest Resources of Ukraine, in 2021, 26 600 checks were carried out regarding compliance with fire safety rules in forests, as a result of which a total of only 233 administrative offence protocols were drawn up (Office of the General Prosecutor, n.d.).

In the opinion of the author of the article, the low number of forest fires recorded (233) compared with the number of investigations (26 600) can be explained by several factors. Firstly, Ukraine's state forest protection authorities do not have the power to carry out operational investigative activities and conduct inquiries and pretrial investigations into environmental crime. Secondly, officials of State Forest Protection of Ukraine act as part of enterprises, institutions and organisations belonging to the sphere of management. Moreover, an official who is not a representative of the authority and acts on behalf of the state, being on the staff of economic enterprises of the State Forest Resources Agency of Ukraine, cannot be independent of this enterprise when performing their law enforcement functions. Thirdly, conducting a criminal investigation into forest arson is highly complex due to the difficulty in establishing the location and identity of the offender and collecting evidence at the scene of the crime. Fourthly, the officials of State Forest Protection of Ukraine lack sufficient experience in investigating criminal offences.

The prevention of forest fires is made difficult by inadequacies in criminal law. For example, forest fires that have resulted in the death of people or significant material damage are often classified as a violation of fire or artificial safety requirements established by law (Article 270 of the Criminal Code of Ukraine). Following a forest fire near the city of Sievierodonetsk in August 2020, in which people died and 90 ha of forest was destroyed, the investigative body of the national police initiated an investigation under part 2 of Article 270 the Criminal Code of Ukraine (LB. ua, 2020). In the opinion of the author, the practice of attributing forest fires to the category of criminal offences against public safety is wrong and therefore a change to criminal law is required.

The analysis of national methods for combating forest fires and for forest fire prevention, conducted by the author, shows that Ukraine uses traditional methods that involve outdated approaches to preventing and containing the spread of forest fires. Such methods include the patrolling of service areas; the technical arrangement of firebreaks, barriers and mineralised strips in forests; the placement of information boards with warnings in recreational areas; the organisation and conducting of comprehensive exercises on extinguishing forest fires; and the carrying out of inspections of forestry enterprises.

According to a European Commission report on forest fires in Europe in 2021, forest fires in Ukraine were mostly extinguished at the initial stage by the forces of the State Forest Guard of Ukraine (71 %), while the State Emergency Service of Ukraine was involved in 29 % of cases, which increased the cost of extinguishing them. Around 4 000 articles and adverts alerting the public to the danger of forest fires were distributed across the press, radio and TV, and social networks. In 2021, around 48 km of firebreaks and 53 000 km of fuel breaks was created, and 276 000 km of fuel breaks and firebreaks were restored (European Commission, 2022, p. 11).

Following the example of the EU, the state forest protection authorities of Ukraine and the State Forestry Agency of Ukraine are focused on implementing preventive measures. Ukraine also has the opportunity to use EU tools to monitor and prevent forest fires: EFFIS, the EU Civil Protection Mechanism and the forest information system of Europe. Recent advances in society have also had an impact on the development of the national forest fire prevention system. For example, the spread of digital technologies and internet use led to the introduction in 2021 by the State Forestry Resources Agency of the automated system 'Fires', which is used to collect and analyse data on forest fires (State Forest Resources Agency of Ukraine, 2023). Work on deciphering data from space surveys of the territory of Ukraine to determine the exact areas of forests and forest certification according to the international scheme of the Forest Stewardship Council is also ongoing. In the future, this will improve the ability to monitor and prevent forest fires.

Conclusions

Forest fires have been an urgent problem for the EU and Ukraine over the past few years and have caused significant damage to society and the natural environment. In almost half of cases, forest fires occur due to violations of fire safety rules.

Currently, the criminal laws of most EU Member States contain provisions for strict liability for forest fires. Despite the difficult situation with forest fires and the government's initiatives to strengthen administrative and criminal liability for forest fires, the Criminal Code of Ukraine still does not contain a specific rule prohibiting forest fires. The State Forest Guard of Ukraine, an LEA, needs to be reformed and given the authority to investigate environmental crime. These facts are evidence of authorities' insufficient regard for the problem of forest fires.

Following the example of Member States, forest fire prevention in Ukraine is focused on implementing preventive measures. Ukraine also has the opportunity to use EU tools for forest fire monitoring and prevention: EFFIS, the forest information system of Europe and the EU Civil Protection Mechanism.

Proposal for change

This article demonstrates severe shortcomings in the legal regulation of procedures for conducting forest arson investigations and preventing forest fires. The current state of affairs requires urgent intervention and the solving of urgent problems. The author has a few recommendations that may help to solve the current problems.

It is recommended that Ukraine's state forest protection guard be reorganised and given the authority to conduct investigative activities, inquiries and pretrial investigations into environmental crime.

It is proposed that a separate rule be added to Chapter VIII of the Criminal Code of Ukraine, 'Criminal violations against the environment', establishing responsibility for forest arson and forest fires due to carelessness.

The author also advises that measures are implemented to inform the public about the significant negative impact of forest fires on human health and the environment, and that valuable tips on fire safety in the forest are developed and shared.

The author proposes that representatives of local communities and nature protection organisations are involved in implementing forest fire prevention measures, and in collecting information about the causes of forest fires during pretrial investigations. For example, it would be appropriate to inform the public about the significant harm to health and the environment from burning dry grass and leaves in the spring.

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Europe Latin America programme of assistance against transnational organised crime (EL PAcCTO): The Jaguar Network

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Abstract

This work was carried out following an environmental crime workshop held by the European Union Agency for Law Enforcement Training (CEPOL).

As we know, environmental crime has no boundaries and speaks all languages, so international support and cooperation are key to undermining and tackling criminality related to the environment and nature.

Many international cooperation programmes exist: bilateral agreements, usually between neighbouring countries with similar issues, such as Portugal and Spain; training and capacity-building institutions like CEPOL; and coordinating and supporting organisations like Europol. The work presented here focuses on programmes that aim to promote cooperation between countries and organisations that share the same interests, like the Europe Latin America programme of assistance against transnational organised crime (EL PacCTO), which has supported the development of a dedicated programme on environmental crime called the Jaguar Network.

In this article, we will try to answer the following question: 'What new operational results does Jaguar Network bring to tackling transnational environmental crime?'

We first present a brief introduction to international institutions, focusing on cooperation bodies. Then, to try to identify and present an example of operational data on the Jaguar Network, we follow an on-the-ground operation

that took place in Portugal and in other countries in Europe through Europol's EMPACT coordinated effort (Europol, n.d.).

Keywords: Jaguar Network; EL PacCTO; Environmental Crime

Introduction

In our interconnected world, the persistence and complexities of international environmental crime pose significant challenges for our planet's well-being and the rule of law. The degradation of natural resources, illicit wildlife trade, illegal logging and toxic waste dumping are not merely local issues; they are part of a global web of criminal activities that transcends borders and threatens ecosystems worldwide.

Addressing these crimes demands a coordinated, multilateral effort that combines legal frameworks, enforcement strategies and international cooperation. This article explores the nature and impact of and responses to international environmental crime, shedding light on the urgent need for collective action to safeguard our environment for future generations.

International police cooperation plays a critical role in addressing the complex and far-reaching challenges posed by environmental crime on a global scale.

Environmental crime encompasses a wide range of illicit activities, including illegal logging, wildlife trafficking, illegal fishing, pollution and the illegal trade in hazardous waste. These crimes not only degrade natural resources but also contribute to biodiversity loss, threaten ecosystems and undermine sustainable development efforts.

In this article, we follow a case-study methodology to analyse the benefits of law enforcement cooperation and try to learn lessons and identify areas for enhancing public awareness of environmental crime policing.

The European framework

This topic is important on a European scale because of the fact that environmental crime knows no boundaries; for example, statistics show that Europe ([93]), through imports and exports, is a key player in this type of criminality, so enforcement of crime-tackling policies and increasing the collection and dissemination of data across world partners are key to tackling environmental crime efficiently.

European intelligence and cooperation systems are in place and are working to tackle environmental crime. However, as mentioned above, worldwide cooperation and partnerships are needed to ensure the availability of real-time information on this type of crime. Joint operations should be undertaken if the need arises, with training being provided to standardise procedures and paperwork, given the different legislation that is likely to apply across the countries and organisations involved in such operations. This is the main message of this work: cooperation is good, and interoperability is key. However, if legislation and criminal court proceedings differ between countries, is there any real advantage to allocating personnel, experts and funds to these institutions? This is the opening question for this work, and we will try to answer it in this article.

([93]) See the Global Environmental Crime Tracker (https://eia-international.org/global-environmental-crime-tracker).

Background: national action and connection to international partners

In this article, we will look at a Portuguese example of cooperation to tackle environmental crime and its links to other institutional and cooperation bodies, such as the Jaguar Network. For this, we will take an in-depth look at one of the most established environmental 'enforcement police' forces in Europe and its development to incorporate national and international knowledge on tackling environmental crime.

In Portugal, the Serviço de Proteção da Natureza e do Ambiente ([94]) (SEPNA) of the National Republican Guard (GNR) was created, initially by order of the Honourable Lieutenant General, General Commander, of 15 January 2001, with an interest in the theme of defence and preservation of nature and the environment for the conservation of natural resources and the balance of ecosystems – a phenomenon of our time so profound and widespread that it required greater intervention by and co-responsibility of the state, as is enshrined in Articles 9 and 66 of the Constitution of the Portuguese Republic (Government of Portugal, 1975).

The growing concern about these matters, the increasing effects of climate change and Portugal's lack of a body with a comprehensive capacity to advise the country led to the signing of a protocol between the Ministry of Internal Affairs and the Ministry of Environment and Spatial Planning, also in the presence of the Secretary of State for Forests, representing the Minister of Agriculture, at an official ceremony held on 21 May 2001. This formalised an institutional partnership of action that has been successively expanded and reinforced, thus giving strength and legitimacy to the creation of the first national police force involved in the protection of the environment and the prevention and supervision of passive and active conduct contrary to the legal standards in force in the area of the environment.

SEPNA of the GNR went on to participate in numerous national and international forums and working groups, at the levels of Interpol, Europol and the EU, as a national Point of Contact (POC), and in several world-class conferences. The force's reputation grew and attracted much interest, having even been recognised as one of the best environmental police forces in Europe, alongside Seprona, the nature protection service of Spain's Civil Guard, in view of its results.

At the first forum of ministers responsible for the internal administration of the Community of Portuguese Language Countries, and coinciding with the second meeting of the community's chiefs of police in Lisbon in 2008, the creation of the Commission for the Protection of Nature and the Environment, coordinated by the GNR through SEPNA, was unanimously approved.

It is also important to highlight the creation, in 2002, of the 'Environment SOS hotline' in Portugal, which at that time was the only environmental hotline in Europe. This permanent service, managed 24 hours a day, gave all citizens the opportunity to report suspected violations of environmental legislation. The government has the capacity to intervene and carry out environmental inspections and investigations anywhere in the country, following the breadth of the mission to protect nature, the environment and forests under Decree-Law No 22/2006 and Ordinance No 798/2006, which trigger the mechanisms necessary for a full inspection throughout the national territory.

([94]) The Environmental and Nature Protection Service.

— SEPNA of the GNR has crossed national borders, becoming a service that, in addition to supporting and intervening in areas related to various ministries, acts with national and international bodies, both governmental and non-governmental. Further proof of its importance can be found in two of the final recommendations of the eighth round of mutual evaluations on 'The practical implementation and operation of the European policies on preventing and combating environmental crime', under Section 10.2.2 'Recommendations to the European Union, its institutions and to other Member States':

— "Member States are also invited to consider establishing dedicated reporting points for environmental crime, in order to encourage citizens to inform the competent authorities of possible environmental offences." (Council of the European Union, 2019). Such as the Environment SOS hotline operated by the GNR;

— "Member States should consider designating a central body/entity or platform at national level in charge of coordinating the efforts of all the authorities involved in the fight against environmental crime, including waste-related crime, with a view to providing synergies, as well as maximising readiness and reaction capabilities." (Council of the European Union, 2019). As the example within the specialized police service SEPNA from the GNR in Portugal.

At the national level, SEPNA of the GNR, in addition to its responsibility as a national and international POC for environmental crime, coordinates all information and other bodies involved in environmental crime, thus ensuring national representation in multiple international forums, such as Europol, Interpol, CITES/EU enforcement, EnviCrimeNet, EL PacCTO and Jaguar Network.

EL PacCTO is an international cooperation programme funded by the EU that seeks to contribute to security and justice in Latin America by supporting the fight against transnational organised crime. EL PacCTO approaches the entire criminal chain from a holistic perspective through its work in three areas: police, justice and prisons ([95]).

Within EL PacCTO, there is a specialised network focused on only environmental crime, namely the Network of Police Specialised in Environmental Crimes in Latin America and the European Union (the Jaguar Network) supported as a coordinated Operational Action within the framework of European Multidisciplinary Platform Against Criminal Threats (EMPACT). The actions and development of activities of this network are specifically focused on the Latin American region, more precisely on the 18 countries that work with EL PacCTO (Argentina, Brazil, Bolivia, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela), as well as the 27 EU Member States ([96]).

Data – operational insight on Jaguar Network and Portugal/Europol

Regarding the scope of the present work, it is the author's aim to present an example of an operation carried out in cooperation between participants in Europe and Latin America under the umbrella of Europol's EMPACT operational actions.

Portugal participated in Operation Madeira de Lei during September 2022, carrying out investigative and inspection actions to combat the illegal trade of and crimes committed against wildlife, especially flora, and in particular with

([95]) https://www.elpaccto.eu/pt/sobre-o-el-paccto/o-que-e-o-el-paccto/.
([96]) https://elpaccto.eu/?page_id=24&lang=pt.

regard to the trafficking, exploitation, commercialisation and ownership of timber in violation of the legislation in force (Europol, 2022).

The national coordination of this operation, encouraged by Europol and EL PacCTO, fell to the GNR, in close collaboration with the Tax and Customs Authority, the Institute for the Conservation of Nature and Forests, the Public Security Police and the Maritime Police. It also counted on the special collaboration, with regard to certain inspection actions in the districts of Braga and Porto, of experts from the Federal Police of Brazil and the Brazilian Institute of Environment and Renewable Natural Resources, better known as IBAMA, in wood identification and forest information analysis. These entities developed the research and inspection actions mainly within the framework of CITES, also known as the Washington Convention, to which 184 countries have acceded and the objective of which is to ensure that the trade in animals and plants does not endanger their survival in the wild. The actions were also developed within the framework of the EU timber regulation, which aims to combat illegal logging and the associated trade in timber and timber products in the Member States, and ultimately contribute to the sustainable management of forests and reduce CO_2 emissions resulting from deforestation and/or forest degradation beyond the borders of the EU.

Within the scope of this operation, 234 inspection actions were carried out in Portugal by the entities mentioned above, namely:

- 118 actions related to operators of the trade and processing of timber and derivatives;
- 102 actions related to road transporters of timber and derivatives;
- 14 actions related to containers in seaports.

Twelve notices for violation of the legal provisions in force were prepared, namely;

- three for failing to present an import notification to the customs service in advance;
- three for lacking a licence for the detention/exhibition/marketing of exotic woods;
- two for failing to declare the non-inclusion of species in the CITES regulation;
- two for failing to register with, and register data in, the integrated system of electronic registration of waste (SIRER);
- one for failing to declare in advance the cutting, extraordinary cutting, thinning or uprooting of trees of forest species in the information system of cutting manifest (SiCorte);
- one for lacking proof of the constitution of financial guarantee of environmental responsibility of the initial destination.

At the international level, the operational actions involved, in addition to authorities in Portugal, the police authorities of Brazil, France, Italy, the Netherlands and Spain, as well as EL PacCTO. The actions targeted networks involved in environmental crimes, illegal logging, smuggling, tax evasion, money laundering and document fraud.

From a total of more than 350 enforcement actions that took place on the days of joint action in September 2022, irregularities were detected by investigators in 17 companies (1 in Italy, 1 in the Netherlands, 3 in Spain and 12 in Portugal). The competent authorities have launched criminal proceedings against one of these companies.

National authorities carried out the checks mainly at Brazilian ports for exports and at European ports for illegal imports. Criminal networks falsify documents to disguise the origin of wood or the actual species contained in the shipment to pass through customs controls and reach consumers. Corruption is also an enabler of this criminal activity.

This was the first time that the countries of origin and destination of the illegal timber trade joined forces in coordinated surveillance between the countries that trade in timber. Enforcement actions focused on different criminal activities used by criminal networks to facilitate the illegal timber trade, including document fraud and bribery to disguise the origin or true species of the goods.

Outcomes

In this article, taking into account time and space constraints, we tried to present an example of an operational activity focusing on environmental crime within the context of international cooperation, mainly cooperation between the countries of Latin America and Europe.

In response to the opening question, 'Is there any real advantage to allocating personnel, experts and funds to these institutions?', based on the example given, we think the answer is blunt and simple 'yes', but it is not easy to achieve and not as straightforward as one might think.

SEPNA was put forward as an example of an enforcement police force dedicated to the environment with years of practice; however, cooperation on the Madeira the Lei operation was possible only due to international mechanisms facilitated by Europol and EL PacCTO (the Jaguar Network). Furthermore, in this instance, the expertise and knowledge of Brazilian colleagues on illicit timber trafficking were key to the whole operation in Europe. However, the national legislation of Brazil is different from that of the other countries of Latin America and Europe, and the penalisation of this kind of criminality is possible only with great effort from all parties, since it is virtually impossible to detect, in this example timber trafficking, without the flagging of suspicious activities by the exporting country.

Working in isolation versus working in collaboration

The operation described above was the first of its kind on a national territory, so, at the time of writing this article, no operational comparison was possible. However, we can assure you that, in other cases regarding CITES, and not only in relation to timber, there is a real need for intelligence from the exporting country, and it is not always possible to gather this.

Working on environmental crime in isolation versus working with a network can have significant implications for the effectiveness and impact of law enforcement efforts. We will now explore the key differences through a comparative lens.

An isolated investigation limits the scope of operations to within one's own jurisdiction. This can be restrictive when dealing with crimes that have transnational aspects, such as wildlife trafficking or illegal logging, which spans across borders.

Working with and within a network enables the pooling of resources, sharing of expertise and access to technologies that may not be available to individual bodies. This enhances the capacity to conduct more robust and sophisticated operations against perpetrators of environmental crime.

Legal framework and jurisdiction

Collaboration with a network facilitates the harmonisation of legal frameworks, extradition agreements and mutual assistance treaties between countries. This streamlines legal processes and allows for the more effective pursuit and prosecution of criminals across borders. Working with a partner country also promotes information and intelligence sharing. This facilitates a more comprehensive analysis of criminal patterns and behaviours, enabling law enforcement agencies to make informed decisions and target high-value individuals or operations.

Tackling crime as an isolated country/organisation may not achieve the necessary deterrence effect on perpetrators of environmental crime, especially those who operate with impunity due to weak law enforcement in certain jurisdictions.

In summary, tackling environmental crime in isolation is often challenging and limited in scope, and partnering with another country/organisation/network offers numerous advantages. Collaboration enhances operational reach, optimises resource allocation, overcomes legal hurdles, promotes information sharing and strengthens deterrence. By leveraging the benefits of international cooperation, LEAs can combat environmental crime more effectively and protect natural resources on a global scale.

Conclusions

We can conclude that the importance of international police cooperation in combating environmental crime cannot be overstated for several key reasons.

- **Transnational nature of environmental crime.** Environmental crimes often involve perpetrators operating across multiple jurisdictions. Traffickers of wildlife products, for example, may exploit weak law enforcement in one country to smuggle goods into another. Effective police cooperation is essential for tracking and disrupting these networks that operate internationally.
- **Sharing intelligence and resources.** International cooperation enables LEAs to share intelligence, expertise and resources. By pooling information and coordinating efforts, police can better understand the modus operandi of criminal networks, identify key players and dismantle their operations more effectively.
- **Capacity building.** Many countries, especially in regions with high levels of biodiversity, may lack the resources, training or technology needed to combat environmental crime on their own effectively. Through cooperation, LEAs can assist each other in building capacity, developing specialised skills and implementing best practices in investigation and enforcement.

— **Legal frameworks and extradition.** Cooperation facilitates the harmonisation of legal frameworks and extradition processes among countries. This is crucial for prosecuting individuals involved in environmental crime who may seek refuge or operate in jurisdictions with weak law enforcement.

— **Global impact.** Environmental crime has global repercussions, such as the depletion of endangered species, deforestation and pollution that crosses borders. Collaborative efforts are necessary to prevent irreparable damage to the environment and to protect humankind's common heritage.

— **Enhancing deterrence and accountability.** By working together, LEAs can send a strong message of deterrence to potential offenders. Strengthening international cooperation enhances the likelihood of offenders being apprehended and prosecuted, thereby increasing the chances that those involved in environmental crime are held to account.

Efforts to promote international police cooperation in combating environmental crime are already under way through initiatives such as the one presented in this article and many others under the umbrella of Europol. These initiatives focus on building networks, facilitating information exchange, conducting joint operations and providing training to strengthen enforcement capacities globally.

In conclusion, effective international police cooperation is indispensable in the fight against environmental crime. By fostering collaboration, sharing resources and aligning strategies, LEAs can better protect our planet's natural resources and biodiversity for present and future generations. Urgent and concerted action at the international level is needed to confront this growing threat and ensure environmental sustainability and security worldwide.

Proposal for change

This kind of cooperation allows, as we have seen, the standardisation and application of procedures and intelligence to tackle international environmental crime. However, only some laws in partner countries are worthy of international attention, such as the example of CITES, even when taking a broader approach to tackling environmental crime in Europe.

It would be easier for LEAs, even with joint action investigation teams, to follow clear legislative guidelines to enable the streamlining of processes and also the tackling of transnational crime.

The best way forward is to develop protocols to enhance international cooperation and coordination among LEAs, utilise advanced technologies such as AI and RS to improve the detection and monitoring of environmental crimes, and continue to implement capacity-building programmes to empower law enforcement personnel and institutions in combating environmental crime.

By adopting a multifaceted approach that integrates international cooperation, advanced technologies and capacity-building efforts, and by working together across borders and leveraging innovative solutions, we can enhance police work and increase public awareness of environmental crime.

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A well-functioning organisation for detecting and investigating environmental crimes: what is needed and how to get there? Experiences from Sweden

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Environmental crime is a relatively new area for law enforcement authorities to handle in many European countries. The investigations are complicated and require new investigation methods, competences and a multidisciplinary approach that is different from what police organisations are used to.

Most police authorities are at the beginning of a long process of finding out the best ways to combat environmental crimes. Instead of repeating the mistakes made by other countries in this process, it is important to learn from each other. This is especially relevant in the area of environmental crime, since environmental legislation in different Member States has a lot in common, it being based on the Environmental Crime Directive (ECD), other common EU legislation, treaties and conventions signed by all Member States.

The development of a law enforcement organisation specialising in environmental crimes started in Sweden in 1999 when a new cohesive environmental act entered into force. Since then, the police and prosecutor's office have reorganised their resources for handling environmental crimes, the Environmental Act has been modified and new structures for multidisciplinary cooperation have been formed, etc. Some progress has definitively been made, but a lot remains to be done. This article describes the initiatives taken to tackle environmental crimes in Sweden more efficiently and the challenges that have yet to be solved.

Keywords: Environmental crime, Environmental act, investigating crime, Swedish investigations, crime detection, Environmental Crime Directive (EDC)

Introduction

Based on experiences from the Swedish legal system, this article will describe some of the challenges of detecting and investigating environmental crime. Since the Environmental Act came into force in 1999, several measures have been taken to improve how authorities deal with environmental crime. These measures and some remaining challenges are described in the article.

The need for change and measures to be taken is based on the situation in Sweden. However, my experiences of working with environmental crimes in different parts of the world indicate that environmental crimes are largely similar (but maybe on different levels) wherever they occur in the world. Therefore, the ways to detect and investigate them are similar, too. Sharing best practices and solutions to common problems, as is the ambition of this article, is an efficient tool to improve how we handle environmental crimes in different countries.

Environmental crimes in Sweden

A large-scale environmental crime (e.g. the BT Kemi case in 1976; see BRÅ (2022)) where the authorities failed to penalise the perpetrator (in spite of clear evidence) was the spark that ignited efforts to improve environmental legislation in Sweden (Mårland, 2002). The efforts led to a new comprehensive legislation, the Environmental Act, enforced in 1999.

More comprehensive legislation was followed by the Swedish government's demand for more efficient enforcement of environmental crimes (and indirectly by the EU). Hence, the police and prosecutor's office started to organise their authorities in a more efficient way to combat environmental crimes. Emphasis was placed on how to detect serious environmental crimes and investigate them more effectively.

There has been some substantial progress since 1999, as I will describe in this article. However, there are still a lot of things lacking and deficiencies in how we handle, detect and investigate environmental crimes in Sweden.

The most worrying problem with environmental crimes is that the large majority of them remain undetected. The motivated criminal who wants to dump waste, release more chemicals than permitted from their plant or use an illegal pesticide faces a small or non-existent risk of detection.

Many other forms of crime are detected and reported by the victim of the crime; others are possible to detect because they occur in places where authorities are present. The latter is usually not the case in places where most environmental crimes occur.

Detection of environmental crimes is often a true challenge – mostly because it is a 'victimless' crime. Richard Macrory, Professor of Environmental Law at University College London, sums it up as follows:

> The potential gap between the formal law and its enforcement is seen in many fields of law, but it raises particular challenges in the field of environmental protection. In areas of law such as competition, social security, or consumer protection, there are clearly defined victims with legal interests who can and will ensure

that the law is enforced. In contrast, the environment is often unowned in legal terms – with the consequence that the environment dies in silence, it has been said. The responsibility for its legal protection lies largely on public authorities – the police, local authorities or specialised regulatory agencies – often under competing policy priorities and severe resource constraints.

The second largest problem with environmental crimes is that if and when they are detected, the likelihood that the perpetrator will be brought to justice is slim. This situation is not limited to Sweden but is prevalent globally, too.

Legal background

The implementation of Sweden's new Environmental Act was an important improvement, as described above. The Swedish Environmental Act is now being revised for the second time. Clearer definitions of the use of administrative sanctions instead of legal sanctions, such as fines, and harsher sentences for crimes that are not dealt with by administrative sanctions are some of the goals of the revision of the Environmental Act.

Contrary to the ECD and environmental legislation in many other European countries, in the Swedish Environmental Act negligence is sufficient to constitute a crime in most paragraphs in the 29th chapter of the act containing the penal provisions. Intent or at least serious neglect is required in the ECD. The difference in the level of intent required by our national legislation and the ECD will be a challenge for Sweden when implementing the ECD.

Another fundamental difference is that Swedish environmental law criminalises unlawful acts, such as the release of environmentally hazardous substances. There is thus an early completion point. The ECD emphasises the **effects** of environmental crimes, that is, the damage that has occurred or that is expected to occur. The experiences of effect-based environmental legislation and how it can complicate law enforcement have led Sweden to argue for a more act-related structure of the ECD.

Experiences in investigations

In most countries, environmental crimes are a rather new phenomenon. There have certainly been acts by humanity that have had devastating effects on the environment since prehistoric times. However, laws to protect the environment are a recent phenomenon and, hence, environmental crimes, too.

Before 1999, there was no collective legislation protecting the environment in Sweden and, consequently, no specialist within the police or prosecutor's office. Cooperation between inspection authorities and the police was non-existent (Government of Sweden, 1997).

Since the implementation of the new and collective Environmental Act of 1999, the Swedish legal system has developed means and structures to handle environmental crimes effectively, at least more effectively than before 1999. This article is based on personal experiences of working in different positions within the police, including intelligence, investigations and strategic issues concerning environmental crimes since 1999 up to today. The descriptions of problems and possible solutions are based on the analyses that led to the organisational changes

and new methods that partly have been adopted since 1999, or are in a process to be adopted. To be able to investigate environmental crimes successfully, the following basic factors have to be in place.

— Motivated, well-trained staff with specialised expertise. This is not limited to the police. Probably the most important step in improving the handling of environmental crimes in Sweden was the creation of a specialised prosecutors' unit within the Office of the Prosecutor-General, REMA (the National Environmental Crime Unit). By letting environmental crimes be handled by a few specialists instead of them being spread out among general prosecutors, the competence in prosecuting increased significantly and the problems related to the priority given to environmental crimes in relation to other crimes were solved. Similar steps were taken by the police in 2015, such as creating regional specialised units for handling environmental crimes, work-related crimes and illegal hunting of protected species.

— Legislation that is well adapted and functional in order to protect the environment. The legislation has to enable legal actions against legal entities or individuals that violate environmental laws, combining natural science and law in a rational way.

— An organisation that enables specialised forensics to respond, take samples and collect evidence soon after an environmental crime is detected (as the evidence/pollutant will otherwise often be impossible to sample). The EU's ambitious project 'Protecting the European territory from organised environmental crime through intelligent threat detection tools' (Perivallon) seems promising when it comes to more effective detection of environmental crimes by using different technologies and AI.

— Cooperation between law enforcement authorities (i.e. police and prosecutors) and environmental authorities at the national level, and structured cross-border cooperation when investigating transnational crimes such as illegal export of waste.

— Inspection authorities that are the 'eyes and ears' of the police authority. They must have the competence, resources and authority to detect violations of the Environmental Act. They should work in such a way that they can discover more serious, deliberate environmental crimes in cooperation with law enforcement agencies.

Investigations into environmental crimes are both similar to and different from investigations into more traditional crimes, such as economic crimes, violent crimes and theft. It is mostly regulatory authorities that detect and report environmental crimes (while the public dominates in reporting other types of crimes).

There is often a clear need for assistance from specialists and external authorities (compared with most other crime areas, where the police authority has all the competence needed within its own authority). There are often no individual crime victims or plaintiffs in environmental crimes, as there are in violent crimes and cases of theft, fraud, etc. These factors have an impact on how environmental crimes are detected and investigated.

In other respects, environmental crimes are similar to other crimes and should be investigated in the same way. For example, when a uniformed, first-response unit comes to the scene of a suspected environmental crime (a stream full of dead fish, polluted by a nearby chemical plant, or a leaking oil cistern threatening the groundwater), it is important that it treats the scene as what it is, namely a crime scene. A crime scene should be sealed off, forensics

should be called in and witnesses should be interviewed (and, of course, resources to clear up the damage must be summoned).

Proposal for change

Effective and structured cooperation between police/prosecutors and supervisory authorities is considered to be a key factor when trying to improve the enforcement of environmental law. Different measures should be taken to enhance cooperation at different levels.

Regional and national liaison teams should be formed, consisting of representatives from different branches of the inspection service, the police, and other relevant authorities (customs, coastguard, etc., depending on the topic). Experts from inspection authorities can assist the police throughout the whole investigation process.

The use of criminal intelligence in combating environmental crimes on a large scale really can be a game changer. When applied to environmental crimes, intelligence can be very effective in detecting more serious offences at an early stage. For instance, illegal transboundary shipments of waste have successfully been targeted by using intelligence to locate which shipments to stop and search. A large majority of those targeted as a result of intelligence were found to be illegal, according to statistics from the Environment Agency of England and Wales (www.environment-agency.gov.uk). A more random approach would, of course, have been much less effective. Competitors, the public, compliance and monitoring authorities, branch organisations and bailiffs, etc., are valuable sources of information. Again, the fact that environmental crimes are relatively new and complicated and, so far, are not given high priority, hinders the effective use of intelligence to combat them. A clear directive instructing national and regional intelligence units to put effort into tackling environmental crimes is called for.

An increasing challenge for environmental crime units in many European countries is that environmental crimes are increasingly transnational and involve convergence crimes (ELI, 2022) and/or can be defined as organised crimes. This requires a multidisciplinary approach and structured sharing of information between law enforcement authorities and between law enforcement authorities and environmental authorities/supervisory authorities.

Strict legislation on confidentiality in Sweden, and probably in other countries as well, is regarded as a major obstacle to combating environmental crimes. Less strict regulation of what information authorities can share about environmental crime-related matters and when is needed. A number of initiatives have been undertaken recently by the government to investigate how sharing of information between different authorities can be done more efficiently (Government of Sweden, 2023).

As mentioned previously, environmental crimes are in some ways similar to and can often be investigated in the same way as other crimes. However, this is not always the case. A first-response unit with little or no experience of environmental crimes may consider an environmental crime, such as the ones mentioned above (a stream full of dead fish or a leaking oil cistern) to be 'someone else's problem', it not being a crime, but an 'accident'. The standard procedures for other types of crimes, such as securing and documenting the crime scene, collecting evidence and interviewing witnesses, etc., will not be carried out. We have some unfortunate examples of a first-response unit arriving at an environmental crime scene in Sweden, doing nothing, as one may expect from police officers, and,

hence, making further investigation of the crime impossible. The reason is that the officers did not realise that the incident was a potential crime. Luckily, we have other examples where officers first on the scene have done more than one could expect and collected all the evidence needed for a successful investigation. One cannot expect uniformed officers to be experts on environmental crimes. However, they should know what constitutes an environmental crime, the basic legislation and which experts to contact within the police and the regulatory authority when they arrive at the scene of a suspected environmental crime. There will need to be more of a focus on training and competence in the future.

Since the only really bad sample is the one that is not taken, legislation should allow civil authorities/supervisory authorities to take samples that can be used as evidence when the use of police forensics, for different reasons, is not an option. Traditional forensics, for example recording fingerprints left on empty bottles of chemicals, the marks left by tools on an opened oil drum or the tyre tracks left by a truck that dumped waste in a meadow, must not be forgotten (as sometimes happens) when investigating environmental crimes.

In my view, legislation has to focus on the (illegal) act itself. When a factory has exceeded the permitted emissions, it should be punishable. If an act causes, or is likely to cause, damage to the environment and people's health, etc., it should be punishable. The ability to protect the environment or people's health is much more complicated if an **effect** has to be proven. An effect can appear in the future or not be detected at all (being caused by the accumulation of toxic emissions over the years or because the link between a release of emissions and future health problems cannot be proven, even if relevant).

Inspection authorities have to work in such a way that they can also discover more serious, deliberate environmental crimes. Traditionally, inspection authorities have worked more as 'consultants' in Sweden, announcing their arrival at the company to be inspected in advance or, even worse, performing their inspections only by studying reports sent to them by companies. It is increasingly understood in Sweden that this defensive approach is used by companies that want to save money by not applying measures required by environmental law. Slowly, and under pressure from the National Environmental Protection Authority, the local and regional inspection authorities are shifting towards a more investigative and questioning approach.

Conclusion

In spite of all the improvements that have been made, there is still much that can be done to improve how we handle environmental crimes in Sweden as well as in most countries. Small changes to organisational structures, legislation, investigative methods or the ways organisations cooperate can make a big difference.

Until now, law enforcement authorities have been focusing on investigating environmental crimes, with improved results in recent years. Now, as the threats from environmental crimes increase (described well by Europol (2022)), we also need to focus on how to prevent and detect environmental crimes more effectively. Sharing ideas between countries is one key to success. Improved cooperation between authorities, the establishment of intelligence units focusing on environmental crime, a multidisciplinary approach and increased sharing of information between law enforcement authorities are some of the further measures that can be taken.

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At a time when climate issues are in the spotlight, for the worst reasons and with even worse consequences for Earth and humanity, CEPOL has taken on the responsibility of launching a thematic issue on environmental crime. How should we look at it?

Crimes against the environment cover a wide range of activities that have in common the violation of environmental legislation. The focus is frequently on preventing harm to human health and preserving biodiversity, particularly in protected areas.

Environmental crimes should be considered significant threats to ecosystems, which carry high risks and exploit growing vulnerabilities. They represent significant threats to the physical environment, its resources, biodiversity, human health, the economy and, more generally, society.

An environmental crime does not have to be large in scale to be relevant.

The types of environmental crime are vast, and the consequence of this is twofold: on the one hand, the environment, generally speaking, is an attractive target across a broad spectrum; on the other hand, environmental legislation is also comprehensive and captures a broad spectrum of criminal behaviour. Once again, as in other crime areas, it is a game of cat and mouse, the outcome of which is down to the authorities involved.

To give just a few examples, the illegal felling of trees, the trade in protected wild animal or plant species, the contamination of water in violation of established rules, and the illegal transport of waste make clear the impact that environmental crime can have on our society and our environment. Worse still, the criminal actors and the legal companies are often indistinguishable. The so-called green economy often hides environmental crimes committed upstream and is a way of laundering the image of some corporations.

This justifies environmental crime being one of the EU's priorities in the fight against serious and organised crime under the 2022–2025 Empact initiative. Environmental crime is one of the 10 priorities set out in this European strategy, with the following statement:

> To disrupt criminal networks involved in all forms of environmental crime, with a specific focus on waste and wildlife trafficking, as well as on criminal networks and individual criminal entrepreneurs with a capability to infiltrate legal business structures at a high level or to set up own companies in order to facilitate their crimes.

To this end, Empact provides a specific operational plan for each priority.

We all realise that many social practices that cause environmental damage are not criminal in nature, or at least some of these practices were not crimes until relatively recently. Cultural attitudes towards land use can vary, with some communities valuing traditional practices that may not align with modern sustainable practices. We must, therefore, recognise the need for prosecutors to move with the times and the increasing involvement of police forces in ensuring people are complying with environmental laws.

It is essential to distinguish between intentional error (intentional misconduct) with environmental consequences and negligence and ignorance (which can have criminal consequences), as the modes of prevention are different. Often, negligence and ignorance are cultural legacies that persist and should not be justified but can nevertheless be explained in the light of tradition and custom. An example that often occurs is slash-and-burn agriculture, which is still practised in many countries but has enormous ecological and safety risks for the population. On a smaller scale, we can think of small bonfires to clear land, but these are often the cause of major fires, which fall into the category of fires caused by negligence. Awareness raising and close monitoring by the authorities is essential.

In cases of deliberate wrongdoing, such as premeditated deforestation or industrial activities that lead to water and soil contamination, the criminality of these acts is unequivocal. Those accountable for such infractions face legal repercussions. Regardless of whether the offence was the result of intentional actions or negligence, the overarching outcome remains consistent: significant environmental degradation.

The differences in environmental crimes between countries and regions worldwide can be attributed to various factors, including legal frameworks, enforcement mechanisms, socioeconomic conditions and cultural attitudes towards environmental protection. Many European countries have well-established and comprehensive environmental laws that align with EU regulations. There are stringent penalties for violations, and environmental protection is often treasured in national constitutions. The EU emphasises sustainable development, and Member States typically have robust monitoring and enforcement compliance mechanisms. European environmental enforcement is generally more systematic, with specialised agencies responsible for monitoring compliance and prosecuting offenders. There is a strong emphasis on accountability, with public access to information and the ability of civil society to challenge environmental decisions.

In other parts of the globe, enforcement can be weak, often influenced by corruption or lack of resources. In many instances, environmental regulations are bypassed or ignored, particularly in remote areas where illegal activities

like illicit logging or mining occur. Additionally, criminal organisations may exploit lax enforcement to engage in environmentally harmful activities.

There is generally a higher level of public awareness and advocacy regarding environmental issues in Europe, supported by strong civil society organisations. Economic systems often prioritise sustainability as part of their growth strategies, driving legislative measures to protect the environment. In summary, all world regions face environmental crimes, but the legal, enforcement and cultural contexts significantly shape how these crimes manifest and are addressed in each region.

From what we have written above, the importance of this thematic edition of the *European Law Enforcement Research Bulletin* seems justified, and we want to emphasise its timeliness and the quality of the work gathered here. The timeliness is not justified by the first-hand revelation of some threats and facts that jeopardise the environmental balance. These threats and facts are well known and have, to a certain extent, been widely publicised by the media. This publication is an opportunity to raise awareness of these environmental problems among a community of readers who can bring these problems and their lessons to their police work agenda and practices. Hence, the quality of the works published here, some of them presented as case studies, is important.

Each article offers added value through its problem-oriented approach to LEA work. The significance of utilising new technologies, varying in complexity, is addressed in nearly all the contributions and should be highlighted in this editorial note.

Knowing how to act more effectively to prevent environmental crimes, which are highly complex and numerous, could be the take-home message of this thematic bulletin.

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Phillip Screen: Università Cattolica del Sacro Cuore and Crime & tech

Country: Italy

Expertise area: Illicit trafficking, organised crime, illicit networks

Phillip Screen	Biographical introduction
	Phillip Screen is a PhD candidate at Università Cattolica del Sacro Cuore in Milan. His research explores the links between illicit drug trafficking, terrorism and organised crime networks. He is also a researcher at Transcrime, the Joint Research Centre on Innovation and Crime at Cattolica, and at Crime & tech. Previously, he taught criminology and security at Flinders University in Australia. His research focuses on how illicit networks operate and intersect with global security concerns. **ORCID**: https://orcid.org/0009-0006-3351-7112 **Contact**: phillip.screen@unicatt.it
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Co-author: João Gama **Country**: Portugal	Full Professor, Faculty of Economics, University of Porto, and INESC TEC **Expertise area**: Machine learning, change detection, evolving data **ORCID**: https://orcid.org/0000-0003-3357-1195 **Contact**: jgama@fep.up.pt
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Country: The Netherlands

Expertise area: Environmental crime, data science, AI, geo-spatial data

Tatjana Kuznecova:	Biographical introduction
	Tatjana Kuznecova is a senior researcher in the research group 'Technologies for Criminal Investigations' at Saxion University of Applied Sciences. She leads the 'Data Science and Crime' research line, focusing on data science, geo-spatial data and AI for safety and security, with a special interest in environmental crime. Tatjana has also worked as a researcher and teacher at other universities in Latvia and the Netherlands. **ORCID**: https://orcid.org/0009-0002-0283-9435 **Contact**: t.kuznecova@saxion.nl
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Lieselot Bisschop: Erasmus University Rotterdam

Country: The Netherlands

Expertise area: Environmental harm, corporate crime, organised crime, public–private cooperation

Lieselot Bisschop	Biographical introduction
	Criminologist Lieselot Bisschop specialises in environmental harm, corporate crime and organised crime, and their governance. Her research covers PFAS pollution, e-waste trade, planned obsolescence, wildlife trade, gold and timber trade, shipbreaking and land loss. In addition, since 2018, she and her colleagues have conducted practice-oriented studies on organised drug crime, particularly in the Port of Rotterdam. **ORCID**: https://orcid.org/0000-0002-7298-4067 **Contact**: bisschop@law.eur.nl
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Volodymyr Veretiannikov: Donetsk State University of Internal Affairs

Country: Ukraine

Expertise area: Environmental law

Volodymyr Veretiannikov	Biographical introduction
	In 2003, Volodymyr Veretiannikov qualified as a lawyer, and in 2005 he obtained a Master of Law at the Luhansk State University of Internal Affairs, named after E. O. Didorenko. Since 2009, he has been working at higher educational institutions (universities) of the Ministry of Internal Affairs of Ukraine. Since 2013, he has held management positions at these universities. In 2022, he became a Doctor of Philosophy in Law at the Luhansk State University of Internal Affairs. **ORCID**: https://orcid.org/0000-0001-7513-2292 **Contact**: vladimirveretyannikov@gmail.com

Pedro Maia Ribeiro: Guarda Nacional Republicana

Country: Portugal

Expertise area: Environment, law enforcement, international cooperation

Pedro Maia Ribeiro	Biographical introduction
	Pedro Maia Ribeiro is a Major from the Portuguese Republican National Guard (GNR) and gained his expertise on tackling Environmental Criminality working in the Environment and Nature Protection Service (SEPNA) within GNR. Before joining SEPNA he gathered experience on a technical level as the GNR´s National Coordinator in Chemical Biological Nuclear and Radiological (CBRN) events, supporting, at the time, serious waste and pollution related investigations. Of his experience it is also relevant to mention the coordination of deployment of Remotely Piloted Aircraft Systems (RPAS) and training and operational use of Remote Sensing applied to investigations. Mr. Ribeiro is the Head of Control, Organization and Planning Office of the National SEPNA's Directorate. In the academic level Mr. Ribeiro has a Master Degree on Military Sciences, specialized in Security, a Post Degree in Security and Safety Sciences and Post Degree on Environmental Law. **ORCID**: https://orcid.org/0009-0006-0729-5157 **Contact**: ribeiro.pam@gnr.pt

Henrik Forssblad: Division for Innovation in Policing and Law Enforcement at the Swedish National Operations Department

Country: Sweden

Expertise area: Environmental crime, environmental law, investigation methodology

Henrik Forssblad	Biographical introduction
	Henrik Forssblad works in the Division for Innovation in Policing and Law Enforcement at the Swedish National Operations Department, focusing on strategic issues related to environmental crime. A police officer with a master's degree in forestry, he has worked on environmental crime since the Swedish Environmental Code came into force in 1999, holding roles in investigation, intelligence and EU missions, with environmental crime as a central theme. **Contact**: henrik.forssblad@polisen.se

Maria João Guia, editor-in-chief: European Union Agency for Law Enforcement Training (CEPOL)

Country: Portugal and Hungary

Expertise area: Strategic border management, migration, human trafficking, migration and crime, rights of victims of crimes

Maria João Guia	Biographical introduction
	Maria João Guia is the Research & Knowledge Management Officer at CEPOL. She holds a PhD in law and sociology, (Law, justice and citizenship on the XXIst century), and four master's degrees (in law, sociology, translation and strategic border management). She is professionalised in pedagogy and invited Assistant Professor of Criminology at Universidade Autónoma de Lisboa (UAL). She is the author of several scientific books and articles, the most recent book published by Springer in 2024, co-edited with Professor Anabela Miranda Rodrigues, *New Forms of Human Trafficking: Global South Highlights and Local Contexts on Sexual and Labor Exploitation*. **ORCID**:https://orcid.org/0000-0003-1876-8694 **Contact**: maria.guia@cepol.europa.eu; mjguiaual@gmail.com

Matteo Arru, co-editor assistant of this special number: European Union Agency for Law Enforcement Training (CEPOL)

Country: Italy, Hungary

Expertise area: Information systems, artificial intelligence, operational excellence

Matteo Arru	Biographical introduction
	Matteo Arru's research specialises in applying AI, natural language processing and business process management to improve organisational efficiency. His work, particularly in law enforcement training, focuses on enhancing security and operational capabilities through digital transformation and advanced AI tools. He has significant expertise in knowledge management systems, cybersecurity and AI-driven innovation. **ORCID**: https://orcid.org/0000-0003-2756-9582 **Contact**: matteo.arru@cepol.europa.eu; matteo@arru.it

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Country: Italy, Hungary

Expertise area: Criminology, political science, terrorism

Giacomo Florio	Biographical introduction
	Giacomo is a multilingual junior professional currently serving as an Administrative Assistant at CEPOL – the European Union Agency for Law Enforcement Training in Budapest. He holds a master of law in criminology and Security from the University of Lausanne and a bachelor's degree in political science from the University of Trieste, enriched by academic exchanges in Paris and Montreal. **ORCID**: https://orcid.org/0009-0003-0539-5953 **Contact**: Giacomo.florio.ext@cepol.europa.eu

André Pires da Silva, trainee/editor assistant: European Union Agency for Law Enforcement Training (CEPOL)

Country: Portugal

Expertise area: Portuguese Law, European Law

André Pires da Silva	Biographical introduction
	André Pires da Silva is a trainee at CEPOL – the European Union Agency for Law Enforcement Training. He holds a Bachelor's degree in Law from the Faculty of Law of the University of Lisbon (where he also had an exchange experience at the Comenius University, Bratislava) and a Master of Laws (LL.M) in European Public Law from the Maastricht University. **Contact**: andre.pires-da-silva.int@cepol.europa.eu

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Country: Lithuania

Expertise area: Geopolitical security, human rights, hybrid threats

Aurelija Pūraitė	Biographical introduction
	Dr Aurelija Pūraitė is the Vice-Dean for Science and Project Activities at the Academy of Public Security, Mykolas Romeris University, and Head of the Sustainable Security Research Centre. A distinguished scholar, she has authored over 50 scientific articles and book chapters, and leads numerous scientific and educational projects aimed at advancing sustainable security initiatives. **ORCID**: https://orcid.org/0000-0001-9228-1396 **Contact**: aurelija.puraite@mruni.eu

Bernd Bürger: Institute for Further Education of the Bavarian Police

Country: Germany

Expertise area: Leadership, Public Order Policing, Shiftwork

Bernd Bürger	Biographical introduction
	Colonel Dr. Bernd Bürger has served with the Bavarian State Police since 1997 and brings extensive practical experience in both leadership and incident management. He holds a master's degree in criminology and police science from the Ruhr University Bochum (ECTS A), a master's degree in Public Administration – Police Management (ECTS A) as well as a PhD in Public Administration from the German Police University and is a certified Positive Leadership PERMA-Lead® Consultant. **ORCID**: https://orcid.org/0009-0002-0386-3613 **Contact**: bernd.buerger@polizei.bayern.de

Eugenio Zaniboni: University of Foggia

Country: Italy

Expertise area: International cooperation against transnational organised crime

Eugenio Zaniboni	Biographical introduction
	Eugenio Zaniboni is Associate Professor of International Law and has a PhD in European Public Law and is a CEPOL Expert Trainer and an Italian Ministry of Interior Expert Trainer and Advisor. He was appointed as Italian member of the Board of Editors of the CEPOL *European Law Enforcement Research Bulletin*. **ORCID**: https://orcid.org/0000-0001-7645-076X **Contact**: eugenio.zaniboni@unifg.it

Mihaela Pop: Bihor County Police

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Mihaela Pop	Biographical introduction
	Since 2003, Mihaela has been a police officer with Bihor County Police in Romania, focusing on international relations, especially after Romania's 2007 EU accession. She holds an economics degree from the University of Oradea, a specialisation in international relations from the Alexandru Ioan Cuza Police Academy, and a master's degree in freedom of movement for persons in Europe. Currently, she oversees international cooperation and acts as a data protection officer, ensuring compliance and coordinating crime prevention efforts. **Contact**: mihaela.pop@bh.politiaromana.ro

Nada Milisavljević: unit "Innovation and Security Research" of the Directorate-General Migration and Home Affairs (DG HOME)

Country: Belgium

Expertise area: Fighting Crime and Terrorism, including Resilient Infrastructure (FCT/INFRA).

Nada Milisavljević	Biographical introduction
	Dr. Ir. Nada Milisavljević works in the unit "Innovation and Security Research" of the Directorate-General Migration and Home Affairs (DG HOME), where she is the EU security research coordinator as well as the team leader for the area of Fighting Crime and Terrorism, including Resilient Infrastructure (FCT/INFRA). Before joining the European Commission, Nada was a researcher at the "Signal and Image processing Centre" of the Royal Military Academy of Belgium, and she is (co)author of around 100 scientific publications, mainly in the areas of image processing and data fusion. Nada holds a Bachelor and a Master degree in electrical engineering, and a PhD degree in applied sciences.

Roberto Fernandes: Public Security Police; Higher Institute of Police Sciences and Internal Security (ISCPSI)

Country: Portugal

Expertise area: International relations, policing, internal security

Roberto Fernandes	Biographical introduction
	Dr Roberto Fernandes is a Police Colonel in the Portuguese Public Security Police (PSP) and holds a PhD in International Relations, specialising in Geopolitics and Geoeconomics. He serves as Innovation Adviser, Researcher, and Lecturer at the Higher Institute of Police Sciences and Internal Security (ISCPSI). Dr Fernandes is also an appointed External Expert for CEPOL and COST, and a member of the Editorial Board of the European Law Enforcement Research Bulletin (ELERB). His research interests focus on security governance, innovation in policing, and the geopolitical dimensions of internal security. **ORCID**: https://orcid.org/0000-0002-3649-8694 **Contact**:rnfernandes@psp.pt

Ruža Karlović: Ministry of the Interior of the Republic of Croatia – University of Applied Science of Criminal Investigation and Public Security

Country: Croatia

Expertise area: Police and society, crime, crime prevention

Ruža Karlović	Biographical introduction
	Dr. Ruža Karlović is an assistant professor at the University of Applied Sciences for Criminal Investigation and Public Security, which is affiliated with the Ministry of the Interior. She holds a master's degree in criminal investigation and earned her doctorate in sociology from the University of Zagreb. Her research primarily focuses on crime prevention, and the sociology of crime. Dr. Karlović has contributed to numerous international security projects as part of the Horizon 2020 program. Currently, she serves as the president of the Ethics Committee at her institution. In addition to her teaching and research, she has authored several scientific papers, conference summaries, and books. Dr. Karlović is also a member of the European Society of Criminology (ESC). **ORCID**: https://orcid.org/0000-0002-6810-0062 **Contact**:rkarlovic@fkz.hr

Vesa Huotari: Police University College, Finland

Country: Finland

Expertise area: Police education, evaluation, leadership

Vesa Huotari	Biographical introduction
	Vesa Huotari (Ret.) worked as a senior researcher at the Police University College, Finland, from 2006 to 2025. He did research on various topics and enjoyed working on ideas and felt most at home with theoretical, Methodological, and philosophical issues. For several years Vesa was CEPOL's Research and Science Correspondent to Finland. **Contact**: retired

Paulo Machado: ICPOL – PSP Research Unit, Portugal

Country: Portugal

Expertise area: Sociology, statistics applied to crime research, ecology of crime

Paulo Machado	Biographical introduction
	Paulo Machado has a PhD in sociology of development and social change at the Universidade Nova de Lisboa and a postgraduate qualification in social demography. He is Scientific Coordinator of the ICPOL – PSP Research Unit and Professor of Sociology and Cultural Studies at the Higher Institute for Police Sciences and Internal Affairs (Lisbon). He is a consultant for the Council of Europe Committee on Safety and Security at Sports Events and is a former consultant at the European Forum for Urban Security (EuroSocial programme in Latin America). He is President of the Portuguese Association of Demography. **ORCID**: https://orcid.org/0000-0003-1555-3620 **Contact**: pfsmachado@iscpsi.pt

Rita Faria: School of Criminology, University of Porto, and CIJ – Interdisciplinary Research Centre on Justice

Country: Portugal

Expertise area: Environmental crime, criminology, qualitative

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	Rita Faria is an Assistant Professor at the Faculty of Law of the University of Porto, vice-director of the School of Criminology, and Director of the PhD programme in criminology. She is currently the Director of the Interdisciplinary Research Centre on Justice (CIJ), and her preferred research topics are white-collar, corporate and occupational crime, environmental crimes, research misconduct, and gender-based violence and migration. She has been contributing to the development of qualitative methods in criminology. **ORCID**: https://orcid.org/0000-0003-0093-0550 **Contact**: rfaria@direito.up.pt

Ana Guerreiro: University of Maia and Faculty of Law, University of Porto (FDUP)

Country: Portugal

Expertise area: Organised crime, criminal networks, female criminality

Ana Guerreiro	Biographical introduction
	Ana Guerreiro holds a PhD in criminology. She is Assistant Professor at the University of Maia and Invited Assistant Professor at FDUP. A researcher at the Interdisciplinary Centre for Gender Studies and at the Interdisciplinary Research Centre on Justice, her main research topics include female criminality, violent and organised crime, criminal networks, sentencing studies and prevention policies. Ana was also nominated in 2024 as a CEPOL External Expert. **ORCID**: https://orcid.org/0000-0003-2312-6266 **Contact**:aguerreiro@umaia.pt

Pedro Trovão Do Rosário: Universidade Autónoma de Lisboa

Country: Portugal

Expertise area: Constitutional law, fundamental/human rights, constitutional justice

Pedro Trovão Do Rosário	Biographical introduction
	Pedro Trovão Do Rosário has a PhD in law (constitutional and political law). He has been teaching since 1991, receiving his doctorate in 2008. He teaches master's and doctorate programmes at universities in Portugal, Spain and Brazil, and at the Portuguese Bar Association. He is a member of IACL, IAB and various legal committees. He is a researcher at Jusgov and co-coordinator of the Ratio Legis research group. He has been a practising lawyer since 1993, and is currently employed at Trovão do Rosário & Associados. **ORCID**: https://orcid.org/0000-0002-2891-4053 **Contact**: prosario@autonoma.pt; ptr@trovaodorosario.pt

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Country: Poland

Expertise area: Prevention of radicalisation, community policing and crime prevention, evidence-based evaluation, policy and practice, designing of preventive measures

Marzena Kordaczuk-Wąs	Biographical introduction
	Marzena Kordaczuk-Wąs has a PhD in social sciences, specialises in the sociology of security and crime prevention. She served 18 years in the Polish police, focusing on engagement of police measures in social prevention. Currently, she is a senior training officer at CEPOL, coordinating the law enforcement cross-border operational cooperation, information exchange and interoperability portfolio. Marzena is also an expert in radicalisation prevention and collaborates with the Polish Platform for Homeland Security and Collegium Civitas. She worked with the Radicalisation Awareness Network as co-chair of the RAN-POL Working Group, and currently continues as the Leader of the EU Knowledge Hub on Prevention of Radicalisation training component. **ORCID**: https://orcid.org/0000-0001-5479-7455 **Contact**: marzena.kordaczuk-was@cepol.europa.eu

Anja Bothe: University of Lisbon

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Anja Bothe	Biographical introduction
	Anja Bothe is a German academic from Münster who studied at the Universities of Bielefeld, Coimbra and Hamburg. She earned her PhD at the University of Hamburg in 2003 and completed postdoctoral studies in Berlin and Coimbra in 2010. Since 2010, she has lectured at the Autonomous University of Lisbon and the Atlantic University Institute. She has evaluated applications for the Centro de Estudos Judiciários since 2016 and is a member of the Portuguese Bar Association. **ORCID**: https://orcid.org/0000-0001-7300-0034 **Contact**: abothe@autonoma.pt

Annika Talmar: European Union Agency for Law Enforcement Training (CEPOL)

Country: Hungary

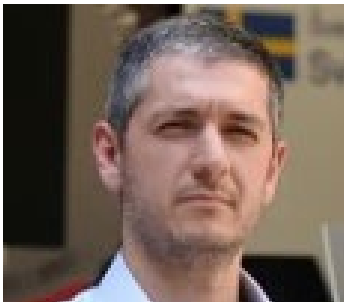
Expertise area: International humanitarian law, European policy, law enforcement

Annika Talmar	Biographical introduction
	Annika Talmar, justice counsellor at the Permanent Representation of Estonia to the EU in civil law matters. She holds a PhD in law from the University of Tartu, specialising in international humanitarian law. She worked at the Estonian Academy of Security sciences as a researcher and at the Permanent Representation of Estonia to the EU as a home affairs counsellor specialising in police cooperation and CEPOL as the first liaison officer in Brussels. **Contact**: annika.talmar@gmail.com

Dean Savić: Ministry of the Interior of the Republic of Croatia

Country: Croatia

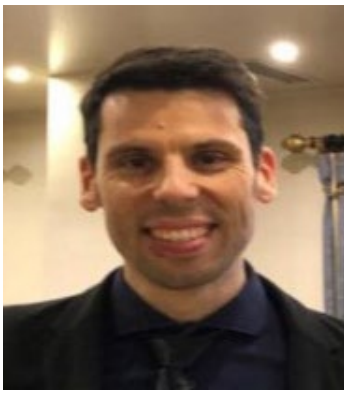
Expertise area: Organised crime, terrorism, crime investigation

Dean Savić	Biographical introduction
	Dean Savić has been an employee of the Ministry of the Interior of the Republic of Croatia since 1991. He received his PhD degree at the Faculty of Political Sciences in Zagreb. He is the author of several scientific and professional papers. He has completed several courses in the field of criminal investigations at the University of Applied Sciences in criminal investigation and public security in Zagreb. **Contact**: dsavic@mup.hr

Emanuel Azevedo Carvalho: Autonomous University of Lisbon

Country: Portugal

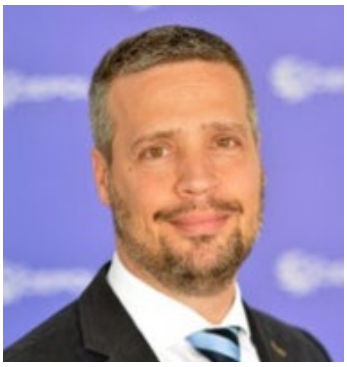
Expertise area: Criminal policy, criminal law, international criminal law

Emanuel Azevedo Carvalho	Biographical introduction
	Emanuel Azevedo Carvalho has a PhD in law from the Autonomous University of Lisbon (UAL) and is an Assistant Professor at UAL and a researcher at Ratio Legis – Centre for Research and Development in Legal Sciences at UAL and at the Justice and Governance Research Centre (Jusgov) at the University of Minho Law School. He is a member of the Institute for International Legal Co-operation and a trainer at the Portuguese Bar Association (in the area of domestic violence). He is a lawyer and legal consultant, and an arbitrator and conflict mediator. **ORCID**: https://orcid.org/0000-0001-5053-2425 **Contact**: emanuecarvalho44900p@gmail.com

Gábor Kemény: CEPOL

Country: Hungary

Expertise area: Information exchange, cross-border cooperation, law enforcement organisational environment

Gábor Kemény	Biographical introduction
	Gábor Kemény is an experienced senior police officer and education professional with a demonstrated history of working for law enforcement authorities at the national and international levels. He is skilled in law enforcement, cross-border cooperation, leadership, capacity building, training and project management. He has a strong education background, with various postgraduate qualifications in the fields of the special jurisprudence of the law of the EU and strategic border management. **ORCID**: https://orcid.org/0000-0003-0062-2160 **Contact**: Gabor.kemeny@cepol.europa.eu

Gediminas Buciunas: Academy of Public Security at Mykolas Romeris University, Vytautas Magnus University

Country: Lithuania

Expertise area: Organised crime, domestic violence, hybrid threats

Gediminas Buciunas	Biographical introduction
	Associate Professor Dr Gediminas Buciunas is a distinguished academic and legal professional with extensive experience in prosecution and international advisory roles. Holding a PhD from Vytautas Magnus and Mykolas Romeris Universities, he has been a prosecutor in Lithuania since 1991 and served as an advisor in Afghanistan and Ukraine. As a part-time lecturer, he has contributed to several universities and published widely on security, terrorism and legal issues. **ORCID**: https://orcid.org/0000-0002-1826-0527 **Contact**: gediminas1967@mruni.eu; gediminas1967@gmail.com

Markus Muehlbauer: Bavarian Police Training Institute in Ainring

Country: Germany

Expertise area: Weapons, hunting, environmental crime

Markus Muehlbauer	Biographical introduction
	Markus Muehlbauer studied at the Police Department of the University of Applied Sciences for State Employees in Sulzbach-Rosenberg/Bavaria and served for over 20 years as a police officer, service group leader and operations manager. Now he works as a specialist teacher in weapons, explosives, hunting, fishing and environmental crime at the Bavarian Police Training Institute in Ainring. As a hunter and fisherman, he is deeply connected to nature and helps educate park rangers, conservation officers and young hunters. **Contact**: markus.muehlbauer@polizei.bayern.de

Massimo Mecella: Sapienza Università di Roma

Country: Italy

Expertise area:Information systems engineering, artificial intelligence, security and safety

Massimo Mecella	Biographical introduction
	Massimo Mecella is a full professor at Sapienza University and has authored over 250 papers, with an h-index above 40. He has been involved in numerous European and Italian research projects and served as the technical manager for Workpad and SM4All, coordinated by Sapienza University. He is part of the steering committees for CAiSE, ICSOC, Intelligent Environments, AVI and SummerSOC. Currently, he is vice-director of Sapienza's BSc/MSc degrees in computer science and AI, and was director from 2020 to 2023. **ORCID**: https://orcid.org/0000-0002-9730-8882 **Contact**: massimo.mecella@uniroma1.it; massimo.mecella@gmail.com

Mihaela Meresi: University Alexandru Ioan Cuza of Iasi, Romania

Country: Romania and Belgium

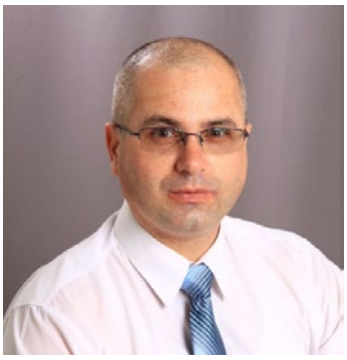
Expertise area: Criminology, forensic psychology, predictive policing, probation

Mihaela Meresi	Biographical introduction
	Dr Mihaela Meresi is a Romanian researcher in social sciences, focusing on green energy, social development, criminology and forensic psychology. Since 2008, she has managed key research and innovation projects and contributed to EU policies on open science, general data protection regulation and open data. She holds a PhD in sociology (2007) from Alexandru Ioan Cuza University of Iaşi and integrates research, policy and diplomacy to drive transformative solutions. Her discoveries in predictive policing have attracted the interest of IGI Global Scientific Publishing. **ORCID**: https://orcid.org/0009-0005-4692-6911 **Contact**: meresi.mihaela@gmail.com

Mircea Constantin Scheau: University of Craiova

Country: Romania

Expertise area: Critical infrastructures, information technology, cybersecurity and financial crime

Mircea Constantin Scheau	Biographical introduction
	Mircea Constantin Scheau has a PhD in public order and national security. He is author or co-author of several volumes, one of which - *Cybercrime Regarding Financial Transfers* - received the Victor Slăvescu Prize awarded by the Romanian Academy, and of over 50 articles related to management, law enforcement, infrastructures, technology, defence and cybersecurity. He lectures at international conferences and is an Honorary Associate Researcher at, member of, or collaborator with, prestigious universities. **ORCID**: https://orcid.org/0000-0002-3847-5998 **Contact**: mircea.scheau@edu.ucv.ro

Ondrej Blažek: Academy of the Police Force in Bratislava

Country: Slovakia

Expertise area: Administrative law, crisis management and civil protection, public administration

Ondrej Blažek	Biographical introduction
	From 2019 to 2021, Ondrej Blažek worked at the Academy of the Police Force in Bratislava at the Department of Public Administration and Crisis Management. From 2021, he started working at the Department of Administrative Law. During his time at the university, he authored university textbooks, monographs and scientific articles on the subjects of crisis management, civil protection, public administration and administrative law. **ORCID**: https://orcid.org/0000-0001-8459-670X **Contact**: ondrej.blazek@akademiapz.sk

Stijn Aerts: Secretariat of the European Crime Prevention Network

Country: Belgium

Expertise area: Crime prevention, internal security policy, evaluation

Stijn Aerts	Biographical introduction
	Stijn Aerts is the coordinator of, and a senior research officer at, the Secretariat of the European Crime Prevention Network. He holds a PhD in Arabic Studies from the University of Leuven, Belgium, and spent about a decade doing academic research—mostly on the (prevention of) radicalisation and violent extremism in Belgium and Egypt. At EUCPN, his focus shifted to crime prevention in general, with a focus on situational crime prevention and evidence-based prevention policy. **Contact**: stijn.aerts@ibz.be

Terhi Kankaanranta: Police University College

Country: Finland

Expertise area: Economic crime, environmental crime, crime investigation

Terhi Kankaanranta	Biographical introduction
	Terhi Kankaanranta, PhD in health economics, is a Senior Researcher at the Police University College of Finland. Her expertise includes economic and environmental crimes, human trafficking and economic crime investigation, as well as job satisfaction factors. She has managed several research projects, including illicit waste trafficking (BlockWaste) and modelling pretrial investigations of human trafficking (Ihmemalli). **ORCID**: https://orcid.org/0000-0002-9909-8153 **Contact**: terhi.kankaanranta@polamk.fi

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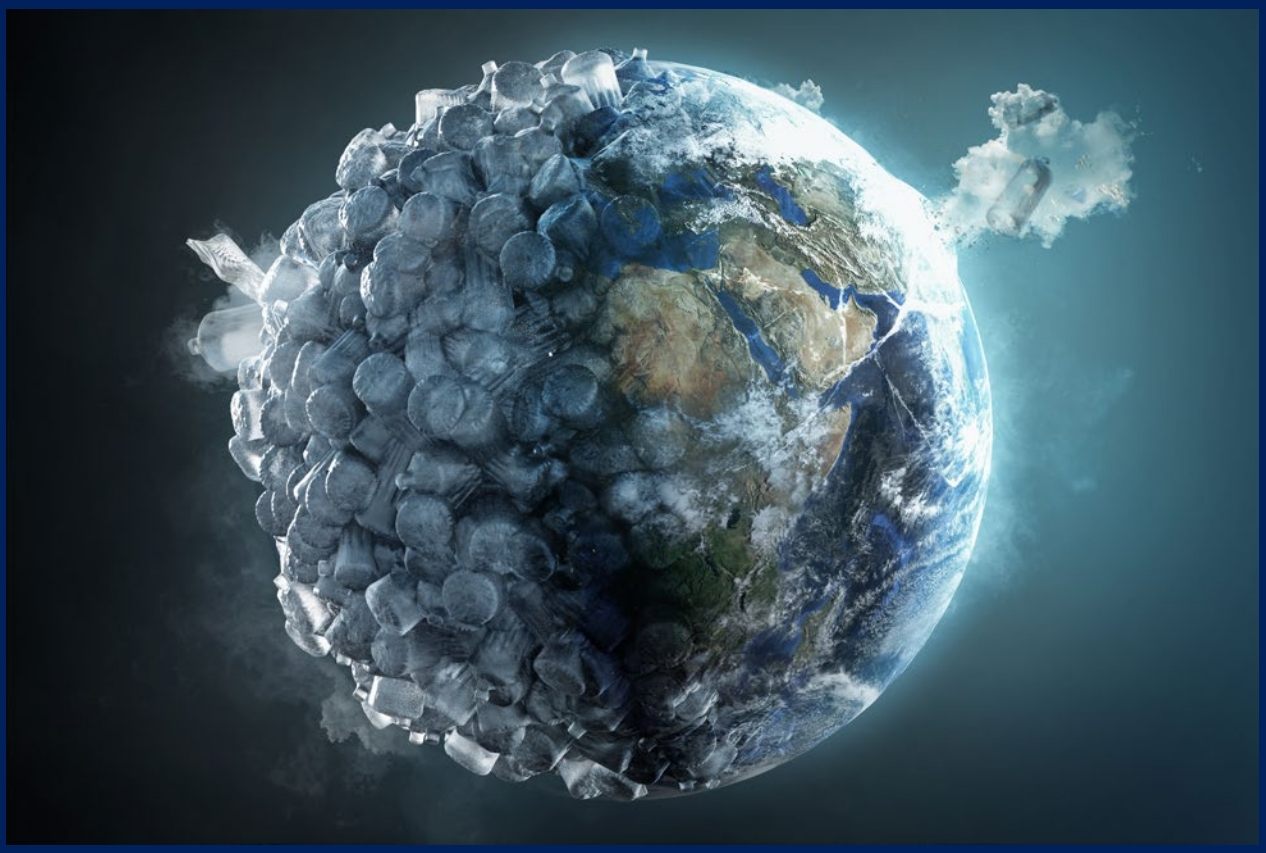

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