



Signs of how the Sydney Declaration article is received in the forensic science literature

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ABSTRACT

The Sydney Declaration is an initiative led by an informal group of forensic scientists with diverse backgrounds. It offers a vision of forensic science based on the trace, as a vestige of a past event related to security or a possible law violation. An article published in *Forensic Science International* (FSI) introduces to this view [1]. Our investigation delves into how the forensic science literature has received this article (the SD article), nearly two years after its publication. One of the main challenges of this exploratory study was to define the appropriate scope of forensic scientific literature, within which the SD article must be located. In general, the publishing domain is quickly evolving, with many competing players, while still being structured around standard academic disciplines. The forensic literature, meanwhile, is scattered and poorly connected. This reflects the fragmentation of practice and research in forensic science, and the difficulty of situating a scientific activity in such a way as to bring out its forensic substance. Nonetheless, the SD article fills a gap. By deciphering the critical concept of trace, it highlights how pivotal forensic science is in addressing societal challenges. Scholarly literature expresses clear quantitative interest in the SD article. It has received significant qualitative citations on multiple levels and dimensions, in a highly relevant manner and in accordance with its aim of providing a forensic foundation for various debates that have been conducted separately, notably over the last fifteen years.

1. Introduction

The Sydney Declaration (SD) article [1] includes a definition and seven principles which form the scientific foundations of forensic science. It reverses the logic of traditional visions based on the dispersed application of sciences and technologies within a legal framework. Instead, it revolves around an object of study: the trace, remnant of a past activity of interest. The emphasis is on problem-solving by focusing on the exploitation of the information conveyed by the trace, rather than on the technologies (means) themselves [2]. It expresses the uncertainties intrinsic to the reconstruction process, and expands the role of forensic science, recognising the growing importance of traces in our society, for deciphering many forms of out of norms activities. It brings unity to the fragmented debate in forensic science, thanks to the transversality of the concept of trace.

The SD article and its accompanying initiative thus serve as a framework for revitalising the discourse on forensic science rather than prescribing a normative approach. The SD article has been paving the way for the conference of the International Association of Forensic

Science (IAFS) in 2023. The SD initiative (well beyond the article itself) has been presented at workshops, conferences, working groups and professional associations, as well as through education and training. Furthermore, it is being translated into multiple languages. Forensic associations and laboratories are utilising it to define a strategic orientation [3], as well as to guide implementation, research, training and practices in forensic science.

Although there are signs of concrete influence, a more structured evaluation of the wider initiative's impact is only just beginning. Findings have been presented at IAFS 2023 in Sydney. This special issue of *Forensic Science International* dedicated to the Sydney Declaration and the status of forensic science¹ will also support this process.

To offer a complementary view on how the Sydney Declaration has penetrated various forensic areas, we focus this contribution on the SD article [1]. The following specific research questions are addressed: how the forensic science literature space can be characterised in a changing scientific publishing landscape? How the SD article arises interest within this space? How is it used and understood? Eventually, how durable will it be?

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¹ <https://www.sciencedirect.com/journal/forensic-science-international/special-issue/10B5JPP63Q9> (last access, March 2024)

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The indicators established to measure the impact of an article essentially consist of counting the number of times an article has been cited, and situating this number as a function of time and within a population of comparable published documents.

The importance attached to citation indicators for evaluation purposes does, however, require a number of precautions in order to be appropriately interpreted. Human factors have been shown to have a considerable influence on indicators, to the point where deviant behaviour are observed [4]. For instance, well-known modus operandi are used to “game the system” in order to artificially increase the author’s own indexes or institutional ranking [5–7]. Recently, the digitalisation of journals has altered various aspects of the publishing landscape. As part of this trend, new business models have caused the proliferation of so-called predatory journals, which largely bypass peer-review processes [8]. They also favour the diversification of existing well-established journals (e.g. *Nature* or *Forensic science international* with their many declinations), leading to greater fragmentation of scientific contributions. This background also suggests a more systemic doubt about how publishing structures value innovation and social impacts [4,9]. In this perspective, Weyermann et. al [10] draw a particular attention to the increase in publications in forensic science over the last two decades and questioned its actual impact on the discipline and relevance of the knowledge being produced.

Aware of all these limitations and biases, we describe some salient features of the particular space of forensic literature in the first section of this paper. Then, we evaluate the SD article within this particular ecosystem, and determine its position. To achieve this objective, we utilise bibliometric instruments provided by publishers. These instruments have become increasingly diverse and complex in recent years. Instead of producing unreliable statistics, we emphasise the significance of the patterns and indications discovered. We also include a qualitative assessment of the citations garnered by the SD article thus far to better grasp its reception and potential applications.

2. Scientific publication in forensic science

Forensic literature inherits, to varying degrees, the general characteristics and evolution of the entire scientific publishing landscape. At the same time, the contexts in which forensic research is conceived and conducted give rise to a variety of specific interests that influence the shape of the forensic literature space.

2.1. Publishing interests in forensic science

The whole publication structure is unfavourable to the participation of active researchers and practitioners from certain regions of the world where publication codes are not part of the culture or where resources are too scarce to meet standards in research. Valuable contributions are also written in language other than English, which make them less visible within the system of indicators [11]. This unbalanced situation is particularly evident in forensic research, where certain regions are over-represented in the literature, while ideas from other part of the globe, such as Africa, are under-valued [3].

Moreover, it has been found that larger communities are more advantaged than smaller ones by evaluation systems that focus on traditional indicators, as this size determines the scale of reciprocal citations [12]. This has a major influence on the small forensic community, whose members may be tempted to seek greater impact by publishing in journals focused on fundamental disciplines that bring together many more scientists [10].

Forensic scientists are either fully or partially integrated within an academic organisation, or practising in laboratories and police operational structures. They have very different interests in publishing [2]. It would be doubtful that the part of the research in forensic science immersed within the academic system would be immune to side effects related to the reliance on metrics by quality systems used for governing

research: individuals and institutions are ultimately required to follow the rules and adapt their target to the objectives behind those metrics [10].

One can assume that the orientations and intensity of research leading to publications that are carried out in forensic laboratories greatly vary with inter-laboratory working groups’ activities, partnerships with universities, and some forms of recognition of publishing efforts and research culture secured by quality system environments. In any case, individual motivation remains hence an important factor in this context.

Research carried out by practitioners is considered as more “applied” than fundamental, even if such distinction is less straightforward in forensic science than it may appear [10]. Publication is stimulated by incentives, for instance, through a variety of European research funding offered around the activity of the European Network of Forensic Sciences Institutes (ENFSI)² or related to broader international security programs.

Some laboratories have hybrid structures. They are belonging to an academic environment while offering forensic services, particularly in the medical domain. They are then driven by objectives in tension, according to publishing.

Eventually, the justice system has urged the forensic science community to reform and increase research, to reinforce the “scientificity” of forensic operations from a law perspective [13]. The publication process should then participate to guarantee some quality requirement that helps law gatekeepers to evaluate what “science” and results published can valuably enters decision-making processes of the justice system [13–16].

In their survey, Neuteboom et. al. [17] express, however, a mitigated reality. They noticed that only 54,7% of the participants answered that research is considered as a forensic science task (n = 95, persons committed to the quality system of their laboratory). These environments are submitted to high operational pressure and necessarily focus on the immediate satisfaction of customers’ requirements. Customers of forensic science providers are neither interested in the academic ranking of an institution, nor impressed by scholarly publications. These authors suggest that many of the complex case studies faced by laboratories should be more systematically reported to the scientific community through publishing. It may reside here a fundamental misunderstanding causing tensions. It is difficult for practitioners to meet the formal methodological requirements of editorial committees and academic reviewers. They are assessing papers according to empirical approaches related to Galilean sciences, while forensic science is essentially a case-based endeavour [18]. At the same time, the practical knowledge available in forensic laboratories is inaccessible to academic institutions that are far removed from the reality of imperfect data and the constraints of dealing with complex individual cases. The result is a vast waste of knowledge.

It is not exaggerated to pretend that, beyond noticeable exceptions and efforts,³ a publishing culture has mostly not penetrated organisations at the heart of the practice of forensic science, because quality systems broadly implemented in laboratories [19–21] force employees to target mostly other indicators.

However, this situation does not mean that scientific publishing does not influence forensic practices or the other way round, but this effect remains difficult to detect and evaluate particularly through bibliometric indicators suffering from such incompleteness.

² See for instance: <https://enfsi.eu/projects/monopoly-programmes-mp> (last access, March 2024)

³ Consider for instance the impressive research culture in laboratories such as the Netherland Forensic Institute.

2.2. Discerning a forensic science subspace

The forensic umbrella hence gathers a particularly broad variety of stakeholders that have many different interests and develop different sorts of incentives for participating in the publication process (private and public operational laboratories, police or independent, specialised forensic science laboratories or technology providers, academics)[2].

The positioning of forensic science has always been controversial, views are multidimensional and there is no consensus on the need to express the existence of forensic science and how to define it [22,23]. This is also reflected in the evolution of the structure of forensic literature itself. For example, the many declinations of FSI contribute to the idea that forensic science should be seen as an application of another core discipline (e.g. digital investigation, genetics, animals and environment, mind and law). This framework may also serve the interests of departments in academic institutions that are integrating a forensic research activity as an application of one fundamental science [24]. Eventually, the pervasive idea that forensic science should be a sub-domain of legal medicine or, at another extreme, sociology or criminology, is reflected in the structure of the publication databases and the citation counting forensic science's contribution (see below). This is exactly the kind of issues the SD article aims to address.

"Forensic science" is generally not identified as a field in its own right in the research arena. In many national and international funding bodies, even submitting a project in forensic science is not possible. It must be connected to a predetermined traditional division of disciplines, or, at best, considered in an inter/pluri-disciplinary category. Accountability systems follow this logic, making the contribution of forensic researchers difficult to decipher and creating biases when projects are assessed. Papers are often qualified within the standard typology occasionally as a law, legal medicine or criminological research rather than being identified as a forensic science article on its own right. Claiming a position in forensic science therefore offers little advantage to researchers who will gain greater recognition through indicators in larger communities directly linked to the fundamental sciences, from which they originate in the majority.

3. Evaluating the SD article

From this background, we can state more precisely how the SD article fits into this complex ecosystem.

3.1. Specific objectives

Specifically, we aim at:

- Making a description of the SD article in terms of bibliometric indicators.
- Defining a relevant forensic subspace against which the main indicators can be compared. Describe and interpret results.
- Qualitatively evaluating how the declaration has been cited.

We recognise many limitations to the ways such objectives can be approached due to the conceptual framework described above. The whole approach, however, is also intended to explore bibliometric issues and question how the discipline of forensic science, if it exists as stated by the declaration, reflects in the publications space.

3.2. Methodology

The many bibliometric computerised instruments available present significant differences. At least three different databases and systems are commonly used: *Web of Science* (originating from the Science citation index), *Scopus* and *Google Scholar*. If we briefly present the citations of the SD article in the three databases, we will then focus exclusively on *Scopus*. It registers data from the main sources of forensic science and

generally covers a little broader than *Web of Science*. *Google Scholar* offers the largest view, including references to different kinds of books, reports and doctoral theses, which are generally less considered by other databases. However, it is also more inclined to take into account irrelevant citations from so-called predatory literature, although *Scopus* is not immune to such sources.⁴

There are also some pragmatic reasons for choosing *Scopus*. Authors have access to the basic instruments through their institutional affiliation. The infrastructure provides a set of basic analytical tools and extraction mechanisms necessitating only basic programming skills. There was no access to the more elaborated instrument connected to *Scopus* called *SciVal*. This limits the possibilities for more in-depth analysis such as the number of downloads, clustering authors or using the notion of "topics" dynamically constructed from the data (see below).

We have chosen to carry out this evaluation in three main stages:

1. a simple descriptive part to understand how various indicators behave for the SD article (4.1–4.9):
 - a. profiling the article, its authors and the journal (FSI),
 - b. defining subspaces in which the SD article is interpreted,
 - c. situating the SD article within these subspaces.
2. A qualitative evaluation of who is citing the Declaration, why and how (4.10). This exploration is made possible by the relatively low number of papers to be reviewed in more detail to date (21 articles not self-cited, October 22th, 2023).

Statistical treatments have been carried out with Excel and R software.

4. Results

4.1. Profiling the article

The SD article proposes a definition of forensic science around the notion of trace, as the vestige of an activity of interest. It can be seen as belonging to a family of fundamental articles that emphasises the importance to strongly define the discipline, with its own principles, as pivotal in expressing the relations between science, justice, and security.

It contrasts with much of the forensic literature, which adopts the "commonly accepted view that any science used in a legal setting is forensic science" [23] p.2. The forensic literature is therefore generally more focused on the assessment of technologies, based on a fundamental science (e.g. physics, biology, chemistry, computer science), to which the forensic label is attached for their more or less obvious legal or investigative flavour.

4.2. Profiling the authors of the SD paper

The SD article has been elaborated by 11 authors located in Australia, Canada, Finland, Switzerland, the UK, Ireland, and the United States of America (US). This is an informal group, made up of people who have met over a fairly long period as part of their international involvement in forensic science. It was not initiated by a research organisation or institution, nor was it attached to an association or any other structure prompted by a government or a private body. While regrettably, nobody originates from Asia, Africa and South America, authors bring together a broad diversity of experiences in academic, police and forensic laboratories. Generations are well covered, and females represent more than one third of the group. The large number of authors means that the article is clearly part of a collective publication style, which can influence outreach and citations. Despite their very different backgrounds and the variety of environments surrounding

⁴ https://idea-en.cerge-ei.cz/files/IDEA_Study_2_2017_Predatory_journals_in_Scopus/mobile/index.html (last access, May 2024)

their activity that can influence their individual conception, the authors have reached a common and substantial conceptualisation. This underlines the transversality of the scientific proposal.

It is important to mention that other forensic scientists contributed early on to the Sydney Declaration initiative, and some joined the group to support the idea at various international conferences. They were not directly involved in the drafting of the article, but indirectly influenced its development through their previous scientific contributions or discussions with the authors. They currently have an active participation in its outreach. The declaration which will still evolve must be distinguished from the SD article. The latter is a preparatory work, a strong proposal aimed at stimulating interest and structuring the debate, rather than a final version.

4.3. Profiling the journal

The SD article was published in *Forensic science international* (FSI). This journal was chosen by the authors because they see it as well established in forensic science with a double-blind peer review and a strong editorial board. Its impact factor for the two preceding years is 2.2. *Scopus* provides its own yearly *CiteScore* for the journal measuring average citations received per document published during the year. Its value is 4.8, which situate the Journal in third position in 2022 relatively to all the journals registered in *Scopus* (search carried out in September 2023) whose title contains *forensic science*⁵ (n= 23). The first two ones corresponds to journals of the FSI's declinations: *Forensic science international: Genetics* and *Forensic science international: Digital investigation*. Within the *Scopus* database, FSI, as a journal, is classified in *Medicine/ Pathology* and *Forensic Medicine* as well as *Social sciences/Law*, by following the ASJC (All Science Journal Classification) system. Jones [16] has evaluated FSI within this categorisation, through *Journal Citation Reports* (JCR), which is a new dashboard developed around *Web of Science*. As another measure, the *SCLImago Journal Rank* (SJR) indicator is declining (from 1.312 in 2013–0.740 in 2022)⁶ [25]. It is computed by taking into account a notion of “prestige” of the journals citing FSI's documents. It situates also FSI as a *Medicine/ Pathology and forensic medicine* or *Social sciences/Law* journal. Thus, in all perspectives, articles published in the journal inherit from these categorisations, while the SD article strongly supports the view of forensic science as a discipline in its own right, related to, but not subordinate to legal medicine or social sciences and law. Comparisons between journals using these indicators are therefore not very informative, as the world of forensic science constitutes a relatively small community whose scientific activity is mostly dispersed in journals run by other dominant disciplines operating according to their own rules.

However, database search methods have changed radically with the progressive digitisation of scientific publishing. This should, therefore, relativise the importance of these categories (including the source in which an article is published) when searching for forensic topics. Nevertheless, indicators on the quality of research influencing funding bodies remain largely aligned with these categories and largely determine the way in which forensic projects are evaluated.

4.4. Number of citations

All the authors of the SD article are active in the field of scientific publication and tend to deal with fundamental forensic subjects. This results in a relatively high number of self-citations (Table 1). The SD article receives near the same numbers of citations by *Web of Science* and *Scopus*, but not entirely from the same documents as only 16 are in common. Of importance, *Web of Science* is incorporating *Wiley's interdisciplinary reviews: forensic science*, where fundamental aspects of

Table 1

Number of documents citing the SD article with and without self-citations from Google scholar, Scopus and Web of Science, October 26th, 2023.

| | Google scholar | Scopus | Web of Science |
|-------------------------|----------------|--------|----------------|
| Included self-citations | 51 | 30 | 25 |
| Without self-citations | 39 | 21 | 16 |

forensic science are frequently presented. It is then not surprising that the SD article is cited in this journal (5 citations, 3 self-cited recorded in *Web of Science*). Surprisingly, this journal, at least at the time of the study, was not included in the *Scopus* database. Conversely, relevant journals such as *Forensic science international: Synergy* (6 citations of the SD in *Scopus*) is not integrated in *Web of Science* yet.

This result tends to confirm certain limitations in terms of the completeness of databases recording essential contributions in forensic science. From now on, we will focus our analysis on *Scopus* data assuming that the sample extracted has some good degree of representativeness.

4.5. Evolution of the numbers of documents citing the SD article

Fig. 1 shows that it took 127 days and then 179 days, between the SD article's publication and the first and the second citation, respectively. This data confirms the kind of inertia generally observed in the scientific literature [4]. At first glance, the citation pattern shows significative and regular activity, with no obvious acceleration.

4.6. Journals having published articles citing the declaration (Scopus)

70% of the papers citing the SD article are published in the most traditional forensic journals (FSI, FSI:Synergy, Science and Justice, Australian Journal of Forensic Sciences, Journal of Forensic sciences) (Table 2).

4.7. Other indicators available

Scopus offers another complex set of indicators to complement citations. Some are intended to provide early social signs of interest from traces detected on the web in various contexts not directly linked to the publishing space (e.g. social media) [26]. For example, an “attention score” of 31 was provided by altmetrics (August 18th, 2023).⁷ This is supposed to situate it in the top 5% of “all research output scored by the system for articles having the same ‘age’”. Activities on social media, in particular the number of tweets (now X posts), are other components of those systems, whose relevancy can change rapidly with the dynamic of the web. They are strongly influenced by the activities of the authors and their networks (i.e. self-advertisement and number of followers). The *Scopus* indicator mentioned 108 tweets (today's X posts), while the altmetrics platform mentioned 42 (same date). However, a significant number of these posts were generated by the authors themselves, their institutions or the IAFS association, which initiated the idea of the declaration at an online conference in May 2021.⁸ Moreover, the transformation of Twitter, that has become X, changes the dynamic of social networks and consequently, the relevancy of indicators.

Another indicator, the *Scopus Field-Weighted Citation Impact* (FWCI), is explained on the *Scopus* web site as: « The FWCI is the ratio of the document's citations to the average number of citations received by all similar documents over a three-year window”. The SD article received a score of 16.44 (September 4th, 2023), bearing in mind that the article was classified in “disciplines” determining “similarity” that might not be compatible with the definition of forensic science disseminated by the

⁵ Includes *Science and Justice - Journal of the Forensic Science Society*

⁶ <https://www.scimagojr.com/journalrank.php> (last access, May 2024)

⁷ For instance www.altmetrics.com

⁸ <https://vimeo.com/557933148/34fb079498> (last access, May 2024)

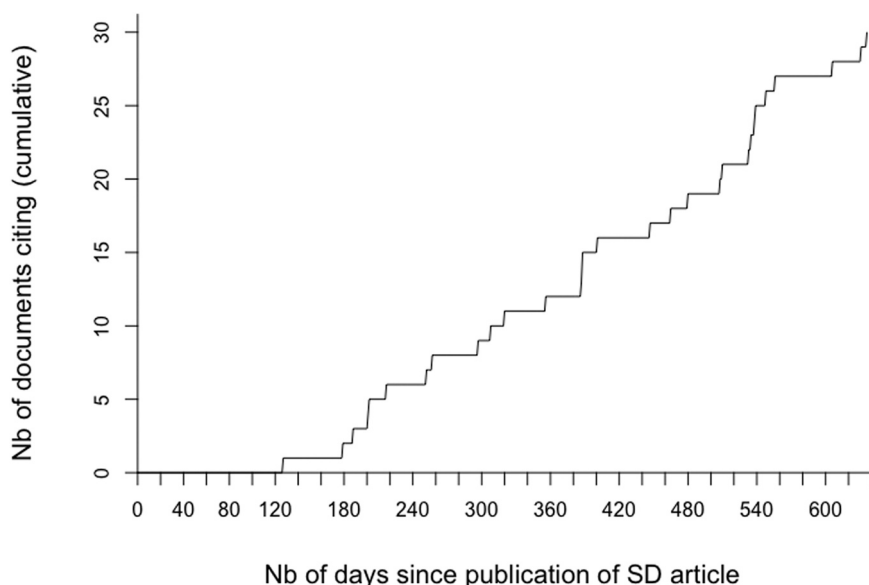


Fig. 1. Cumulative evolution of the number of documents citing the SD article (extracted from Scopus, with self-citations, $n=29$). Citations are of any types (reviews, articles, book chapters, letter to editors). Date of publication of the SD article: January 11th, 2022. Date of data extraction: October 22th, 2023. Some citing documents may have been published during the last part of this period, while still not being introduced into the Scopus database.

Table 2

Source title of journals, proceedings and books where a document has cited the SD article. Date of extraction: October 22th, 2023.

| Source title | Nb of citations |
|-----------------------------------------------------------------------------------------------------------|-----------------|
| Forensic Science International | 6 |
| Forensic Science International: Synergy | 6 |
| Australian Journal of Forensic Sciences and Justice | 4 |
| Journal of Forensic Sciences | 3 |
| Canadian Journal of Bioethics | 2 |
| Encyclopedia of Forensic Sciences: Volume 1–4, Third Edition | 1 |
| Genes | 1 |
| Proceedings of International Conference on Intelligent Systems, Advanced Computing and Communication 2023 | 1 |
| Revista Brasileira de Ciencias Policiais | 1 |
| Revista Brasileira de Direito Processual Penal | 1 |
| Sensors | 1 |
| Water (Switzerland) | 1 |
| Critical criminology | 1 |

SD article itself. Eventually a *prominent score* is an aggregate “that shows the current momentum of a Topic. It is calculated by weighing 3 metrics for papers clustered in a Topic: Citation count, Scopus views and Average *CiteScore* ». This notion of Topic is dynamic. It belongs to the *SciVal* tools and expresses, “a collection of publications with a common intellectual interest. It can be large or small, new or old, growing or declining”.⁹ In terms of Topics, the SD article has been classified as: *Forensic sciences*, *Jurors*, *Dermatoglyphics*. The *prominent score* percentile of 92.402 (August 27th, 2023) is associated to this clustering of documents. This indicator is supposed to detect the most prevalent areas where funding is the more likely to be accessible. It has hence been conceived with a strong research governance objective [27]. Once again, the SD article has been incorporated into topics that do not correspond to the delimitation of the discipline as it advocates it. Without being presented as an application of another science, projects are rarely assessed and supported on the basis of their forensic science substance.

⁹ https://service.elsevier.com/app/answers/detail/a_id/27947/supporthub/scopus/ (last access, Mai 2024)

4.8. Comparative background: FSI

The first space where it seems reasonable to situate the SD article is formed by the documents published in the same journal: *Forensic science international*.

We have decided to extract from *Scopus* all FSI’s document published between 2013 and 2022. We will also be focusing on 2021 as the period just before the SD article was published (January 11th, 2022). Limitations again relate to the definition of a forensic space (FSI is defined mostly as a legal medicine journal), evolution and whether the SD article is really comparable to other articles published in FSI.

4.8.1. Descriptions of papers published in FSI

We note the decline in the number of documents published in FSI since 2019 (Fig. 2). This could be due to the fragmentation of submissions in the previously mentioned various FSI declinations. Through *Scopus’* analytical tools, we learn that 93% of those documents are journal articles, 3,6% reviews and the remaining 3.4% are editorials, letters, erratum, book chapters, notes or conference papers.

When it comes to the analysis through a notion of “subject areas”, those documents are shown to be classified in the categories Medicine (98%) and Social sciences (1,7%) which are assumed to correspond to the more general classification system used in *Scopus*. By assumption and personal knowledge of the authors related to the content of this journal, we can nevertheless accept that the journal is relevant to research in forensic science in general. Indeed, while about half of the papers published in FSI can be classified in the subject areas of medicine (i.e. legal medicine), the remaining papers concern research in forensic science subjects unrelated to medicine

4.8.2. Citation counts: Comparisons in FSI

The bibliometric studies in the field of scientific publishing in general show that there is a certain inertia in the citation of a document Section 1 [4]. In order to get an idea of how this plays out for FSI articles, we selected publications for the years 2013, 2021 and 2022 (i.e. 10 years before, 1 year before and the same year as the SD article, respectively) (Fig. 3, Table 3).

Significant evolutions have taken place between 2013 and 2022, in terms of the quantity and diversity of journals inserted in the *Scopus* system. The methods used to collect, collate, search and process data

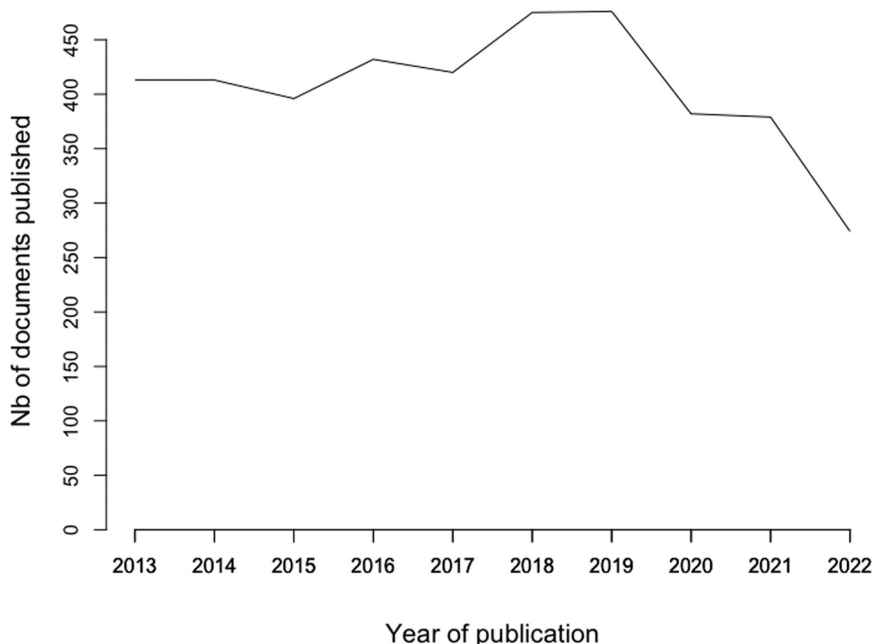


Fig. 2. Number of publications in FSI for years 2013–2022 (n = 4060). It has been generated by searching and extracting the data directly from Scopus. Date of extraction: August 13th 2023.

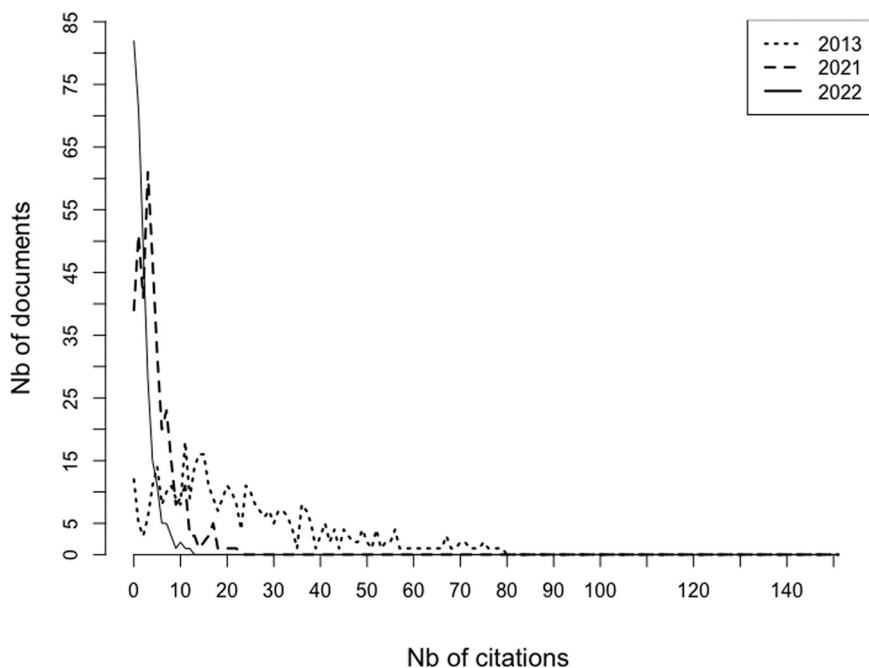


Fig. 3. Number of citations in FSI for documents published in 2013 (n = 413), in 2021 (n=379) and in 2022 (n=274). Extracted from Scopus (August 13th, 2023).

Table 3
Description of differences between 2022, 2021 and 2013.

| Forensic science International publications | 2022 | 2021 | 2013 |
|--------------------------------------------------------------------------|---------|---------|---------|
| Number of documents | 274 | 379 | 412 |
| Number of cited documents | 202 | 345 | 401 |
| Number of documents having received no citation (without self-citations) | 72 (91) | 34 (46) | 11 (12) |
| Percentage of documents having received no citation | 26% | 9% | 3% |
| Number of citations | 577 | 1927 | 10877 |
| Average number of citations per cited documents | 3 | 6 | 27 |

have also dramatically changed. Still, our data confirm that relatively "young" articles (between 1.5 and 2.5 years old) tend to receive little citations (i.e. 26% and 9% of the documents published in 2022 and 2021 have no citation to date, respectively). After ten years, the curve flattens considerably, diminishing the number of documents without any citations at all (i.e. only 3% of the papers published in 2013 have no citation). This tends to show that documents have a relatively long life, which might contradict the common sense idea that modern science takes into account only the most recent ideas and results. Self-citations and some gaming processes might also play a role. However, the number of not cited documents after 10 years is very close with or without

self-citations (i.e. 11 vs 12 not cited documents). We will not address further this hypothesis here.

Compared to the 2021 series (documents published just before the SD article), the SD article is comfortably situated in the top 1% of the most cited articles. This is a sign of strong early interest in it (a more detailed analysis of these citations is developed below).

With 30 citations, compared with documents published in FSI in 2013, the SD article is situated well above the median (19), above the average (26.1) and close to the 3rd quartile (33). The paper's destiny is still undetermined, but the signs and overall trends tend to predict an optimistic evolution in these bibliometric terms in future years.

4.8.3. Downloads

We do not have access to tools that track the number of document downloads (SciVal). However, since its publication, the SD article has appeared in the list provided by FSI's website as one of the 10 most downloaded articles over the last 90 days. In 2022, it was ranked 5th, on February 20, 2nd on March 13 and 1st on April 13. It was then ranked 7th from mid-May 2023 to October 2023.

4.9. The SD article within a forensic science literature space

We have observed that, so far, the SD article has been cited mainly by traditional forensic science journals. However, documents published in other journals, books or proceedings have also cited the paper. We assume that the publishing landscape is changing radically towards greater fragmentation [10,28]. The space for forensic research cannot therefore be limited to a single journal or to a set of traditional journals. The question is how to delimit a relevant forensic science space to situate the SD article.

4.9.1. A delineation of the forensic literature space

For many reasons developed above, such a space cannot be based on the broad categories that structure data in the Scopus database. Search criteria relating to title and abstract, as well as keywords determined by the authors themselves (author keyword) have been chosen to implement this selection/delimitation process. Visions of forensic science are so divergent that we imagine a greater commitment to the existence of a discipline (the SD article theme) when authors explicitly use terms such as "forensic science" or "forensic sciences" in these components of a

document. We will call it the "forensic science criterion". There are obviously some limits to this definition as some authors may not index their paper as a forensic science article, because they perceive a redundancy with the name of the journal. We have, moreover, no control of the way each publisher is dealing with author keywords (recommendations, policies, etc.). For instance, the proportion of documents responding to this criterion in FSI for the period 2013–2022 is 1'135 (August 27th, 2023), i.e. 28% of all the documents published in FSI. Thus, we may have lost here some relevant articles. On the other hand, it can be argued that not all articles published in FSI are entirely relevant to forensic science [10]

As discussed by Roux and al. [29], an alternative term is *forensics*, which is assumed to express a fragmented vision, more linked to another core discipline than thought as belonging to a scientific field as such (which is the theme of the SD article). However, *forensics* is also being used through *digital forensics*, which is how the new community strongly rooted in IT tends to qualify its activity. *Criminalistics* is also an historically important term, as it follows Kirk's holistic conception around the development of the School of Criminology at University of Berkeley [30]. Of course, by its objectives and content, the SD article is better situated in the context of the use of *forensic science* or *criminalistics*, rather than *forensics*.

Fig. 4 shows the evolution of results returned by searching with those different keywords.

These curves (Fig. 4) show that the *forensics* denomination is now dominant, even by separating documents that are termed as *digital forensics* by the authors. There are, however, other terms, such as *media forensics* or *information forensics and security* (IFS) that are used to delineate connected fields, which are not taken into account here. The *forensics* criterion contains hence still a strong digital flavour. Interestingly, the intersection between results obtained using the *forensic science* criterion shows little overlap with those obtained using the *forensics* criterion (i.e. only 2–7% of the papers are indexed under both criteria) (Table 4). This might support the hypothesis of two separated conceptions of the discipline [29] that has guided our choice for delineating the adequate space.

4.9.2. Journals publishing the articles retrieved by the forensic science criterion (2021)

We limit this analysis to journals producing forensic science(s)

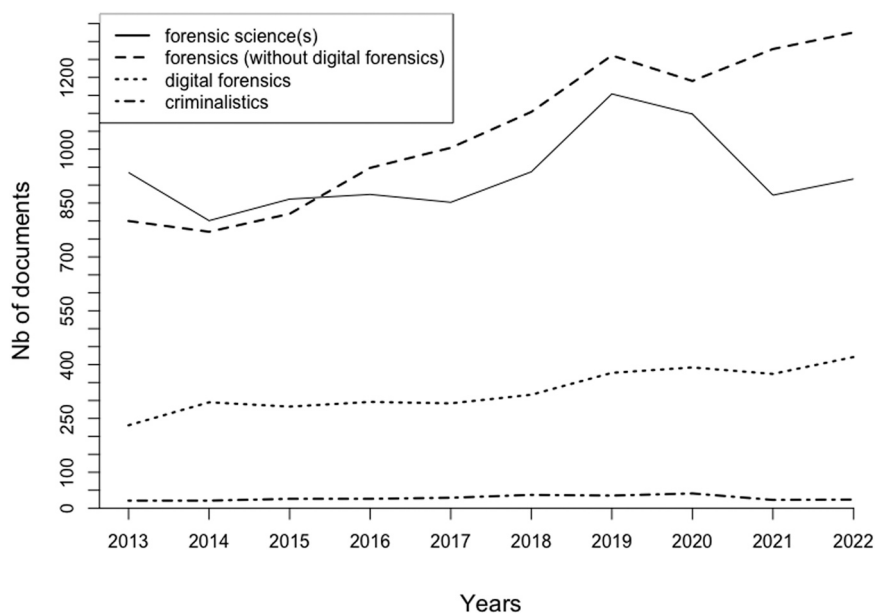


Fig. 4. Number of documents published from 2013 to 2022, using the different terms either in the title, the abstract or the keywords (extracted with the function TITLE-ABS OR AUTHKEY from Scopus. The two upper lines represent the forensics respectively forensic science criterion. Extraction August 19th, 2023.

Table 4
Intersection of results. Date of extraction: August, 19th 2023.

| Intersection | Forensic science(s) (n= 9301) | Forensics (without digital forensics) (n = 10'502) | Digital forensics (n = 3'277) | Criminalistics (n = 283) |
|---------------------|-------------------------------|----------------------------------------------------|-------------------------------|--------------------------|
| Forensic science(s) | | 640 | 140 | 83 |
| Forensics | 640 | | 0 | 27 |
| Digital forensics | 140 | 0 | | 1 |
| Criminalistics | 83 | 27 | 1 | |

articles to the year 2021. High concentrations can be observed. The *forensic science* criterion returned 872 documents in 368 sources (mainly journals). If we consider only the journals that generated 5 or more articles in 2021, this is 31 journals with a total of 435 articles (8.4% of journals account for around 50% of documents meeting the forensic science criterion). 272 journals have produced only one document (representing 31% of all documents). This confirms a very high degree of fragmentation as previously observed [10,28]. A similar analysis using the *forensics* criterion (n = 1360) shows more dispersion of the production (see Table 5). This tends again to confirm that the term *forensics* convey a different, more fragmented, vision of forensic publications. It should be noted, however, that even if documents using *digital forensics* have not been taken into account, journals using the term *forensics* that concentrate more than 5 articles during 2021 have a strong digital connotation (*Forensic science international: digital investigations, Lecture Notes in Computer Science, Advances in Intelligent Systems and Computing, Multimedia Tools and Applications*).

These results support the idea of a more integrated view of the discipline when forensic science is used in place of forensics. In this sense, the SD article could provide a stronger marker in the future for delimiting the ecosystem of forensic literature by expressing the study of trace as a fundamental tenet.

4.9.3. *Nb of authors per articles from 2013 to 2022*

The SD article is a collective endeavour. More generally, co-authorship can be expected to be used particularly in an interdisciplinary enterprise such as forensic science. Fig. 5 shows the number of documents published as a function of the number of co-authors, using the forensic science criterion, in 2013 and in 2022.

With its eleven authors, the SD article is well above the average, but, surprisingly, should not be considered an outlier, since we note that in 2022, 46 (5%) papers have been published with 11 or more authors. A slight increase in the number of authors was noted in 2022 compared to 2013 (median increased gradually during this period from 3 to 4), which tends to confirm more general observations in scientific publishing [31]. Further interpretation would require a more in-depth analysis of the different types of projects or motivations behind the documents that is out of the scope of this paper.

Table 5
Comparison of journals citing documents responding respectively to the forensic and forensics criterion.

| Forensic science criterion, 2021 n= 872 | Forensics criterion, 2021 (without digital forensics) n= 1362 |
|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 368 sources (journals) | 718 sources (journals) |
| 31 sources (8.4% of the sources) producing 5 or more documents, generating together 435 documents (50%) | 45 sources (6,2% of the sources) producing 5 or more documents, generating together 461 documents (34%) |
| 272 journals generating 1 document, covering 31% of all documents | 524 journals generating 1 document, covering 38% of all documents |

4.10. *Specific citations of the SD article*

In *Scopus*, the SD article was cited, at the end of October 2023, by 30 other documents. We have selected 21 documents by excluding self-citations from the authors (see Table 6).

First authors of these citing articles are affiliated in an organisation located in the UK (5), Brazil (3), Australia (3), Switzerland (2), the Netherland (1), Norway (1), Israel (1), Mexico (1), Seychelles (1), India (1), Canada (1), US (1). One of these authors has two affiliations, each in two different countries (Australia and Seychelles). One of these first authors, located in the Netherland, has published two documents. Four of the co-authors of all the documents appear in two articles each. The international coverage is relatively broad, even if some regions are not represented (e.g. Eastern Europe).

In the sample, the host institution of first authors is academic environments (18), police services/forensic units (2) and police forensic laboratories (2). One of these authors has an affiliation both in an academic environment and in a police organisation.

However, we have not confronted these distributions for instance with the institutions hosting authors of documents falling under the forensic science criterion.

The SD article has been cited 39 times in the 21 documents (max = 7). Most citations are in the introduction or in a conceptual section at the beginning of the document (79%). This is not surprising as the SD article mainly allows to situate each article within forensic science. This indicates that the SD article is about to become central to this function, which corresponds to a characteristic of the most influential articles in the scientific literature that tend to appear in the introduction rather than in other parts of the citation texts [4,6,7]. 18 out of the 21 documents are written in English, 2 in Portuguese and one in French.

At an epistemological level, Giovannelli [44] cites the SD article for attesting a growing interest in auto-reflections in forensic science and using it, in particular, by adopting a trace perspective in his formulation of a Theory Synthesis.

Bouzin et al. [41] points out that the conceptual framework provided by the SD article is a useful basis for switching from a focus on technologies to the essence of forensic science. This level of abstraction set, for example, a scientific ground for the development of a forensic culture, even in contexts where vast deployment of technologies is unrealistic: "The Declaration outlines a set of foundational principles for forensic science, designed to underpin practice. However, it also invites further debate and modification as part of the ongoing discussion to define and direct forensic practice into the future. We assert that the sustainable provision of forensic science must become a critical element of this international discourse. As a community, forensic science has been proactive in the development and adoption of new technologies and techniques, information sharing and data exploitation. The time has now come for us to bring together the combined knowledge of the Global North and South forensic communities with the goal of assuring sustainable, quality forensic science service provision on an international scale." [41] p.6. This view has been since endorsed further by the African Forensic Sciences Academy [3]¹⁰.

Pasquier [48] use a similar argument from the SD article to disregard the usual sterile technical narrative surrounding the use of databases in the area of forensic intelligence. For him, a well-balanced use of traces in forensic intelligence must rest on the more fundamental basis presented in the SD article.

The SD article constitute then a powerful conceptual tool for delimiting many forensic areas in the whole forensic space. This is particularly evident in Taylor's proposal. He develops the idea of forensic intelligence as an adaptation of forensic science to the evolving reality of crime and policing strategies, by citing the SD article. The trace-based definition emphasises the multi-dimensional purpose of forensic

¹⁰ <https://africanfsa.org/forensic-sciences> (last access, March 2024)

Table 6

List of the 21 documents that are citing the SD article (October 22th 2023), where it is cited and why. The distinctions are inspired from [4,5,53]. In function of the type of document, all categories do not apply. Use of the framework/definition means that the SD article is cited in order to situate a paper and for using its definitions. Noticed/supporting an argument means that the SD article is noticed in a state of the arts or supporting an argument. Applied means that the citing article situates itself as an application of the SD article.

| Citing document | Journal | Cited where | | | | | Reason for citing | | | |
|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|--------------|----------------------|---------|---------|------------------------|-------------------|------------------------------|--------------------------------|---------|
| | | Introduction | Conceptual framework | Methods | Results | Discussion/ Conclusion | TOTAL per article | Use of framework, definition | Noticed Supporting an argument | Applied |
| Advancing a paradigm shift in evaluation of forensic evidence: The rise of forensic data science [32] | FSI: Synergy | X | | | | | 1 | X | | |
| The shifting narrative of uncertainty: a case for the coherent and consistent consideration of uncertainty in forensic science[33] | Australian Journal of Forensic science | XX X | X X X | | | | 7 | X | | |
| Analysing the digital transformation of the market for fake documents using a computational linguistic approach [34] | FSI: Synergy | X X | | | | | 2 | X | | |
| The influence of investigative psychologists on the recognition and collection of evidence by forensic examiners [35] | FSI: Synergy | | X X | | | | 2 | X | | |
| Integrity, Trustworthiness, and Effectiveness: Towards an Ethos for Forensic Genetics[36] | Gene | X | X X | | | | 3 | X | | |
| How may analysis of an inner layer of clothing affect the scene reconstruction in a shooting incident? [37] | Journal of forensic sciences | X | | | | X | 2 | | | X |
| Swapping carrots for sticks: Forensic science provider views of the forensic regulator act 2021 [38] | Science and Justice | | | | | X | 1 | | X | |
| The transparency and reproducibility of systematic reviews in forensic science [39] | Forensic science international | X | | | | X | 2 | | X | |
| Methodological Guide to Forensic Hydrology [40] | Waters | | X X X X | | | | 4 | X | | |
| Mind the gap: The challenges of sustainable forensic science service provision [41] | Forensic science international | | | | | X | 1 | X | | |
| Survey on Methodological Model of IoT in Digital Forensic [42] | Proceedings conf. (2023 - ISACC) | X | | | | | 1 | X | | |
| Designing the future of forensic science: m tis and forensic intelligence [43] | Australian journal of forensic sciences | | X | | | | 1 | X | | |
| The forensics scientist craft: towards an integrative theory. Part 1: microapproach [44] | Australian journal of forensic sciences | | XX X | | | | 3 | X | | |
| Dialogue between chemistry and law: a necessary approach to drug law [45] | Revista Brasileira de Ci ncias Policiais | | | | | X | 1 | X | X | |
| “Blood, Bucks and Bias”: Reliability and biasability of crime scene investigators' selection and prioritization of blood traces [46] | Science and Justice. | X | | | | | 1 | X | | |
| Introducing a Rapid DNA Analysis Procedure for Crime Scene Samples Outside of the | Sensor. | X | | | | | 1 | | | X |

(continued on next page)

Table 6 (continued)

| Citing document | Journal | Cited where | | | | | | Reason for citing | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|--------------|----------------------|---------|---------|------------------------|-------------------|------------------------------|--------------------------------|---------|
| | | Introduction | Conceptual framework | Methods | Results | Discussion/ Conclusion | TOTAL per article | Use of framework, definition | Noticed Supporting an argument | Applied |
| Laboratory—A Field Experiment [47] | | | | | | | | | | |
| A footwear marks database in Western Switzerland: A forensic intelligence success [48] | Forensic science international | | | | | X | 1 | X | | |
| When Bacteria Make the Law: Ethical, Epistemic, Legal, Political, Social and Technical Perspectives on the Use of The Human Microbiome for Legal Purposes [49] | Canadian Journal of Bioethics, letter to the editor | | | | | | 1 | | X | |
| Forensic evidence in Criminal Procedure: the comprehension and mitigation of forensic errors as a mechanism to promote the adversarial principle, the full defense and the right to legal evidence [50] | Revista Brasileira de Direito Processual Penal | X | | | | | 1 | | X | |
| Adapting forensic case reporting to account for marginalization and vulnerability [51] | Forensic science international: Synergy | | X | | | | 1 | | X | |
| Biology and Criminology: Data Practices and the Creation of Anatomic and Genomic Body ‘Types’ [52] | Critical criminology | X | | | | X | 2 | | X | |

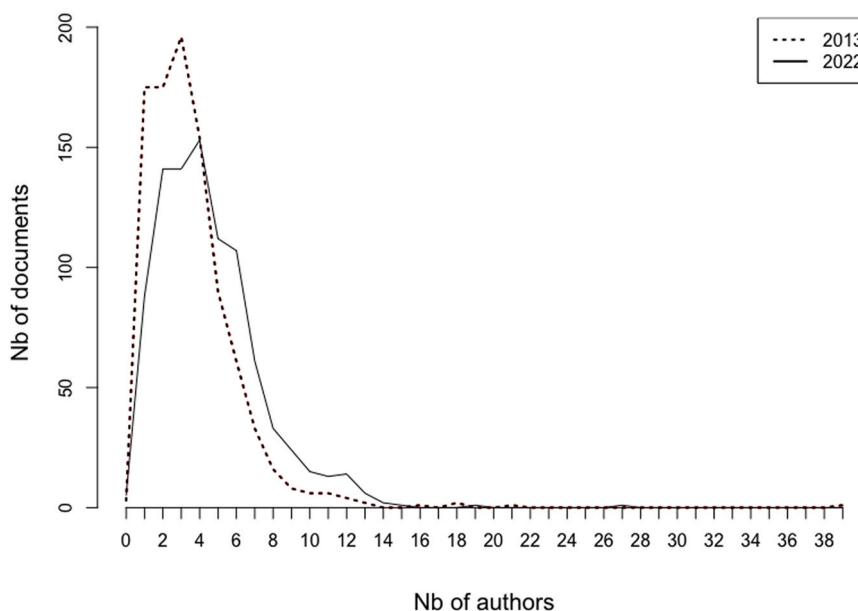


Fig. 5. Number of documents in function of the number of authors for each documents published in 2013 (n= 934) and in 2022,(n = 918), by using the forensic science criterion. This comparison tends to confirm the hypotheses that the number of authors has a little increased from 2013 (median: 3, sd: 2.61; max: 39) to 2022 (median: 4, sd 2.91; max: 21). Date of extraction from Scopus: August 27th, 2023.

science (principle 6 of the SD) and found the building of such frameworks [43].

Supporting the idea of expanding information extracted in forensic anthropology, beyond the resolution of a single case, through the detection, analysis and reporting of patterns from different situations, is another motivation for citing the same principle of the SD article. This type of analysis calls for the full potential of forensic observations to be

used in interdisciplinary work to study broader societal issues than those to which forensic science is traditionally confined [51].

The SD article was also used to propose an interdisciplinary vision, enabling the human microbiome to be taken into account holistically, when forensic applications are envisaged. This proposal incorporate ethical, epistemological, legal, political, social and technical dimensions [49]. This pivotal role of the SD article is also apparent when arguments

extend to international security, global justice systems and, ultimately, human rights [38].

In the same vein, some authors cite the SD article to argue for the necessity to develop “a strong ethos that will support the development of and adherence to professional ethics in both research and application, cementing the building of a trustworthy community and epistemic culture” [36]p.4.

From a criminological perspective critical of the use of phenotyping as a mean of visualising bodies that respond to the principle of “marking”, Kaufman and Vestad [52] use the SD article to acknowledge that forensic science is very attentive to the adequate communication of findings. They doubt, however, that beyond discussions on the methods used and communication strategies, there is a deep critical approach to the creation of anatomical markers and their impact. The authors cite the SD article in their conclusion for emphasising that a debate has started by representative of the forensic community. It opens to interdisciplinary endeavour and broader ethical reflection on the use of traces.

On another level, the SD article highlights the omnipresence of uncertainty in forensic science, making it an epistemological subject in its own right [33]. In this sense, the concept of trace defined in the SD article, with its intrinsic incompleteness, help situate arguments by expressing uncertainties as a continuum in the reconstruction process (principle 5 of the SD article) [33].

Rodrigues and Bruni [45] cite the SD article in relation to their study of the articulation between science and justice. Drawing on practice and scientific literature, they show how the translation of scientific findings into legal terms when analysing potentially illegal substances is a source of misunderstanding and tension. This articulation requires an in-depth understanding of the whole forensic process with its levels of interpretation.

The SD article was also used for situating an emerging field (forensic hydrology) as a forensic area, by making analogies and systematically comparing specific methodologies with the definition and the seven principles [40].

The article also contributed to study how a particular case has been logically processed. In particular, it helped to situate in forensic terms the methodology and reasoning applied throughout the treatment of the case, notably by highlighting the importance of considering the crime scene as a scientific endeavour belonging to the whole chain, and forensic activities as case-based [37]. This citation underlines a crucial aim of the SD article, namely, to make sense of practices. It opens the way to numerous possibilities for using the SD article as a framework, to guide the development and implementation of forensic processes, to situate the crime scene at its heart, and to design operational training and education programs.

The SD article also enabled to integrate different partners around a common definition in forensic terms of a problem that requires the use of linguistics to process massive traces concerning the dissemination of false documents on the Internet [34]. In a similar vein, the SD article also played a key role in supporting de Roo et al.’s [35] argument for the use of knowledge in psychology at the crime scene, as part of an interdisciplinary endeavour.

The citation of the SD article was less central, for example, to recognise a movement of self-reflection that does not yet sufficiently stimulate, guide and reduce disparities in the elaboration of reviews in forensic science [39], or in attesting to the importance of considering the human factor in forensic evaluations [50].

The SD article has also been used for definition purpose, such as in Morrison [32] (footnote) who distinguishes different terms and refer to the “trace” as a generic notion.

Finally, by discussing methodological model of IoT in digital forensic science, Roy et al. [42]p.1 cite the SD article in the following way: “Meanwhile, forensics elucidated as the “application of scientific methods and techniques to matters under investigation by a court of law”. This latest citation expresses a link between a digital field and the

principles and thus, it is welcome. However, beyond using *forensics*, it fails to grasp the central argument of the SD article which is to refocus attention on the trace, as an atomic object of study, rather than insisting on the technological dimension, which often contains little transversality. In the Interpol literature reviews 2019–2022 related to the digital aspects, there is an encouraging observation that “digital forensics, now increasingly being referred to as digital forensic science, has reached a threshold of maturity both as computer science and forensic science” [54]. This observation is still not evident in the data we have collated, but obviously entirely in line with the direction promoted by the SD article.

5. Conclusion

The 21 documents we have analysed may create the impression of addressing disparate and seemingly unrelated subjects, given the current fragmented view of forensic science. Nevertheless, all of them cite the SD article to convey the forensic foundation of their arguments. Consequently, this approach permits us to step back from the fragmented debates that have been ongoing for at least the past fifteen years [13]. Models on uncertainties, the human factor and biases, quality management, and organisational choices, including the positioning and organisation of forensic activities in justice and security systems, as well as ethics, reporting, and the integration or decentralisation of technologies, all share a common scientific foundation. Forensic science can now provide the basis to underpin the political, legal, economic, and societal challenges involved in tracing human behaviour.

Unfortunately, the SD article has not yet been the subject of serious and constructive criticism in the literature. Moreover, it may occasionally be perceived as expressing “obvious things”.

This indifference and misunderstanding of the challenges ahead augurs an uncertain future for forensic science and the SD article. It remains unclear how the discipline will resist to the centrifugal forces present in forensic science, which are exacerbated by the publishing landscape’s structure. It is crucial to follow whether, conversely, the SD article is helping to shape the ecosystem of forensic literature focused on the foundations of a discipline.

CRediT authorship contribution statement

Olivier Ribaux: Project administration, Software, Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis, Investigation, Methodology. **Céline Weyermann:** Methodology, Validation, Writing – review & editing, Conceptualization, Data curation, Formal analysis. **Kevin Lopes Fernandes:** Conceptualization, Investigation.

Declaration of Competing Interest

The authors have no conflict of interest to mention.

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