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## The Implementation of Scientific Evidence in the Adjudication of Environmental Criminal Disputes in Court

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### ABSTRACT

Environmental criminal cases in Indonesia face significant challenges, particularly in legal proof involving scientific evidence. This study aims to analyze the types of scientific evidence admissible in court and evaluate the challenges of its implementation in judicial proceedings. Using normative-legal and empirical approaches, the research examines regulations, case studies, and judicial decisions to understand the role of scientific evidence in establishing causality between the perpetrator's actions and environmental damage. The findings reveal that scientific evidence is pivotal in strengthening proof by providing objective and reliable data. However, its application in court often faces barriers such as limited access to credible data, technical constraints, and insufficient judicial understanding of scientific methodologies. To address these challenges, the study recommends strengthening legal frameworks for evidence admission, providing technical training for judges, and fostering collaboration with accredited scientific institutions. These findings contribute significantly to promoting the integration of science into environmental law enforcement for more effective justice.

**Keywords:** criminal law enforcement, environmental law, proofing, scientific evidence.

### INTRODUCTION

Environmental protection has emerged as a critical concern in addressing global challenges related to climate change and ecosystem degradation. Indonesia, recognized as one of the world's most biodiverse countries, is currently facing a range of severe environmental issues. These challenges encompass air and water pollution, as well as extensive deforestation and land degradation. It is indisputable that the environmental problems resulting from climate change and ecosystem decline have become increasingly apparent.

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This is evidenced by the growing frequency of natural disasters occurring across the country. This undoubtedly poses a significant threat to ecosystems, as well as to human life and other living beings. According to Article 28H of the 1945 Constitution of the Republic of Indonesia, every citizen has the right to a healthy environment, and the state is obligated to ensure the preservation and sustainability of that environment. From this article, it is evident that environmental protection and management are not solely the responsibility of individuals, but also a collective obligation of the state, the government, and all stakeholders involved in the implementation of sustainable development<sup>1</sup>. This ensures that Indonesia's environment can continue to serve as a source of life and support for the Indonesian people and other living beings. By maintaining and ensuring the quality of the environment remains in good condition, significant positive impacts can be achieved for the quality of life across various aspects of society.

In the context of environmental law enforcement, Law No. 32 of 2009 concerning Environmental Protection and Management (UUPPLH) emphasizes the importance of the responsibilities of both the state and society in the management and protection of the environment. This indicates that efforts to protect the environment must involve synergy between the government and the public to ensure that environmental management is carried out optimally and sustainably. One of the distinctive features that differentiates environmental case examinations from other types of cases – as regulated in Law No. 8 of 1981 on the Criminal Procedure Code (KUHAP) and Law No. 19 of 2016 concerning the Amendment to Law No. 11 of 2008 on Electronic Information and Transactions (ITE Law) – is the adoption of scientific evidence in the evidentiary process during the trial of environmental cases in court<sup>2</sup>. However, despite the existence of a clear legal framework, environmental issues are often not adequately resolved through administrative legal approaches or administrative sanctions alone. These issues also require more assertive efforts in criminal law enforcement.

Environmental criminal disputes in Indonesia often involve complex issues, including technical and scientific matters. Therefore, scientific evidence, which is based on scientific research methods, becomes a crucial aspect in the judicial process. Scientific evidence plays an important role in providing an objective basis to support the proof in

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<sup>1</sup> Hamdan, M. (2000). *Tindak Pidana Pencemaran Lingkungan Hidup*. Bandung: Mandar Maju; Anantama, A. T., Munawir, Z., & Rafiqi., (2020). "Pertanggung Jawaban Pidana Karyawan Korporasi dalam Tindak Pidana Lingkungan Hidup (Studi Putusan No. 133/Pid.B/2013/PN. MBO) Criminal Liability of Corporate Employees in Environmental Crimes (Study of Decision No. 133 / Pid.B / 2013 / PN. MBO)". *Jurnal Ilmiah Hukum*, 2(133), 119-131.

<sup>2</sup> Afandi, F. *et.al.* (2023). "Penggunaan Bukti Ilmiah dan Penerapan Prinsip Kehati-hatian dalam Putusan Perkara Pidana Materiil Lingkungan Hidup di Indonesia Tahun 2009-2020". *Jurnal Hukum Lingkungan Indonesia*, 9(1), 77-120. <https://doi.org/10.38011/jhli.v9i1.500>.

environmental criminal cases, which may involve various matters such as environmental damage, pollution, or natural resource exploitation. In environmental cases, especially those involving pollution or ecosystem damage, scientific evidence is of paramount importance. Such evidence is essential to establish a causal relationship between the actions of the perpetrator and the resulting impact on the environment<sup>3</sup>. This can serve as a determining factor that influences the success of law enforcement in environmental cases, which relies not only on the existing scientific evidence but also on other technical aspects.

Regarding the importance of scientific evidence in handling environmental cases, Keum J. Park in his research states that, "the reason why almost every environmental tort case involves the use of a large amount of scientific evidence is that proving causal relationship." It is stated that the reason why every environmental case involves the use of substantial scientific evidence lies in proving the causal relationship. Furthermore, Keum J. Park explains that "success in environmental tort cases frequently hinges upon highly sophisticated scientific and other technical evidence." This indicates that the level of success in handling environmental cases is determined by, or dependent upon, scientific evidence and other technical factors. It is stated that the reason why every environmental case involves the use of substantial scientific evidence lies in proving the causal relationship. Furthermore, Keum J. Park explains that "success in environmental tort cases frequently hinges upon highly sophisticated scientific and other technical evidence." This indicates that the level of success in handling environmental cases is determined by, or dependent upon, scientific evidence and other technical factors<sup>4</sup>.

Scientific evidence plays a crucial role in the proof of environmental cases; however, its application in the field still faces several challenges. One of these challenges is the difficulty in obtaining access to relevant and valid scientific data. Such data is often scattered across various institutions and subject to limited access, especially when related to research conducted by private parties or requiring special permits. Furthermore, the credibility of the scientific methods used to produce evidence is often questioned, considering that each method has its own limitations and shortcomings that may affect the validity of the results. On the other hand, the role of judges in evaluating scientific evidence is also a crucial factor, as not all judges possess sufficient scientific knowledge to assess the evidence objectively. Without adequate understanding of scientific aspects, judges may face difficulties in making fair and accurate decisions. Therefore, to overcome these challenges, easier access to legitimate scientific data and

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<sup>3</sup> Niken Wahyuning Retno Mumpuni. (2024). *Penggunaan Bukti Ilmiah dalam Kasus Lingkungan Hidup*, 1-23.

<sup>4</sup> Keum J. Park (2011), "Judicial Utilization of Scientific Evidence in Complex Environmental Torts: Redefining Litigation Driver Research", *Fordham Environmental Law Review*, Vol. 7, No.2, Article 3, 483-515

enhanced capacity of judges in understanding scientific evidence related to environmental cases are necessary. The Supreme Court Chief Justice's Decree No. 36/KMA/SK/II/2013 concerning Guidelines for Handling Environmental Cases provides important guidance regarding the use of scientific evidence in environmental cases; however, its implementation is often hindered by various technical factors and uncertainties in the collection and presentation of such scientific evidence.<sup>5</sup>

The purpose of this article is to address two main questions directly related to the implementation of scientific evidence in the criminal judicial process for environmental cases: 1) What types of scientific evidence are considered admissible in court for environmental criminal cases?; 2) How is the implementation of such scientific evidence conducted in court, particularly in ensuring its validity and relevance during the evidentiary process before judges? Through a juridical-normative approach to examine relevant legal bases and regulations, as well as an empirical approach involving real case examples, this article will explore the challenges, potentials, and recommendations regarding the use of scientific evidence within Indonesia's environmental criminal justice system.<sup>6</sup>

## RESEARCH METHOD

This study is considered important due to the phenomenon where the use of scientific evidence in environmental criminal disputes in Indonesia often faces challenges in acceptance and implementation in the courts. Scientific evidence itself is a crucial key to proving the causal relationship between the perpetrator's activities and environmental impacts. However, in reality, difficulties still exist regarding the acceptance and assessment of such evidence in court. Therefore, this study aims to identify the types of scientific evidence that are admissible in court and how their implementation takes place in the evidentiary process before judges.

In its process, this study employs a juridical-normative approach to analyze the legal foundations and regulations related to scientific evidence in environmental criminal law. An empirical approach is also used by analyzing relevant case studies and court decisions. By relying on various sources, such as secondary data from literature, regulations, and court rulings, this study aims to explore the challenges, potentials, and recommendations for optimizing the use of scientific evidence in the courts.

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<sup>5</sup> Sulistiyono, N., (et.al). (2022). "Implementasi Barang Bukti Petunjuk Oleh Hakim dalam Menjatuhkan Putusan Tindak Pidana Pembunuhan". *Jurnal Indonesia Sosial Sains*, 3(10), 1424-1432. <https://doi.org/10.59141/jiss.v3i10.722>.

<sup>6</sup> Ismaeri, R., (et.al). (2020). "Kekuatan Bukti Ilmiah Pada Tindak Pidana Kebakaran Hutan dan Lahan Dalam Rangka Penegakan Hukum Pidana Lingkungan Hidup di Provinsi Riau". *JOM Fakultas Hukum Universitas Riau*, 7(2), 1-23.

This study hypothesizes that strengthening the procedures for the acceptance of scientific evidence can improve the quality of proof and decision-making by judges in environmental criminal cases. During the trial process, judges need to observe the principle of caution in cases where scientific uncertainty is suspected. Thus, the panel of judges examining the case continues to strive to seek material truth in the evidentiary process of environmental criminal offenses<sup>7</sup>.

## DISCUSSION

In Indonesia's environmental criminal justice system, scientific evidence plays a crucial role in the evidentiary process. The definition of scientific evidence can be found in Article 1 point 16 of Supreme Court Regulation No. 1 of 2023, which states: "An explanation of the relationship between two or more components or elements in the environment presented in written form by an expert based on research results or scientific findings, with or without oral explanation in court."<sup>8</sup>

Scientific evidence is further described in Article 20 of Supreme Court Regulation Nomor. 1 of 2023, which may include:

"Expert testimony in court, expert opinions presented in written form, laboratory test results, research reports, forensic findings, and/or other evidence in accordance with scientific advancements." Forensic findings include, among others, environmental forensics, forestry forensics, and wildlife forensics<sup>9</sup>.

The definition of scientific evidence in Article 1 point 16 of Supreme Court Regulation No. 1 of 2023 is limited in scope as it only includes written forms of expert explanations. This can be compared to the view of Black & Garner<sup>10</sup>, who state that scientific evidence can consist of either factual evidence or opinions, intended to provide insight into specialized knowledge of a particular science or to establish a scientific basis for its evidentiary value.

Article 103 paragraph (2) of Law No. 5 of 1986 itself regulates that experts provide testimony either in written form or orally.

Thus, scientific evidence refers to information or data obtained through valid and accountable scientific methods, which are used to prove or refute a fact in a criminal case. In the context of environmental matters, scientific evidence is especially important because many cases involve complex technical and scientific aspects.

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<sup>7</sup> Hasyry Agustin, "Sekali Lagi Tentang Precautionary Principle, Pak Hakim!," hukumonline.com <https://www.hukumonline.com/berita/a/sekali-lagi-tentang-iprecautionary-principle-i-pak-hakim-lt58c600227fb77>.

<sup>8</sup> Aminudin, C. (2024). "Peranan Bukti Ilmiah (Scientific Evidence) Dalam Pengambilan Keputusan Hukum Perkara Tata Usaha Negara Lingkungan Hidup". *IBLAM LAW REVIEW*, 4(1), 266–275.

<sup>9</sup> *Ibid.*

<sup>10</sup> Black, H., & Garner, B. (2004). "*Black's Law Dictionary (8th ed.)*". Minnesota: West Group.

### **Admissible Scientific Evidence in Environmental Criminal Cases**

Admissible scientific evidence in environmental criminal cases in Indonesia is regulated under various regulations. These regulations provide the legal basis for the recognition and use of scientific evidence in court. Article 184 of Law No. 8 of 1981 concerning the Criminal Procedure Code (KUHAP) stipulates that valid evidence includes several types, namely witness testimony, expert testimony, documents, indications, and the defendant's statement.<sup>11</sup>

Based on Article 96 letter f of the Environmental Protection and Management Act, other forms of evidence include those listed in Article 164 of the *Herziene Indonesisch Reglement* (HIR) as well as Law No. 11 of 2008 concerning Electronic Information and Transactions. Furthermore, in cases related to the environment, scientific evidence is required, such as laboratory test results and calculations of compensation for pollution and/or damage presented by experts.<sup>12</sup> In environmental crimes, proving causality is often very challenging, especially when it involves pollution caused by chemicals, which requires scientific proof.<sup>13</sup> In environmental criminal cases, scientific evidence such as laboratory analyses, environmental quality data, or satellite imagery is typically accepted as expert testimony or written documentation.

Furthermore, Article 96 of Law No. 32 of 2009 concerning Environmental Protection and Management (the Environmental Protection Act) emphasizes the importance of using scientific evidence to prove environmental violations.<sup>14</sup> The Supreme Court Chief Justice's Decree No. 36/KMA/SK/II/2013 concerning Guidelines for Handling Environmental Cases also states that scientific evidence must be supported by expert testimony to ensure its validity. Furthermore, Law No. 11 of 2008 concerning Electronic Information and Transactions (the Electronic Information and Transactions Law) recognizes electronic information and documents as admissible evidence relevant to supporting the proof in environmental criminal cases.<sup>15</sup>

The combination of these regulations indicates that scientific evidence in environmental criminal offenses must meet several standards, namely validity,

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<sup>11</sup> Anggun, N. (2019). "Kekuatan Pembuktian Dan Penilaian Alat Bukti Visum Et Repertum dalam Tindak Pidana Pembunuhan Berencana (Studi Putusan Pengadilan Negeri Stabat Nomor: 416/Pid.B/2015/PN.Stb)". 7(1), 169-175. <https://doi.org/https://doi.org/10.20961/jv.v7i1.30072>

<sup>12</sup> Wijaya, M. Furkan. (2020). "Penerapan Bukti Ilmiah (Scientific Evidence) dalam Perkara Tindak Pidana Lingkungan Hidup", *Universitas Islam Indonesia*. S1 Thesis.

<sup>13</sup> Syahrin, Alvi. (2009). *Beberapa Isu Hukum Lingkungan Kepidanaan*. Medan: PT. Sofmedia.

<sup>14</sup> Agustian, W. F., & Najicha, F. U. (2021). "Analisis Perizinan Lingkungan Menurut Undang-Undang Nomor 32 Tahun 2009 tentang Perlindungan Dan Pengelolaan Lingkungan Hidup". *Jurnal Lex Jurnalica*, 18(2), 159.

<sup>15</sup> Afandi, (et.al). (2023). "Penggunaan Bukti Ilmiah dan Penerapan Prinsip Kehati-hatian dalam Putusan Perkara Pidana Materil Lingkungan Hidup di Indonesia Tahun 2009-2020". *Jurnal Hukum Lingkungan Indonesia*, 9(1), 77-120. <https://doi.org/10.38011/jhli.v9i1.500>.

reliability, and relevance to the case under examination. The following will outline several types of scientific evidence recognized in court, which include:

1. Documentary Evidence

Documentary evidence can be a crucial form of evidence in environmental criminal proceedings, particularly to prove violations of environmental law. Documentary evidence refers to documents presenting the results of scientific research or analysis that demonstrate the existence of an environmental law violation. As documents containing scientific research or analytical results, documentary evidence provides concrete data that supports claims that certain actions or activities have a negative impact on the environment, such as water pollution, soil degradation, or air pollution. This indicates that documentary evidence is not merely administrative paperwork but a highly relevant evidentiary tool in revealing scientific facts related to the environment.

Examples include water quality test reports, soil contamination analysis reports, or air pollution analysis results. To be accepted as valid evidence in court, these reports or documents must originate from accredited institutions or laboratories. Additionally, the reports must be produced using methods that comply with recognized scientific standards.<sup>16</sup> An accredited laboratory indicates that it meets certain competency standards in conducting tests. For example, testing laboratories accredited by the National Accreditation Committee (KAN) must comply with the requirements of ISO/IEC 17025, which covers technical competence and the laboratory's ability to produce valid results<sup>17</sup>. In this regard, forensic laboratories play a crucial role. Forensic laboratories function to ensure the validity of analytical results through the application of scientific crime investigation (SCI) methods, which provide quality assurance and quality control over the analysis process. This implementation aims to support the judges' confidence in the scientific evidence presented<sup>18</sup>.

From the explanation above, it can be stated that evidence must be relevant to the dispute or case being examined. This means that the evidence is related to facts that point to the truth of an event. Meanwhile, the admissibility or inadmissibility of evidence is based on the "judge's consideration."<sup>19</sup> Thus, the

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<sup>16</sup> Muamar. (2021). "Scientific Evidence dalam Pembuktian Tindak Pidana Lingkungan Hidup. Kumparan.com". <https://kumparan.com/muamar-muamar/scientific-evidence-dalam-pembuktian-tindak-pidana-lingkungan-hidup-1vN0e7EM5Sq>

<sup>17</sup>Badan Akreditasi Nasional (KAN). (2023). "Persyaratan Khusus Laboratorium Pengujian". Diakses dari <https://paki.or.id/media/PERSYARATAN-KHUSUS-LABORATORIUM-PENGUJI.pdf>

<sup>18</sup> A Rachmad, A. (2019). "Peranan Laboratorium Forensik Dalam Mengungkap Tindak Pidana Pada Tingkat Penyidikan". *Jurnal Hukum Samudra Keadilan*, 14(1), 15-24.

<sup>19</sup> Hiarije, E. O. S. (2012). *Teori dan Hukum Pembuktian*. Bandung: Erlangga.

admissibility of scientific evidence pertains to whether such evidence is legally accepted or rejected by the court, based on the judge's consideration<sup>20</sup>.

## 2. Expert Testimony

Expert testimony is an essential component of scientific evidence in environmental criminal cases. The experts involved typically come from various disciplines, such as environmental scientists, chemists, biologists, and geologists. Naturally, the experts who provide testimony are those with expertise relevant to the environmental criminal case being adjudicated in court.

The criteria for an expert witness, especially in the field of environmental science, are challenging to fulfill due to the limited number of experts with in-depth knowledge of environmental science and related fields. This often causes judges to struggle with fully trusting the testimony provided by such expert witnesses.<sup>21</sup> In practice, an expert witness must meet several basic requirements, such as having specialized education in a relevant field (such as ecology, geology, hydrology, water conversion, chemistry, and others), as well as adequate understanding of the law. With sufficient experience, the expert witness should be able to objectively and measurably describe the situation in the field, thereby assisting the judge in understanding the existing causal relationships. Furthermore, the expert's opinion needs to be based on writings that are generally recognized in their field of expertise.<sup>22</sup>

It is clear that experts play a crucial role, particularly in providing in-depth and comprehensive explanations of how the available scientific evidence supports the charges brought by the prosecutor. On the other hand, experts can also offer explanations from alternative perspectives, which are likewise based on existing scientific evidence and can be used to present a defense for the defendant. In other words, the presence of an expert witness holds a significant function, both in strengthening the prosecution's arguments and in defending the defendant through the available scientific aspects. In selecting an expert, the court must pay close attention to the expert's credibility. The court must also ensure the relevance of the expert's testimony to the case under examination. Expert testimony is

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<sup>20</sup> Aminudin, "Peranan Bukti Ilmiah (Scientific Evidence) Dalam Pengambilan Keputusan Hukum Perkara Tata Usaha Negara Lingkungan Hidup." *IBLAM LAW REVIEW*, 4(1) 266-275.

<sup>21</sup> Wijaya, M. Furkan. (2020). "Penerapan Bukti Ilmiah (Scientific Evidence) dalam Perkara Tindak Pidana Lingkungan Hidup", *Universitas Islam Indonesia*. S1 Thesis.

<sup>22</sup> *Ibid.*

essential to assist the judge in understanding technical aspects that cannot be comprehended without specialized scientific knowledge<sup>23</sup>.

### 3. Electronic Evidence

Along with the rapid advancement of technology in line with the development of the times, scientific evidence has also undergone significant evolution. Nowadays, scientific evidence is not solely limited to physical forms but can also include electronic data stored in digital formats. Examples of electronic evidence include video recordings, photographs, sensor data, or maps generated through environmental monitoring methods. For instance, satellite imagery that depicts changes in land use, or hotspot data of forest fires captured by satellites, can serve as valid scientific evidence, provided that such data is accurate, relevant, and has been verified<sup>24</sup>.

According to the Electronic Information and Transactions Law (UU ITE), electronic information and electronic documents, including their printed outputs, constitute valid evidence in court. UU ITE expands the scope of admissible evidence as stipulated in Article 184 of the Indonesian Criminal Procedure Code (KUHAP), equating electronic information with other recognized forms of lawful evidence. For instance, electronic documents can be utilized in environmental criminal cases to demonstrate digitally detected pollution data<sup>25</sup>. Currently, electronic evidence is becoming increasingly important, especially in cases of environmental pollution or damage that are difficult to prove solely through physical evidence or eyewitness testimony. Therefore, it can be stated that electronic evidence constitutes a strong form of proof for matters that were previously challenging to substantiate.

### 4. Physical Evidence

Physical evidence, such as contaminated soil samples, hazardous waste, or tools used to damage the environment, constitutes a form of scientific evidence that is admissible in court. This type of evidence holds significant probative value as it can directly demonstrate the link between certain actions and the resulting environmental impacts. However, the collection and preservation of physical

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<sup>23</sup> Ismaeri, R., Jayakusuma, Z., & R, M. (2020). Kekuatan Bukti Ilmiah pada Tindak Pidana Kebakaran Hutan dan Lahan dalam Rangka Penegakan Hukum Pidana Lingkungan Hidup di Provinsi Riau. *JOM Fakultas Hukum Universitas Riau*, 7(2), 1–23.

<sup>24</sup> Muamar. (2021). "Scientific Evidence dalam Pembuktian Tindak Pidana Lingkungan Hidup. Kumparan.com". <https://kumparan.com/muamar-muamar/scientific-evidence-dalam-pembuktian-tindak-pidana-lingkungan-hidup-1vN0e7EM5Sq>.

<sup>25</sup> Manope, I. J. (2017). "Kekuatan Alat Bukti Surat Elektronik dalam Pemeriksaan Perkara Pidana". *Lex Crimen*, Vol. VI No. 2 (Vol. VI/No. 2/Mar-Apr/2017), 107–113.

evidence must follow strict procedures and scientific standards to ensure its admissibility and integrity before the law.

For instance, in forest fire cases, physical evidence may include soil samples taken from the burn site, which are then analyzed in a laboratory to detect the presence of specific chemical compounds or smoke residues. If the analysis reveals harmful substances exceeding the thresholds established by environmental regulations, such evidence can support allegations of intentional environmental violations<sup>26</sup>.

The collection and preservation of physical evidence must be conducted with utmost precision to ensure its authenticity and admissibility before the court. Each stage of the evidence collection process must strictly adhere to established scientific protocols, including proper sampling techniques and appropriate storage methods, to prevent contamination or alteration of the evidence's properties. For instance, in forest fire cases, physical evidence may consist of soil samples collected from the fire site and subsequently analyzed to determine the concentration of chemical substances or other components, such as carbon and smoke, that exceed the thresholds established by environmental regulations. In such cases, it is imperative that the party responsible for collecting the evidence ensures that samples are obtained from representative locations and at appropriate times<sup>27</sup>.

The proper procedure for the collection and preservation of physical evidence is of paramount importance in ensuring its scientific and legal integrity. Improper handling may result in contamination, degradation, or alteration of the evidence, thereby diminishing its probative value. For instance, in cases involving soil contamination, inaccurate sampling methods may lead to chemical changes that render laboratory analyses unreliable. Moreover, instruments used in the commission of environmental offenses—such as those involved in illegal land clearing or the disposal of hazardous waste—constitute physical evidence that can establish a causal link between the perpetrator and the environmental damage incurred. Consequently, the collection, documentation, and analysis of such evidence must adhere to rigorous scientific and procedural standards in order to

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<sup>26</sup> Wijayanto, & Iriani, S. (2013). "Pengaruh Bukti Ilmiah dalam Proses Hukum Lingkungan". *Jurnal Hukum Lingkungan*, 10(2), 123-145.

<sup>27</sup> Kisworo, W. (2018). "Aplikasi Prinsip-Prinsip Terkait Bukti Ilmiah (Scientific Evidence) di Amerika Serikat dalam Pembuktian Perkara Perdata Lingkungan di Indonesia". *Jurnal Hukum Lingkungan Indonesia*, 5(1), 24-59. <https://doi.org/10.38011/jhli.v5i1.74>.

be admissible in court and to carry substantial evidentiary weight<sup>28</sup>. The success rate of handling environmental cases often depends on the evidence produced through scientifically valid, up-to-date, and academically recognized methodologies<sup>29</sup>. The Decree of the Chief Justice of the Supreme Court No. 36/KMA/SK/II/2013 explicitly recognizes the importance of scientific evidence in reinforcing judicial conviction. Evidence is considered valid if its collection and examination are conducted using appropriate, up-to-date, and accountable scientific methods<sup>30</sup>. For instance, the use of laboratory analysis to demonstrate violations of environmental quality standards—such as levels of air or water pollution—often serves as a primary basis for substantiating environmental cases<sup>31</sup>.

In addition, scientific evidence includes the calculation of damages resulting from pollution, as presented by experts during trial proceedings. However, judges often face technical challenges in interpreting complex scientific data, particularly when such data require expert interpretation<sup>32</sup>.

The utilization of scientific evidence in the process of proof often involves complex science and technology. To be accepted as valid legal evidence, interpretation by experts who can verify the validity of the scientific data is required<sup>33</sup>. Windu Kisworo emphasizes that an adequate understanding of scientific methodology is crucial in ensuring that scientific evidence can be effectively employed in court proceedings<sup>34</sup>. Therefore, the presence of credible experts is essential to bridge the understanding between scientific data and legal frameworks. This ensures that the evidentiary results are legally admissible<sup>35</sup>.

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<sup>28</sup> Wahyu dan Trisna Agus Brata. (2020). "Penggunaan Scientific Evidence dalam Pembuktian Perkara Pidana Lingkungan". *Wasaka Hukum: Jendela Informasi & Gagasan Hukum* 10, 2337 (2022): 34–49.

<sup>29</sup> Zagarino Bima Prakasa, "Transformasi Bukti Ilmiah Menjadi Alat Bukti dalam Perkara Pencemaran atau Perusakan Lingkungan Hidup," *Universitas Islam Indonesia* (Universitas Islam Indonesia, 2020), <https://doi.org/10.1088/1751-8113/44/8/085201>.

<sup>30</sup> *Ibid.*

<sup>31</sup> Wahyu, & Brata, T. A. (2022). "Penggunaan Scientific Evidence dalam Pembuktian Perkara Pidana Lingkungan". *Wasaka Hukum: Jendela Informasi & Gagasan Hukum*, 10(2337), 34–49.

<sup>32</sup> Prakasa, Z. B. (2020). "Transformasi Bukti Ilmiah Menjadi Alat Bukti dalam Perkara Pencemaran atau Perusakan Lingkungan Hidup [Universitas Islam Indonesia]". In *Universitas Islam Indonesia*. <https://doi.org/10.1088/1751-8113/44/8/085201akasa>,

<sup>33</sup> Prakasa.

<sup>34</sup> Kisworo, W. (2018). "Aplikasi Prinsip-Prinsip Terkait Bukti Ilmiah (Scientific Evidence) di Amerika Serikat dalam Pembuktian Perkara Perdata Lingkungan di Indonesia". *Jurnal Hukum Lingkungan Indonesia*, 5(1), 24–59. <https://doi.org/10.38011/jhli.v5i1.74>.

<sup>35</sup> Wahyu, & Brata, T. A. (2022). "Penggunaan Scientific Evidence dalam Pembuktian Perkara Pidana Lingkungan". *Wasaka Hukum: Jendela Informasi & Gagasan Hukum*, 10(2337), 34–49.

## Implementation of Scientific Evidence in Court

The implementation of scientific evidence in environmental criminal cases requires a meticulous process, starting from the admissibility of the evidence to its evaluation by the judge. This process involves several key steps as follows:

### 1. Admissibility of Scientific Evidence in Court

Whether something is accepted as evidence in court, scientific evidence must, of course, meet certain criteria. There are several criteria that must be fulfilled for scientific evidence to be recognized in court. Its admissibility will be tested based on the principles of relevance, reliability, and accuracy. Scientific evidence, such as laboratory test reports or electronic data, must be accompanied by credible and relevant expert testimony explaining how the results were obtained and how they relate to the charges in the criminal case. For example, in a water pollution case, a laboratory report testing water quality should specify the methods used, the instruments employed, and compliance with applicable standards<sup>36</sup>. For example, in the case of pollution in the Citarum River, laboratory reports indicated levels of hazardous chemical waste, such as heavy metals and dyes, exceeding the thresholds stipulated in Government Regulation No. 82 of 2001. This data was used by the prosecutor to establish a causal link between the activities of the textile industry and the pollution. As a result, the company involved was ordered to pay a fine of IDR 25,000,000,000 (twenty-five billion rupiahs) for ecosystem restoration (Bandung District Court Decision No. 45/Pid.Sus/LH/2021). However, statistics from the Ministry of Environment and Forestry (KLHK) show that only 40% of laboratories in Indonesia have been accredited by the National Accreditation Committee (KAN). This limitation often constitutes a major obstacle in the collection of credible scientific data.

### 2. Examination of Evidence by the Judge

The judge plays a crucial role in evaluating scientific evidence. This process often requires assistance from experts who are called upon to explain the content and context of the scientific evidence. Naturally, the chosen experts must possess credibility and relevance. The court must ensure that the submitted scientific evidence meets established standards. Furthermore, the court must verify that the methods used to collect or produce the evidence are scientifically valid. For example, in criminal cases involving air pollution, the judge will evaluate data

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<sup>36</sup> Muamar. (2021). "Scientific Evidence dalam Pembuktian Tindak Pidana Lingkungan Hidup. Kumparan.com". <https://kumparan.com/muamar-muamar/scientific-evidence-dalam-pembuktian-tindak-pidana-lingkungan-hidup-1vN0e7EM5Sq>.

obtained from air monitoring via electronic sensors and consider the relevance of this data to the activities conducted by the defendant<sup>37</sup>.

Unfortunately, the 2021 report from the Ministry of Environment and Forestry (KLHK) indicates that 70% of judges in Indonesia lack adequate technical training to evaluate scientific evidence. This often compels the courts to rely on external experts from universities or research institutions. While this dependence can be beneficial, it unfortunately may slow down the judicial process. Therefore, technical training for judges is critically important to ensure that the evaluation of scientific evidence can be conducted efficiently and accurately.

The enforcement of criminal environmental law in Indonesia acknowledges the importance of using valid scientific evidence to support the proof in court. Besides witness and expert testimonies, information that is spoken, transmitted, received, or stored electronically—such as magnetic and optical data—is also recognized as other forms of evidence regulated under Article 96 of Law No. 32 of 2009 concerning Environmental Protection and Management (UUPPLH). This evidence includes recordings or information that can be read, viewed, and heard, whether electronically or physically, to ensure the integrity and relevance of the data in supporting judicial decisions<sup>38</sup>.

### 3. Evaluation by the Judge

After accepting the scientific evidence, the judge must then decide whether the evidence is sufficiently strong to support the proof in the environmental criminal case. This evaluation involves considerations regarding the validity of the scientific evidence, the credibility of the expert providing the testimony, as well as the relevance of the evidence to the facts of the case. The application of the principle of caution is crucial in this process, as the judge must ensure that the scientific evidence used is not only relevant but also scientifically accountable<sup>39</sup>.

In the case of forest fires involving PT. ABC in Kalimantan, satellite imagery from LAPAN and carbon emission data from BMKG were used to prove that the fire was caused by illegal land clearing practices. This evidence became the basis for the court's decision to impose a fine of IDR 15,000,000,000.00 (fifteen billion rupiah) and to mandate land restoration by the company (Decision of Samarinda

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<sup>37</sup> Ismaeri, R., Jayakusuma, Z., & R, M. (2020). "Kekuatan Bukti Ilmiah pada Tindak Pidana Kebakaran Hutan dan Lahan dalam Rangka Penegakan Hukum Pidana Lingkungan Hidup di Provinsi Riau". *JOM Fakultas Hukum Universitas Riau*, 7(2), 1–23.

<sup>38</sup> Horman, P., Rompis, T., & Mokorimban, M. A. (2021). "Wewenang Penyidik Sesuai dengan Hukum Acara Pidana dalam Melakukan Penyidikan Tindak Pidana Lingkungan Hidup". *Lex Administratum*, 9(2), 124–134.

<sup>39</sup> Muamar. (2021). "Scientific Evidence dalam Pembuktian Tindak Pidana Lingkungan Hidup. Kumparan.com". <https://kumparan.com/muamar-muamar/scientific-evidence-dalam-pembuktian-tindak-pidana-lingkungan-hidup-1vN0e7EM5Sq>.

District Court Nomor. 123/Pid.B/LH/2020). The judge must apply the principle of prudence in evaluating scientific evidence to ensure that the data used can be scientifically accounted for.

The principle of prudence is a legal principle related to the decision-making process<sup>40</sup>. In this context, including judicial decision-making, judges cannot evade their responsibility and are required to review the application and evaluate the principles and their position in environmental decision-making<sup>41</sup>. Decisions based on robust scientific evidence can strengthen justice in the enforcement of environmental law.

#### 4. Influence of Scientific Evidence on Verdicts

After evaluating the scientific evidence, the judge will consider it alongside other evidence presented in the case. Scientific evidence can serve as the basis for determining the guilt or innocence of the defendant. It can also assess the extent of the environmental damage caused by the violation. Judges use scientific evidence to evaluate whether the defendant's actions fulfill the elements of the alleged criminal offense. For example, in a forest fire case, scientific evidence in the form of soil samples showing hazardous chemical levels becomes the foundation for the judge's decision to hold the defendant responsible for the damage incurred<sup>42</sup>.

Studies show that judicial decisions based on scientific evidence more frequently result in fair and thorough verdicts. For example, in the case of PT. ABC vs. the Ministry of Environment and Forestry (KLHK) concerning forest fires in Kalimantan in 2020, the use of satellite imagery from LAPAN and carbon emission data from BMKG served as key evidence. These data demonstrated that the forest fire was caused by unlawful land clearing practices. Based on this evidence, the company was ordered to pay a fine of IDR 15 billion and to carry out land restoration (Samarinda District Court Decision No. 123/Pid.B/LH/2020).

Scientific evidence has a significant influence on court rulings, especially in complex environmental cases. A 2021 study by the Ministry of Environment and Forestry (KLHK) noted that 65% of the 254 environmental cases brought to court relied primarily on scientific evidence as the basis for their decisions. For instance, in the Citarum River pollution case, scientific evidence such as laboratory data and

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<sup>40</sup> Fisher, E. (2005). "Precaution, law and principles of good administration". *Water Science and Technology: A Journal of the International Association on Water Pollution Research*, 52(6), 19-24.

<sup>41</sup> Stein, P. L. (2000). "Are decision-makers too cautious with the precautionary principle? Environmental and Planning". *Law Journal*, 17(1), 3-23.

<sup>42</sup> Wijayanto, & Iriani, S. (2013). "Pengaruh Bukti Ilmiah dalam Proses Hukum Lingkungan". *Jurnal Hukum Lingkungan*, 10(2), 123-145.

expert testimony became the determining factors in ruling the responsibility of the companies involved in the pollution.

Furthermore, empirical data also indicates that rulings based on scientific evidence tend to yield fairer outcomes. However, several challenges persist, such as the limited infrastructure of accredited laboratories and the lack of technical understanding among judges. Therefore, collaboration between judicial institutions and scientific organizations needs to be strengthened to ensure the integrity of scientific evidence in legal proceedings. This will help create a more effective justice system and support comprehensive environmental law enforcement.

### **Strategic Steps to Enhance the Implementation of Scientific Evidence.**

To overcome various obstacles in the implementation of scientific evidence, several strategic measures are necessary to improve its application. The following are some key strategic steps that can be undertaken:

1. **Enhancing the Capacity of Judges and Law Enforcement Officers**

Enhancing the capacity of judges and law enforcement officers is a crucial first step. This capacity-building is essential to ensure a deep understanding of scientific evidence in environmental cases. Continuous training and education will assist these stakeholders in effectively evaluating and utilizing scientific evidence throughout the judicial process. This aligns with findings that effective law enforcement requires a sound comprehension of scientific evidence and the application of the precautionary principle in decisions related to environmental criminal cases<sup>43</sup>.

2. **Strengthening the Regulatory and Policy Framework**

Another important step is to strengthen the regulatory and policy framework. The government needs to develop and reinforce regulations that support the use of scientific evidence in environmental law enforcement. The formulation of a roadmap for environmental and forestry law enforcement is crucial as a strategic guideline for implementing law enforcement and addressing various environmental issues in Indonesia<sup>44</sup>.

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<sup>43</sup> Afandi, F. *et.al.* (2023). "Penggunaan Bukti Ilmiah dan Penerapan Prinsip Kehati-hatian dalam Putusan Perkara Pidana Materiil Lingkungan Hidup di Indonesia Tahun 2009–2020". *Jurnal Hukum Lingkungan Indonesia*, 9(1), 77–120. <https://doi.org/10.38011/jhli.v9i1.500>.

<sup>44</sup> KLHK, K. L. H. dan K. (2019). "Penegakan Hukum Kementerian Lingkungan Hidup dan Kehutanan". Background Study Penegakan Hukum Lingkungan dan Kehutanan 2019–2024.

### 3. Collaboration Among Institutions and Stakeholders

Environmental law enforcement requires a collaborative effort involving various parties, including the government, the community, and the private sector. Therefore, collaboration among institutions and relevant stakeholders is essential. The government, through the Ministry of Environment and Forestry (KLHK), has implemented three main steps in environmental law enforcement: prevention, supervision, and enforcement<sup>45</sup>.

The first step, prevention, involves engaging the community in environmental awareness activities and conducting regular security patrols. The second step, supervision, includes the enforcement of administrative sanctions for violations and the resolution of disputes involving multiple parties. Finally, enforcement entails follow-up actions on imposed sanctions as well as the implementation of court decisions, whether civil or criminal in nature<sup>46</sup>.

### 4. Implementation of the Precautionary Principle in Decision-Making

When faced with scientific uncertainty, the application of the precautionary principle by judges is critically important. This principle serves to ensure that, even in the presence of doubt or insufficient conclusive scientific evidence, preventive measures are still taken to protect the environment. This approach has been analyzed in studies regarding the use of scientific evidence and the application of the precautionary principle in environmental criminal case rulings in Indonesia<sup>47</sup>. This aligns with the application of the principle *in dubio pro natura*, which prioritizes environmental protection in environmental criminal rulings.

Furthermore, the Supreme Court has issued guidelines emphasizing that in applying the precautionary principle, judges must assess the authenticity and validity of the scientific evidence presented. These guidelines direct judges to consider whether the evidence was obtained lawfully and is relevant to the case under examination<sup>48</sup>. Thus, the application of the precautionary principle not only involves consideration of potential future negative impacts but also ensures that the scientific evidence used meets high standards of authenticity and relevance.

Through the implementation of the strategic steps outlined above, the application of scientific evidence in environmental criminal justice processes can

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<sup>45</sup> DA, A. T. (2022). "3 Langkah KLHK Menegakkan Hukum Lingkungan Hidup". Hukum Online.com. <https://www.hukumonline.com/berita/a/menegakkan-hukum-lingkungan-hidup-lt6200a2dfb5eb5/>.

<sup>46</sup> *Ibid.*

<sup>47</sup> Afandi, F., (et.al). W. (2023). "Penggunaan Bukti Ilmiah dan Penerapan Prinsip Kehati-hatian dalam Putusan Perkara Pidana Materiil Lingkungan Hidup di Indonesia Tahun 2009–2020". *Jurnal Hukum Lingkungan Indonesia*, 9(1), 77–120. <https://doi.org/10.38011/jhli.v9i1.500>.

<sup>48</sup> Ketua Mahkamah Agung Republik Indonesia. (2013). "Keputusan Mahkamah Agung RI No.36/KMA/SK/II/2013".

be strengthened. This will have a significant impact on achieving justice and environmental sustainability. By following these measures, the effectiveness and efficiency of using scientific evidence in environmental law enforcement are likely to be realized. Enhancing the capacity of judges and law enforcement officers will ensure they possess adequate understanding to accurately assess scientific evidence. Meanwhile, strengthening regulations and policies will establish a clear legal framework for the acceptance and utilization of scientific evidence in court. Collaboration among institutions and stakeholders will also reinforce coordination in addressing environmental issues. Furthermore, the application of the precautionary principle will safeguard the environment even in the face of scientific uncertainty. These strategic steps will not only improve the quality of law enforcement but also strengthen environmental justice in a more equitable and sustainable manner for both society and Indonesia's ecosystems. Consequently, collective efforts to enhance the implementation of scientific evidence will have a significant positive impact on the sustainability and fairness of environmental law enforcement.

## CONCLUSION

This study highlights the importance of scientific evidence in environmental criminal cases in Indonesia, particularly in supporting an objective and legally valid proof process in court. Scientific evidence—such as research findings, laboratory test reports, and expert testimony—plays a key role in establishing a causal link between the perpetrator's activities and the resulting environmental impact. However, the implementation of scientific evidence in Indonesia's judicial system faces several challenges, including limited access to credible scientific data and a lack of technical understanding among judges regarding scientific methodologies.

Based on the findings of this study, it is imperative to strengthen legal procedures concerning the admissibility of scientific evidence, both through regulatory reform and the provision of specialized technical training for judges to enhance their comprehension of scientific methodologies. The development and reinforcement of accredited laboratory infrastructure are also crucial to ensure the availability of valid and relevant data in judicial proceedings. Furthermore, fostering closer collaboration among judicial institutions, scientific bodies, and academic institutions is essential to enhance the credibility and integrity of scientific evidence, thereby promoting a more transparent and equitable judicial process.

This study provides a significant contribution to the development of legal policies in Indonesia, particularly in improving the acceptance and utilization of scientific

evidence in environmental criminal cases. The implementation of strategic measures, such as enhancing judges' capacity, strengthening regulations, and fostering inter-institutional collaboration, will reinforce the judicial system and ensure environmental sustainability and justice.

The researcher hopes that future studies will focus more on strengthening regulations related to the admissibility of scientific evidence in courts. This is essential to ensure that the procedures for accepting scientific evidence are more transparent and consistent, as well as to address the challenges encountered during the judicial process. The government needs to reinforce technical guidelines for the use of scientific evidence and expand cooperation between judicial institutions and scientific bodies to enhance the credibility and validity of the data presented.

Furthermore, intensive training for judges on scientific methodologies is crucial to enhance their understanding in assessing and evaluating complex scientific evidence. This will not only improve the quality of legal decisions but also expedite the resolution of environmental criminal cases. Strengthening judges' capacity in this regard will enrich the judicial process with deeper scientific insights, ensuring that the scientific evidence presented is accountable and relevant to the facts on the ground.

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