

## EDITORIAL

## Shifting Evidence: The Impact of Climate Change on Forensic Medicine

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Climatic change which is causing abrupt changes in weather patterns has become a major cause of concern over the past several years as it has affected multiple facets of the nature and human lives. Amidst the several fields which have been impacted forensic science is one area which too got impacted by swinging climate change patterns. This has led to challenges in the functioning of forensic investigation as well and requires development of few tangible and adjustable means to ensure the standard and reliability of forensic techniques. This editorial tries to examine the various ways in which forensic investigative process is affected by the changes of climatic patterns as well as to explore the means which can be used to mitigate these challenges.

### Rate of decomposition and calculation of time since death:

One of the main effects of climate change on the methods used in forensic investigations has been identified as variations in the pace of decomposition. The amount of time after death, or the autopsy interval (PMI), is one of the most important aspects of forensic pathology. Previous research indicates that PMI is influenced by several important elements.<sup>1</sup> Recent trends from the southern hemisphere of the globe suggest that the PMI and the time since death are highly impacted by climate variations. Furthermore, there's a good chance that day-to-day temperature changes observed in temperate regions would yield inaccurate results if replicated elsewhere.<sup>1,2</sup>

The estimation of the Postmortem Interval (PMI) may be challenging due to unpredictable climate patterns brought about by climate change, which include higher temperatures and varying amounts of precipitation. Additionally, certain postmortem processes, like the decomposition rate, may be greatly impacted by climate changes.

Elevated temperatures have the potential to accelerate the decomposition process by stimulating the growth of bacteria and insects, both of which are essential to the body's breakdown process. Conversely, this approach may be hindered by an unanticipated drop in temperature or changes in humidity. Due to these conditions, conventional techniques for estimating PMI which rely on historical data and common environmental standards may also become less reliable. Therefore, forensic experts should develop and update new techniques that consider the changing climate by using real-time environmental data to increase accuracy.

Temperature variations will have an impact on some important methods, as those employed in the recovery of human remains. For example, the differences in temperature between the air around an active maggot mass and the surrounding air are the primary focus when using thermal imaging to locate human remains.<sup>3</sup> Therefore, there's cause for concern that this technique's efficacy might be impacted by rising ambient temperatures.

**Safeguarding the evidence:** The preservation of forensic evidence is also impacted by climate change. Blood, semen, and saliva are examples of biological evidence that are prone to

changes in their surroundings. DNA profiling has proven to be incredibly useful for forensic investigators and law enforcement in both identity verification and crime investigation.<sup>4</sup> Samples are frequently taken from crime scenes for DNA analysis, which is used for paternity testing and human identification from human remains.<sup>5</sup>

When surfaces are left outside, where average temperatures and relative humidity are 18.8°C, 71% at night and 24.1°C, 63% during the day, DNA cannot survive on them for as long as it can in the lab when they are left in the dark and at room temperature.<sup>6</sup> In an investigation, Lee et al.<sup>7</sup> discovered that DNA was more durable on a range of surfaces under controlled settings, such as 19–25°C and 50–77% relative humidity, as opposed to higher temperatures (22–34°C) and 50–99% relative humidity, under uncontrolled conditions. Furthermore, physical integrity of non-biological evidence might be affected by climate change. For example, extended droughts and rising temperatures may cause wildfires to occur more frequently, which may destroy outdoor crime scenes and evidence. In a similar vein, evidence that is exposed to heat and sunshine for an extended amount of time may deteriorate. The development of resilient evidence preservation systems and procedures that can withstand the effects of climate change is required considering these environmental challenges.

**Evolving aspects of Forensic Entomology:** Another field that is rapidly being impacted by climate change is forensic entomology, which is the study of insect activity on decomposing remains. Climate change will affect all the various fields of entomology, which include forensic, veterinary, and agricultural. The effects of climate change on forensic entomology have already been discussed. For instance, Atencio-Valdespino and Collantes-González discussed alterations to entomological distributions in the context of Panama's emerging profession.<sup>8</sup>

When calculating PMI, the consistent succession of insect species on a corpse is a significant consideration. On the other hand, several insect species are seeing changes to their seasonal patterns and geographic ranges due to rising global temperatures. The effects of species extinction because of shifting settings are one of the difficulties entomologists faces.<sup>9</sup>

Certain species that were previously believed to be unique to tropical areas have been discovered in temperate zones, and other species are adapting their reproductive strategies. Because the current models are based on established species patterns, these modifications may introduce errors into forensic entomological examinations. As a result, forensic entomologists need to carry out continual research to record these modifications and modify their techniques.

**Implications for the Study of Aquatic Forensics:** The phenomena of climate change pose specific challenges for forensic investigations involving aquatic environments. Changing salt levels, increasing sea levels, and warmer water can all influence the disintegration of corpses in water. The

distribution and activity of marine organisms that aid in decomposition are likewise impacted by these changes in the environment. Forensics specialists must adapt their methods to account for these variations. This entails developing methods for estimating PMI in aquatic settings. To construct comprehensive models that accurately depict the current and future conditions of aquatic environments, it may be necessary to integrate data from the fields of hydrology, climate science, and marine biology.

**Strategies to adjust forensic investigations to the changing climate:** The forensic expert community must be proactive and interdisciplinary to address the many challenges posed by climate change. Some strategies to mitigate the impact of climate change on forensic investigations include the following:

**More Accurate Environmental Tracking:** Forensic teams should use advanced environmental monitoring equipment to collect data on temperature, humidity, and other relevant characteristics at crime scenes in real time. With the use of this data, forensic models can be altered, and PMI and other important estimations' accuracy can be raised.

**Collaboration Across Disciplines:** Experts such as climatologists, entomologists, forensic scientists, and others must work together. Forensic procedures can be enhanced to better account for environmental changes through information sharing and the integration of specialists from many fields.

**Continuous Learning and Instruction:** To stay abreast of the latest discoveries and advancements regarding climate change and its implications for forensic science, experts in the field of forensic medicine must stay informed. Regular training sessions and seminars help ensure that practitioners have the necessary skills to adapt to evolving situations.

**Creation of Novel Technology:** Financial support for the development and use of novel forensic technology is vital. This includes powerful data analysis software, complex DNA preservation techniques, and inventive methods for recreating crime scenes in dynamic environments.

**Changes to the Protocol and Policy:** Forensic agencies should review and amend current policies and procedures to account for the consequences of climate change. This means developing methods for obtaining and storing evidence during extreme weather and ensuring that forensic practices are resilient to environmental disruptions.

**To sum up:** The impact of climate change on forensic investigations is one novel subject that requires immediate

attention. The community of forensic experts must adapt to changing conditions to maintain the precision and consistency of its methods. Forensic specialists should embrace interdisciplinary collaboration, continuous education, and technological innovation to overcome these challenges and continue providing essential insights into criminal investigations. The stakes are so high that there has never been a more urgent need for adaptable, creative solutions. Together, the forensic science community can continue to advance justice in a world that is always evolving while also adapting to the effects of climate change.

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Introduction to the author of the editorial:

My name is Dr. Dipayan Deb Barman and I am currently the Associate Dean of Research and Professor, as well as the Head of the Department of Forensic Medicine and Toxicology at Shri Sathya Sai Medical College & Research Institute in Tamil Nadu. My primary concentration is on forensic toxicology and clinical forensic medicine services. In the near future, I see a promising opportunity to combine forensic medicine with sciences like as bioinformatics, epigenetics, and artificial intelligence. This convergence promises major advances and potential for novel research and practical applications in the field.

