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MARINE FORENSICS- A NECESSITY

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ABSTRACT

Crimes are being committed on the land as well as in the sea. The modus operandis of crime has become quite complex. It has become increasingly difficult to apprehend criminals and offenders in the marine environment. The efforts required in this direction need more stringent maritime laws and the use of marine forensics methods in the investigation of crime. Some emerging problems of the occurrence of crimes in marine environment have been highlighted in the present paper along with possible remedies on the basis of marine forensics. The discussions in the paper led the authors to state that marine forensics is a necessity all over the globe and more so in India.

Keywords: Marine Forensics, Marine Environment, Oil spillage, Sea mammals, Suffocation, Illegal smuggling etc.

INTRODUCTION

Marine Forensics can be defined as the branch of forensic science which helps in the investigation of criminal cases pertaining to the marine life and the marine environment. It can also be called to be the scientific study of the incidents or accidents involving water bodies including oceans, streams, rivers, lakes, ponds, swimming pools, dams and other water reservoirs. Precisely, the term marine forensics is applied to the law enforcement for the protection of fisheries, marine mammals and other endangered species of aquatic or marine animals, it can be called as a field of study that applies forensic science principles to investigate crimes and accidents that occur in marine environments. This includes crimes such as piracy, smuggling, and illegal fishing, as well as accidents such as shipwrecks and oil spills. By using techniques such as DNA analysis, chemical analysis, and ballistics, marine forensics can provide critical evidence to support legal and regulatory actions.

APPLICATIONS OF MARINE FORENSICS

Marine forensics is helping the world in several ways by proving to be an aid in combatting illegal activities such as smuggling, illegal poaching of marine mammals, piracy etc., and by analyzing evidence marine forensics can help the investigators and the authorities identify and prosecute criminals and discourage others from engaging in such activities. The field also helps to protect the environment by

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investigating episodes such as oil spills and forms of pollution. Marine forensics in this regard can help in identifying the origin of the pollution and further helping in improving safety measures and preventing the same from occurring in future.

The field can also majorly contribute in advancing the scientific knowledge about marine ecosystems and how human intervention is causing an impact to the same and thus suggest measures by which changes can be made to protect and preserve the marine life.

In general, marine forensics plays an important role in protecting the environment, promoting safety, and combating illegal activities in marine environments, which in turn can benefit the world as a whole.

WHY MARINE FORENSICS SHOULD BE USED?

There are diverse reasons why there is a need to give more emphasis to marine forensics:

- Growing importance of the marine environment: The marine environment is becoming increasingly important due to the growth of global trade, fishing, and tourism. As a result, there is a greater need to protect the marine environment and to investigate crimes and accidents that occur in this environment.
- Unique challenges of marine investigations: Investigating crimes and accidents that occur in the marine environment presents unique challenges, such as the difficulty of collecting and preserving evidence in a corrosive and unpredictable environment. Marine forensics provides specialized knowledge and techniques to address these challenges.
- Increasing Environmental Contamination: The marine environment is under increasing threat from pollution, overfishing, and climate change. By investigating incidents of pollution and other forms of environmental damage, marine forensics can help to protect the marine environment. [1]

CONCERNS AND DISCUSSIONS

It is high time that Marine Forensics should be paid much attention upon so as to support the enforcement of our nations law in order to protect the marine mammals, fisheries resources and most importantly the endangered species. India lacks in Forensic analysis of marine species and there is a need to establish marine forensic units in order to protect the marine life.

India has a vast coastline approximating 7,516.6 km[2] along the Arabian sea in the west and the Bay of Bengal in the east. Gujarat is the only state in India with the longest coastline of around 1600 km holding large diversity of habitats, coral reefs, wetlands, sea grasses, mangroves and is home to a large number of marine species.[3]

With the growing number of marine crimes like illegal smuggling of animals and plants, drug trafficking, carrying of illegal weapons and artillery, fishing or sailing in unauthorized areas, discharging of pollutants in ocean waters, maritime piracy etc.…, the marine life as well as the human life is at a higher risk and it is high time that proper laws and rules should be implemented and scientific analysis should be carried out so as to protect the country from such losses. Maritime security should be improved and proper forensic investigations and scientific examinations should be carried out so as to know the origin of the crime, level of damage caused and measures that can be taken to protect the marine, human life and countries economy from these odious crimes.

Apart from this Maritime Frauds are also increasing day by day with a few being on the top list like Cargo and Documentary frauds, Bunkering frauds, Blackmailing frauds, Cyber frauds, Marine Insurance frauds etc, forensic scientific analysis and document examinations should be carried out to check on the various frauds occurring and identify the areas where the country is lagging and provide high security in those areas so as to prevent further losses.[4]

Several other systems like Bill of Ladings Electronic Registration Organisation (BOLERO) should be introduced in the country to ease the use of E-Bills as a part of Blockchain and make it available for everyone in the loop thus making it possible to eliminate the frauds in paper bills of ladings.[5] Other frauds like manipulation and adulteration in fuels and cyber attacks should be scientifically analyzed and important measures should be taken so as to catch the culprit and avoid further damage due to these crimes.

With the enormous increase in the marine crimes, forensics can play a key role in enforcing the treaties and laws that can protect the marine life. This can apprehend the offenders under maritime laws and put them forward for punishments.

A forensic investigator can be of a great help in solving issues related to various types of marine accidents like Offshore Oil Rig Mishaps, Commercial

Fishing Mishaps, Tugboat Accidents, Cargo and Crude Oil tanker accidents, Crane Mishaps, and many more by identifying its root cause and avoiding the reoccurrence of the incident by conducting proper forensic testing and metallurgical analysis of the shipwrecks.[6] Laboratory testing of the subject should be conducted to determine the strength, chemistry, ductility and composition of the subject material so that advanced measures can be taken for the hypothesized circumstances. A careful examination and good detective work can help in avoiding marine crimes and furthermore prevent hazards.

Environmental forensics plays a major part in the protection of marine life. A Forensic scientist can be of big help in investigating the various contaminants being released in the waters by using various techniques and instruments like High Resolution Gas Chromatography and Mass Spectrometry[7] Brazil, in September 2005 and effect a preliminary geochemical survey of this environment. A combination of bulk analytical parameters, such as carbon isotope (δ13C, High Performance Liquid Chromatography, Size-exclusion HPLC, Infrared Spectroscopy (IR), Ultraviolet (UV), Supercritical Fluid Chromatography (SFC) and Fluorescence Spectroscopy, Thin-Layer Chromatography (TLC), Isotope Ratio Mass Spectrometry, and Gravimetric methods for the identification of the toxic contaminants and differentiating between the anthropomorphic and anthropogenic contaminants and also identify the marine oil pollution and its spill source.[8] including recognition of relative distribution patterns of petroleum hydrocarbons, analysis of 'source-specific marker' compounds, determination of diagnostic ratios of specific oil constituents, isotopic analysis, and several other emerging techniques. The issue of how biogenic and pyrogenic hydrocarbons are distinguished from petrogenic hydrocarbons is also addressed. Finally, the example of the Exxon Valdez spill is reviewed to illustrate how complex hydrocarbon mixtures were identified and allocated to multiple sources by using these advanced chemical fingerprinting techniques.",",container-title":"Journal of Chromatography A","DOI":"10.1016/S0021-9673(99

Other generic forensic techniques can also be put into use for Contaminants Age Dating of the underground storage tanks.[9] Forensics can also be used for the identification of chemicals released in the oceans and seas like chlorinated solvents, pesticides, fungicides and gasoline additives etc to determine its toxicity level and the amount of damage it is causing to the marine life so that necessary actions can be taken against the ones who are the root cause of the vandalization. Microscopy techniques are other alternatives that can be used for the screening of microfibers and microplastics present in the seabed sediments that are causing extensive pollution in the environment and contaminating the marine life.

With the growing years there is a rapid hike in the crimes related to animal cruelty, poaching, trade of flora and fauna, illegal collection of marine life etc and it's a need that forensic DNA analysis be put into more use for the investigation of these crimes.[10]but is rapidly gaining importance and is increasingly being applied to caseworks, in compliance with the laws on the conservation, protection, and welfare of wildlife and to warrant animal rights. Crimes against animals are currently widespread worldwide, being a huge source of income for criminals when wildlife trade and poaching of exotic, rare, protected or threatened species are concerned. At small geographic scale, poaching and illegal harvest of wild animals can rage on endemic populations of high conservational value; thus significantly affecting local biodiversity. DNA analysis is now becoming an essential tool available to law-enforcement authorities, and is increasingly crucial for assigning the responsibility of crimes against animals. Typically, methods and procedures of wildlife DNA analysis are originally developed for animal genetic research and only subsequently are they transferred to forensic frameworks. As in human forensics, for caseworks where wildlife is involved, investigations start with the collection of evidence on the crime scene. Biological samples are then submitted to different molecular methodologies for DNA testing, depending on the queries posed by the law enforcement. In wildlife forensics, DNA analysis is mostly requested to identify: unknown species from parts of animals that have lost their identifying morphological features; gender, when animal crimes are sex-specific; single individuals for matching DNA profiles between 358seized carcasses and biological traces from poaching sites; population of origin when the species is protected in one area of its distribution and not in another; paternity/maternity and family relationships to ascertain whether captive-bred individuals are possessed legally or wild-caught animals have been unlawfully removed from their habitats. Operationally, PCR-based DNA amplification, sequencing, fragment analysis and single nucleotide polymorphisms analysis are currently the most popular techniques

in wildlife forensic laboratories, even though new approaches like whole-genome sequencing through next-generation sequencing technology, are rapidly making their way. Standardization and validation of procedures, quality assurance, and biostatistical treatment of molecular data, following in the footsteps of human forensics, are playing an increasingly important role in wildlife DNA forensics, especially in the view of admissibility of forensic results as scientific evidence in court.","container-title":"Forensic DNA Analysis","ISBN":"978-1-00-304302-7","note":"number-of-pages: 28","publisher":"Apple Academic Press","title":"Wildlife Forensics: DNA Analysis in Wildlife Forensic Investigations","title-short":"Wildlife Forensics","author":[{"family":"Lorenzini","given":"Rita"},{"family":"Garofalo","given":"Luisa"}],"issued":{"date-parts":[["2021"]]}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"} Around 20,000 marine species are listed in the International Union for Conservation of Nature (IUCN) red list[11] currently of threatened species and it's a need that we save them to save the planet.

Species identification is a must in these cases in order to identify from where the particular samples originated from using various techniques and Next Generation Sequencing technologies. Animal cruelty, Epidemiology, Illegal collection of livestock, poaching etc can be well identified using STRs.

Forensic evidences can be used to prosecute cases involving hunting/poaching of endangered marine animals by conducting autopsies to know what caused an animal's death. Analyzing the tissue and blood samples, conducting DNA tests can help in studying the possible reasons for the death of the animal. Seafood frauds can also be investigated using the DNA testing so as to identify whether the ingredients mentioned on the label matches in original or not and hence can keep a track on the illegal trade of the protected species of fishes.

Release of industrial effluents in the water bodies is also a major concern as it is polluting the water and ultimately releasing harmful chemicals and heavy metals in it which again effects the overall food-chain and ecosystem. Forensic toxicological analysis of the metals should be carried so as to know what are the metals effecting the wildlife and hence necessary measures can be taken to protect them and needed action can be taken against the ones who are the root cause.

Not only DNA but even trace evidences like hair, nails, fins and other animal trails should be investigated and demonstrative evidences need to be looked upon which are mostly overlooked and proper crime scene processing and further recognition of the case factor should be carried out. When these measures will be implemented and proper processing will be carried out then only the marine life can be protected and forensics can be called as one weapon towards protection of the species.

Protection of marine mammals, fisheries resources and endangered species was drafted under the Marine Mammal Protection Act (MMPA) of 1972 enacted on October 21 by USA[12]. This act was enacted due to the increased concerns related to marine species, when the marine mammals started declining enormously due to human interventions. Marine Mammal Commission, National Oceanic & Atmospheric Fisheries (NOAA) and United States Fish and Wildlife Service are a few federal entities which shares the responsibilities of protecting Marine life under the MMPA, it was focused towards the conservation of marine life by bringing down the harassment, capturing, killing and hunting of the marine mammals, along with this it also aimed towards producing "maximum sustainable yield".

The amendment of MMPA took in 1992 in order to include the Marine Mammal Health and Stranding Response Programs considered as the Title IV which ratifies the emergency responses, monitors the health conditions of mammals in affliction and also investigates the marine mammals unusual mortality events. The Title IV was further amended in the year 2000 in contemplation to incorporate the John H. Prescott Marine Mammal Rescue Assistance Grant Program which allows the data collection from the dead or living abandoned animals[13]. India too has taken initiative towards protection of wildlife through the Wildlife Protection Act of 1972[13] which protects some species of marine animals but however needs to be expanded in respect of other species.

Marine Forensics also involves the investigation of various accidents or incidents that occur in the oceans and seas. The investigators investigate the various problems occurring in the water bodies being it from collisions to marine pollution etc. Typical marine incidents or the accidents that commonly occur and are investigated and analyzed by the marine forensic

scientists includes the ship generated suction accidents, vessel induced damages, groundings, cargo damage or loss, weather related incidents, maneuvering, sea keeping, mooring etc.

Oceans are considered as the massive water bodies on earth. As with the growing population, pollution is also at a hike marine pollution has also become a concern with stretching out of harmful and dangerous substances like plastic, agricultural and industrial waste, chemical particles and oil into the oceans, ship pollution i.e., accidental release of large-scale oil into the ocean is one such mess that causes a catastrophic effect on the marine animals which ultimately leads to their suffocation and death.

The United Nations Convention on the Law of the Sea (UNCLOS) III defines "Marine Environment Pollution" as: "The Introduction by man, directly , or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards of human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities"[14].

As with the growing Industrial activities, the consumption of crude oil has increased at a stake. Transportation of oil via sea route is a common procedure that is being followed since ages. As the transportation of petroleum has increased with the time, the risk to the environment has also increased along with it. Marine pollution due to oil spillage is one such common constant concern that the government is worried about. Marine pollution due to oil not only effects the marine life but human lives too. It puts their life on risk as the direct impact is majorly caused on the food chain which ultimately leads to causing damage to the entire ecology.

Various factors are in complex with the sequel of marine pollution due to accidental oil spillage, it may encompass the type of oil being carried weather heavy, medium or light oil as they have different reacting properties depending upon the composition, the location of the incident weather being a costal or sensitive area, along with this many other factors like the total amount of oil spill, weather and sea conditions, even which time of the year it is also matters in the level of damage that is caused and what impact it will have on the innocent lives.

The crude oil when spilled on the costal or ocean waters, whether intentional or accidental floats on the surface of the water forming a thick layer and eventually spreads through the flowing wind or the water currents. It is a major concern as when this casualty occurs and if not cleaned at appropriate time it may stay in the water for a longer period of time hence blocking the entry of oxygen in the water due to which the fisheries and the other marine species get affected and suffer from deformities and diseases effecting the food web.[15]

To stop this huge loss salient points should be thrown light upon like-

1. Imposing strict punishments to those who dissuade the regulations and rules made by the government.
2. Even the making of the ships should be paid a keen attention upon as the construction and the materials used during its make and model plays a very important role and may either result in causing horrifying casualties or preventing huge loss.
3. Forensic Engineers should also involve in investigating the crime scene in this case well in order to check every bits to know where there was a defect in making of the ships, whether proper equipment's and machineries were used and many other aspects which leads to these kind of mis happenings.
4. Fingerprinting of the oil so as to investigate the crude oil spill should also be carried out using the analytical tools such as Gas Chromatography–Mass Spectrometry (GC–MS), Gas chromatography (GC) and related ancillary techniques and stable isotopes.[16]

Not only due to oil spillage during export and import, pollution of the seabed can also be a resultant of offshore oil and gas activities which discharge oil into the marine environment during the production and exploration process. It can either be due to accidental oil dropout during the well testing, release of oil at the time of drilling process, breaching of pipelines and disruption of oil wells etc.

Untreated disposing of the wastes containing hydrocarbons and various other chemicals also puts the marine life at risk. Hence before dumping the waste into the environment, it should be first treated so that the harmful chemicals are removed or diluted to prevent the harm to the marine species.

Air pollution is another major concern that effects the marine lives. The gases released during the process of generating electricity, employing compressors and pumps, venting during unloading of tanks are some

reasons which causes air pollution as they release some harmful gases like Methane, Carbon dioxide, Sulphur and Nitrogen oxide into the environment which adds to the climate change as a result the stratospheric ozone undergoes depletion and global warming increases and furthermore increases the concentration of carbon dioxide and pH in the water bodies due to which lot of changes occur underwater affecting the valuable lives.

Ocean acidification caused due to the emission of various poisonous gases during shipping decreases the ocean's pH (according to the data obtained from IUCN, there is 10 times increase in rate of ocean acidification as compared to anything experienced in the last 300 million years). Due to the increasing ocean temperatures there is a lot of changes that is impacting the growth of species and effecting the rate of reproduction and also influencing the amenities that the society can obtain from the oceans in the form of food, income and costal protection.[17]

Illegal dumping of the wastes from the ships in the form of plastics, food wastes, cargo residues, fishing gears, operational wastes like the clinkers and ash from boilers and shipboard operations, oil used in cooking, cleaning agents used in deck and animal cadaver etc. also adds to a type of marine pollution caused due to their disposal. This Illegal dumping can be investigated and tracked using advanced technologies developed by the forensic environmental engineers which includes the use of special aerial platforms like UAS/Drones etc. containing thermal sensors that monitors and detects the environmental abnormalities.

CONCLUSIONS

1. In the contemporary times scientific methods are being used by the criminals to commit crimes and to destroy evidences. Marine Forensic can help combating such scientific criminals.
2. When oral testimony is failing continuously in the courts of law due to human bias and witness resiling in the courts of law, marine forensic evidence is highly reliable.
3. Marine Forensic investigations are the key to success in the investigation of marine crime or the crime in marine environment.
4. Thus, marine forensics is utmost needed in India and abroad in the effective investigations of marine crimes.

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