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Exposing the Ecological Consequences : Wildlife affected by Electromagnetic Pollution

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Abstract: *The environments supporting wildlife are severely impacted by electromagnetic pollution, which results from a growing number of human activities. Recently, unsettling links between electromagnetic radiation and behavioral abnormalities in animals have been found. The widespread impact of electromagnetic pollution raises questions about the stability of many species' habitats, from disrupted nesting behaviors to changed migratory patterns in birds. Social dynamics and abnormal behavior in marine habitats can be disrupted by underwater electromagnetic waves, endangering the complex communication networks of marine life. The critical need for comprehensive conservation plans that take into account not just direct habitat concerns but also the more subtle yet widespread effects of electromagnetic pollution on the complex web of biodiversity and species survival is highlighted by the results of this study.*

keywords: *EMF: electromagnetic fields, EMR: Electromagnetic radiations, TRAI - , EIAs- , ICNIRP - , MTBS- ,*

1. INTRODUCTION

The wide spread of electromagnetic fields (EMFs) in today's fast evolving technological landscape has become a necessary aspect of everyday existence. Due to the widespread presence of electromagnetic pollution—which can be found in anything from power lines to Wi-Fi networks and mobile phones—there are worries over the possible effects on the ecosystem [1,3,4,5]. An increasing amount of research indicates that wildlife may also be vulnerable to the ecological effects of electromagnetic pollution, despite the focus on the effects on human health.

Electromagnetic pollution, commonly referred as electromagnetic radiation (EMR) or electromagnetic interference (EMI), is the wide range of electromagnetic fields that are released by different electronic devices and communication equipment. This encompasses power frequency fields from electrical systems, microwave radiation from sources like radar systems, and radiofrequency radiation from wireless communication equipment [3,4,5,8]. Electromagnetic radiation is crucial for both natural and technological development. Sunlight, for photosynthesis, and Earth's electromagnetic field protect the globe from space radiation. Technology uses visible light, microwaves, and radio waves for communication. However, increased exposure to artificial radiation raises health concerns. Balancing radiation benefits and potential hazards is essential for ecosystem and human health.

1.1 Sources of Electromagnetic Pollution

1.1.1 Natural Sources

Cosmic radiation, including solar and cosmic rays, originates from the sun and outer space and can penetrate Earth's atmosphere. Earth's magnetic field generates low-level magnetic radiation, crucial for migratory animal navigation and shielding against solar wind. Thunderstorms and lightning produce electromagnetic radiation, typically radio waves, causing "sferics," a phenomenon caused by lightning's ability to produce radio waves [1,4].

1.1.2 Man-Made Sources

Electromagnetic fields (EMFs) are produced by various sources, including power lines, electronic devices, wireless communication devices, medical imaging equipment, radio and TV broadcast towers, and power plants and industrial equipment. Power lines and transformers emit low-frequency EMFs, which weaken with distance, and exposure is typically higher in close proximity. Electronic devices

like computers, televisions, and microwave ovens emit EMFs, with the strength depending on their power and proximity. Wireless communication devices emit radiofrequency (RF) radiation, used for transmitting information wirelessly and in modern telecommunications. Medical imaging equipment generates varying levels of EMF radiation for imaging purposes. Broadcasting facilities emit radiofrequency radiation to transmit signals over the airwaves, with the strength decreasing with distance. Industrial processes and equipment can produce strong EMFs as byproducts [1,4].

Types of Radiations

There are two categories of sources of electromagnetic radiation. Ionizing radiation is a type of radiation that comes from X-rays, T-rays, and other radiation sources. In order to make the particles clearly charged, it can enable the radiated material to give free electrons. Non-ionizing radiation originating from microwave and radio frequency recurrence is the other type of radiation [1,2,4]. When the substance that is emitted retains energy, it can result in a shift in the electron energy level. EMF radiations can be classified as either ionizing or non-ionizing depending on the frequency and power level [1,2,4]. Electromagnetic radiation that is ionizing is defined as radiation with waves that are strong enough to overcome the electrons' coupling energy in atoms or particles, creating particles in the process. such as gamma, X, and UV radiation. An electromagnetic radiation that does not carry enough energy per quantum to ionize particles or atoms is referred to as non-ionizing radiation [1,2,4]. For instance, low frequency radiations such as microwaves, radio waves, and infrared radiations [1,2].

The growing number of power lines and wireless technologies contribute to electromagnetic pollution, which has a variety of negative effects on different types of life. Electromagnetic fields have the potential to cause disturbances to the navigation and communication habits of birds, especially those that are migratory. This could result in modified migration paths or challenges in identifying food sources. Bees are essential pollinators for agriculture and ecosystems, but because electromagnetic radiation interferes with their communication among colonies, they may have difficulties foraging and navigating. Population dynamics may be impacted by the altered behavior, disturbed circadian cycles, and altered reproductive patterns that mammals and rodents may display. Disturbances in the bioelectric fields of marine creatures, such fish and cetaceans, may affect their ability to navigate and communicate underwater. Because they depend on electromagnetic signals for growth and development, plants may experience physiological changes that could have an impact on their ability to reproduce and general health. The widespread impact of electromagnetic pollution highlights the necessity of thorough investigation and mitigation strategies to lessen its negative ecological effects.

1.5 Problem of statement

The escalating prevalence of electromagnetic pollution poses a serious threat to wildlife and ecosystems, necessitating a comprehensive seminar report. This study aims to investigate the specific ecological consequences of electromagnetic fields on various species and assess the potential long-term impact on biodiversity and ecosystem stability.

Table1.1. *Harmful levels of different species [1]*

Species	**Harmful level**
Human	30-300 MHz
Birds	1.33 MHz
Bees	50 Hz
Marine Animals	3 kHz & 300 GHz
Rodents	916 MHz

2. LITERATURE REVIEW

This study is on impact of electromagnetic pollution on wildlife and ecosystems as it is growing concern of modern society which is increasingly relies on electronic devices and wireless technologies.

Neha and Gupta (2017) said that the effects of electromagnetic radiation on creatures, thermal and non-thermal effects on live things, and proposes strategies to reduce electromagnetic pollution, which is becoming increasingly prevalent due to rapid advancements in electronic technology (IJEAST, 2017)[1]. Iagăr et.al (2017) examines electromagnetic radiation from various household equipment

using the FA306 electromagnetic field analyzer, analyzing its effects at different distances and operating modes, and the cumulative impact of multiple sources (lagar, 2017)[2]. Batool et.al (2019) stated that EMR radiation can cause diseases in living beings, making it difficult for people to move away from it. However, EMR has advantages in biomedical and telecommunication technologies, making it impossible to stop using radiations (Batool, 2019)[3]. Indian national academy of engineering (2013) EMR is a form of environmental pollution that pollutes the radio spectrum. INAE Studies show short-term and medium-term effects on animals and humans, particularly children, weak or sick persons, pregnant women, and small animals (INAE, 2013)[4]. Levitt et.al (2022) The research states that there is sufficient data to suggest that increasing background levels of anthropogenic non-ionizing electromagnetic fields (EMF) from 0 Hz to 300 GHz may be harming non-human species at ecosystem and biosphere levels across all taxa. (Levit, 2022)[5]. Levitt et.al (2021) emphasizes the need for laws and regulations to protect non-human species from electromagnetic pollution, highlighting the need for further research and regulations (Levit, 2021)[6]. Froidevaux et.al. (2023) study draws attention to the possible biological impacts of radiofrequency electromagnetic fields on animals and suggests mitigation strategies, particularly in view of the swift growth of 5G and 6G technologies and mobile communication networks. (Froidevaux, 2023)[7].

My research aligns with the existing studies that delve into the intricate realm of the effects of electromagnetic pollution on wildlife and ecosystems. As the world is progressing rapidly in technology, it becomes imperative to achieve a harmonious equilibrium between innovation and environmental preservation.

3. DISCUSSION

Potential behavioral alterations in animals have been linked to electromagnetic pollution, which originates from sources such as power lines and wireless devices. Disorientation may occur in animals like birds and insects that depend on the Earth's magnetic field for orientation [1,8,14,15].

Electromagnetic pollution (EMF) can disrupt hormone levels and circadian rhythms, affecting avian nesting and reproduction. The Earth's magnetic field, crucial for bird navigation, may be obstructed by EMF, affecting their ability to perceive and interpret cues. Negative impacts on avian reproduction include altered nesting habits, lower hatching success, and poor parental care. Exposure to EMF also increases stress and corticosterone levels in birds, potentially affecting their health and immune systems. The impact on avian populations as a whole remains unclear, but if prolonged exposure is substantial, population decreases may be a contributing factor. The overall impact on avian populations remains unclear [1,8,14]. An increase in cellular mobile base station (GSM 900 or 1800) proliferation has been correlated with a decline in bird diversity in a number of nations.1.6% [14]The UK is the country where this influence is most illustrated by the dramatic decrease in a number of urban bird species, most notably the sparrow. Over the course of thirty years, the number of sparrows in the nation fell from 24 million to 14 million [14].2 Suddenly, between 1994 and 2002, as mobile technology spread throughout the nation, there was a 75% reduction [14]. A similar situation has been noted in Valladolid, Spain, where the installation of many cell phone base stations between 1997 and 2007 [14]resulted in a decrease in the species diversity of birds and nesting pairs. Three of the fourteen bird species that can be found in the city entirely vanished over this time, four of them showed a reduction in number, and seven of the remaining species remained steady. Throughout general, fewer birds were seen throughout the city. In a similar vein, it was shown that White stork (Ciconiaciconia) productivity was higher in its nests situated far from cell phone base stations in Spain than it was in those situated within 200 meters[14] of the antenna. Recently, a large number of sparrows vanished in Belgium. A significant spatial variation in the number of house sparrows was discovered to be correlated with the electromagnetic field's strength.

Electromagnetic radiation frequencies can affect the direction of the magnetic compass, potentially impairing the foraging and homing abilities of bees and other pollinators that rely on the Earth's magnetic field for navigation [1,8]. While there is little evidence suggesting that bees' reproduction ability may be impacted by exposure to specific frequencies, the long-term survival of bee populations may be significantly affected. Physiological effects include variations in foraging time, distance traveled, and recall of food source locations. EMFs may also affect bees' memory and learning skills, which are essential for effective foraging and navigation. Colony Collapse Disorder (CCD) is another issue caused by electromagnetic pollution, which can cause entire colonies of bees

to vanish, endangering agricultural and pollination services. In a present investigation, Apis cerana colonies were positioned at different distances from the cell phone tower—100, 200, 300, 500, and 1000 meters [10]— with varying radiation levels in order to determine the impact of EMR. These distances were measured using a 3-Axis RF electromagnetic field meter (model: EMF-819). Colonies positioned 500 meters away from the tower had much higher brood areas, honey hoarding capacities, pollen stores, and queen prolificacy than colonies located 1000, 300, and 200 meters

[10] away. Colonies put 100 meters away [10] from the tower had the lowest of these values. The current study's findings showed that the electromagnetic radiation emitted by cell phone towers had the greatest impact on Apis cerana colonies located in close proximity to them.

Research indicates that marine species may experience behavioral changes due to exposure to specific electromagnetic fields, such as changes in food habits, swimming patterns, and mating behaviors. These changes may impact reproduction, such as egg development, larval phases, and reproductive success. Physiological effects include hormone imbalances, stress reactions, and disturbances in growth and development. Marine life may also suffer sensory perception interference, particularly for species that rely on electric and magnetic fields for communication and navigation. Certain animals, like sharks and rays, use electromagnetic fields to navigate and identify prey, which may be affected by disturbances in their migratory and hunting habits [1].

Electromagnetic pollution has been linked to behavioral changes in mammals and rodents, including increased anxiety and decreased social interactions. Research suggests a connection between EMF exposure and abnormal child development, altered sperm parameters, and decreased fertility. Animals exposed to high levels of electromagnetic radiation during pregnancy may also experience developmental consequences. Physiological changes, such as alterations in immunological response, increased oxidative stress, and disturbed hormone control, are also linked to EMF exposure. Concerns over the long-term health impacts of exposure to electromagnetic fields are raised. Further research is ongoing on the potential link between EMF and cancer risk, with certain studies suggesting a higher chance of developing specific types of malignancies [1].

4. MITIGATION STRATEGIES

Electromagnetic pollution in India threatens wildlife and ecosystems, disrupting animal behavior and reproduction. To mitigate this, regulatory measures are needed, including stringent emission limits for telecommunication infrastructure, Environmental Impact Assessments, electromagnetic compatibility assessments, habitat planning, public awareness campaigns, and collaboration among regulatory bodies, environmental agencies, and the public [16,17,18,19,20,21].

1.2 IN INDIA

In India, regulatory measures are typically overseen by agencies such as the Telecom Regulatory Authority of India (TRAI) [19,20] and the Ministry of Environment, Forest and Climate Change (MoEFCC). These bodies collaborate to develop and enforce standards that strike a balance between technological advancement and environmental protection.

Department of Telecommunications and TRAI's Emission Standards [17,18,19,20]

- Establish and update standards for electromagnetic emissions from communication devices and infrastructure.
- Enforce emission standards for telecommunication infrastructure and promote technology use to minimize pollution.
- Collaborate with other regulatory bodies for comprehensive oversight.
- Form and update guidelines for power line installation to minimize environmental impact.
- Conduct environmental impact assessments for projects with potential electromagnetic pollution.
- Ensure projects with potential electromagnetic pollution undergo rigorous EIAs to mitigate environmental impacts.

REGULATORY MEASURES

- Enforcement of emission standards for devices and infrastructure emitting electromagnetic radiation.

- Control of high-EMF-emitting infrastructure through zoning and land use planning.
- Environmental Impact Assessments to evaluate potential impacts on wildlife and ecosystems.
- Monitoring programs to ensure compliance with emission standards.
- Adherence to international standards for a globally informed approach.
- Public awareness and education about environmental impacts.
- Adaptive regulations to technological advancements and scientific understanding.

2. Legal Framework in India on Radiation

The study looks at potential improvements to the effectiveness of legal norms. In addition, environmental laws such as the Air (Prevention and Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, the Indian Wireless Act, 1933, the Indian Telegraph Act, 1885, Atomic Energy Act, 1962, and Telecom Regulatory Authority of India Act, 1997, have been critically analyzed along with reports such as Inter-Ministerial Committee (IMC) Report, 2011 and the ICNIRP Guidelines of 1998. The researcher hopes to explore proposed laws that could positively alter the framework through this section. In light of the information previously provided as well as the many complaints that people have made about their health and other medical issues pertaining to radiation hazards and wellbeing. The stations that control mobile tower radiation are called mobile tower base stations, or MTBS [15, 16,17,18,19,20].

1. The first Act relating to mobile towers radiation defined wireless communication as : The term "wireless communication" refers to any method of sending or receiving information using electricity, magnetism, radio waves, Hertzian waves, or writing without the need for cables or other continuous electrical conductors to connect the sending and receiving devices [15,16,17].

2. The TRAI Act define, the telecommunication service as : "A telecommunication service is any kind of service that is provided to users through the transmission or reception of signs, signals, writing, images, sounds, or intelligence of any kind by wire, radio, visual, or other electro-magnetic means; it does not include broadcasting services." This definition includes voice mail, electronic mail, data services, audio text services, video text services, radio paging, and cellular mobile telephone services [15,18,19].

5. Conclusion

Electromagnetic pollution is a significant threat to wildlife and ecosystems, requiring a shift in our understanding of technological advancements. It can cause bird species to become disoriented, marine life to be threatened by aquatic habitats, and soil microbial communities to change. Sustainable technologies like low-emission devices and energy-efficient communication networks can help balance technology and nature. However, responsible governance and regulatory frameworks must be updated to keep up with rapid technological advancements. Environmental impact evaluations are crucial for a pre-emptive strategy.

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