



Investigating Influence of Electromagnetic Radiation from Mobile Tower's on Sparrow Health and Population Dynamics

Utkarsh Mahesh Mahale

S.k Somaiya College of Vidyavihar, Vidyavihar University, Vidyavihar Mumbai 400077, India

ABSTRACT

The research is focused on both the impact of radiation on sparrows and their population dynamics. The global distribution and ecological importance of Sparrows provides them as a model species to monitor environmental change, which is why they are selected for this study. The research also looks at radiation and sparrow reproductive health. Analysis uncovers consistent radiation-linked, network-mediated costs causing reduced reproductive success. Which all the findings showed and observed that chronic exposure to radiation can have drastic population declines resulting in disrupted human health as well as wildlife health or ecosystems. In addition, the results from these studies could have implications for human health due to a variety of biological responses observed in sparrows that equally might be symptomatic of potential future risks among exposed humans.

1. Main Text

In the rapidly evolving world of technology, we've witnessed remarkable advancements, from the early days of massive computers to the compact and powerful devices we carry in our pockets today. The journey from **ARPANET (Advanced Research Projects Agency Network)**, the first operational packet-switching network, to the cutting-edge **Wi-Fi 6E** technology, highlights the incredible progress in connectivity. Similarly, the evolution from early "G" networks to the current "5G" network underscores our strides toward achieving the fastest and most reliable connections.

The development of network infrastructure has been equally significant. The first mobile tower in India was established by the **Indian Army and BSNL** at the **Siachen Glacier**, marking the beginning of mobile communication in challenging terrains. **Modi Telstra's Mobile net**, the first mobile service network provider in India, paved the way for the multitude of network service providers we rely on today. With the proliferation of network towers across the country, the availability and quality of network services have drastically improved, bringing us closer to an era where **6G** technology is on the horizon.

In this on-going development of advanced and fast networks we need to understand the broader and wide area of impact on environment and living organisms. While the benefits of these networks are created to take advantage but similarly it has an adverse effect of the radiation from towers to the human beings as well as the wildlife. Among the species the major priority affected is to sparrows known as their close interaction to the human beings.

This research focuses on **INVESTIGATING INFLUENCE OF RADIATION ON SPARROW HEALTH AND**

POPULATION DYNAMICS exploring the potential physiological, behavioural, and ecological changes in sparrows. The study implements to contribute a better understanding of radiation on sparrow on advancing technology.

The declining population of sparrows, particularly in urban areas, is a matter of concern. Over the past five years, their numbers have dropped by as much as 60%. One of the leading causes of this decline is believed to be electromagnetic radiation from mobile network towers. These towers emit non-ionizing radiation, which is thought to interfere with the sparrows' ability to navigate, reproduce, and communicate.

While mobile networks were first established in India around 1994 by BPL Mobile Communications, the intensity and reach of network radiation were relatively low in the early stages. However, as the network infrastructure expanded over the years, with stronger and more widespread signal transmission, the radiation exposure in urban areas increased. This rise in radiation levels is now considered a significant factor contributing to the disruption of the natural habitat and behaviours of sparrows. Other contributing factors could include urbanization, habitat loss, and pollution.

Sparrows, like many other species, are sensitive to changes in their environment, and their sharp decline serves as an indicator of the broader environmental challenges brought about by modern human activities.

1.1 Diverse Effect of Radiation on Navigation System of a sparrow

"Sparrows, like many other birds such as Parrots, Owls, and Crows, use a navigation system that relies on a combination of natural cues and biological mechanisms. Sparrows employ magnetic field detection, sun and star navigation, and infrasound detection to navigate to their respective destinations."

Due to following factors, there are difficulties for a sparrow to navigate: -

1. **Disruption of Magnetic Sensing:** - Sparrow uses Earth's Magnetic field for navigation. Artificially created electromagnetic fields from mobile towers, cell phone signals etc interfere with the ability to sense the magnetic field which disturbs their navigation system.
2. **Magnetoreception in Birds:** - Birds like sparrow contain **Magnetoreception** Mechanism which is based on magnetite that allows the birds to detect magnetic field of Earth. High level **Electromagnetic Radiation** impacts on functioning of their navigation.
3. **Behavioural Changes:** - Exposure to high levels of radiation can cause behavioural changes in sparrow like birds. This causes the navigation errors in the sparrow like bird's flight paths to reach at their destination.
4. **Stress and Health Effects:** - Exposure to radiation might cause stress or health issues on sparrow and birds like sparrow which can impact their ability to navigate.

1.2 Decline in Population Dynamics of Sparrow: -

In India more than 1 billion people use mobile phones and network connectivity this network connectivity has network issues with the network towers placed at various locations.

Currently India has 7.37 lakh towers and 23.7 lakh base stations. Each network tower uses 800 MHz to 1900 MHz of frequency and produces 4.5 to 10 W/m². (Watts Per Square Meter).

2. Literature Review

The decline in sparrow population particularly has a matter of concern globally. In India the major decrease in sparrow numbers has been a attention from researchers who tends to understand the possible causes of Electromagnetic Radiation. This literature review aims to study the existing research study that explore the effects between EMR from mobile towers and population dynamics of a sparrow in India.

Sparrows have been common in urban and rural areas. Studies from Europe and North America suggest that population of sparrows has been declining over past few years. As there are the focused research objectives due to which they are declining but there are also more reasons for the same. Following are the reasons for declining of sparrow population: -

Changes in habitat loss, changes in food availability, and more exposure to non- ionizing radiation from Mobile Network Towers.

The research is mainly focused on Electromagnetic Radiation factor affecting on Sparrow. Balmori (2005) conducted a research study on impact on EMR on avian species, demonstrating that birds exposed to radiation from Mobile Network Towers showed behavioral changes in them.

3. Design

3.1 Research Design

A structured questionnaire was developed to gather personal responses regarding **Investigating Influence of Electromagnetic Radiation from Mobile Tower's on Sparrow Health and Population Dynamics in India**. The questionnaire consisted of questions to collect personal response data and **quantitative data**.

The questions were designed in such a way that they could address key areas such as: -

- Observations of sparrow population changes in specific regions.
- Presence of mobile tower in nearby area.
- Personal opinions on environmental and health issues of that impact on sparrow

3.2 Data Collection

The survey was created and distributed through Google Forms as it is an Online Platform that is easy to access for the respondents

The survey was supplied to people in the form of social media and email so that maximum participants would be able to participate.

Responses were collected over a particular period so that the respondent.

Google Forms automatically compiled the responses into a excel file so that it was easy to access all the responses that were collected.

3.3 Sampling

Data for investigating the influence of radiation on sparrow health and population dynamics is collected through **Google Forms** using a **survey**, that adapt **convenience sampling** by targeting respondents who are easily accessible or likely to have relevant information about sparrow populations and radiation exposure.

3.4 Survey Content

1. How often do you observe sparrows in your area?
2. Have you noticed any change in the sparrow population in your area over the past 5 years?
3. Are you aware of any sources of radiation near your area (e.g., cell towers, powerlines, industrial sites)?
4. Do you believe that radiation could impact the health of sparrows?
5. Have you noticed any correlation between the presence of radiation sources and sparrow population changes in your area?
6. Do you think these environmental factors could be affecting the sparrow population in your area?
7. Do you take any actions to support the sparrow population in your area? (e.g., providing food, nesting boxes)
8. How important do you think it is to monitor and protect sparrow populations?
9. Do you have any additional observations or comments about sparrow health and population in your area?
10. Do you think that network radiation can cause decrease in population on sparrow and other species of birds as well as human life?
11. Do you believe that while technological advancements are beneficial, they can also have negative impacts on ecosystems, including human beings and bird species like sparrows?"

4. Discussion

4.1 Research Problem

Investigating the impact of Electromagnetic Radiation from Mobile towers on the health and declining population of sparrows in India. The rapid expansion of mobile communication networks across India has led to a significant increase in the number of mobile towers installed in both urban and rural areas. While these technological advancements have improved communication infrastructure and connectivity, there is growing concern about the potential environmental impact of electromagnetic radiation (EMR) emitted by these towers on various ecosystems.

4.2 Research Objectives

4.2.1 Assess the effects of radiation from mobile towers on sparrow health and behaviour

This objective focuses on the effects of radiation from mobile towers on sparrow health and behaviour of the sparrow like how the sparrow interact if it gets affected by the radiation and what factors harm to their lifestyle. Understanding the effects of EMR is crucial to determining whether radiation is main factor in their population dynamics and wellbeing.

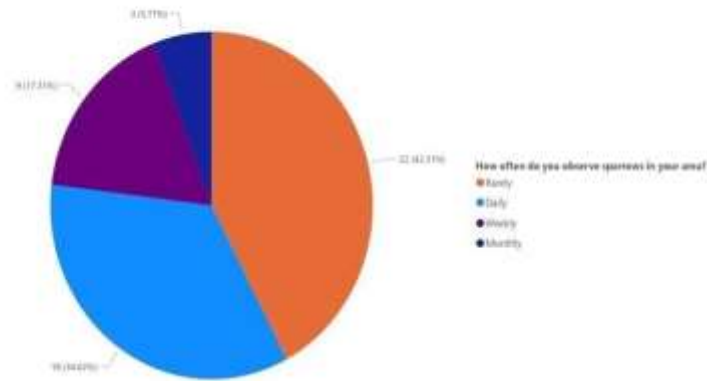
4.2.2 Analyze the correlation between mobile tower radiation and sparrow population

Increase in the mobile towers have been a main reason for population decrease in sparrow. Electromagnetic radiation coming from these towers interfere in the navigation of sparrow, habitat of the sparrow, health and wealth of sparrow, affecting their survival and reproduction. By this analysis and correlation between mobile tower radiation and sparrow population researchers aim to determine difference between radiation levels.

5. Results

- i. Above is the pie diagram which shows the analysis of the question – How often do you observe sparrows in your area?

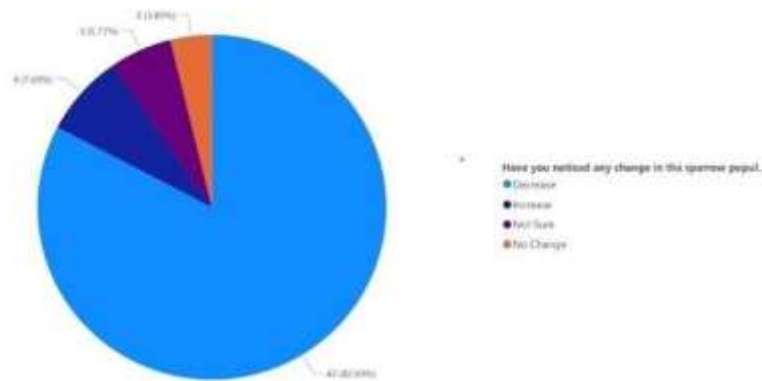
Count of How often do you observe sparrows in your area? by How often do you observe sparrows in your area?



Orange indicates that the average responses have answered Rarely. (42.31%) Blue indicates that the average responses have answered Daily. (34.62%) Purple indicates that the average responses have answered Weekly. (17.31%) Navy Blue indicates that the average responses have answered Monthly. (5.77%)

- ii. Above is the pie diagram which shows the analysis of the question – Have you noticed any change in the sparrow population in your area over the past 5 years?

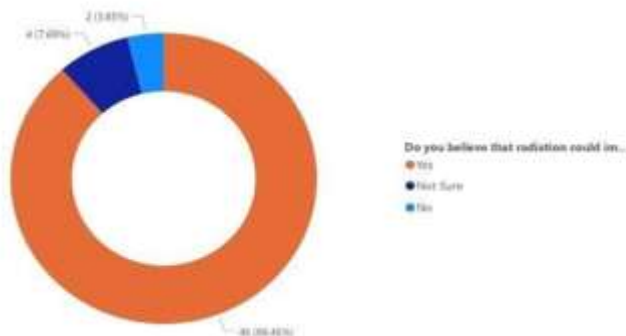
Count of Have you noticed any change in the sparrow population in your area over the past 5 years? by Have you noticed any change in the sparrow population in your area over the past 5 years?



Blue indicates that the average respondent have answered **Decrease**. (82.69%) Navy Blue indicates that the average respondent has answered **Increase**. (7.69%) Purple indicates that the average respondent has answered **Not Sure**. (5.77%) Orange indicates that the average respondent has answered **No Change**. (3.85%)

- iii. Above is the pie diagram which shows the analysis of the question – Do you believe that radiation could impact the health of sparrow?

Count of Do you believe that radiation could impact the health of sparrows? by Do you believe that radiation could impact the health of sparrows?



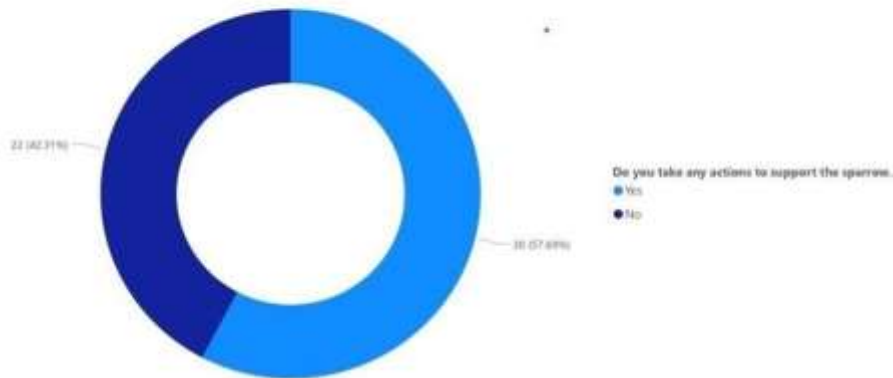
Orange indicates that the average respondent has answered **Yes**. (88.46%)

Navy Blue indicates that the average respondent has answered **Not Sure**. (7.69%)

Blue Indicates that the average respondent has answered **No**. (3.85%)

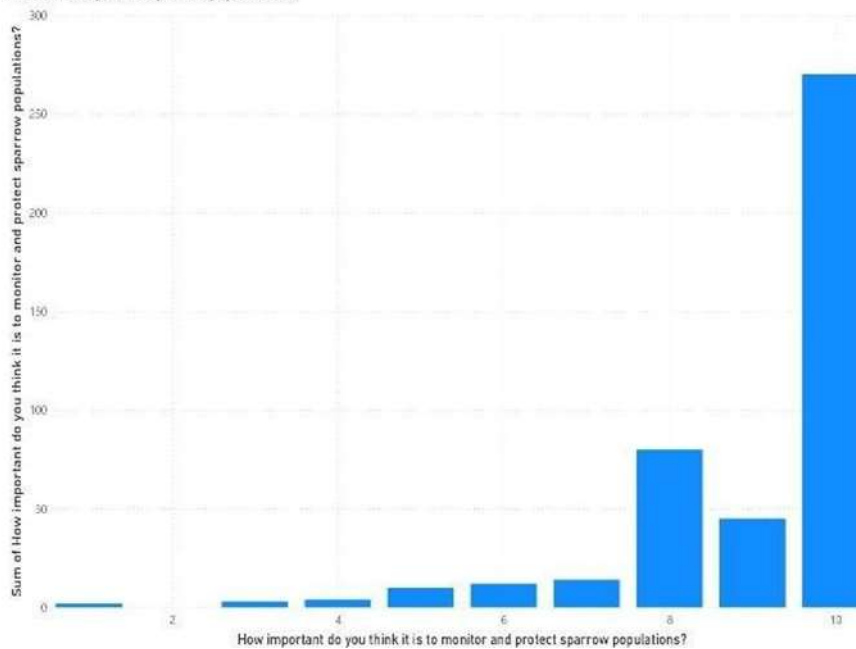
- iv. Above is the pie diagram which shows the analysis of the question – Do you take any actions to support the sparrow population in your area? (Example: - Providing food, nesting boxes)

Count of Do you take any actions to support the sparrow population in your area? (e.g. providing food, nesting boxes) by Do you take any actions to support the sparrow population in your area? (e.g. providing food, nesting boxes)



Blue indicates that the average respondent has answered Yes. (57.69%) Navy Blue indicates that the average respondent has answered No. (42.31%)

Sum of How important do you think it is to monitor and protect sparrow populations? by How important do you think it is to monitor and protect sparrow populations?



The bar graph shows the results of a survey assessing the importance and protecting sparrow populations. The X- axis represents the importance on a scale from 1 – 10 and the Y – axis displays the number of responses for each level.

5.1 Key Points Key Points: -

- 1. **Strong emphasis on Importance: -**

Majority of respondents have rated importance of monitoring and protecting sparrow populations at **highest level (10)** indicating recognition of the change in population.

- 2. **Moderate Importance Rating: -**

Some of the respondents rated the importance between **7 to 9** stating the moderate concern for the issue.

3. Minimum ratings: -

Very few of them have responded were rated below 7 suggesting that the vast majority of respondents believe that sparrow conservation is important.

Overall, the data reflects a clear report that the high importance of efforts to monitor and protect sparrow populations with respondents responding that it is critically important to manage the radiation control from the Network Towers and it's critical to manage the sparrow population for the better ecosystem.

5.2 Research Findings

The Electromagnetic Radiation that spreads from Mobile Network Tower, each Tower contains around 800MHz to 1900 MHz (Megahertz) of Frequency. This radiation is measured expressed in terms of Power Density (measured in watts per square meter W/m^2). **Specific Absorption Rate (SAR)** is used for its biological effects instead of directly from frequency range.

Calculating the Radiation levels: -

To measure the power density at a given distance can be calculated using this formula: -

$$\text{Power Density}(S) = \frac{P_{out} \times G}{4\pi r^2}$$

Where:

P_{out} = Transmitter power (in watts) G = Antenna gain R = Distance from the antenna

Logistic Growth Model (Verhulst-Pearl logistic growth): -

Population dynamics is logistic growth equation.

$$\frac{dN}{dt} = rN \left(1 - \frac{N}{K} \right)$$

Where:

$N(t)$ = population size at time t r = rate of population

K = maximum population that environment can support t = time

Reduced Reproductive Success: -

Exposure to radiation reduces the reproductive success of sparrows decreasing the population growth rate (r). Let $E(t)$ represent the radiation exposure at time t . The growth rate r can be modified to depend on radiation exposure.

$$r_{\text{effective}}(t) = r - \alpha E(t)$$

Where:

α = sensitivity factor that shows how strongly radiation affects the growth rate Hence the Modified equation becomes:

$$\frac{dN}{dt} = (r - \alpha E(t)) N \left(1 - \frac{N}{K} \right)$$

Direct Morality from Radiation Exposure: -

Alternate way to show the impact of radiation is to introduce a morality term that increases radiation. Population of sparrow that we experience is assumed to as death rate that is proportional to $E(t)$.

$$\frac{dN}{dt} = rN \left(1 - \frac{N}{K} \right) - \beta NE(t)$$

Where:

β = morality $E(t)$ = radiation

Radiation Threshold Effect: -

Assume that threshold E_{th} , which radiation has no effect and above which the population is affected. Which represents the formula as:

$$\frac{dN}{dt} = rN \left(1 - \frac{N}{K} \right) - \beta N \cdot \Theta(E(t) - E_{th})$$

Where $\Theta(x)$ is the step function which is 0 if $x \leq 0$ and 1 if $x > 0$

Radiation Exposure Model: -

$$E(t) = \frac{P_{out} G}{4\pi r^2}$$

The radiation exposure $E(t)$ we can use the power density of electromagnetic radiation from a mobile tower.

P_{out} = power output G = antenna gain

r = distance from tower to sparrow habitat

According to all this formula we are going to calculate the radiation (power density) from a network tower operating in the 800 MHz to 1900 MHz frequency range we need to use power density formula.

$$S = \frac{P_{out} \cdot G}{4\pi r^2}$$

Where:

S = Power Density (W/m²)

P_{out} = Transmitter power output G = Antenna gain r = Distance from antenna

Calculations: -

Transmitter Power Output P_{out} A normal mobile tower might transmit power levels from **20W** to **100W**

Antenna Gain (G) a normal mobile network tower might be around 15dbi, which is approximately 32 gain converting dbi to linear scale.

Distance (r) let us assume and calculate the power density of 100 meters and 500 meters The power density at both distances 2 power levels **20W** and **100W**

[1] At 100 meters for 20W transmitter $P_{out} = 20W$ (transmitter power),

$G = 32$

$r = 100 \text{ m } \pi = 3.1416$

$P_{out} \times G = 20 \times 32 = 640$

$r^2 = (100)^2 = 10000$

Now Multiply 12.5664 by 10000

$12.5664 \times 10000 = 125664$

Now Divide 640 by 125664

$640 / 125664 \approx 0.0051 \text{ W/m}^2$

Similarly,

At 100 meters at 100W is $\approx 0.0255 \text{ W/m}^2$ At 500 meters at 20W is $\approx 0.0002 \text{ W/m}^2$ At 500 meters at 100W is $\approx 0.0010 \text{ W/m}^2$

As we observed at the calculations that 0.0051 W/m^2 may be a low intensity radiation. But if still sparrow like birds were exposed to the network tower levels they impact health issues like radiation sickness, reproductive issues, or even death depending on the exposure duration and intensity.

Even like birds human also gets affected due to mobile and mobile network tower radiation though the radiation intensity might be less the minimal effect may last for the longer time and then can cause health issues like radiation burns or increased cancer risk.

Decline in Urban Areas, cities like Delhi the sparrow population has dropped around 60% to 80% over last 20 years. A 2012 report of Indian Council of Agricultural Research (ICAR) stated that decline in sparrow population across various metropolitan areas.

A study conducted in Andhra Pradesh showed that there is decline in population of sparrow around 70% over a span of 10 years. As same conducted in Mumbai showed a decline around 50% to 70% with reports.

Overall in the past 30-40 years sparrow numbers have reduced around 50-90% in various cities of India due to presence of high radiation Mobile Network Towers.

6. Conclusion

6.1 Conclusion

Cellular wireless radio services towers use frequencies between 824 and 894 (MHz)

Personal Communications Services (PCS) towers use frequencies range from 185 and 1990 (MHz) 2G GSM towers use 900 MHz and 1800 MHz bands. 3G towers use 2100 MHz band.

4G/LTE towers use bands ranging to 2300 MHz (TD-LTE), 1800 MHz (FDD-LTE) and 850 MHz (FDD-LTE).

5G network is latest new technology over the fastest communication source which uses multiple frequencies for different applications that are used to run on daily basis.

This research evaluates the impact of electromagnetic Radiation on sparrow along with the solution for the same.

Over on a conclusion these network frequencies should be reduce the electromagnetic radiation from the mobile Network Tower that is impacting on the population of sparrow even it affects the health of sparrow and same applies for human beings.

Other factors affecting that there are no nests to build for sparrow due to development of urbanization, modern architecture buildings, and excessive uses of chemicals on insects that are used to kill on which their nestlings are needed.

Electromagnetic Radiation from the mobile tower is the major reason for the decrease in population of sparrow. Therefore the purpose of this research is to develop to improve the technology in such a way that it should be eco friendly and Telecommunications become safer to use.

6.2 Future Work

Future work I would prefer to reduce the frequency levels coming from the Mobile Network Tower's so that there will be less amount of radiation that would be produced. And also prefer that to make up some hardware and software technology that would be not very much eco friendly but that can make less amount of radiation so that human and bird species like sparrow would live more and other factors like building up nests and providing food for the sparrow and water would suggest that where ever there is an forest zone areas do not demolish them and if there are nests build up not to drop them off.

REFERENCES

- [1] Impact of Electromagnetic Radiations on House Sparrows (*Passer Domesticus*) ISSN: 2278-0181
- [2] Electromagnetic Radiations: A Possible Impact on Population of House Sparrow (*Passer Domesticus*) ISSN 2409-3629.
- [3] Electromagnetic Pollution as a Possible Explanation for the Decline of House Sparrows in Interaction with Other Factors. *Birds* **2021**, 2(3), 329-337
- [4] Bhattacharya, R., Roy, R., & Ghosh, S. (2010). Decline of the House Sparrow: Population trends in India. *Indian Birds*, 6(3), 53-57
- [5] Saini, A., & Khera, N. (2014). Impact of Electromagnetic Radiations from Mobile Towers on Sparrows (*Passer domesticus*). *International Journal of Zoology and Research*, 4(2), 17-22.
- [6] Indian Council of Agricultural Research (ICAR). (2012). Status of Sparrow Population in India. Report by ICAR, New Delhi.
- [7] Choudhury, A. (2011). The Vanishing House Sparrow. *Sanctuary Asia*, 31(6), 18-24.
- [8] Balmori, A. (2009). Electromagnetic pollution from phone masts: Effects on wildlife. *Pathophysiology*, 16(2-3), 191-199.
- [9] Khera, N., Das, A., & Srivastava, S. (2010). Habitat-wise density and diversity of avifauna in urban Delhi: The house sparrow as an indicator species. *Urban Ecosystems*, 13(1), 111-120
- [10] Royal Society for the Protection of Birds (RSPB). (2002). The Decline of the House Sparrow in the UK: A global trend
- [11] https://powerfulsignal.com/cellular-frequency-bands/?srsltid=AfmBOoo02QKO3f6rCqDmbXPDSI_oLkSCvnr9CGRbkNogEnIRV0_BQpGU

-
- [12] <https://en.wikipedia.org/wiki/ARPANET#:~:text=The%20Advanced%20Research%20Projects%20Agency,technical%20foundation%20of%20the%20Internet>.
- [13] The decline of population of house sparrow in India PRATIBHA SHARMA1*,MANPREET BINNER2 ISSN: 2367-9026