# Influence of SAR ,Rain attenuation and Air pollution attenuation on the performance of 4G.5G & 6G networks

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**Abstract**

The use of radio spectrum frequencies is growing as a result of new technologies. Advanced wireless technologies effects the human skin, animals,climatic and environmental conditions. The specific brain absorption rate, rain attenuation, and air pollution attenuation resulting from increased use of mobile phone radiation are the outcomes of analytical research. The specific absorption rate of wireless networks is discussed in this paper as a function of distance from the source. The research focuses on the environment's mutipath propagation-related attenuation of rain and air pollution by 4G, 5G, and 6G networks.

Keywords:specific absorption rate,rain attenuation, air pollution attenuation,wireless networks

## Introduction

The quick development improves connectivity,reduced latency and faster data rates are the results of developing technnology.rapid advance In emerging technologies leads to faster data speeds,lower latency and increased connectivity. Improved connectivity, reduced latency and faster data rates leads to the development of technology.Wireless networks emit high frequency electromagnetic radiation,impact of new technologies causes the decline of bird population.The impact of advanced technologies plays a crucial role in reduction of bird population due to high frequency electromagnetic radiation emitted by wireless networks. Electromagnetic radiation causes to effect bird physiology,behavior and overall health with consequences of their survival [1].

Improved connectivity, reduced latency, and faster data rates leads to the development of technnology.Wireless networks emit high frequency electromagnetic radiation, impact of new technologies causes the decline of bird population. Physiology f Birds' physiology, behavior and general health are all impacted by electromagnetic radiation,which can have an impact on their survival [2].

This report aims to present possible risks that new technologies may pose to ecosystems.

Even while wireless networks use little power, extended exposure to them may cause localized heating effects and affect birds that live close to cell towers.

Due to optimal tower location that minimizes disturbance of avian habitat, exposure to radiofrequency r adiation results in reduced hatching success and breeding patterns in birds [3-6]. Rain attenuation is impacted by wireless networks in important ways, such as frequency, rain rate, dista nce, and polarization, which pollutes the environment. Compared to 5G networks with intelligent mitigation methods,4G networks are more vulnerable to rain Because beamforming and power control techniques are used, 6G networks are not impacted by rain.

Particles suspended in the atmosphere due to particulate matter emission can affect the propagation of electromagnetic waves [7-9]. The electromagnetic wave signal may sufer from attenuation and cross polarization upon encounter with the suspended particles. The primary reason for attenuation is the conversion of electromagnetic energy into some other form of energy, such as heat [11-13].

All scattering computation theories and methods are generally based on solving Maxwell's equations either numerically or analytically. a few precise numerical solutions, in turn, often reduce to an analytical solution by means of expanding the incident and felds that were scattered [15-19]. Thus, analytical and numerical solutions for non-spherical particles are often interwoven. Moreover, in this case, it is impossible to take into account all the factors afecting the solution of a calculus scheme based on Maxwell's equations, so the results obtained will be strongly dependent on the simplifying hypotheses made.

The purpose of this paper is to provide potential threats of emerging technology on ecosystem . Althouth wireless networks operate at low power level with prolonged exsposure could lead to localised heating effects, may impact birds living near cell towers. Exposure to RF radiation leads to lower hatching success in birds,breeding patterns due to optimized tower placement of minimization of bird habitat disruption.

Wireless networks affect the rain attenuation with key parameters like frequency,rain rate,distance and polarization leads to environmental pollution.4G networks are more affected to rain when compared to 5G networks with smart mitigation methods. 6G networks is not affected with rain due to usage of beamforming and power control methods.

There has been scientific investigation into potential health effects. unable to keep pace with the rapid advances in the applications of RF fields to our daily lives and work environment. This delay has led to widespread concern among the general public and workforce and there remained unresolved health issues demanding to addres them urgently. Much of this concern arises because new technologies are introduced without provision of public information about their nature or discussion of the debate the scientific community regarding potential health consequences. Mobile phones are one such item. Industry sources suggest that there will be falling costs for mobile phones. The use of these phones has increased in recent years. dramatically with this falling cost.

Microwave radiation (MW) is absorbed near the skin, despite the fact that radiofrequency radiation can be absorbed all the physique There are two sources of radio frequenscy (RF) exposure from the mobile phone system, base station antennas, and the mobile phone or handset. Exposure from the antennas is continuous, irradiates the whole body and exposes an entire community. Exposure from the handset to The head is stronger, but only for short periods of time. and tends to be of concern to the user.

For analyzing absorption of energy by the human body, electromagnetic fields can be divided into four ranges [21-22]: Frequencies from about 100 kHz to less than about 20 MHz, where absorption in the trunk rapidly decreases with decreasing frequency, and significant absorption may occur in the legs and neck; Frequencies in the range from about 20 MHz to 300 MHz, at which relatively high . The entire body can absorb a substance, and to even higher values if partial body (e.g., head) resonances are considered; Frequencies between about 300 and 500 MHz to a few GHz, where significant local, irregular absorption takes place. Frequencies above about 10 GHz, at which energy absorption occurs primarily at the body surface.

A CDMA phone transmits with an average power of 200mW, the power varying depending on the quality of interface with the base station. Multiple users are accommadated by transmitiing the signal over a wide spectrum (spread spectrum) and applying digital codes to the data. The mobile phone uses the code to distinguish its a message intended for other users. All users share the same range of radio spectrum. This technique permits more users in a given cell than for an equivelant GSM site and in general results in lower exposures from base stations than from GSM sites.

When a GSM digital phone is transmitting, the signal is time with seven other people. This indicates that any one second each of the eight users on the same frequency is allotted 1/8 of the time and the signal is reconstituted by the recipient to construct speech. In order to limit interference between neighboring cells mobile phones are designed to use as little power as possible to keep communication. Peak power output corresponds to 2 Watts or 2000 milliwatts (mW) which averages to 250 mW of continuous power[23-24].

Specific absorption rate (SAR) [W/kg] describes the possible biological effects of RF fields. The high energy of thermal effects on biological systems are caused by exposure to RF fields. tissues and produces significant SAR values. However, RF's biological effects, or so-called non-thermal effects, The nature of low-energy fields is still a mystery. The basic concern of the present work is health hazard.

The exposure of high intensity electromagnetic waves in the ultra high frequency (i.e., 300 MHz-3 GHz) range generates heat, which can cause thermal damage to the brain, specially of the children. This temperature may rise up to approximately 0.1°C in 1 mm3 after 33 hours of continuous phone use. In general, exposure to a uniform (plane wave) electromagnetic field results in a highly non-uniform the body's energy distribution and deposition.

**Methodology**

1. Computation of Specific absorption rate using 4G,5G and 6G networks using inverse square law.

2.Evaluationof rain attenuation of 4G, 5G, and 6G networks with ITU-R P.838-3 model.

3.Calculation of air polluton attenuation in 4G,5G and 6G networks with Beta pollution model.

Specific absorption rate (SAR) indicate absorption of electromagnetic energy by the body. It

is used to calculate the radiated signal from wireless routers, base stations, and mobile phones. SAR relies on body distance from mobile phone or Wi-Fi router. The inverse square law that governs SAR states that the power density of electromagnetic waves decreases as

distance from wireless devices increases.

$$SAR = \frac{1}{d^2} \qquad \text{-----------------(1)}$$

SAR -Surface absorption rate

d- source distance

Computation of SAR is obtained from the expression (1) the corresponding values are represented in table 1.

Table 1: SAR of 4G.5G and 6G

| Parameter | 4G | 5G | 6G |
|---|---|---|---|
| SAR(d=10 meters) | $10^{-3}$ W/Kg | $0.9 \times 10^{-3}$ W/Kg | 0.2$\times 10^{-3}$W/Kg |
| SAR(d=50 meters) | $4 \times 10^{-5}$W/Kg | $2 \times 10^{-5}$W/Kg | $0,8 \times 10^{-5}$W/Kg |
| SAR(d=100 meters) | $10^{-5}$W/Kg | $9 \times 10^{-6}$W/Kg | $3 \times 10^{-6}$W/Kg |

Using 4G, 5G, and 6G networks, the surface absorption rate at d=10m, 50m, and 100m is determined from the plot. It is noticed that SAR of 4G network is more than 5G and 6G networks.It is analysed that SAR decreases significantly as distance from the source increases, following the inverse square law.

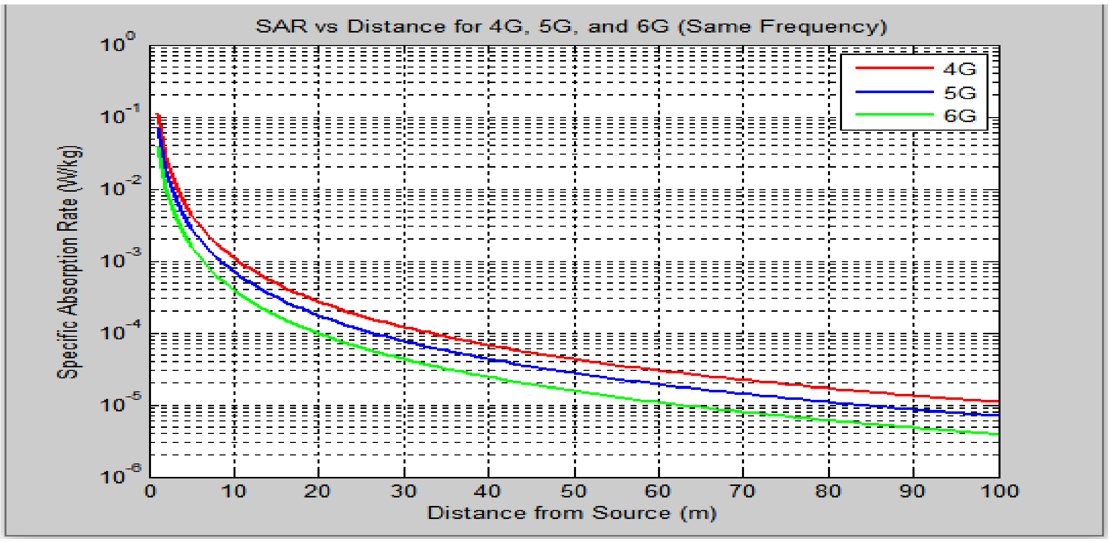


Fig1. Variation of SAR using 4G,5G and 6G

High-frequency wireless communications face a significant obstacle in the form of rain attenuation, particularly in the 5G (mmWave) and 6G (THz) bands. Raindrops absorb and scatter electromagnetic waves, resulting in signal degradation. The model depicts rain attenuation over a distance of d (km).

$$A(d) = \Upsilon_R \times d \quad \text{-------------------}\{2)$$

$A(d)$ - Rain attenuation (dB)

$\Upsilon_R$ - Specific rain attenuation (dB/km)

d - Link distance

4G experiences minimal rain impact due to lower frequencies usage for long range communication . 5G shows moderate rain attenuation at distances beyond a few kilometers requiring small cells with beamforming to mitigate losses. 6G signals faces extreme rain attenuation due to its requirement for higher data rates and dense urban deployment.

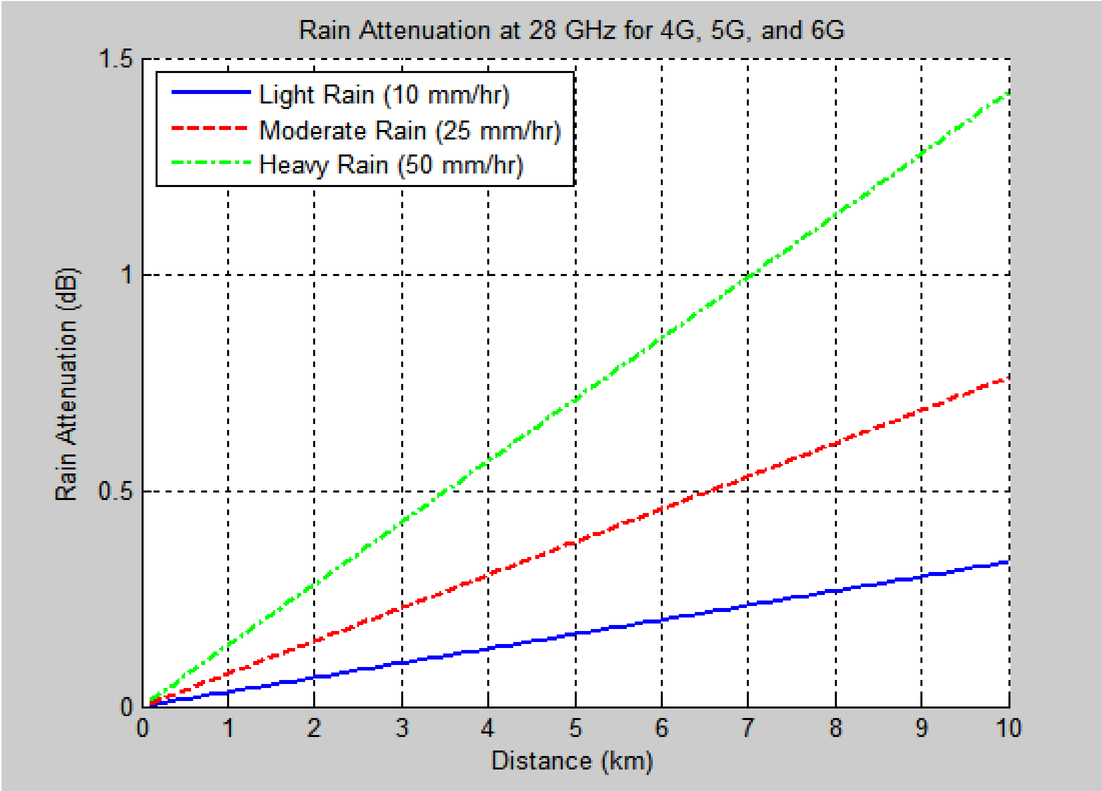


Fig2. Variation of Rain attenuation

Rain attenuation is evaluated based on the expression (2), the corresponding values are obtained at different cases is represented in table 2.

| Parameter | Light rain(10mm/hr) | Moderate rain(25mm/hr) | Heavy rain(50mm/hr) |
|---|---|---|---|
| Rainattenuation(d=3 m) | 0.08 dB | 0.25 dB | 0.6 dB |
| Rainattenuation(d=6 m) | 0.1 dB | 0.4 dB | 0.8 dB |
| Rainattenuation(d=10 m) | 0.4 dB | 0.7 dB | 1.4 dB |

Table 2: Rain attenuation

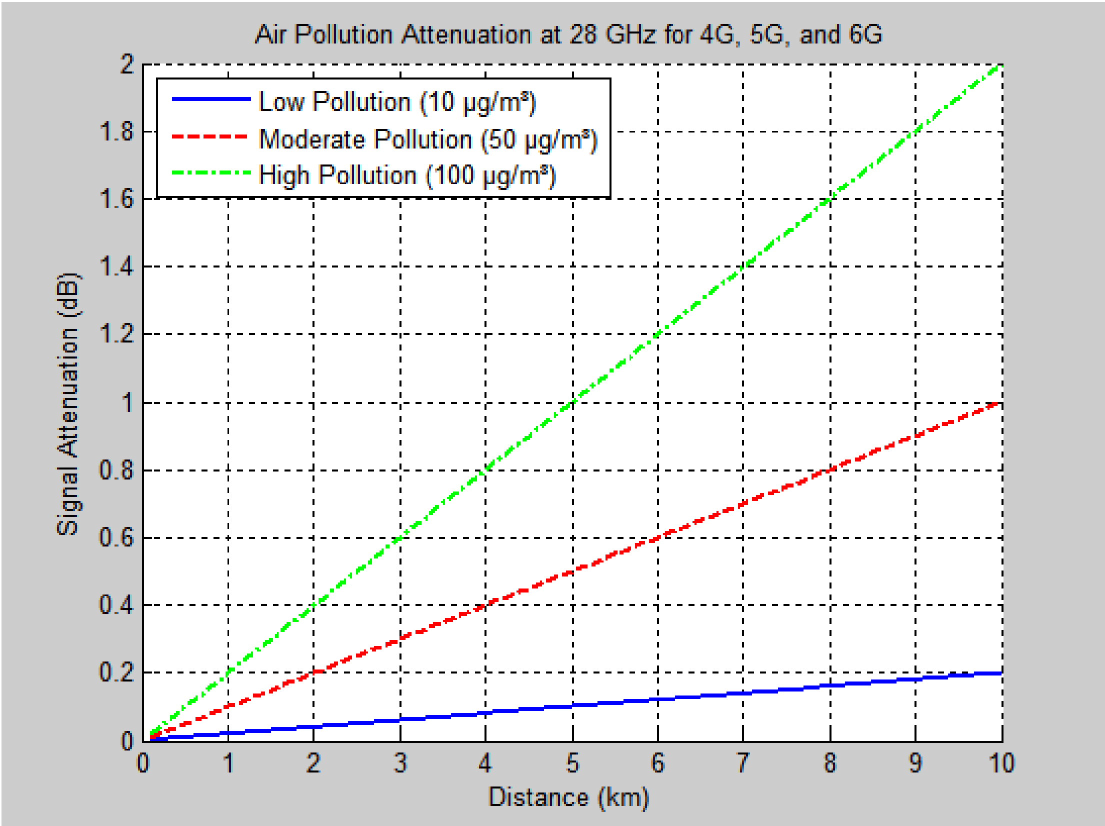


Fig2. Variation of Signal attenuation

Wireless signals are attenuated by airborne pollutants based on frequency dependent,humidity and temperature. 4G networks face with minimal air pollution due to its low frequency, in 5G networks in smog heavy cities faces moderate attenuation, 6G networks operates at 100 GHz faces severe signal degradation in polluted environments. Air pollution affects through absorption,scattering and depolarization with minimal impact susceptible to mitigiate with advanced compensation techniques.

Signal attenuation is evaluated at light rain,moderate and heavy rain and the corresponding values are obtained at different cases is represented in table 3.

| Parameter | Light rain(10mm/hr) | Moderate rain(25mm/hr) | Heavy rain(50mm/hr) |
|---|---|---|---|
| Signal attenuation(d=3 m) | 0.08dB | 0.3dB | 0.6dB |
| Signal attenuation(d=6 m) | 0.15dB | 0.6dB | 1.2 dB |
| Signal attenuation(d=10 m) | 0.2dB | 1dB | 2 dB |

Table 3: Signal attenuation

**Conclusion**

Avanced wireless technologies evolve from 4G to 5G and 6G, SAR values are influenced by changes in frequency bands, in 4G SAR complaince is managed effectively,in 5G SAR leads to lower penetration depth in human tissue, where as in 6G SAR can be controlled by SAR assessment methods. Due to differences in propagation and frequency band, rain attenuation has different effects across 4G, 5G, and 6G networks. In 4G, rain attenuation is negligible; in 5G and 6G, it is a problem. Future research must concentrate on innovative mitigation techniques like advanced signal processing,network densification and advanced communication tehcnologies, to ensure reliable wireless connectivity in bad weather conditions.

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