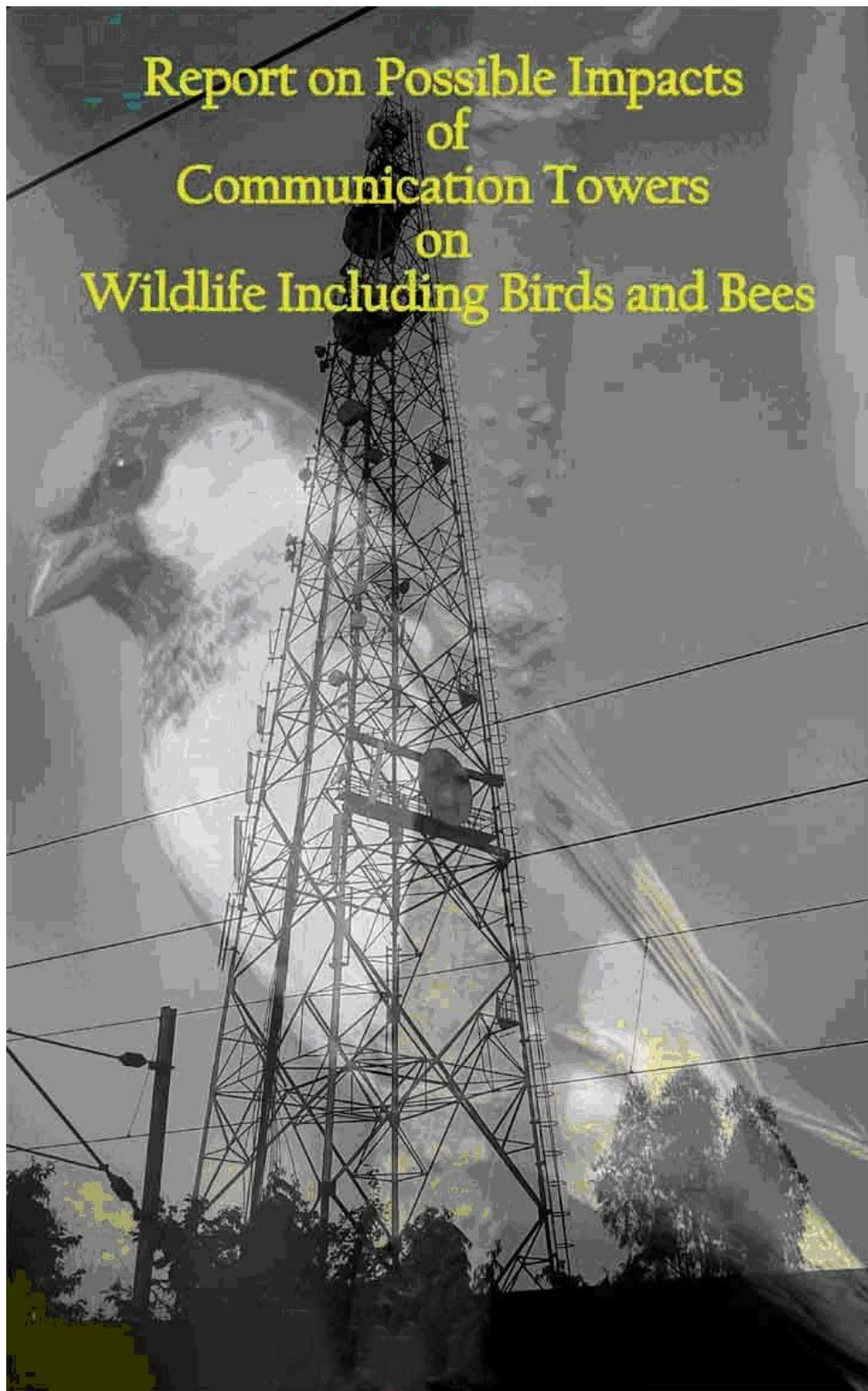


**Report on Possible Impacts
of
Communication Towers
on
Wildlife Including Birds and Bees**



Expert Group to study the possible impacts of communication towers on Wildlife including Birds and Bees

Executive summary

India is one of the fastest growing mobile telephony industries in the world. It is estimated that by 2013, 1 billion plus people will be having cell phone connection in India. To support this growth of cell phone subscriber in the country, there has also been a tremendous growth of infrastructure in the form of mobile phone towers. Today, in absence of any policy on infrastructure development and location of cell phone towers, large numbers of mobile phone towers are being installed in a haphazard manner across urban and rural areas including other sparsely populated areas in India.

The transmission towers are based on the electromagnetic waves, which over prolonged usage have adverse impacts on humans as well as on other fauna. The adverse effects of electromagnetic radiation from mobile phones and communication towers on health of human beings are well documented today. However, exact correlation between radiation of communication towers and wildlife, are not yet very well established.

The Ministry of Environment and Forests usually receives several questions regarding this issue. In view of one such Lok Sabha Starred question regarding 'Ill effects of Mobile Towers on Birds' received on 11th August, 2010, an 'Expert committee to Study the possible Impacts of Communication Towers on Wildlife including Birds and Bees' was constituted on 30th August, 2010 by Ministry of Environment and Forest, Government of India.

The Expert Committee had five important mandates which are as follows:

- I. To review all the studies done so far in India and abroad on aspects of ill effects of mobile towers on animals, birds and insects.
- II. To assess the likely impacts of the growth in the number of mobile towers in the country
- III. To suggest possible mitigatory measures.
- IV. To formulate guidelines for regulating the large-scale installation of mobile towers in the country
- V. To identify the gap areas for conducting further detailed research.

The Committee studied all the peer reviewed articles/ journals published on the impact of radiations on wildlife throughout the world and compiled them. Subsequently, detailed analysis of the papers was done to find out the impacts of electronic magnetic fields (**EMF**) on wildlife

including birds and bees and the gap areas for conducting further detailed research were identified.

The review of existing literature shows that the Electro Magnetic Radiations (EMRs) are interfering with the biological systems in more ways than one. There had already been some warning bells sounded in the case of bees and birds, which probably heralds the seriousness of this issue and indicates the vulnerability of other species as well. The electromagnetic radiations are being associated with the observed decline in the population of sparrow in London and several other European cities (Balmori, 2002, Balmori, 2009, Balmori & Hallberg, 2007). In case of bees, many recent studies have linked the electromagnetic radiations with an unusual phenomenon known as 'Colony Collapse Disorder'. A vast majority of scientific literature published across the world indicate deleterious effects of EMFs in various other species too.

In spite of the recent studies indicating possible harmful impact of EMF on several species, there are no long-term data available on the environmental impacts of EMRs as of now. Studies on impact of cell phone towers and EMR on birds and other wildlife are almost non-existent in India. Moreover, pollution from EMRs being a relatively new environmental issue, there is a lack of established standard procedures and protocols to study and monitor the EMF impacts especially among wildlife, which often make the comparative evaluations between studies difficult. In addition to the gap areas in research, the necessary regulatory policies and their implementation mechanism also have not kept pace with the growth of mobile telephoning. Our guidelines on exposure limits to EMF need to be refined since the ICNIRP Standard currently followed in India is coined based on only thermal impact of Radio Frequency and are dismissive of current epidemiological evidence on impacts of non-thermal nature on chronic exposure from multiple towers. Meanwhile, the precautionary principle should prevail and we need to better our standards on EMF to match the best in the world.

Along with the growth of phone towers and subscribers, India is also witnessing a rapid population growth. To feed and support this rapidly growing population the agricultural security and the factors influencing them should be of concern. However, the population of many species such as honey bees, which is one of the most important pollinator and important factor for agricultural productivity, has seen a drastic population drop. Unfortunately we do not have much data about the effects of EMR available for most of our free-living floral and faunal species in India. Therefore, there is an urgent need to do further research in this area before it would be too late.

Introduction

During recent years, there has been an increase in the usage of telecommunication devices, which has become an easy means for communication. The use of mobiles have become more conspicuous, during the last decade and this has led to construction of transmission towers in large numbers, both in the urban, as well as in rural areas including other sparsely populated areas. Transmission towers are based on the electromagnetic waves, which over prolonged usage have adverse impacts on humans as well as on other fauna. The adverse effects of electromagnetic radiation from mobile phones and communication towers on health of human beings are well documented today. Recently the electromagnetic fields from mobile phones and other sources have been classified as “possibly carcinogenic to human” by the WHO’s International Agency for Research on Cancer (IARC). However, exact correlation between radiation of communication towers and wildlife, are not yet very well established. Though, there have been growing concerns about the impacts of mobile towers on wildlife, and couple of studies conducted in India and worldwide indicates the possibility of negative effects of radiation.

The Ministry of Environment and Forests (MoEF) usually receives questions on such subject during the last couple of years. One such question, that the Ministry of Environment and Forests replied to on 11th August, 2010 was a Lok Sabha Starred question number 244 regarding ‘Ill effects of Mobile Towers on Birds’. In the above mentioned question, Hon’ble Member of Parliament (Lok Sabha), wanted to know, whether any studies have been conducted on the ill effects of mobile towers on birds and bees and also whether the Government has set up any committee to look into the issue.

In view of this, an urgent need was felt to constitute an Expert Group to assess the level of possible impacts of growth of mobile towers in urban, sub-urban and even rural/forest areas on the wildlife including birds and bees and to suggest appropriate mitigative measures for the problem. Hence, the ‘Expert committee to Study the possible impacts of communication towers on wildlife including Birds and Bees’ was constituted on 30th August, 2011 by Ministry of Environment and Forest, Government of India. The constitution and the terms of references of the committee are at **Annexure I**.

The committee had the following important five mandates to be completed:

- I. To review all the studies done so far in India and abroad on aspects of ill effects of mobile towers on animals, birds and insects.
- II. To assess the likely impacts of the growth in the number of mobile towers in the country
- III. To suggest possible mitigatory measures.

- IV. To formulate guidelines for regulating the large-scale installation of mobile towers in the country
- V. To identify the gap areas for conducting further detailed research.

In order to achieve its mandate, the committee had convened three meetings and discussed the issue thread bare. After the discussions, in third meeting, the committee had decided to finalise its report. Subsequently, hundreds of research papers were collated, analyzed and reviewed. Detailed descriptions were noted of important and relevant papers. Drafts were circulated within the Committee members for comments.

It should be noted that this is not a complete review of the impact of the electromagnetic radiation on all life forms as **the mandate of the Committee was limited to birds and bees**. However, for the context purpose the committee has referred to many papers concerning other taxa (See Literature Cited).

The findings of the committee based on the above mandates are provided in detail in the following paragraphs.

Scientific background on the issue

Rapid developments in various fields of science and technology in recent years have intensified the human interference into the natural environment and associated physical, biological and ecological systems resulting in various unintended and undesirable negative impacts on environment. With economic, social and scientific development, increasingly fresh avenues for environmental pollution are being thrown open in recent times. Pharmaceutical, genetic, nano-particulates and electro-magnetic pollutions are the prominent ones among them which were in the limelight in recent times for all the negative reasons.

The intensity of manmade electromagnetic radiation has become so ubiquitous and it is now increasingly being recognized as a form of unseen and insidious pollution that might perniciously be affecting life forms in multiple ways (Balmori 2006a; Balmori 2006b; Balmori 2009; Tanwar 2006). The **electro-magnetic fields (EMF)** as a pollution called ‘electro-smog’ is unique in many ways. Unlike most other known pollutants, the **electro-magnetic radiations (EMR)** are not readily perceivable to human sense organs and hence not easily detectable. However, their impacts are likely to be insidious and chronic in nature. However, it is possible that other living beings are likely to perceive these fields and get disturbed or sometimes fatally misguided. Because the EMR pollution being relatively recent in origin and lately being recognized as a pollutant coupled with its expected long-term impacts and lack of data on its effect on organisms, the real impacts of these pollutants are not yet fully documented in the scientific literature.

The electromagnetic radiations (EMR) are extensively used in modern communication and technology. Radio waves and microwaves are forms of electromagnetic energy that are collectively described by the term "**radiofrequency**" or "**RF**". RF emissions and associated phenomena can be discussed in terms of "energy", "power", "radiation" or "field". Electromagnetic "radiation" can best be described as waves of electric and magnetic energy moving together (i.e., radiating) through space (Cleveland, Fields, and Ulcek 1999).

The first mobile telephone service started on the non-commercial basis on 15 August 1995 in Delhi. During the last 16 years, India has seen exponential growth of mobile telephoning. With this growth, a number of private and government players are coming in to this lucrative and growing sector. At present nearly 800 million Indians have mobile phones, making it the second largest mobile subscribers in the world after China. At present, there are nearly 15 companies providing mobile telephoning. However, necessary regulatory policies and their implementation mechanism have not kept pace with the growth of mobile telephoning. Moreover, there have been not enough scientific studies on the impact of mobile phone towers on human health or its environmental impacts.

Most of the short-term studies primarily looking into the thermal impacts of EMR exposure on biological systems have neither succeeded to detect any statistically significant changes in the biological processes nor could prove any acute change in health conditions at the present background levels of exposures (Brent 1999; Hanowski Niemi and Blake 1996; Hoskote, Kapdi and Joshi 2008; Lönn *et al.* 2005; Mixson *et al.* 2009; Zach and Mayoh 1984; Zach and Mayoh 1986). On the other hand, long-term studies have reported alarming observations, detecting negative consequences on immunity, health, reproductive success, behaviour, communication, co-ordination, and niche breadth of species and communities (Preece *et al.* 2007; Levitt and Lai 2010; Hardell *et al.* 2008; Hardell *et al.* 2007; Fernie and Bird 2001).

- **Impact on birds and bees:** Of the non-human species, impacts on birds and bees appear to be relatively more evident. Exposure to EMR field is shown to evoke diverse responses varying from aversive behavioural responses to developmental anomalies and mortality in many of the studied groups of animals such as bees, amphibians, mammals and birds (Zach and Mayoh 1982; Zach and Mayoh 1982; Batellier *et al.* 2008; Nicholls and Racey 2007; Bergeron 2008; Copplestone *et al.* 2005; Sahib 2011). Honey bees appear to be very sensitive to EMF (Ho 2007; Sharma and Kumar 2010; Ho 2007) and their behavioural responses, if scientifically documented, could be used as an indicator of EMF pollution.
- **Impacts on other wildlife:** Other wildlife such as amphibians and reptiles also appear to be at high risk with possible interference of EMF with metamorphosis and sex ratios where temperature dependent sex determination is operational. Several investigations into

environmental effects of EM fields are covered in some of the unpublished / grey literature and impact assessments submitted to various regulatory government agencies (Bergeron 2008a; Bergeron 2008b; Cleveland, Fields, and Ulcek 1999; Coplestone *et al.* 2005; G. Kumar 2010; Hutter *et al.* 2006). Such reports are either not in the public domain, or scattered and often difficult to access.

- **Impacts on Human:** Since its inception, there have been concerns about the ill-effect of the mobile towers and mobile phones. Despite being a relatively newly acknowledged form of pollution, EMRs and their negative impacts on biological systems and environment have already been reported by several studies. However most of the available scientific literature on the negative environmental effects of electromagnetic fields reports the results of experimental and epidemiological studies examining the impact on various aspects of human health (Tanwar 2006; Savitz 2003; Preece *et al.* 2007; Oberfeld *et al.* 2004; Navarro *et al.* 2003; Lönn *et al.* 2005; Kundi and Hutter 2009; Hardell *et al.* 2007; Kapdi, S. Hoskote and Joshi 2008; Hallberg and Johansson 2002).

Present scenario: At present, there could be more than 5 billion mobile phone subscribers globally (www.who.int/mediacentre/factsheets/fs193/en). Recently, in May 2011, the WHO's International Agency for Research on Cancer (IARC) has classified electromagnetic fields from mobile phones and other sources "possibly carcinogenic to human" and advised the public to adopt safety measures to reduce exposures, like use of hand-free devices or texting. For details please see Press Release No. 208, dated 31 May 2011 on IARC-WHO (http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf). Their findings were published in the July 2011 issue of the medical journal *Lancet*. Later, WHO clarified that some of the findings published in *Lancet* were not reported properly in the media and the risk is not as great as made out in the media. Some of the cell phone manufactures have objected to these findings (For example see www.Physorg.com). Some earlier investigators also have contended that there is no measurable risk of reproductive failure and birth defects from EMF exposures in humans (Brent *et al.* 1993), while several others do not agree with that conclusion (Gandhi 2005; Kapdi, Hoskote and Joshi 2008; Pourlis 2009; G. Kumar 2010). Studies carried out on the RF levels in North India, particularly at the mobile tower sites at Delhi have shown that people in Indian cities are exposed to dangerously high levels of EMF pollution (Tanwar 2006).

Existing world-wide standard and permissible limits

Two major transmission protocols currently in use for mobile telephony are GSM (900 to 1800 MHz) and CDMA (824-844 MHz paired with 869-889 MHz). The Telecom Engineering Centre (TEC) of DoT had proposed display of Specific Absorption Rate (SAR) value in handsets. As indicated in the table below, current Indian standards on exposure are much higher than many other countries.

Power Density (W/m ²)	International Exposure limits adopted by various countries
10	FCC (USA) OET-65, Public Exposure Guidelines at 1800 MHz
9.2	ICNIRP and EU recommendation 1998 – Adopted in India
3	Canada (Safety Code 6, 1997)
2	Australia
1.2	Belgium (ex Wallonia)
0.5	New Zealand
0.24	Exposure limit in CSSR, Belgium, Luxembourg
0.1	Exposure limit in Poland, China, Italy , Paris
0.095	Exposure limit in Italy in areas with duration > 4hours
0.095	Exposure limit in Switzerland
0.09	ECOLOG 1998 (Germany) <i>Precaution recommendation only</i>
0.025	Exposure limit in Italy in sensitive areas
0.02	Exposure limit in Russia (since 1970), Bulgaria, Hungary
0.001	"Precautionary limit" in Austria, Salzburg City only
0.0009	<i>BUND 1997 (Germany) Precaution recommendation only</i>
0.00001	New South Wales, Australia

Table 1. Guidelines and Limits on Exposure Limits in Various Countries (Source: Girish Kumar 2010)

1. ICNIRP Guidelines (International Radiofrequency Guidelines):

In April 1998, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) published, guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields in the frequency range up to 300 GHz. These guidelines replaced previous advice issued in 1988 and 1990. The main objective of the ICNIRP Guidelines is to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects (ICNIRP, 1998). An adverse health effect is defined by ICNIRP as one which causes detectable impairment of the health of the exposed individual or of his or her offspring; a biological effect, on the other hand, may or may not result in an adverse health effect.

2. Guidelines and Limits followed by Other Countries:

Some countries have established new, low-intensity based exposure standards that respond to studies reporting effects that do not rely on heating. Consequently, new exposure guidelines are having hundreds or thousands times lower than those of Institution of Electronics and Electrical Engineers (IEEE) and ICNIRP. Table 2, shows some of the countries that have lowered their limits, for example, in the cell phone frequency range of 800 MHz to 900 MHz. The levels range from 10 microwatts per centimeter squared in Italy and Russia to 4.2 microwatts per centimeter squared in Switzerland. In comparison, the United States and Canada limit such exposures to only 580 microwatts per centimeter squared (at 870MHz) and then averaged over a time period (meaning that higher exposures are allowed for shorter times, but over a 30 minute period, the average must be 580 microwatts per centimeter squared or less at this frequency). The United Kingdom allows one hundred times of this level, or 580 x 100 microwatts per centimeter squared. Higher frequencies have higher safety limits, so that at 1000 MHz, for example, the limit is 1000 microwatts per centimeter squared (in the United States). The exposure standards for each individual frequency in the radiofrequency radiation range needs to be calculated. These are presented as reference points only. Emerging scientific evidence has encouraged some countries to respond by adopting planning targets, or interim action levels that are responsive to low-intensity or non-thermal radiofrequency radiation bio effects and health impacts.

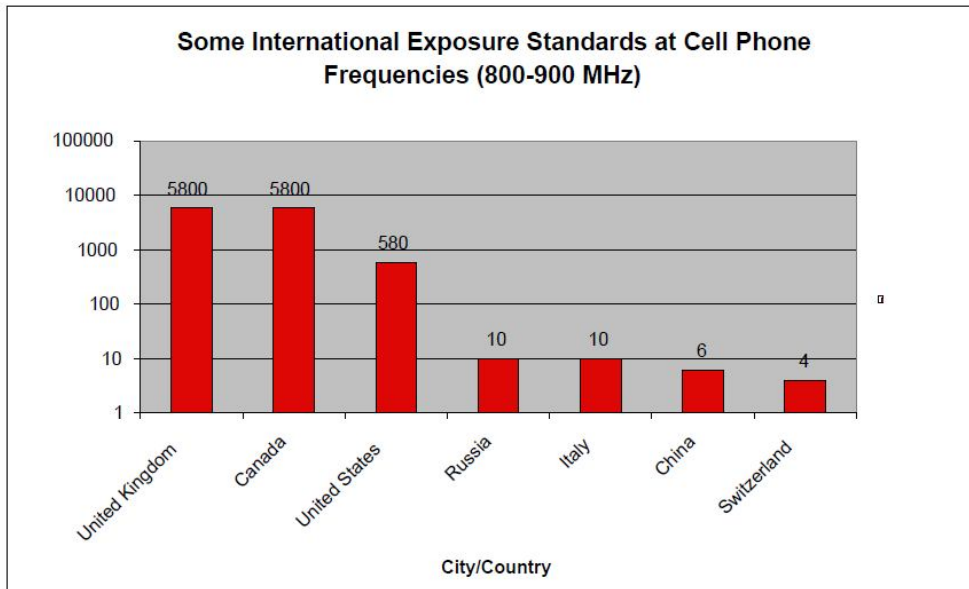


Table 2. Some International Exposure Standards at Cell Phone Frequencies (800-900 MHz) (Values of exposure in microwatts per centimeter squared)

Professional bodies such as IEEE and ICNIRP continue to support “thermal-only” guidelines:

- a) by omitting or ignoring study results reporting bio-effects and adverse impacts to health and wellbeing from a very large body of peer-reviewed, published science because it is not yet “proved” according to their definitions;
- b) by defining the proof of “adverse effects” at an impossibly high a bar (scientific proof or causal evidence) so as to freeze action;
- c) by requiring a conclusive demonstration of both “adverse effect” and risk before admitting low-intensity effects should be taken into account;
- d) by ignoring low-intensity studies that report bio-effects and health impacts due to modulation;
- e) by conducting scientific reviews with panels heavily burdened with industry experts and under-represented by public health experts and independent scientists with relevant low-intensity research experience;
- f) by limiting public participation in standard-setting deliberations; and other techniques that maintain the status quo.

(Source: “*Bio Initiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*” by 'Cindy Sage, and David Carpenter (2007))

Detailed analysis of the Issue vis-à-vis the TORs

- ***TOR I: To review all the studies done so far in India and abroad on aspects of ill effects of mobile towers on animals, birds and insects.***

Though EMR is a relatively newly recognised pollutant, many recent studies have pointed to their harmful long-term impacts on health and environment. Hence the most important mandate of the committee was to study all the peer reviewed articles/ journals published on the impact of radiations on wildlife throughout the world and to compile them. Subsequently, detailed analysis of the papers was done to find out the impacts of electronic magnetic fields (EMF). The research papers were then listed in to three categories: showing impact on organisms, no impact and neutral or inconclusive evidence (See Table No. 3).

Literature review:

A review during the international seminar entitled “Effects of electromagnetic fields on the living environment” held in Ismaning, Germany in 1999, organized under WHO’s International EMF Project, observed that the EMF impacts on environment are minimal and localized and has opined that the human EMF exposure limits recommended by the International Commission on Non-Ionizing Radiation (ICNIRP, 1998) would also be protective of the environment as well (Foster and Repacholi 1999). However, recent research reports are at odds with these propositions, including the latest report from WHO indicating a possible link with cell phone use and brain glioma (Baan *et al*, 2011).

Several species are known to have the capability to sense and respond to EM fields, especially the earth's magnetic field (Kirschvink 1982). However, little is known of the exact physiological mechanisms involved. Three major hypotheses of magnetic-field detection have been proposed (Lohmann and Johnsen 2000): a) *Electromagnetic induction* (as in Electro sensitive sharks and rays), b) *Biogenic magnetite* and c) *Chemical reactions modulated by magnetic fields*. Despite notable recent progress, primary magneto-receptors have not yet been identified unambiguously.

Most of the reported studies examined (n=919) deal with the EMF impacts on human subjects (81%), while only 3% of them reports impact on birds and just 2% on wildlife. The present report is based on relevant papers and documents obtained mainly from online archives of JSTOR (www.jstor.org) and Google scholar (<http://scholar.google.co.in/>). Salient features of the reported studies on the impact of EMF on different faunal groups are discussed below (can be included below).

An Analysis of Results of Literature Survey:

After careful screening that involved deletion of duplicate records and addition of new references, the 1080 references initially compiled for the analysis of literature (which formed the base for our overview) were reduced to 919 references. These final 919 study reports are used here for the present final analysis.

The studies were broadly classified based on the subject organisms into four categories- Birds, Bees, Other Animals (including wildlife) and humans. Based on the study's findings regarding the impact of EMFs on the subject, each category was further subdivided into three groups- Impact, No Impact or Neutral/ Inconclusive, as given in table 3 below. As noted below majority of the studies reported negative impacts by EMFs.

Table 3. Number of research studies (collected from Open access Bibliographic databases) collected and collated based on the study subjects and results

	Impact	No Impact	Neutral/ inconclusive	Total (n)
Birds	23	3	4	30
Bees	6	1	0	7
Human	459	109	174	742
Other Animals (+Wildlife)	85(+13)	16(+1)	10(+7)	111(+21)
Plants	7	0	1	8
Total	593	130	196	919

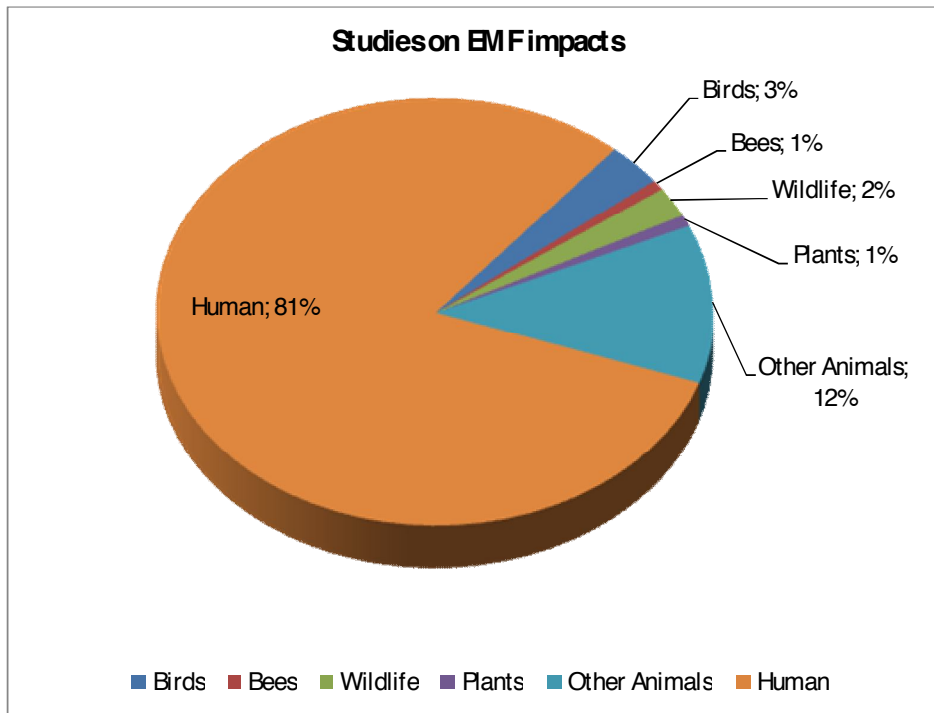


Fig 1. Proportion of studies on different groups of organisms

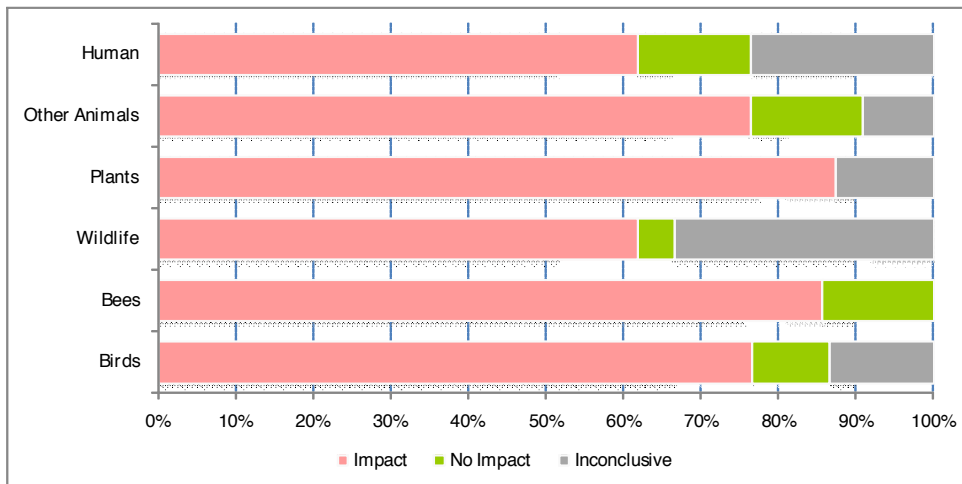


Fig 2. Proportion of study results in various groups of organisms (n=919). The 'Impact' (in red) indicates percentage of studies that reported harmful effect of EMR

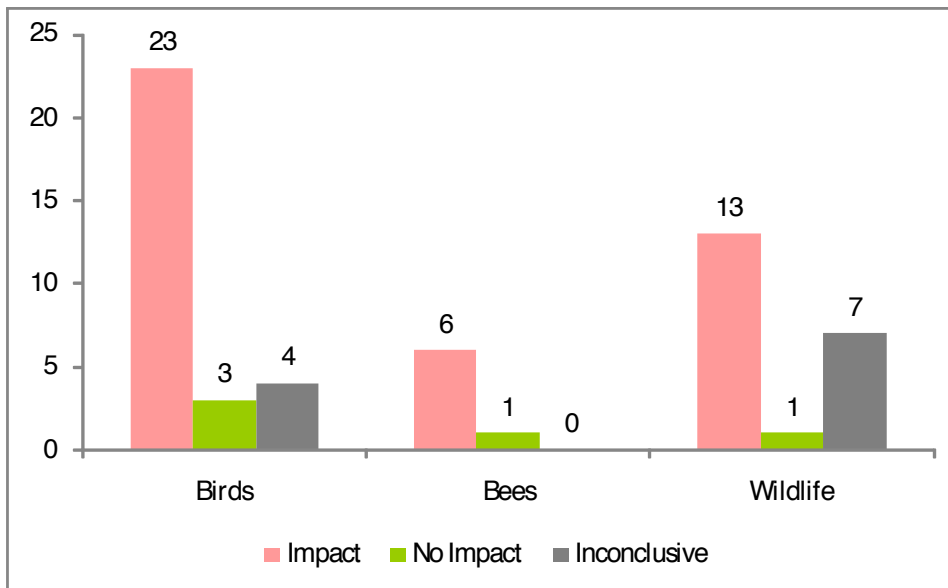


Fig 3. Proportion of study results in Birds, Bees and Wildlife (n=919).

- **TOR II: To assess the likely impacts of the growth in the number of mobile towers in the country.**

India has the second largest population of mobile subscribers in the world and in the absence of any proper policy regulating the construction of mobile towers, the risk of the likely negative impacts of EMF on the health of humans and wildlife is huge. Based on the analysis of the reported studies, the impacts of EMF on different faunal groups were identified, the salient features of which are as discussed below:

Effect on Birds: The earliest reported study on impacts of microwave radiation on birds dates back to 1960s (Tanner, Romero-Sierra, and Davie 1967). In birds, their ability to fly expose them to a greater risk of direct irradiation and hence they appear to be at greater risk as far as effects of EMRs are concerned (Balmori 2005; Balmori and Hallberg 2007; Summers-Smith 2003; Zach and Mayoh 1982; Zach and Mayoh 1984; Zach and Mayoh 1982; Joris and Dirk 2007). Observed effects of exposure to non-ionizing radiation in avian species are mostly from radiation-induced temperature increases (Batellier *et al.* 2008). The incubating avian egg provides a model to study non-thermal effects of microwave exposure since ambient incubation temperature can be adjusted to compensate for absorbed thermal energy. Non-thermal levels of non-ionizing radiation can affect a bird's ability to recover from acute physiological stressors, apart from other potential physiological and behavioural repercussions. Although earlier research indicated that modulated radiofrequency radiation increased calcium-ion efflux in chick forebrain tissue, disagreement on experimental techniques and incongruous results among related studies have

made final conclusions elusive. In another study, which was carried out by National Research Centre of Canada on interaction of electromagnetic fields and living systems with special reference to birds, it was observed that following the onset of radiation, stabilizing period of the egg production in birds was affected (Bigu, 1973).

Birds have been shown to be able to reliably detect magnetic fields in both the field and laboratory. The rapidly increasing number of cell-phone subscribers is resulting in higher concentration levels of electromagnetic waves in the air, which clashes with the earth's electromagnetic field (Hyland, 2000). Some researchers have reported malformations in chicken embryos exposed to a sinusoidal bipolar oscillating magnetic field (Balmori and Hallberg 2007).

According to a thermal modelling study of a bird subjected to continuous wave (CW) microwave radiation (2.45 GHz), the model predicted that tolerance to microwave radiation for a bird was positively correlated with its mass and that ambient temperature is the environmental variable that has most influence on the level of tolerance for microwave radiation (Byman *et al.* 1986).

Effect on House Sparrows: House Sparrow (*Passer domesticus*) is associated with human habitation and it is one of the indicator species of urban ecosystems. A declining population of the bird provides a warning that the urban ecosystem is experiencing some environmental changes unsuitable for living in the immediate future (Kumar, 2010). London has witnessed a 75 per cent fall in House Sparrow population since 1994, which coincides with the emergence of the cell-phone (Balmori, 2002). Electromagnetic radiation may be responsible, either by itself or in combination with other factors, for the observed decline of the sparrows in European cities (Balmori, 2009, Balmori & Hallberg, 2007). Research in Spain proved that the microwaves released from these towers are harmful to House Sparrows and the increase in the concentration of microwaves results into decrease in House Sparrow populations (Everaert & Bauwen, 2007). Reproductive and co-ordination problems and aggressive behavior has also been observed in birds such as sparrows (Balmori, 2005). General methodology used for such study was, from each area, all sparrows were counted in addition to the mean electric field strength (Everaert & Bauwens, 2007). In similar studies in India, population of *Passer domesticus* was found fast disappearing from areas contaminated with electromagnetic waves arising out of increased number of cell phones, in Bhopal, Nagpur, Jabalpur, Ujjain, Gwalior, Chhindwara, Indore & Betul (Dongre & Verma, 2009). It was also observed that when 50 eggs of House Sparrow, exposed to electromagnetic radiation (EMR) for durations of five minutes to 30 minutes, all the 50 embryos were found damaged in a study carried out by the Centre for Environment and Vocational Studies of Punjab University (Kumar 2010, Ram 2008).

Male sparrows were seen at locations with relatively high electric field strength values of GSM base stations, providing evidence of how long-term exposure to higher levels of radiation negatively affects the abundance or behavior of House Sparrows in the wild. Thus,

electromagnetic signals are associated with the observed decline in the sparrow population in urban areas.

Effect on White Storks: In monitoring a White Stork (*Ciconia ciconia*) population in Valladolid (Spain) in vicinity of Cellular Phone Base Stations, the results indicated the possibility that microwaves are interfering with the reproduction of White Stork (Balmori, 2010).

Effect of Mobile Radiation on Honey Bees: Many recent studies have linked the electromagnetic radiations with an unusual phenomenon in bees known as 'Colony Collapse Disorder'. Colony Collapse Disorder (CCD) occur when a hive's inhabitants suddenly disappear, leaving only queens, eggs and a few immature workers. The vanished bees are never found, but thought to die solitarily far from home. The theory is that radiation from mobile phones interferes with bees' navigation systems, preventing them from finding their way back to their hives. Even the other animals, parasites and other bees, that normally would raid the honey and pollen left behind when a colony dies, refuse to go anywhere near the abandoned hives. Some scientists believe that CCD is the result of high electromagnetic radiation. As long back as early 1970s, Wellenstein (1973) had reported that the navigational skills of the honey bees were being impacted by high tension lines. In a recent study (Stefan *et al.* 2010) significant differences have been detected in returning of honeybees to their hives: 40% of the non-irradiated bees came back compared to 7.3% of the irradiated ones.

The alarm was first sounded in last autumn, but has now hit half of all American states. The West Coast is thought to have lost 60 per cent of its commercial bee population, with 70 per cent missing on the East Coast. CCD has since spread to Germany, Switzerland, Spain, Portugal, Italy and Greece. John Chapple, one of London's biggest bee-keepers, announced that 23 of his 40 hives have been abruptly abandoned (<http://www.independent.co.uk/environment/nature/are-mobile-phones-wiping-out-our-bees-444768.html>).

In India, studies conducted by Sainudeen (2011) have proved experimentally that once mobile phones in working condition with frequency of 900 MHz for 10 minutes were kept in the beehives, the worker bees stopped coming to the hives after ten days. He also found drastic decrease in the egg production of queen bees (100 eggs/ day compared to 350 eggs/ day in the control colonies). Earlier studies have also shown (e.g. Greenberg *et al.* 1981) lower eggs being laid in beehives exposed to high voltage transmission lines. Another possible impact of EMR on the bees is the eggs that are exposed to cell phone radiation produce only drones (Brandes and Frish, 1986). Similar studies on a larger scale and better sample size are required in India.

Other wildlife: Phone masts located in the living areas of animals and birds are continuously irradiating some species that could suffer long-term effects, like reduction of their natural defences, deterioration of their health, problems in reproduction and reduction of their useful territory through habitat deterioration. Electromagnetic radiation can exert an aversive

behavioural response in rats, bats and birds such as sparrows. Therefore microwave and radiofrequency pollution constitutes a potential cause for the decline of animal populations and deterioration of health of plants living near phone masts (Balmori, 2005).

Arguably, the most serious concern about the impact of EMF on the living systems appears to be its long term effects on genes and reproductive fitness of species. Today, there is evidence that Electromagnetic Radiation is genotoxic (Blaasaas, Tynes, and Lie 2003; Joris and Dirk 2007; Pourlis 2009; Cherry 2000). An experiment on Common Frog (*Rana temporalis*, new name *Hylarana temporalis*) indicated that radiation emitted by phone masts in a real-time situation may affect the development and may cause rise in mortality of exposed tadpoles. This research may have huge implications for the natural world, which is now exposed to high microwave radiation levels from a multitude of phone masts (Balmori 2010). However, it requires long-term monitoring studies for establishing any causative link between reproductive fitness and EMFs and such data is presently lacking. Moreover, available short term studies are grossly inadequate. For instance a recent review that analysed the literature (till 2001) on the effects of EMF associated with mobile telephony on the prenatal and postnatal development of vertebrates reported that the majority of the studies examined indicated no strong impact on the animal reproduction and development (Pourlis 2009).

Effect on bats: Activity of bats seems to be much reduced in areas with Electro-magnetic fields with densities more than 2V/m (Balmori, 2009). Based on this fact it was recommended to use EMR to repel bats from wind farms (Nicholls and Racey, 2007). In another study in a Free-tailed bat colony (*Tadarida teniotis*) the number of bats decreased when several phone masts were placed 80m from the colony (Balmori *et al.*, 2007).

- **TOR III: To suggest possible mitigatory measures**

Decision was taken in the first and second meetings of the Expert Group to study all peer reviewed articles/ journals published on the impact of radiations on wildlife and to compile the list of the measures taken throughout the world to mitigate the effects of radiations on wildlife including birds and bees. Hence, the standards and exposure limits of radio frequency of different countries were studied in this regard.

Various organizations and countries have developed standards for exposure to radio frequency energy as discussed above. Some countries have established new, low-intensity based exposure standards that respond to studies reporting effects that do not rely only on heating. Currently, the World Health Organization is working to provide a framework for international harmonization of RF safety standards.

Emerging scientific evidence has encouraged some countries to respond by adopting planning targets, or interim action levels that are responsive to low-intensity or non-thermal radiofrequency radiation bio effects and health impacts. It is the WHO's view that scientific

assessments of risk and science-based exposure limits should not be undermined by the adoption of arbitrary cautionary approaches. Therefore, throughout the world there has been a growing movement to adopt a precautionary approach.

- **TOR IV: *To formulate guidelines for regulating the large-scale installation of mobile towers in the country***

With the rapid growth of the mobile industry in India, mobile towers are being built in a haphazard manner without any prior planning and regulation. Hence in view of this, along with lack of any policy controlling the construction of such mobile towers, one of the main tasks of the committee is to formulate guidelines to regulate their installation. At the first meeting of the Expert Committee held on 09.2010, it was decided that few members of the Expert Group will participate in the meeting of the Inter-Ministerial Committee on EMF Radiation held in Ministry of Telecommunications on 06.12.2010, to share the concerns on human as well as wildlife health and to devise a common set of guidelines for mobile towers in the country. The minutes of the meeting was submitted to the Ministry.

- **TOR V: *To identify the gap areas for conducting further detailed research***

At the first meeting of the committee, all the members had agreed that the research in India on this issue is very scanty and much research has to be done in this field especially on birds and bees, as well as to find solutions to this issue. Hence, in the second meeting of the Expert Group held on 14.02.2011, a decision was taken to identify the gap areas in research on the issue of impact of radiations on wildlife including birds and bees.

Gap areas for research: Ample information on the impact of EMF on human health is available. However these results cannot be extrapolated to reflect impacts on wildlife impacts since the impact highly varies even within same species depending on multiple factors such as body size, age, earthing, fat content in the body, objects in the immediate vicinity and so on.

Not much data is also available on biological impacts on wild species except for a few species like sparrows and bees. Even this little available information is not reflective of the impact of present background levels of radiation. Information on effects with regards to specific frequencies and species response is lacking. Data on navigation and seasonal migrations as indicated by studies on homing pigeons (Kirchwink 1982) are lacking from the Indian context.

The current ICNIRP guidelines on EMF are developed based especially on laboratory studies, epidemiological data on humans, occupational exposures, in-vitro investigations, observations on cellular changes under control conditions etc. Ecological issues appear to be hardly taken care of. One needs to acknowledge that laboratory observations need not necessarily reflect field effects. Therefore we have to re-visit the guidelines taking account low level electro-smog on wild species especially birds, bees, amphibians etc and modify them accordingly. Our guidelines need to be refined since the ICNIRP Standard currently followed in India is coined

based on only thermal impact of RF and is dismissive of current epidemiological evidence on impacts of non-thermal nature on chronic exposure from multiple towers. The limit on whole-body average SAR is 0.08 W/kg. It is a long way to go before we can have the required long-term 'Species specific data' to decide on the threshold exposure levels for various wildlife species. Till such time a **precautionary principle approach to be used to minimize the exposure levels and we may have to move ahead and adopt stricter norms followed in some other countries like Russia, China, New Zealand etc.**

Since EMF being an invisible form of pollution there needs to be an independent system for monitoring of EMF pollution across the country.

The EMF pollution has reportedly caused population declines on sparrows and bees (causing disorientation and Colony Collapse Disorder (CCD)). It has also resulted in aversive behaviour in bats and sparrows, abnormal behaviour in Tits, Kestrels, reproductive failure in White Storks and also fatal bird collisions with involving communication towers causing the death of several million birds of 230 species each year in the USA alone. However, sound scientific investigations in this regard are lacking in India and such studies needs to be undertaken on an urgent basis.

The following areas for specific studies are suggested to be taken up:

- Field studies on impact of cell towers on bee colonies and apiculture,
- Bird/bat/insect mortalities at mobile phone towers with special reference to towers along bird migratory paths,
- Studies on birds / bats / bees to find the effect of EMR on their communication, orientation and co-ordination
- Effect of EMF on amphibian metamorphosis and sex determination in reptiles
- Laboratory studies to develop an understanding on certain species, on their physiological and behavioural aspects, making use of the techniques of bioassay/bio-monitoring
- Measurement, monitoring and mapping of background EMF levels and power density across India involving independent research agencies.
- Regulations/standards to include the ecological characteristics of an area while determining the location of transmission towers, relay stations etc
- Regulations to control installation of transmission towers in human residences/hospitals/dense habitations
- Conduct ecological impact assessment of transmission towers and base stations, with standardised protocols/parameters

Future Scenario

India is one of the fastest growing mobile telephony industries in the world. It is estimated that by 2013, 1 billion plus people will be having cell phone connection in India. With the growth of cell phone subscriber, it has also lead to growth of infrastructure in the form of mobile phone towers. Today, in absence of any policy on infrastructure development and location of cell phone towers, large number of mobile phone towers are being installed in a haphazard manner across urban and sub urban habitats in India.

Along with the growth of phone towers and subscribers, India is also witnessing a rapid population growth. To feed and support this rapidly growing population the agricultural security and the factors influencing them should be of concern. However, the population of many species such as honey bees, which is one of the most important pollinator and important factor for agricultural productivity, has seen a drastic population drop.

Precautionary approach

Throughout the world there has been a growing movement to adopt a precautionary approach. The WHO defines the Precautionary Principle as a risk management concept that provides a flexible approach to identify and manage possible adverse consequences to human health even when it has not been established that the activity or exposure constitutes harm to health.

It is the WHO's view that scientific assessments of risk and science-based exposure limits should not be undermined by the adoption of arbitrary cautionary approaches. The compliance of mobile phone networks and handsets with the ACMA regulations is regarded as a prudent and cautious approach to ensure that the community is not adversely affected by, but benefits from developments in communications.

The Department Of Telecom has constituted an Inter-Ministerial Committee to examine the effect of EMF Radiation on health. The report of the committee is placed in DOT website. The IMC report is under examination of DOT at present.

Recommendations

Following recommendations have been put forward by few members of the Committee:

- 1) EMF should be recognised as a pollutants/ regular auditing of EMF should be conducted in urban localities/educational/hospital/industrial/residential/recreational premises and around the protected areas and ecologically sensitive areas.
- 2) Introduce a law for protection of urban flora and fauna from emerging threats like ERM/EMF as conservation issues in urban areas are different from forested or wildlife habitats.
- 3) Bold signs and messages on the dangers of Cell phone tower and radiation which is emitted from it are displayed in and around the structures where the towers are erected. Use visual daytime markers in areas of high diurnal raptor or waterfowl movements.
- 4) To avoid bird hits, security lighting for on-ground facilities should be minimized and point downwards or be down-shielded.
- 5) Independent monitoring of radiation levels and overall health of the community and nature surrounding towers is necessary to identify hazards early. Access to tower sites should be allowed for monitoring radiation levels and animal mortality, if any.
- 6) Procedure for removal of existing problematic mobile towers should be made easy, particularly in and around protected area or urban parks and centres having wildlife .
- 7) Strictly control installation of mobile towers near wildlife protected areas, Important Bird Areas, Ramsar Sites, turtle breeding areas, bee colonies, zoos, etc up to a certain distance that should be studied before deciding and should also be practical. Ecological assessment / review of sites identified for installing towers before their installation also may be considered in wildlife / ecologically / conservational important areas.
- 8) The locations of Cell phone towers and other EMF radiating towers along with their frequencies should be made available on public domain. This can be at city/ district/ village level. Location wise GIS mapping of all cell phone towers be done by DoT. This information will help in monitoring the population of birds and bees in and around the mobile towers and also in and/or around wildlife protected areas.
- 9) Public consultation to be made mandatory before installation of cell phones towers in any area. The Forest Department should be consulted before installation of cell phone towers in and around PAs and zoos. The distance at which these towers should be installed should be studied case by case basis.
- 10) Awareness drive with high level of visibility in all forms of media and regional languages should be undertaken by the Government to make people aware about various norms in regard to cell phone towers and dangers from EMR. Such notices should be placed in all wildlife protected areas and in zoos.
- 11) To prevent overlapping high radiations fields, new towers should not be permitted within a radius of one kilometer of existing towers.

- 12) If new towers must be built, construct them to be above 80 ft and below 199 ft. tall to avoid the requirement for aviation safety lighting. Construct unguyed towers with platforms that will accommodate possible future co-locations and build them at existing 'antenna farms', away from areas of high migratory bird traffic, wetlands and other known bird areas.

Note: Many of the above recommendations have already been given by Government of Delhi and West Bengal (appendix III). The Supreme Court of India has sought explanation from all mobile phone operators and various government and semi-government agencies over the issue of alleged "illegal" and unregulated constructions of mobile phone towers on top of buildings across the country (see www.thehindubusinessline.in/2005/09/27/stories/2005092703950900.htm). Similarly, recent rulings in June 2011 by Punjab and Haryana High Courts also direct the government to inform public about the health hazards (www.indianexpress.com/news/Inform/public/about/health/hazards/of/mobile/tower//HC-to-Govt/800786/).

Conclusion

The review of existing literature shows that the EMRs are interfering with the biological systems in more ways than one and there had already been some warning bells sounded in the case on bees (Warnke 2007; vanEngelsdorp *et al.* 2010; Gould 1980; Sharma and Neelima R Kumar 2010) and birds, which probably heralds the seriousness of this issue and indicates the vulnerability of other species as well. Despite a few reassuring reports (Galloni *et al.* 2005), a vast majority of published literature indicate deleterious effects of EMFs in various species. The window of frequency range and exposure time required to make measurable impacts would vary widely among species and unfortunately we do not have any such data available for most of our free-living floral and faunal species in India. There is an urgent need to focus more scientific attention to this area before it would be too late.

Microwave and radiofrequency pollution appears to constitute a potential cause for the decline of animal populations (Balmori 2006; Balmori and Hallberg 2007; Balmori Martínez 2003; Joris and Dirk 2007; Summers-Smith 2003) and deterioration of health of plants and humans living near radiation sources such as phone masts. Studies have indicated the significant non-thermal long-term impacts of EMFs on species, especially at genetic level which can lead to various health complications including brain tumours (glioma), reduction in sperm counts and sperm mobility, congenital deformities, Psychiatric problems (stress, 'ringxiety', sleep disorders, memory loss etc.) and endocrine disruptions. However similar aspects are yet to be studied among animal populations.

Pollution from EMRs being a relatively new environmental issue, there is a lack of established standard procedures and protocols to study and monitor the EMF impacts especially

among wildlife, which often make the comparative evaluations between studies difficult. Moreover, there are no long-term data available on the environmental impacts of EMRs as of now. Well-designed long-term impact assessment studies would be required to monitor the impact of ever-increasing intensities of EMRs on our biological environment. Meanwhile the precautionary principle should prevail and we need to better our standards on EMF to match the best in the world.

Studies on impact of Cell phone tower radiation on Birds and wildlife are almost non-existent from India. There is an urgent need for taking up well designed studies to look into this aspect. Available information from the country on the subject of EMF impacts is restricted to few reports from honey-bees. However, these studies are not representative of the real life situations or natural levels of EMF exposure. More studies need to be taken up to scientifically establish if any, the link between the observed abnormalities and disorders in bee hives such as Colony Collapse Disorder (CCD).

Appendices

Appendix I: Photographs showing mobile towers

Appendix II: Precautionary boards about mobile towers

Appendix III: GRs of Delhi and West Bengal Governments

Appendix IV: Bibliography

Members of the Expert Committee

1. Dr. Asad Rahmani, Director, BNHS (Chairman)
2. Representative of Wildlife Institute of India (Dr. Dhananjai Mohan, Dr. B.C. Choudhary)
3. Representative of Deptt. of Telecommunications, New Delhi [Shri. P. K. Panigrahi, Sr. DDG (BW)]
4. Representative of the Centre for Environment & Vocational Studies, Punjab University
5. Representatives of WWF India (Gp Captain Naresh Kapalia, Dr. Parikshit Gautam)
6. Representative of Indian Institute of Science, Bangalore (Prof. H.S. Jamadagni)
7. Representative of Indian Institute of Technology, New Delhi (Prof. R.K. Patney, Deptt. of Electrical Engineering)
8. Representative of SACON (Dr. P.A. Azeez, Director, Dr. Arun Kumar)
9. Dr. Sainuddin Pattazhy, Associate Professor, Deptt. of Zoology, University of Kerala
10. Ms. Prakriti Srivastava, DIG(WL), MoEF (Member Secretary)

Appendix I



Cell phone Towers on commercial and residential Structures



Cell Phone Tower



Cell Phone towers near Keoladeo National Park, Bharatpur, Rajasthan

Appendix II

Precautionary Boards (Some samples)

AREA DEMARCATION



CAUTION
RADIOFREQUENCY RADIATION

- Area of Unrestricted Occupancy
- Minor Injury Possible from Misuse



WARNING
RADIOFREQUENCY RADIATION

- Area of Restricted Occupancy
(RF Workers Only)
- Serious Injury Possible from Misuse



DANGER
RADIOFREQUENCY RADIATION

- Area of Denied Occupancy
- Critical Injury or Death Possible

Appendix III

Delhi
Government

Vivek Rao
Principal Secretary (Health & FW)

D.O.No.
Dated

141 / Exposure at Electro magnetic /
Pg. Secy H&W / 133-14 /
10/01/2008

Dear

The existing guidelines for granting permission for installation of towers on ground/roof tops for Cellular Mobile Phone Services finalized pursuant to a meeting held at Raj Niwas on 26.7.2002 have been reviewed on the basis of certain representations from the public and it has been decided that henceforth such towers in residential areas should be permitted only in consultation with the concerned Resident Welfare Associations and not left to bilateral negotiations between Telecom companies and individual residents/house owners. In this regard the following additional precautionary measures are also recommended for adoption by the local authorities:

- * Installation of Base Station Antennas within the premises of schools and hospitals may be avoided because children and patients are more susceptible to Electro Magnetic Field.
- * Installation of Base Station Antennas in narrow lanes should be avoided in order to reduce the risks caused by any earth quake or wind related disaster.
- * The Base Station Antennas should be at least 3 m away from the nearby building and antennas should not directly face the building. Further, the lower end of the antenna should be at least 3 meter above the ground or roof.
- * In case of multiple transmitter sites at a specific locality sharing of a common tower infrastructure, should be explored, as far as possible, which can be coordinated through a nodal agency.
- * Access to Base Station Antenna sites should be prohibited for general public by suitable means such as wire fencing, locking of the door to the roof etc. Access to tower site, even for the maintenance personnel, should be for a minimum period as far as possible.
- * Sign boards/Warning Signs are to be provided at Base Station Antenna sites which should be clearly visible and identifiable. A warning sign should be placed at the entrance of such zone.

Contd....2/-

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: 2 :

- * The "Warning Sign" should discourage longer stay in the zone, even for the maintenance personnel. The sign board may contain the following text:


- j. Danger! RF radiations, Do not enter!
- ii. Restricted Area

- * The operators and maintenance personnel, who are dealing with radio frequency devices, specially with Base Station Antennas installed on towers and at any other outdoor sites, should be protected from electromagnetic radiations. It is required that operators and maintenance personnel should be educated for possible hazards from these devices.

This issues with the approval of LG.

With regards,

Yours sincerely,

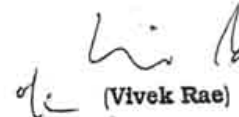
 (Vivek Rae)

To

1. Shri Ashok Nigam, Commissioner, MCD, Delhi
2. Shri Dinesh Rai, VC, DDA, Delhi
3. Shri Parimal Rai, Chairperson, NDMC, New Delhi

Copy to the following:

1. Principal Secretary to LG, Raj Niwas, Delhi.
2. Principal Secretary to CM, Delhi
3. Pr.Secretary(Urban Development), GNCT of Delhi
4. Secretary (Environment), Govt. of NCT of Delhi, Delhi.
5. Shri T.V.Ramachandran, Director General, Cellular Operators Association of India, 14, Bhai Veer Singh Marg, New Delhi-01.
6. Shri S.C.Khanna, Secretary General, Association of Unified Telecom Service Providers of India, B-601, Gauri Sadan, 5, Hailey Road, New Delhi-01.

 (Vivek Rae)

West Bengal Government

In case of non-compliance of the aforementioned directions, regulatory order will be issued in accordance with law.

By Order,
Sd/-
(M. L. Meena)
Principal Secretary,
Department of Environment

No. EN/ 939/TI-IV-1/001/2006

Dated: April 24th, 2008.

Copy forwarded to :-

1. The Incharge, M/s. Bharti Mobitel Limited (Airtel), Infinity Building, 5th Floor, Salt Lake Electronics Complex, Bidhannagar, Block G.P. Sector-V, Kolkata-700091.
2. The Incharge, Vodafone Essar East Limited (Vodafone), Constantia Office Complex, 4th Floor, 11, Dr. U.N. Brahmachari Road, Kolkata-700017.
3. The Incharge, Aircel Business Solutions (Aircel), Benfish Bhawan, No. 31, GN Block, 5th Floor, Sector-V, Salt Lake, Kolkata-700 091.
4. The Incharge, Tata Teleservices Limited (Tata Indicom), C/o. Videsh Sanchar Bhawan, Camp Office- 1/18, C.I.T. Scheme, VII M, Ultandaga, Kolkata-700054.
5. The Incharge, Bharat Sanchar Nigam Limited (BSNL Mobile), Telephone Kendra, P-10, New CIT Road, Kolkata-700073.
6. The Chairman, West Bengal Pollution Control Board.
7. The Member-Secretary, Central Pollution Control Board, Paribesh Bhawan, CBD-cum-Office Complex, East Arjun Nagar, Delhi-110032.
8. The Chief Environment Officer, Department of Environment, Govt. of West Bengal.
9. The Member-Secretary, West Bengal Pollution Control Board, 'Paribesh Bhawan', Salt Lake City, Kolkata-700098.
10. The Commissioner, Kolkata Municipal Corporation, 5, S.N. Banerjee Road, Kolkata-700013.
11. The Commissioner, Howrah Municipal Corporation, Howrah.

12. The Chief Executive Officer, _____

13. The Executive Officer, _____

14. The Secretary,Zilla Parishad.

with a request to circulate this memo. to the Panchayats for information and necessary action.

15. The District Magistrate _____

Sd/-

HENCE, in exercise of the powers conferred under Environment (Protection) Act, 1986 and rules made thereunder, all mobile phone service providers are hereby directed to follow the following guidelines strictly at the time of installation of the mobile towers.

- Installation of Base Station Antennas within the premises of schools and hospitals may be avoided because children and patients are more susceptible to Electro Magnetic Field.
- Installation of Base Station Antennas in narrow lanes should be avoided in order to reduce the risks caused by any earth quake or wind related disaster.
- The Base Station Antennas should be at least 3 m away from the nearby building and antennas should not directly face the building. Further, the lower end of the antenna should be at least 3 metre above the ground or roof.
- In case of multiple transmitter sites at a specific locality sharing of a common tower infrastructure, should be explored, as far as possible, which can be coordinated through a nodal agency.
- Access to Base Station Antenna sites should be prohibited for general public by suitable means such as wire fencing, locking of the door to the roof etc. Access to tower site, even for the maintenance personnel, should be for a minimum period as far as possible.
- Sign boards/Warning Signs are to be provided at Base Station Antenna sites which should be clearly visible and identifiable. A warning sign should be placed at the entrance of such zone.
- The "Warning Sign" should discourage longer stay in the zone, even for the maintenance personnel. The sign board may contain the following text :
 - i. Danger ! RF radiations, Do not enter !
 - ii. Restricted Area.

The operators and maintenance personnel, who are dealing with radio frequency devices, specially with Base Station Antennas installed on towers and at any other outdoor sites, should be protected from electromagnetic radiations. It is required that operators and maintenance personnel should be educated for possible hazards from these devices.

All local authorities are also requested that before giving any permission for installation of the mobile towers aforementioned guidelines should be

Appendix IV

Bibliography

List of Scientific Papers (n=919) on Impact of EMFs classified Subject-wise

Each bibliographic entry is marked with category codes in square brackets []

B= Birds; E= Bees; H = Humans; W= Animals/ Wildlife; P= Plants
+ = Impact reported; - = No Impact; * = Inconclusive/ Impact not evaluated

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