Utilization of mobile phone towers by birds in Mayiladuthurai Taluk, Nagapattinam district, Tamil Nadu, Southern India.

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Abstract

Utilisation of mobile cell towers by birds was assessed in six different areas of different companies viz., AIRCELL, AIRTEL, BSNL, RELIANCE, TATANDICOM and VODAFONE. Totally 10 different species of birds belonging to four orders from eight families were observed to use the towers. Further, 12 bird species were recorded to use the adjoining substrates of mobile cell towers. House Crow (*Corvus splendens*) had a maximum of 31% utilisation followed by Pariah Kite (*Milvus migrans*) by 16.9%. Diversity (H') of 1.702 of the Brahminy Kite (*Haliastur indus*) indicated that this species used almost equally all the company towers. Birds utilized AIRTEL towers maximum followed by BSNL and lowest sightings were observed in VODAPHONE towers. A maximum species richness of nine species were observed to use BSNL and RELIANCE. The bird diversity was highest in BSNL (H'=2.041) followed by RELIANCE (H'=2.021). The perching height of eight different species (which commonly utilising the towers) ranged between 10m and 80m. The behaviour of the birds were resting, calling and feeding while perching on the mobile cell towers. The birds mostly used the cell phone towers to rest. We suggest a long-term study incorporating population and behavioural changes of different bird species along different gradients of microwave around the towers would indicate the pros and cons of the mobile cell towers on birds.

Key words: bird species, behavior, cell company, cell phone towers, diversity index, richness

INTRODUCTION

Urbanisation and technology development became two sides of the same coin for all the counties due to global population increase and sophistication in the way of human life. The technology became a vital tool for overcoming many problems and for having sophisticated life. Hence, people allow intrusions from modern technology (roads, power lines, telephone poles, lamp posts, water towers, dam and road construction, etc.). Furthermore, the technology development especially the communication industry growth was rapid during the end of the last century and now it gets keep expanding.

Among the communication technology, now telecommunication is at the peak. Mobile phones, also called cellular phones or handies, are now an integral part of modern life. The widespread use of mobile phones has been accompanied by the installation of an increasing number of base station antennas on masts and buildings. GSM base stations emit electromagnetic fields at high frequencies in the 900 and 1800 MHz range (= downlink frequency bands), pulse modulated in low frequencies (Hyland, 2000). Antennas of phone towers spreads frequency range of 869 - 894 MHz (CDMA), 935 - 960 MHz (GSM 900) and 1810 – 1880 MHz (GSM 1800) in Second Generation (2G), 2110 – 2170 MHz in 3G, 2300 - 2400 MHz in 4G, 2400 - 2500 MHz in Wi-Fi, Blue Tooth and 3400 - 3600 MHz in 5G services (Mitra and Pattanayak, 2018). Mobile cell phone towers are a necessary element to allow us to transmit our signals from cell phones and must be placed at appropriate intervals along the highway.

Unlike other utility towers and poles, these structures are wireless and usually solitary. While travelling in Indian roads it is not an unusual sight to see electrical lines and telephone poles but now-a-days along with these towers it is common to see many mobile cell phone towers even in villages. The travellers can notice only 50% of the towers and the remaining towers have gone into hiding, disguising themselves as buildings, temple towers, and even trees. The number of towers needed in an area is directly proportional to the density of cell phone users. Towers have proliferated in recent

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years, with an estimated 5000 new towers erected per year during the 1990s, mainly for the cell phone and digital TV industries. As different cell phone companies use different antennas that are all located on the same cell phone tower, these structures can be quite unsightly. Thus the cell phone tower began to be disguised.

For example, there are over 77,000 communications towers in the US, which provide nationwide coverage for cellular telephone, television and radio, paging, messaging, wireless data and other industries. In India, within last two decades, the mobile cell phone users population increased geometrically due to technology development and globalisation. About 5,000 new towers are currently being built each year but this rate is expected to increase with developing cellular telephone and digital television networks. According to Telephone Regulatory Authority of India (TRAI) wireless telephone users in urban area is 63.27% and in rural area 33.20% (cited by Saravanamuttu *et al*. 2016). Although the technology development is rapid, the effects of them are not evaluated properly. Therefore, we aim to investigate to i) Identify and enlist the birds which are utilising the mobile cell phone towers as perching sites, ii) Investigate the behaviour of birds while utilising the mobile cell towers and iii) Assess the mobile cell phone tower characters that are utilised by birds for various activities

STUDY AREA

The present work was carried out in and around Mayiladuthurai Taluk, Nagapattinam District (latitude 10° 46' N and longitude 79° 5' E) of Tamil Nadu, Southern India (refer Fig. 1 of Pandiyan *et al*., 2006 for map). The study area is dominated by wet agricultural lands irrigated by the river Cauvery and its tributaries (Kollidam, Uppanar, Vellar, Manjalar and Arasalar) as the major perennial water sources. Because of large scale agricultural operations involving cultivation of paddy, sugarcane, ground nut, banana, pulses and other cereals, the area is known as the 'Granary' of South India. The terrain is flat and consists of fine alluvial soil, though sandy soil, sandy-clay soil and red soil can also be found sporadically. Generally, December-January is the coolest period and April-May is the warmest. The Northeast monsoon usually brings rain to the study area from October to December (65% of the total annual rainfall) and is therefore, the key factor in demarcating the seasons. Four seasons can be distinguished based on rainfall monsoon (October- December), post-monsoon (January-March), summer (April-June) and pre-monsoon (July -September).

More than 150 species of plants have been recorded belonging to 49 families. Woody plants with sparse distribution are very common in the gardens on road sides and amidst human habitations. Predominant woody plant species are coconut *Cocos nuficera,* palm *Borrassus flabellifer,* illuppai *Madhuca indica,* mango *Mangifera indica,* rain tree *Samonea saman,* tamarind *Tamarindus indicus,* banyan *Ficus benghalensis,* peepul *Ficus religiosa,* ashok *Polyathia longifolia,* neem *Azadirachta indica,* povarasu *Thespesia populnea,* karuvai *Acacia arabica* and odiyan *Odina wodier*. Important shrub species are *Prosopis juliflora, Jatropha glandulifera* and *Adhathoda vesica*. Plantations of *Casuarina equilitifolia* and bamboo *Bamboosa arundinacea* are also found in the study area.

MATERIALS AND METHODS

Mobile Cell Phone Tower and Bird Survey

The mobile cell phone towers of the Cauvery deltaic region was intensively combed by for assessing the utilisation of the towers by bird. The power lines were also searched for bird nesting in this study. The surveys were made on foot. All surveys were conducted during different times of a day. Bibby *et al*. (1984)'s "Look-See method" was employed, wherein all mobile cell phone towers were rigorously searched for perching birds and their activities. Whenever there was a tower atleast one hour observation was made to assess the bird utilisation across different hours of a day. The birds were observed through a 7'x50" binocular and identified using the ornithological field guides (Ali, 2002 and Grimmett *et al*. 1999).

Mobile Cell Tower and Bird Perching Height

The height of the mobile cell tower from the ground level or basement of the tower that was on a building was collected from the respective company or measured from floor by an altimeter. The height of the perch of the bird in the mobile cell phone tower was measured using altimeter or tower record.

Number of Antennas

The mobile cell phone towers are fitted with antennas for transmitting and receiving the signals. There were two types of antennas which were vertical or parabolic in shape. The number of these two types of antennas was counted.

Mobile Cell Tower Colour

The colour of the tower was noted.

Diversity of Birds

$$H' = -\sum_{i=1}^{s} p_i \times \log p_i$$

The diversity of the birds was assessed using hannon-Weiner Diversity Index (H') using the following formula (Shannon and Weiner, 1949).

where p_i =proportion of ith species (ni/N)

ni= number of individuals in each species/category

N=total number observed

S=number of species/categories

$\log p_i$ =natural log of p_i

RESULTS

Mobile Cell Towers

Totally 215 towers were surveyed which belonged to six different cell phone companies namely AIRCELL, AIRTEL, BSNL, RELIANCE, TATANDICOM and VODAFONE. The survey was conducted in nine different areas (Table 1 & 2). The height, colour and location of the towers varied among the companies and in different areas. Totally 35 mobile cell phone towers were unitised by different species of bird. In which, the maximum number of nine BSNL towers were utilised by birds followed by AIRTEL (8) and RELIANCE (7). Only two of the AIRCEL towers were utilised by birds (Table 1). Among the nine areas, the highest number of 13 towers was observed in Mayiladuthurai followed by Kaveri Nagar and Sembonarkil which had five towers each. Only one tower was observed in Puthakaram, Thalainayiru, Darmapuram, and Mannampandal (Table 1). Totally 10 towers were not utilised by birds. Towers of all companies were in this list except AIRCEL. The maximum was AIRTEL. In Sirkali, a maximum of four towers were not utilised by birds (Table 2).

Figure 1: Mobile towers, different types of antenna and birds observed in the Cauvery deltaic region, Tamil Nadu, Southern India.

Bird Species Used the Posts

Totally, 10 different species of birds belonging to four orders from eight families were observed in the study area. The species were Paraih Kite, *Milvus migrans,* Brahmny Kite, *Haliastur indus,* Jungle Crow, *Corvus macrorhynchos,* House Crow, *Corvus splendens,* Black Drongo, *Dicrurus macrocercus,* House Sparrow, *Passer domesticus,* Common Babbler, *Turdoides caudatus,* Common Myna, *Acridotheres tristis,* Blue-rock Pigeon, *Columba livia* and Little Egret, *Egretta garzetta* used the mobile cell tower for various activities were identified and are given in table 3 and figure1. In which, two species were from the order Falconiformes, six species from order Passeriformes and one each in Colombiformes and Ciconiformes (Table 3).

Totally, 12 bird species were observed to use the adjoining substrates of mobile cell towers. The species were Brahminy Kite, *Haliastur indus,* Jungle Crow, *Corvus macrorhynchos,* House Crow, *Corvus splendens,* Black Drongo , *Dicrurus macrocercus,* House Sparrow, *Passer domesticus,* Common Babbler, *Turdoides caudatus,* Rose-ringed Parakeet, *Psittacula krameri,* Asian Koel, *Eudynamys scolopacea,* House Swift, *Apus affinis,* White-breasted Kingfisher, *Halcyon smyrnensis,* Little Egret, *Egretta garzetta* and Indian Pond Heron, *Ardeola grayii* belonging to seven orders from 10 families (Table 4). The Brahminy Kite, Jungle Crow, House Crow, Common Babbler, House Sparrow Little Egret and Black Drongo were the species used both the mobile cell tower and other adjoining substrates. Pariah Kite, Blue-rock Pigeon and Common Myna were the species which utilized only the mobile cell towers. House swift, Asian Koel, Rose-ringed Parakeet, Indian Pond Heron and White-breasted Kingfisher were the species which utilised adjoining substrates (Table 3 and 4). The Pariah Kite was found to nest in the mobile cell towers. Totally two different nests were observed in RELIANCE tower of Mayiladuthurai and AIRTEL tower of Sirkali.

Utilisation of Towers by Bird

The number of sightings and percentage of different species of birds in various mobile cell towers, richness and diversity are given in table 5. House Crow had a maximum of 31% (101) utilisation followed by Pariah

Table 1. Number mobile cell towers of various companies observed in different areas of Cauvery deltaic region of Nagapattinam District, Tamil Nadu, which were utilised by birds.

Location	Mobiles cell companies and number of towers						TOTAL	%
	AIRCEL	AIR TEL	BSNL	RELIANCE	TATA INDICOM	VODAFONE		
Sirkali	-	1	1	-	1	1	4	11.4
Mayiladuthurai	1	4	3	3	2	-	13	37.1
Kaveri nagar	-	1	1	1	1	1	5	14.3
Vaitheeswarankoil	-	-	1	1	1	1	4	11.4
Putthagaram	-	1	-	-	-	-	1	2.9
Thalainayiru	-	-	1	-	-	-	1	2.9
Darumapuram	-	-	1	-	-	-	1	2.9
Mannampandal	-	-	-	1	-	-	1	2.9
Sembanarkoil	1	1	1	1	-	1	5	14.3
Total number of Towers	2	8	9	8	5	3	35	
% of towers used	5.7	22.9	25.7	22.9	14.3	8.8	100	100
No of utilisation by birds	126	22	58	55	49	16	323	
Percentage	39	6.1	18	17	15	5	100	

"-" indicates that no tower of the respective company was observed in that area.

Table 2. Number mobile cell towers of various companies observed in different areas of Cauvery deltaic region of Nagapattinam District, Tamil Nadu, which were not utilised by birds.

Location	Mobiles cell companies and number of towers						TOTAL	%
	AIRCEL	AIR TEL	BSNL	RELIANCE	TATA INDICOM	VODAFONE		
Sirkali	-	1	1	1	-	1	4	40
Mayiladuthurai	-	-	-	-	-	-	-	-
Kaveri Nagar	-	1	-	-	1	-	2	20
Vaitheeswarankoil	-	1	-	1	-	-	2	20
Putthagaram	-	-	-	-	-	-	-	-
Thalainayiru	-	-	-	-	-	-	-	-
Darumapuram	-	-	-	-	-	-	-	-
Mannampandal	-	-	-	-	-	-	-	-
Sembanarkoil	-	-	1	-	-	1	2	-
Total	-	3	2	2	1	2	10	-
Percentage	-	30	20	20	10	20	-	100

"-" indicates that no tower of the respective company was observed to be used by birds in that area.

Kite by 16.9% (55). The Little Egret and Blue Rock Pigeon had 0.3% utilisation. Brahminy Kite, Pariah Kite, House Crow and Black Drongo utilized towers of all companies where as the Little Egret and Blue Rock Pigeon had utilised one tower of BSNL and RELIANCE respectively. The Brahminy Kite had utilized all the towers equally well and had maximum diversity (H') of 1.702 followed by Black Drongo (H'=1.578) and House Sparrow (H'=1.544). The lowest diversity (H'=1.249) of Jungle Crow indicated that they utilized the towers indifferently (Table 5).

Totally 126 sightings of bird utilization was observed on AIRTEL which was maximum followed by BSNL (58). The lowest sightings were observed in VODAPHONE with 16 bird utilizations. A maximum species richness of nine species were observed to use BSNL and RELIANCE. On the other hand, the AIRTEL and VODAFONE had the lowest species richness of 6

Table 3. Bird species which utilised the mobile cell towers for various activities in Cauvery deltaic region of Nagapattinam District, Tamil Nadu.

S.No.	Common Name	Scientific Name	Order	Family
1	Pariah Kite	*Milvus migrans*	Falconiformes	Accipitridae
2	Brahminy kite	*Haliastur Indus*	Falconiformes	Accipitridae
3	Jungle Crow	*Corvus macrorhynchos*	Passeriformes	Corvidae
4	House Crow	*Corvus splendens*	Passeriformes	Corvidae
5	Black Drongo	*Dicrurus macrocercus*	Passeriformes	Dicruridae
6	House Sparrow	*Passer domesticus*	Passeriformes	Passeridae
7	Yellow-billed Babbler	*Turdoides affinis*	Passeriformes	Leiothrichidae
8	Common Myna	*Acridotheres tristis*	Passeriformes	Sturnidae
9	Blue-rock Pigeon	*Columba livia*	Columbiformes	Columbidae
10	Little Egret	*Egretta garzetta*	Ciconiiformes	Ardeidae

Table 4. Birds perched in other substrates adjacent to the mobile cell towers and their activities in Cauvery deltaic region of Nagapattinam District, Tamil Nadu.

S.No	Bird Species	Scientific Name	Order	Family
1	Brahminy Kite	*Haliastur indus*	Falconiformes	Accipitridae
2	Jungle Crow	*Corvus macrorhynchos*	Passeriformes	Corvidae
3	House Crow	*Corvus splendens*	Passeriformes	Corvide
4	Black Drongo	*Dicrurus macrocercus*	Passeriformes	Dicruridae
5	House Sparrow	*Passer domesticus*	Passeriformes	Ploceidae
6	Common Babbler	*Turdoides caudatus*	Passeriformes	Muscicapidae
7	Rose-ringed Parakeet	*Psittacula krameri*	Psittaciformes	Psittacidae
8	Asian Koel	*Eudynamys scolopacea*	Cuculiformes	Cuculidae
9	House Swift	*Apus affinis*	Apodiformes	Apodidae
10	White-breasted Kingfisher	*Halcyon smyrnensis*	Coraciiformes	Alcedinidae
11	Little Egret	*Egretta garzetta*	Ciconiformes	Ardeidae
12	Indian Pond Heron	*Ardeola grayii*	Ciconiformes	Ardeidae

Table 5. Frequency of occurrences of different species of birds utilized various companies mobile phone towers for different activities in Cauvery deltaic region of Nagapattinam District, Tamil Nadu.

Species Name	AIRCEL	AIR TEL	BSNL	RELIANCE	TATA INDICOM	VODAFONE	Total	%	Richness	Diversity (H')
Brahminy Kite	7	3	6	5	10	3	34	10.4	6	1.702
Pariah Kite	24	2	10	8	9	2	55	16.9	6	1.49
Jungle Crow	15	2	4	3	2	-	26	8	5	1.249
House Crow	57	6	9	10	13	6	101	31	6	1.367
Black Drongo	16	6	11	10	4	1	48	14.7	6	1.578
House Sparrow	3	-	2	4	5	2	16	4.9	5	1.544
Common Babbler	4	-	7	3	4	-	18	5.5	4	1.334
Common Myna	-	3	8	11	2	2	26	8	5	1.37
Blue-rock Pigeon	-	-	-	1	-	-	1	0.3	1	0
Little Egret	-	-	1	-	-	-	1	0.3	1	0
Total	126	22	58	55	49	16	326	100	6	
Percentage	38.7	6.7	17.8	16.9	15	4.9	100			
Species richness	7	6	9	9	8	6	10			
Diversity (H')	1.421	1.689	2.041	2.021	1.89	1.635				

Table 6. Number mobile cell towers of various companies observed in different areas of Cauvery deltaic region of Nagaipattinam District, Tamil Nadu, which were used by birds.

Mobile cell company & Area	Tower Height (mt)	Colour	No. of Antennas		of speci	Bird Species	Perch height (mt)	Behaviour
			Parabolic	Vertical				
AIRCEL								
Mayiladuthurai	80	Red & White	1	4	4	Jungle crow	20	Resting
						House crow	20	Calling
						Black kite	80	Resting
						Rose-ringed Parakeet	10	Calling
Sembanarkoil	60		2	5	2	Brahmini Kite	60	Resting & calling
						House Crow	40	Resting & calling
AIRTEL		Red & White						
Puthagaram	80		2	2		Black Drango	40	Resting & feeding
Mayiladuthurai	80		3		2	Jungle Crow		Resting & feeding
						Common Myna	10	Calling
Sembanarkoil	40		5	3	1	House Crow	30	Resting
BSNL		Red & white and Blue						
Thalainayaru	60		5	10	1	Black Drango	15	Resting
Kaverinagar	50			3	3	Common Myna	49	Resting & feeding
						Paraih kite	50	Resting
						House Crow	20	Resting
Mayiladuithurai	40			3	2	Paraih kite	40	Resting
						Black Drango	20	Resting
RELIANCE		Blue						
Mayiladuthuai	80			2	1	Paraihkite	50	Resting
Vaitheeswaran Koil	80		2	3	1	Black Drango	20	Resting
Sembanarkoil	60		2	7	2	House crow	30	Resting
						Jungle crow	10	Resting
Kavery Nagar	60		1	1		Blue rock pigeon	40	
Annampandal	60		3	4		Black drango	10	Resting
TATA INDICOM		Red & white						Resting
Mayiladuthurai	40		3	11		Paraikite	40	Resting
						Common myna	20	Calling
Kaveri Nagar	60		1	3		Brahminikite	60	Resting
VODAFONE		Red & white						
Vaitheeswaran Koil	40			4		Black drango	10	Resting
						Common myna	20	Calling
						Paraihkite	40	Resting
Kaveri Nagar	60		1	3		Black drango	10	Resting
						House crow	10	Calling

each. The bird diversity was highest in BSNL (H'=2.041) followed by RELIANCE (H'=2.021). The lowest bird diversity was observed in AIRCEL (H'=1.421) (Table 5).

Mobile Cell Tower Characteristics and Bird Behaviour

Totally 17 different towers characteristics and bird behaviour from six different areas were analysed (Table 6). The height of the tower ranged from 40-80m. Most of the towers were red and white colour. In 12 towers, both vertical and parabolic antennas were observed (Fig. 1). Out of 17 towers, four did not have parabolic and one tower did not have vertical antenna. The perching height of eight different species (which commonly utilising the towers) ranged between 10m and 80m. The behaviour of the birds were resting, calling and feeding while perching on the mobile cell towers (Fig. 1). The birds mostly used the tower for resting (Table 6).

DISCUSSION

Totally 10 different species of birds belonging to four orders from eight families were observed to use the mobile phone towers in this study. The species were Paraih Kite, *Milvus migrans,* Brahmny Kite, *Haliastur indus,* Jungle Crow, *Corvus macrorhynchos,* House Crow, *Corvus splendens,* Black Drongo, *Dicrurus macrocercus,* House Sparrow, *Passer domesticus,* Common Babbler, *Turdoides caudatus,* Common Myna, *Acridotheres tristis,* Blue-rock Pigeon, *Columba livia* and Little Egret, *Egretta garzetta*. Two species belonged to the order Falconiformes, six to Passeriformes and one each from Colombiformes and Ciconiformes. Most of the species observed to use the towers are principally perching birds and raptors (Grimmett *et al*., 1999). Therefore, they would have used the mobile cell tower as perching sites. On the contrary, according to Ranjit Daniels, in Chennai four of the 200-odd Chennai birds namely House Sparrow (*Passer domesticus*), Red-whiskered Bulbul (*Pycnonotus jocosus*), Brahminy Kite (*Haliastur indus*) and Spotted Dove (*Streptopelia chinensis*) have virtually disappeared. He claims that the microwaves produced by the mobile cell tower could be one of the reasons for the same. He also emphasized that "Birds are known to be sensitive to magnetic radiation. Microwaves can interfere with their sensors and misguide them while navigating and preying".

House Crow was seen to use maximum the mobile cell towers. It is a perching bird and often sits on a vantage point to avoid the predation and to locate the food (Ali 2002). Furthermore it prefers to select open perching sites to increase the visibility for locating food items which could be the reason for utilising the towers maximum. The Pariah Kite utilised the tower frequently and also constructed nests on them. It is a diurnal birds of prey which glide on the sky for prey hunting. Often it uses the tall building for perching and nest construction (Ali, 2002; Grimmett *et al*., 1999). In modern world, the mushrooming mobile cell towers act as perching and nesting site for these diurnal raptors.

Earlier studies by Everaert and Bauwens (2007) and Balmori and Hallberg (2007) indicated that the population of House Sparrow declined in United Kingdom and Spain due to the mobile cell towers. In the present study the population of birds was not estimated. However, it is surprising to notice that the House Sparrow utilise the mobile cell towers for various activities. Earlier, Dr.Vijayan pointed out that sparrows are disappearing from areas where mobile towers are installed and from cities where electromagnetic contamination is very heavy (Mukherjee, 2003). Bird diversity and population reduction was coinciding with the proliferation of Cellular Mobile Base stations in several countries (e.g. Balmori, 2005; Balmori and Hallberg, 2007; Everaert and Bauwens, 2007; Summers-Smith, 2003). Behavioral changes have also been recorded among birds close to the phone antennae (Rafiqi *et al*., 2016). The microwave radiation produced by the cell phone towers produce heating effect on the body of birds which have more volume and less weight, so heating effect is very fast (Dahal, 2013). Almost 13% of the world's bird species found in India are under threat for various reasons: climate change, pollution and strong electromagnetic fields (Dhami, 2020). In recent years, increased public awareness and scientific research have questioned to what extent the non thermal exposure to low-intensity electromagnetic fields may affect the health, reproduction, well-being and behaviour of humans and other organisms especially birds. There is an active and, as yet, unsettled controversy about current safety standards. Some researchers and national committees advised more stringent safety standards, based on experimental data with reported biological effects from (chronic) non thermal exposures. Hence, we suggest a long-term study incorporating population and behavioural changes of different bird species along different gradients of microwave around the towers would indicate the pros and cons of the mobile cell towers on birds.

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