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STUDY OF THE ELECTROMAGNETIC FIELD RADIATED FROM THE CELL PHONE TOWERS WITHIN KATHMANDU VALLEY

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Abstract

With the increase in the use of the mobile phone, widely used wireless technology, people are highly conscious regarding the deleterious effects of the RF signals. To account this consciousness, this research work deals with the assessment of the radiation level near mobile Base Station Towers (BSTs) of Kathmandu valley with the analysis of the observed values in reference to the National and International guidelines and radiation norms adopted in different countries. "Tenmars, TM-196" and GPS map60Csx were employed for the measurement. It is found that the maximum value of the Power density in Kathmandu valley is 0.003602 W/m² at Maximum Peak Point (MPP) near BST of New Baneshwor area, characterized by high traffic (Vicinity population) and all services across the BSTs and the minimum average radiation level far away from the BSTs (Off tower region) with access of the cellular network has 0.00000206 W/m² Power density near Lele area, Lalitpur, which is far less than the Power density near the BSTs. It is found that all observed sites are within the standards of the Nepal Telecommunication Authority (NTA) in terms of the amount of EMFs that the base station is radiating. Power density highly depends on vicinity population and moderately depends on services across the BSTs. Also the BSTs are constructed haphazardly near School and Colleges, Hospitals etc.

Keywords: Base Station Tower; Maximum Peak Point; Nepal Telecommunication Authority; Power Density; Radiofrequency

Introduction

The growth in the global communication industry in recent years has resulted in a dramatic increase in the number of wireless devices. Evolving from a primitive practice in 1914 by wireless trunk to the present day telecom scenario, Nepal is also becoming a progressive and competitive telecom market. Till dates there are six telecommunication service providers with broad range of technologies, among them mobile telephony is widely used wireless technology (NTA, 2013).

Mobile phones, widely used wireless technology, and their base stations transmit and receive signals using Radiofrequency electromagnetic waves. Radiofrequency radiation is a part of Non-ionizing electromagnetic radiation characterized by the frequency spectrum of 3 kHz – 300 GHz (Akabari, 2012). The energy of particles of a Non-ionizing radiation is low, and instead of producing charged ions when passing through matter, it has only sufficient energy to change the rotational, vibrational or electronic valence configurations of molecules and atoms. Hence unlike to the Ionizing radiation, it has sufficient energy only for excitation, the movement of an electron to a higher energy state (Ng, 2003). Radiofrequency fields (RF),

today's concern, are used in wireless communication system such as mobile phone BSTs, radar/satellite links, TV and FM broadcasting stations etc. and devices such as mobile phones, microwave ovens etc. RF fields are also used in different medical purposes like: microwave hyperthermia, therapeutic and surgical diathermy, Magnetic Resonance Imaging (MRI) etc. (Ng, 2003).

An electromagnetic field or wave consists of Electric field (E) and Magnetic field (H) that oscillates in phase perpendicular to each other and also to the direction of the propagation of the energy. At a sufficient distance from the source, where the wave can be described as a plane wave, the Electric and Magnetic fields are at right angles to each other and also to the direction in which the energy is propagating. The amount of electromagnetic energy passing through a point per unit area at right angle to the direction of flow of energy per sec is called the Power density (S) (Jackson, 2009). For a far field region, relation between E, H and S can be written as:

$$H = E/Z$$

Where, Z is impedance in the free space or vacuum and its value is 377 ohm.

Also, $S = E \times H = E^2/377 = H^2 \times 377$ (Griffith, 2010)

Among these three physical quantities, Power density has been measured and presented in this study.

Wireless technology is based on the extensive network of the different base stations that connects the users through RF signals (NRPB, 2013). Due to the rapid increment in the number of customers for diverse services, to provide efficient network, the telecom operators are continuously increasing the number of base stations either the roof top based (RT) or ground based (GF). Due to the lack of any regulations and policies for the placement of Cell phone towers, they are placed haphazardly closer to schools, crèches, and public playgrounds, on commercial buildings, hospitals, colleges, campuses, and terraces of densely populated urban residential areas. Since the electromagnetic radiation can't be seen, smelt or felt, it can be realized only after the biological disorders caused by it, hence the public are exposed to continuous, low intensity radiations from these towers unwillingly (Sivani et al., 2011).

The effects of the RF radiation can be classified into two parts: Short-term and Long-term (Ng, 2003). The short-term effects include effects in brain electrical activity, cognitive function, heart rate and blood pressure which may leads to the burning and tingling sensation in the skin of the head, fatigue, sleep disturbance, dizziness, lack of concentration, ringing in the ears, loss of memory, headache, nausea, vomiting, disturbance in digestive system etc. In contrast, although there are no complete evidences of the long-term effects, these are related to epidemiologic effects including cancer and brain tumors in humans. Also, various studies have shown the ill-effects of Radiofrequency electromagnetic field (RF-EMF) on bees, fruit flies, frogs, birds, and bats. In 2011, International Agency for Research on Cancer (IARC), part of World Health Organization (WHO), designated RF-EMF from cell phones as a "possible human carcinogen" Class 2B. This radiation pollution can be termed as the invisible health hazard pollution (IHHP) is a becoming a new environmental threat (Sivani et al., 2011). To study about RF field, its consequences on humans and to monitor the radiation level different guidelines, practices and recommendations have been initiated by government agencies and international organizations. The most known guidelines are those recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) (ICNIRP, 1998), the Institute of Electrical and Electronics Engineers (IEEE) (IEEE, 2006) and Federal Communication Commission (FCC) (FCC, 1997). Such organizations set guidelines which restrict the amount of electromagnetic energy dissipated in the human body. These limits are provided for both general public and personnel working on site, i.e. occupational. In Nepal, NTA is the only government organization involved in this field. According to the drive test measurement in different locations of the Kathmandu

valley, it proposes the safety guidelines for the EMR as the occupational limit and general limit on Jan 2013; this is the modified FCC guidelines in the frequency range of 300-1500 MHz. According to this the Maximum Permissible Exposure limit for general people is 0.6 W/m² for 900 MHz frequency (this is 1/10th of the FCC guidelines) and 0.1 W/m² for the exposure of greater than 1500 MHz (this is same as FCC guideline) and the occupational limit is 5 times of the above factor (NTA, 2013).

Many researches about the RF are conducted continuously in different countries but there has not been any research on Electromagnetic Field (EMF) radiated from the mobile BSTs in our country, Nepal. To the knowledge of the authors, this research work has been conducted first time in Nepal, dealing with the assessment of the radiation level near mobile Base Station Towers (BSTs) of Kathmandu valley with the analysis of the observed values in reference to the National and International guidelines and radiation norms adopted in different countries to address the consciousness of the public towards RF energy. The radiation level near different BSTs within Kathmandu valley in all possible direction around the cell phone tower of more than 50 BSTs of Nepal Telecom (NTC) and United Telecom Limited (UTL) including the BSTs from dense, medium and least populated area and having different services across the BSTs, Sagarmatha Satellite Earth Station and 10 Offtower sites within Kathmandu valley has been measured. Kathmandu valley comprises of three different districts viz. Kathmandu, Bhaktapur and Lalitpur, which lies between the latitudes 27° 32' 13" and 27° 49' 10" north and longitudes 85° 11' 31" and 85° 31' 38" east. It is located at a mean elevation of about 1,300 meters (4, 265 feet) above sea level [Dangol et al., 2009]. It is expected that the result of this work will be helpful for the concerned authorities and researchers of this field.

Materials and Methods

a) Materials

Mainly Tenmars-TM 196 and GPSMap 60Csx were used during the survey period.

Tenmars, RF Three Axis Field Strength Meter, TM-196

Tenmars, TM-196 is a Non-ionizing radiation (NIR) detector device (Fig. 1), detects the radiation of 10 MHz to 8 GHz frequency range. This is a 3-Axis (isotropic) RF field strength meter with three channel measurement sensor produced by Tenmars Electronics Co.Ltd., Taiwan. This is based on the principle of electromagnetic induction. In recent days, this device is widely used in the monitoring of the cellular/cordless phone radiation safety level, microwave oven leakage detector, personal living environment EMF safety etc. (Tenmars User Manual).

Global Positioning System (GPS)

GPSmap 60Csx (Fig. 2), a space based satellite navigation system that provides the information of the location and

time in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites, is used to measure the distance of the observation point from the base of the cell phone tower.



Fig. 1: Tenmars, TM-196 (RF Detector) Fig. 2: GPS Map60CSx

b) Measurement Steps

At first the information about the different sites selected for the observation were collected from the concerned authorities of the corresponding telecommunication service providers i.e. NTC and UTL. Upon arrival at the BST, the main target was to determine the Maximum Peak Point i.e. MPP, this is the point near the BST having maximum value of the Power density as compared to the other point. For that, GPS was set on and the Tenmars was switched on at the base of the BST. After that the instantaneous value of Power density were observed at different distances along a certain direction until a point having maximum value of the Power density was obtained. Now, that point was fixed as a MPP for that direction. At that point, Tenmars was mounted on the stand at a height of about 15 cm above the ground (Fig. 3) and the instantaneous reading of Power density were recorded for 15 minutes in the interval of 30 seconds and the average and maximum readings were also recorded for the interval of 1 minute and 6 minutes. Also the distance between MPP and BST was also recorded by using GPS. This process was repeated in all the possible directions so that different MPPs were obtained along different directions. Among them the MPP corresponding to the highest value of Power density was considered as a MPP of that BST. During the observation time, it was found that almost all the observations of 6 min and 1 min intervals were within the range of mean \pm S.D of the instantaneous value. Hence, instantaneous value were recorded for only five base stations to check the reliability and uniformity of the device, whereas only average and maximum readings were taken over the intervals of 1 min and 6 min for the remaining BSTs.

During the survey time mainly two different structures of the sectoral towers were found, they are: Green Field (GF) - mounted on the ground, height varies from 15 to 50 meters and Rooftop (RT) – mounted on the roof of a building, height varies from 3 to 15 meters. Different types of the antenna structures and towers found in the survey are illustrated in the Fig. 4. Observations were taken from more than 50 towers within the Kathmandu valley on week days (Sunday to Friday in between 12 - 5 PM) from different

location (Site). The towers were selected from least populated, medium populated and highly populated area having different services across the site. To compare the Power density radiated from the cell phone towers to the background radiation level i.e. radiation level far away from the cell phone towers but having cell phone network, 10 different places of the Kathmandu valley without nearby cell phone tower but with cellular network were selected and the instantaneous value of the Power density for 15 minutes in the interval of the 30 seconds and average value of the power density in the interval of 6 minutes was recorded in those sites. Also, average value of the Power density was recorded around the antennas of the Sagarmatha Satellite Transmission Station, Balambu, Kathmandu.



Fig. 3: Experimental arrangement of the apparatus during survey time



Fig. 4: Different types of the antenna structures found in the survey

Result and Discussion

The Power density of the EMF radiated from the different 25 BSTs representing all observed BSTs and 10 Offtower sites are listed in the table in the appendix section. Table provides brief site description i.e. nature of the BST (Roof top (RT) or Green field (GF)), height of the BST, date and time in which the measurements were conducted, services across the BST, and also the vicinity population i.e. high, medium and least populated site on the basis of the traffic across the BSTs provided by the corresponding authorities of the NTC and UTL, observed quantities: the horizontal distance between the base of the BST and MPP as measured by the GPS and Power density observed at MPP near BST are expressed respectively. At last, the percentage of the maximum Power density from the general public limit as suggested by NTA guidelines (obtained by dividing observed Power density at MPP near different BSTs by 0.6 W/m² (MPE level proposed by NTA for general exposure for 900 MHz frequency) and multiplied by 100) is expressed. This comparative value of the Power density is presented in the line graph (Fig. 5(a)) by taking log of Power density (in microwatt per square meter) on Y-axis and different locations on X- axis.

According to the observed results, it was found that, the maximum value of the Power density; 0.003602 W/m² near New Baneshwor area, the MPP near the Nepal telecom's BST characterized as having more services across the BST

and most populated area nearby (i.e. high traffic across the BST) among the observed sites. The maximum value of the Power density in Lalitpur district was 0.003052 W/m² at MPP near BST of Jawalakhel area, and in Bhaktapur district was 0.002456 W/m² at MPP near BST of Siddhapokhari area, these all BSTs are characterized by high traffic (Vicinity population) and all different services across the BSTs. Also the minimum average radiation level far away from the BSTs (Offtower region) with access of the cellular network has 0.00000206 W/m² Power density near Lele area, Lalitpur, this is far less, (0.003602/0.00000206 = 1748.54) approximately 1748 times less than the Power density near the BSTs

Based on these results, the maximum electromagnetic radiation was approximately 0.60 % of the public limits of the NTA Guidelines. This confirms that all observed sites are well within the standards of the NTA in terms of the amount of EMFs that the base station is radiating. When the observed Power density is compared to the NTA and other international guidelines, it is found that the radiation level is far below the safe level. But NTA (modified FCC guideline) and other international guidelines were prescribed on the basis of thermal effects of RF radiation. When further studies were carried on, although there is no evidence of destructive nature of Non-ionizing radiation, it is concluded that Non-ionizing radiation can cause similar effect as low energy Ionizing radiation (in lower extent) for a continuous and long term exposure as International Agency for Research on Cancer (IARC) has stated that Non-ionizing radiation can cause cancer in humans (Nahas et al., 2011).

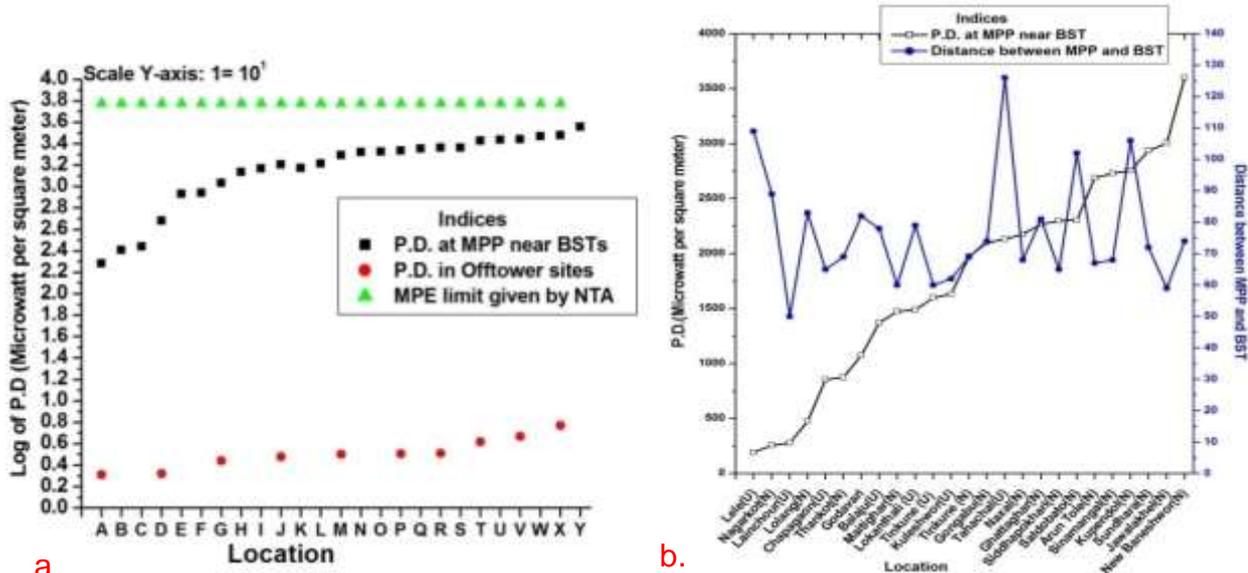


Fig. 5: (a) Graph representing P.D. of different locations (BSTs and Offtower sites) and MPE limit proposed by NTA (b) Graph representing P.D at MPP near BST and corresponding distance between MPP and BST

For P.D. at MPP near BSTs:

A-Lele(U), B-Nagarkot(N), C-Lainchour(U), D-Lolang(N), E-Chapagaon(U), F-Thankot(N), G-Godavari(N), H-Balaju(U), I-Maitighar(N), J-Tinkune(U), K-Lokanthali(U), L-Kuleshwor(U), M-Tinkune(N), N-Gongabu(N), O-Tahachal(U), P-Naxal(N), Q-Ghattaghar(N), R-Siddhapokhari(N), S-Satdobato(N), T-Arun Tole (N), U-Sinamangal(N), V- Kupendol(N), W-Sundhara(N), X- Jawalakhel(N), Y-New Baneshwor(N)

For Off tower sites:

A-way to Lele, D-way to Nagarkot, F-Way to Changunarayan, I-Sundarijal area, L-Way to Lubu, N-Dakshinkali area, Q-Godavari, T-Way to Tapoban, V-Way to Thankot, X-Chovar area

According to the many reports, it is found that many countries in the world have been adopting much stricter maximum radiation density values compared to the international limits: ICNIRP, FCC, IEEE etc like 0.000005 W/m^2 (Australia, New South Wales). India also has adopted ICNIRP limit till September 2013 but, it has been adopting 0.45 W/m^2 limit for general public for the exposure of 900 MHz frequency since September 1, 2013, this is one-tenth of the ICNIRP limit (Sivani et al., 2011). The people in these countries have studied extensively the health hazards of cell tower radiation to adopt stricter radiation norms. As compared to the limit adopted in Australia, this observed value is approximately 720 ($0.003602/0.000005 = 720.40$) times greater than the MPE limit adopted here. So, the MPE limit adopted in Nepal is high with respect to some other countries.

According to the result, it was found that the level of the Power density in Offtower site is too low as compared to the Power density at MPP near BST of New Baneshwor area. Since Offtower sites also have cellular network, corresponding telecommunication service providers are suggested to construct the BSTs far away from the residential areas with proper orientation, so that there will be cellular network with low level of Power density. The maximum value of the Power density at MPP near different antennas within the region of Sagarmatha Satellite Earth Station was 0.02268 W/m^2 , this is about 6 times ($0.02268/0.003602 = 6.29$) higher to than that of maximum Power density obtained at MPP near BST of New Baneshwor area. In addition, it was found that the background radiation level was in the range of 0.0030025 W/m^2 in the front side of the main office and in the range of 0.002135 W/m^2 in the back side of the main office. According to the observation it was found that the background radiation level in this area is almost same as the maximum value of Power density at MPP near BSTs.

According to the news reported in midday Mumbai dated Jan 3, 2010, Mumbai's swanky Usha Kiran building said that four cancer cases were linked to mobile towers installed on facing Vijay apartments in which the radiated power density level was 0.1 W/m^2 which is only 16.67 % of the safe limit of Nepal (Kumar, 2010). Thus, the safe limit adopted by Nepal is high with respect to the health hazards and many people might suffer invisibly because of this.

During the survey period, it was found that the Power density at MPP in certain direction is too large as compared to other direction within the same BST because of the sectoral nature of the antennas used in the BST. Although, telecommunication service providers are not willing to provide information regarding the facing direction in each BST to maintain their security and privacy, it was concluded that the maximum value of the Power density is the Power density at MPP in the bore-site (facing direction) of the

antenna. So, the MPP corresponding to that maximum value of the Power density was fixed as the MPP of that BST.

The maximum value of the Power density in the bore site of the antenna is due to the formation of the main beam along that direction and the lower value but not zero on other directions is due to the formation of the series of the weak beams. Power density level (S) in the bore site direction of the antenna is a function of the number of transmitters N, the maximum radiated power from each transmitter 'P' (which is often equal in all transmitters), antenna gain 'G' and the total distance from the point to the reference antenna 'r' (Sivani et al., 2011).

From the graph, Fig. 5(b), Solid line in the graph represents only the connectivity of the points for the better visualization of the observed data) it is seen that, maximum value of the distance between MPP and BST is 126m and minimum value is 50m and all other distances lies within the range of these values. It is found that the distance between MPP and BSTs and corresponding Power density at MPP near BST does not show any clear and direct relation, rather it is found that the distance between MPP and BSTs depends on a different parameters like: the antenna height, the beam width of the main beam and tilt angle of the antenna, and also depends upon the geographical condition like height, depth etc. of the observation point and environmental factors like weather, wind etc. (Ng, 2003).

Power density at MPP near BSTs depends upon the different factors: site characteristics and general surroundings of each individual site (in terms of geographical nature (height, depth etc.), vicinity population, site specifications (height, services, type etc. of BST), survey time and weather pattern. For the meaningful comparison of results, the measurement conditions as well as site characteristics should be made identical which is not the case in practical scenarios. However, in this study the Power density was studied on the basis of the vicinity population of the BSTs and services across the BSTs, other factors as indicated above are tried to keep identical up to some extent as all the observation are taken on day time (12 PM to 5 PM) during week days (Sunday to Friday).

The result of the graph, Fig. 6(a), Solid line in the graph represents only the connectivity of the points for the better visualization of the observed data, shows that the maximum value of the Power density was obtained at MPP near BST characterized by the high traffic across the BST and minimum value of the Power density was obtained at MPP near BST of having low traffic (traffic refers the number of the users of that BST at a certain time) across the BST. From the trend of the above result, it was found that EMF strengths (Power density) are often low in areas with low traffic than in high traffic areas with some least non-uniformity. The non-uniformity is due to the other sources

of Non-ionizing radiation like nearby BSTs of other service providers, difference in the geographical position like height, depth of the observation point and unknowingly change in the weather pattern. From this result, it is found that Power density radiated from the BST highly depends on the vicinity population (i.e. traffic across the BST) (Taylor, 1990). In some of the BSTs, although the traffic across the BST is medium or low, Power density is extremely high. This is due to the presence of BST of other service provider near to the observed BST. Result from the Sagarmatha Satellite Earth Station also agrees to these results as it has many antennas in the nearby surroundings. Hence, the radiation level of different frequencies at a point is additive in nature (Sivani et al., 2011). So, the different telecommunication service providers are suggested not to construct the BSTs in the close distance

The result of the graph, Fig. 6(b), Solid line in the graph represents only the connectivity of the points for the better visualization of the observed data), representing Power density at MPP near BSTs with number of different services across the BSTs (Different services includes GSM 900, GSM 1800, CDMA, 3G, WiMaX and Internet, also different number of the services includes any of the above stated services) shows that the maximum value of the Power density was obtained at MPP near BST having all i.e. five services across the BST and low value of the Power density was obtained at MPP near BST having only one service across the BST. This value is greater than the Power density at MPP near one of the BST having two services across the BST. From the trend of the above result it is found that EMF strengths (Power density) are often low in areas with fewer services across the BSTs than in more services across the BSTs with more non-uniformity than in the graph representing the Power density on the basis of vicinity population. The non-uniformity is due to the influence of

traffic across the BST, difference in the nature of the services across the BSTs, other sources of Non-ionizing radiation like nearby BSTs of other service providers, difference in the geographical position like height, depth of the observation point and unknown change in the weather pattern (Nahas et al., 2011). Also, it was found that the Power density level at MPP near BSTs of different locations having same number of services was highly different. These results were due to the influence of the traffic across the BST and difference in the nature of the services across the BSTs.

From this result, although, the degree of dependence of the Power density with services is low as compared to that of vicinity population, it can be concluded that Power density depends on the services across the BSTs also.

Conclusion

Observed value of the Power density at MPP near BSTs of different sites lies well within the guidelines given by the NTA and international guidelines in terms of the strength of the EMF radiated from the BSTs but it is high with respect to the health hazards and the radiation norms adopted in some of the countries. Power density level at any point highly depends on vicinity population and moderately depends on services across the BST. Power density at MPP does not shows any clear relation with the distance between MPP and BST but it depends upon the number of sources at the point. It is found that the BSTs are constructed haphazardly closer to schools, hospitals, colleges, densely populated urban residential areas etc. The Maximum Permissible Exposure level proposed by the NTA must be revised on the basis of the health hazards due to the NIR. Different service providers are suggested to construct BSTs far away from the highly residential area with proper orientation and not to construct the BSTs in close distance.

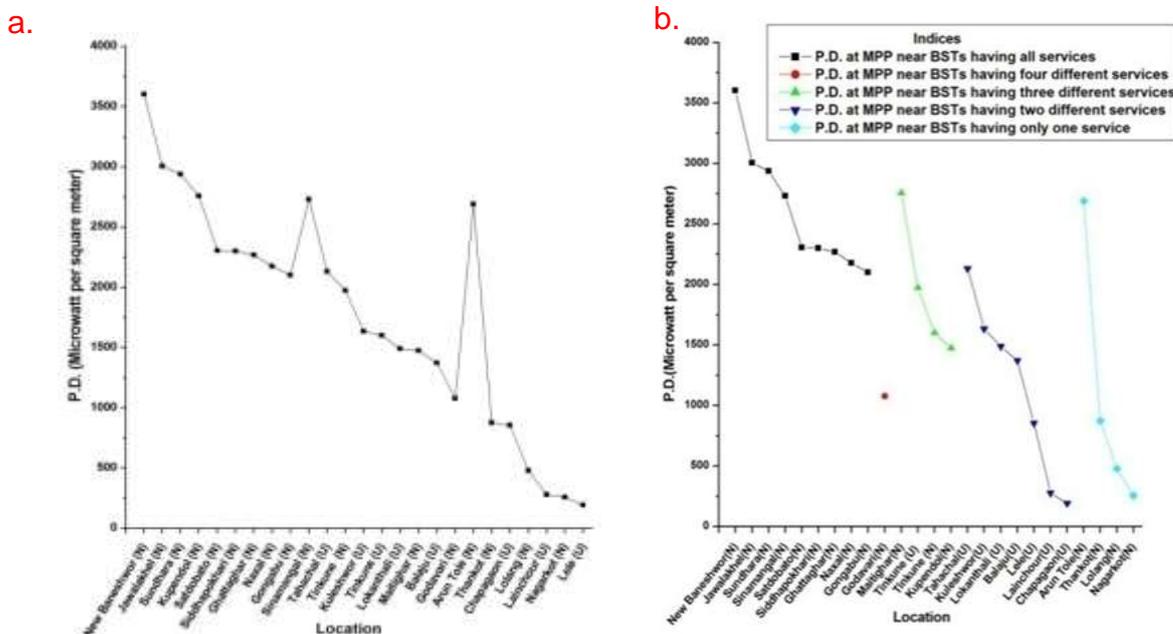


Fig. 6: (a): P.D. on the basis of the number of services across the BST and 6 (b): P.D. on the basis of Vicinity Population

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ANNEX

Table No. 1: P.D. at MPP near BST

Location of the BST	Brief Description	Site	Date & Time	Services on the Site	Distance between MPP and BST	P.D. at MPP ($\mu\text{W}/\text{m}^2$)	Percentage of the Public Limit
Arun Tole (NTC), Lalitpur	RT-8m Medium Pop.		14/07/2014 14:22	GSM-900	67m	2690.0	0.448
Balaju (UTL), Kathmandu	RT-18m Medium Pop.		26/07/2014 16:55	CDMA/ Internet	78m	1371.0	0.228
Chapagaon (UTL), Lalitpur	RT-18m Low Pop.		31/07/2014 15:37	CDMA/ Internet	65m	853.7	0.142
Jawalakhel (NTC),	GF-50m High Pop.		26/09/2014 12:04	GSM/CDMA/ 3G/WiMaX	59m	3006.3	0.501

Location of the BST	Brief Description	Site	Date & Time	Services on the Site	Distance between MPP and BST	P.D. at MPP ($\mu\text{W}/\text{m}^2$)	Percentage of the Public Limit
Kathmandu							
Ghattaghar (NTC), Bhaktapur	RT-20m High Pop.		23/09/2014 14:02	GSM/CDMA/ 3G/WiMaX	81m	2268.5	0.378
Godavari (NTC), Lalitpur	RT-15m Medium Pop.		25/09/2014 14:53	GSM/CDMA/ WiMaX	82m	1077.2	0.179
Gongabu (NTC), Kathmandu	RT-20m High Pop.		19/07/2014 14:56	GSM/CDMA/ 3G/WiMaX	74m	2100.5	0.350
Kuleshwor (UTL), Kathmandu	RT-15m Medium Pop.		26/07/2014 12:16	CDMA/ Internet	62m	1633.4	0.272
Kupendol (NTC), Lalitpur	RT-10m High Pop.		24/09/2014 15:53	GSM/ 3G	106m	2756.4	0.459
Lainchour (UTL), Kathmandu	RT-15m Low Pop.		29/07/2014 14:05	CDMA/ Internet	50m	277	0.046
Lele (UTL), Lalitpur	RT-12m Low Pop.		31/07/2014 14:10	CDMA/ Internet	109m	192.3	0.032
Lokanthali (UTL), Bhaktapur	RT-10m Medium Pop.		22/08/2014 14:36	CDMA/ Internet	79m	1488.7	0.248
Lolang (NTC), Kathmandu	RT-10m Low Pop.		25/08/2014 13:54	GSM-900	83m	478.3	0.079
Maitighar (NTC), Kathmandu	RT-5m Medium Pop.		17/07/2014	GSM/ CDMA	60m	1473.9	0.246
Nagarkot (NTC), Bhaktapur	RT-5m Low Pop.		27/08/2014 12:36	GSM-900	89m	256.5	0.043
Naxal (NTC), Kathmandu	RT-20m High Pop.		25/07/2014 12:10	GSM/CDMA/ 3G/WiMaX	68m	2175.7	0.363
New Baneshwor (NTC), Kathmandu	RT-8m High Pop.		23/07/2014 14:05	GSM/CDMA/ 3G/WiMaX	74m	3602.7	0.600
Satdobato (NTC), Lalitpur	RT-21m High Pop.		14/07/2014 16:04	GSM/CDMA/ 3G/WiMaX	102m	2305.4	0.384
Siddhapokhari (NTC), Bhaktapur	GF-50m High Pop.		06/08/2014 16:18	GSM/CDMA/ 3G/WiMaX	65m	2300	0.383
Sinamangal (NTC), Kathmandu	RT-8m Med Pop.		23/07/2014 16:33	GSM/CDMA/ 3G/WiMaX	68m	2730.6	0.455
Sundhara (NTC), Kathmandu	RT-50m High Pop.		26/08/2014 12:13	GSM/CDMA/ 3G/WiMaX	72m	2937.5	0.489
Tahachal (UTL), Kathmandu	RT-10m Medium Pop.		26/07/2014 14:35	CDMA/ Internet	126m	2130	0.355
Thankot (NTC), Kathmandu	GF-18m Low Pop.		2070/04/13 13:10	GSM-900	69m	874.4	0.146
Tinkune (NTC), Kathmandu	RT-10m Medium Pop.		25/07/2014 13:21	GSM/ WiMaX	69m	1973	0.329
Tinkune (UTL), Kathmandu	RT-18m Medium Pop.		07/08/2014 14:29	CDMA/ Internet	60m	1600	0.267

Table No. 2: P.D. on the Offtower Sites

Location	Date & Time		P.D. ($\mu\text{W}/\text{m}^2$)
Way to Lele	09/09/2013	13:51	2.06
Way to Nagarkot	05/09/2013	12:29	2.09
Way to Changunarayan	05/09/2013	15:38	2.76
Way to Sundarijal	02/09/2013	12:02	3.02
Way to Lumbu	06/09/2013	14:21	3.19
Dakshinkali area	03/09/2013	15:24	3.22
Near Godavari	06/09/2013	13:18	3.23
Way to Tapoban	01/09/2013	12:15	4.15
Way to Thankot	01/09/2013	15:45	4.68
Chovar area	03/09/2013	12:07	5.91