

CrossRef DOI of original article:

Scan to know paper details and author's profile

Received: 1 January 1970 Accepted: 1 January 1970 Published: 1 January 1970

Abstract

Index terms—

1 I. INTRODUCTION

Since its beginnings, mankind has had the enormous need to communicate, interrelate and transmit knowledge, that is, to provide information and reproduce it from one to another; starting from primitive phonemes, cave paintings or writings on stone, thanks to creativity and its systematic application in innovation processes, significant progress has been made in scientific development (Espitia et al., 2021), so that technological innovation has become an essential component of human nature that can provide welfare conditions (Castellanos et al., 2019).

Urban environments increasingly welcome technological developments that help the planning process and improve the quality of life of human beings, and advances in global positioning systems for development (Puentes et al., 2019), the use of artificial intelligence and automatic learning to improve security and defense parameters (Gutiérrez-Portela et al., 2021), support for military forces (Espitia et al., 2021) and even their application to general (Paredes-Chacín et al., 2020) and specific educational processes ??Cuevas and Díaz, 2020), are proof of this.

Nowadays, all information is available to anyone in just a few hundredths of a second with the click of a button or the touch of a touch screen, all thanks to what is called "connectivity". However, despite the rapid technological development, connectivity was difficult to achieve, as urban communities and cities were immersed in a sea of antennas and equipment that, due to their novelty and indiscriminate location, visibly affected the urban landscape.

Over the years, and gradually, the equipment that allows connectivity became part of the urban landscape, in addition to having the advantage of not requiring extensive cabling or fixed points of London Journal of Research in Science: Natural and Formal support in each street, and considering that the attention has been mostly focused on how the concentration of industrial processes negatively affects human health (Zafra-Mejía et al., 2020) and (Eslava-Pedraza et al., 2021), without addressing in detail the impact of connectivity on environmental pollution caused by connectivity.

Wireless technologies, specifically cellular telephony as a product, once its functionality was proven, was made available to the general population, being the pioneers in the Nordic countries despite its high costs at the beginning. The phenomenon of having a communication device without any type of wired connection, portable, similar in use to conventional telephone sets, soon became a success; but it did not stop there, parallel and almost as members of a single gestation, cellular telephony eventually expanded its services and included in its platform the use of another prodigious technological advance such as the Internet. A successful merger was born from that moment and turned the cellular equipment into a multi-equipment that serves as musical equipment, recorder, camera, television, tablet, alarm clock, telephone and remote control, because today through applications and internet connection any user can control the TV, air conditioner or refrigerator among others at long distance.

International organizations and governments were not oblivious to the charm of the services offered by cellular telephony and the Internet, and soon began massification programs reaching the point that today and according to statistics there are more cellular devices in use than people on the planet (UIT, 2016) they would also be inserted into the economy and would create their own space, hence today we hear in the jargon of finance terms such as "digital economy", "e-commerce", "online store" or "virtual shopping" among others (CEPAL, 2013).

In everyday life, more and more people are dependent on connectivity and therefore on technology that generates non-ionizing electromagnetic waves. Some devices that generate electromagnetic waves are acquired voluntarily and others are assigned and provided by service companies for a better operation of their networks

2 ELECTROMAGNETIC WAVES HAVE THREE PROPAGATION MECHANISMS:

48 and products. Therefore, the proliferation of electromagnetic wave generating devices is evident and the increase
49 of environmental pollution by these are increasing in the environment.

50 Studies of environmental contamination by electromagnetic waves have usually focused on studying, analyzing,
51 measuring and issuing recommendations regarding exposure limits to high voltage lines, radio communication
52 stations and recently cell phone base stations (Recommendations to limit exposure to electric, magnetic and
53 electromagnetic fields (up to 300 GHz) (ICNIRP, 1998), but very little interest has been shown in establishing
54 specific recommendations for exposure limits to non-ionizing electromagnetic waves produced by wireless
55 technologies such as those emitted by cellular telephony or Internet or WIFI equipment. Epidemiological scientific
56 studies that normally study the possible effects of the waves produced by cell phone equipment use as a dosimetric
57 magnitude the Specific Absorption Rate (SAR) which is defined as the ratio of energy absorbed over time per
58 unit mass of exposed body tissue (Quintana and Sepúlveda, 2013) or in simpler terms studies the thermal effect
59 of the waves produced by cell phone equipment in the head and more specifically in the human brain. However,
60 over time scientists have asked whether the aforementioned waves not only produce a thermal effect, but whether
61 they can affect the human body without the need for an immediate physical response, which has led to study the
62 possible relationship between the physics of non-ionizing waves and their biological effect on the human being.

63 Unfortunately, the systems work with only one measurement parameter such as Electric Field Strength (V/m),
64 leaving aside the other three parameters such as Magnetic Field Strength (A/m), Magnetic Flux Density (μT)
65 and Power Density (W/M²).

66 The massive presence of electromagnetic radiation emission sources has generated a type of almost imper-
67 ceptible and immaterial pollution called "electromagnetic pollution" or "electro-London Journal of Research in
68 Science: Natural and Formal pollution" (Gallego Serna, 2011). Electromagnetic pollution (term recognized by
69 the WHO in 1981) is caused by the emission of electromagnetic radiation originated by electrical and electronic
70 devices (Méndez, 2008) and has the characteristic of propagating in a vacuum, presenting three phenomena when
71 it collides with an object: being transmitted through the object, being reflected or being absorbed.

72 Scientific communities, research groups and ordinary people are increasingly raising questions about the
73 possible risks resulting from continuous and massive exposure to non-ionizing electromagnetic waves, to such
74 an extent that the World Health Organization (WHO) through the International Agency for Research on Cancer
75 (IARC) has categorized radiofrequency electromagnetic fields as group 2B, defined as "possibly carcinogenic to
76 humans" (IARC, 2013). Unfortunately, the results of the different studies have been varied and contradictory,
77 which has led political communities such as the European Union to take regulatory measures, while many nations
78 are only governed by international regulations or, as in the case of Colombia, only have regulations to regulate the
79 ICT sector and the use of the radioelectric spectrum (Congreso de la República de Colombia, 2019) and (ANE,
80 2020), but from an approach that is subject to international determinations, which are considered permissive due
81 to the low restriction values they handle.

82 2 Electromagnetic waves have three propagation mechanisms:

83 reflection, diffraction and scattering.

84 Reflection occurs when an electromagnetic wave hits a surface of much larger dimensions than the wavelength
85 of the signal and whose properties are different from the previous medium.

86 Diffraction occurs when the path of the wave is obstructed by objects that have sharp corners and edges; when
87 the wave hits the object, secondary waves are produced that are assumed as new wave fronts propagating even
88 in the space behind the object. The naturalization of diffraction at high frequencies depends on the geometry of
89 the obstacle, amplitude, phase and polarization of the wave.

90 The scattering mechanism occurs when the wave is obstructed by objects whose dimensions are much smaller
91 than the wavelength, or when there is a high number of objects per unit volume in the propagation medium.
92 It can also occur due to rough surfaces or irregularities in the communication channel. Objects such as lamps,
93 poles, trees, furniture cause dispersion producing either increase or decrease of the signal (Castellanos y Talero,
94 2005).

95 Indoor propagation is that which occurs in an enclosed environment. In general, it is affected by the same
96 mechanisms of outdoor propagation, although much more marked. In indoor environments, the distances are
97 short, predominantly multipath propagation and there is a greater susceptibility to variations caused by doors,
98 windows, furniture, people, among others (Castellanos y Talero, 2005).

99 Multipath propagation in wireless communications often means that there is no line of sight between the
100 transmitter and the receiver, so the transmitted signal must follow indirect paths.

101 When multiple signals arrive at the receiver through different paths in an indoor environment, two types of
102 interference can occur: constructive interference and destructive interference. Constructive interference occurs
103 when the vector sum of the signals produces an increase in the amplitude of the received signal. Destructive
104 interference occurs when the vector sum of the signals produces a decrease in the received signal at the receiver.

105 Another phenomenon that occurs when handling multipath propagation is fading, which occurs when the
106 receiving antenna does not pick up a single clean signal, receiving multiple replicas that upon reaching the antenna
107 give a resulting signal that may have a different value in amplitude and phase, depending on the intensity and
108 relative propagation time of the waves and the bandwidth of the transmitted signal.

109 London Journal of Research in Science: Natural and Formal

110 Indoor propagation in the framework of this study corresponds to wifi routers and mobile cellular telephony
111 equipment.

112 3 II. METHODOLOGY

113 The mixed methodological approach (Hernández Sampieri, 2014) is represented in the harmonious combination
114 of quantitative and qualitative aspects; in addition, the hypothetical deductive approach that permeates most
115 of the research process is complemented with an inductive approach represented in the possibility of applying
116 the results obtained in multiple and varied contexts. The methodology employed allowed the research to be
117 structured in four phases: documentation, practice, processing and, finally, simulation model.

118 4 III. RESULTS

119 5 Documentation

120 This phase consisted of a search for similar studies and research projects in international, national and regional
121 organizations and institutions.

122 The

123 6 Practice

124 The procedural development of the research project is of a mixed nature, which allows the combination
125 of quantitative aspects with qualitative tools for the collection and analysis of information, represented in
126 measurements and surveys, respectively. In accordance with the project's frame of reference, previous results on
127 London Journal of Research in Science: Natural and Formal the impact of wireless technologies in free spaces
128 (Barrera Monsalve and J. Mosquera, Téllez, 2018) were taken into account to take measurements in living spaces
129 (rooms) at night. Since the characteristics were so accurate, it was logical that the type of sampling was "non-
130 random" since all the homeowners were not willing to allow the operator of the measuring equipment to enter.

131 The first stage established in the qualitative method corresponded to a survey, which was carried out in the
132 Los Pinos neighborhood of the city of Cúcuta, in order to find out where people placed the cell phone equipment
133 while resting or sleeping at night. The survey was conducted with a population of 73 people, establishing as a
134 result that 73.97% of people place the cell phone on the night table next to the bed, 8.22% under the pillow,
135 6.85% under the bed and only 10.96% leave the equipment more than 1.5 meters away from the bed or outside
136 the room; that is, 89.04% of those surveyed leave the cell phone equipment less than 30 centimeters from their
137 head. Additionally, it was established that none of the respondents have the wifi equipment in the room.

138 Source: (Barrera, 2018). The measurements taken in other similar outdoor projects show that the results are
139 usually much lower than the values recommended by international organizations and national legislation, so the
140 project was not a comparison of "recommended values" versus "indoor values", but rather "outdoor values versus
141 "indoor values" of a single study area. The selected sector was the Los Pinos neighborhood in the city of Cúcuta,
142 because it is a densely populated area, it is a residential neighborhood, its topography is flat, the housing has
143 a typical design and most of them have not suffered alterations in their distribution and materials, the date of
144 construction is similar and it has a cell phone base station of a service operator within the study area, This allows
145 us to provide more information about electromagnetic wave pollution from wireless technologies identified in the
146 home, such as cellular telephony, wifi broadband equipment and waves coming from other services with similar
147 characteristics but outdoors. Additionally, points were taken in areas of urban extension of the city. It should be
148 noted that the measurement was of immission due to the contribution of all radiofrequency sources whose fields
149 are present in the place at a height of 1.50 meters.

150 London Journal of Research in Science: Natural and Formal

151 7 Processing

152 The third phase corresponded to the processing of the information collected and in its development box and
153 whisker diagrams were used to compare the three measured variables such as electric field strength (V/m),
154 magnetic field strength (A/m) and power density (W/m²).

155 Source: (Barrera, 2018). As can be seen in Figure 4, the measurements obtained at the sampling points in
156 the Los Pinos neighborhood showed a decrease in electromagnetic wave contamination when cellular equipment
157 was not included.

158 Figure 5 shows the results of the measurements taken in neighborhoods on the outskirts of the city of Cúcuta,
159 which allowed us to identify the increase in electromagnetic wave contamination when cellular equipment was
160 included.

161 Source: (Barrera, 2018) As can be seen, the graphs presented above show opposite behaviors, since the variables
162 studied increase or decrease depending on the inclusion or not of cellular telephone equipment.

163 8 Simulation model

164 The fourth phase of the project corresponds to the design of a simulation model, which consisted of using boxes
165 with a base of 0.30 x 0.60 centimeters and a height of 0.30 centimeters in 5 different materials. The dimensions

11 V. CONCLUSIONS

166 of the boxes were established based on the information obtained in the survey, which showed that most people
167 rest with the cell phone equipment at 30 centimeters or less from the head, a measure that was established as
168 the width of the base; the longest measure of the base was established at 60 centimeters to allow locating inside
169 the boxes both the EMF RF intensity measuring equipment and the emission sources, either the wifi equipment
170 or the cell phone equipment.

171 The time determined for taking measurements is 6 minutes, which corresponds to the time worked during
172 the previous stages of measurement and as established by the IUT-T K.61 recommendation and the Colombian
173 legislation.

174 Source. (Barrera, 2018). As with the field measurements, these were performed indoors at one of the points
175 that presented the least interference at night.

176 Source. Barrera, 2018).

177 9 Final results

178 The analysis of the study shows that environmental contamination by non-ionizing electromagnetic waves from
179 wireless technologies is largely influenced by the construction materials used in the space and the distance to the
180 source.

181 Source: (Barrera, 2018). As shown in graph 8, when the space was confined, the values of electric field (V/m),
182 magnetic field (mA/m) and power density (mW/m²) increased, the latter being the highest with the proposed
183 simulation model. All the materials worked differently, the normal one being the one that reflects the behavior of
184 the environmental contamination corresponding to "no material". The metal box (representing metal carpentry
185 in the living space) works as a Faraday Cage protecting from the emitting source; the clay box (representing
186 masonry in the living space) is shown as the second highest blocking to electromagnetic pollution and; finally, the
187 icopor boxes (representing light construction in the living space) and the melanin (representing London Journal of
188 Research in Science: Natural and Formal furniture and architectural finishes in melanin in the living space) show
189 a higher percentage of affectation by electromagnetic pollution. Finally, the aluminum box (represents aluminum
190 carpentry in the living space) worked as an antenna or an amplifier equipment of the waves and therefore of the
191 electromagnetic pollution.

192 The results obtained for Electromagnetic Contamination, Variation in Living Space in the Los Pinos Indoor
193 Measurement Neighborhood, shown in Figure 4, show the interference phenomenon that affects the results due to
194 radiation resulting from the contribution of all the radiofrequency sources whose fields are present in the area. It
195 is important to keep in mind that it is feasible to reduce EMF in homes through a series of precautionary measures
196 as established by (Álvarez-Ovallos et al., 2014) and (Tomitsch and Dechant, 2015), but in the case of Los Pinos
197 Indoor Measurement it is an interference phenomenon and not a space free of electromagnetic contamination by
198 non-ionizing electromagnetic waves resulting from wireless technologies.

199 The results obtained for Electromagnetic Contamination Variation in Habitable Space in Peripheral Neigh-
200 borhoods Indoor Measurement can be considered normal because when the cell phone is less than 30 centimeters
201 away from the RF EMF intensity measuring equipment, the contamination increases.

202 10 IV. DISCUSSION

203 The proposed simulation model presents the results corresponding to the six restriction media proposed,
204 establishing that there are materials that amplify the value of the electromagnetic waves under study in a constant
205 way for Electric Field (V/m), Magnetic Field (mA/m), and in some cases presenting exponential increases such
206 as the case of Power Density (W/m²) in the scenario corresponding to Aluminum.

207 The scenario corresponding to the Aluminum box shows that there are materials that can amplify values of
208 non-ionizing electromagnetic waves, thus presenting an increase in one of the Electromagnetic Contamination
209 indicators.

210 11 V. CONCLUSIONS

211 The estimation of environmental pollution by non-ionizing electromagnetic waves produced by wireless technolo-
212 gies in living spaces is closely linked to the type of emission sources, number of London Journal of Research in
213 Science: Natural and Formal sources, distance to the sources, location of the space under study and construction
214 materials that confine the site.

215 The discrimination of non-ionizing electromagnetic wave producing devices produced by wireless technologies
216 in residential rest areas should be based on the source and type of non-ionizing electromagnetic wave generated.
217 Indoor emission devices correspond to cellular telephony equipment (mobile broadband) and wifi equipment (fixed
218 broadband).

219 The establishment of the magnitudes of the parameters of non-ionizing electromagnetic waves in living spaces
220 of rest is linked to a series of variables that in most cases the inhabitant cannot establish or but through
221 the implementation of the culture of the correct use of wireless technology devices and the correct architectural
222 design and use of suitable materials of the living space either outdoor or indoor source through visual inspections,
223 electromagnetic pollution can be reduced.

224 Environmental contamination by electromagnetic waves in indoor spaces varies significantly depending on the
225 spatial configuration, architectural arrangement, construction materials used, type of source and distance of the
226 subject to the source, with aluminum being the material with the highest amplification values and clay-based
materials those with the lowest values and therefore the least contamination with indoor sources. ^{1 2 3}



Figure 1: Figure 1 :

227

¹ © 2023 London Journals Press Volume 23 | Issue 1 | Compilation 1.0 Behavioral Analysis Through Simulation Processes of Urban Environmental Pollution by Electromagnetic Waves

² © 2023 London Journals Press Volume 23 | Issue 1 | Compilation 1.0 Behavioral Analysis Through Simulation Processes of Urban Environmental Pollution by Electromagnetic

³ © 2023 London Journals Volume 23 | Issue 1 | Compilation 1.0 Behavioral Analysis Through Simulation Processes of Urban Environmental Pollution by Electromagnetic Waves

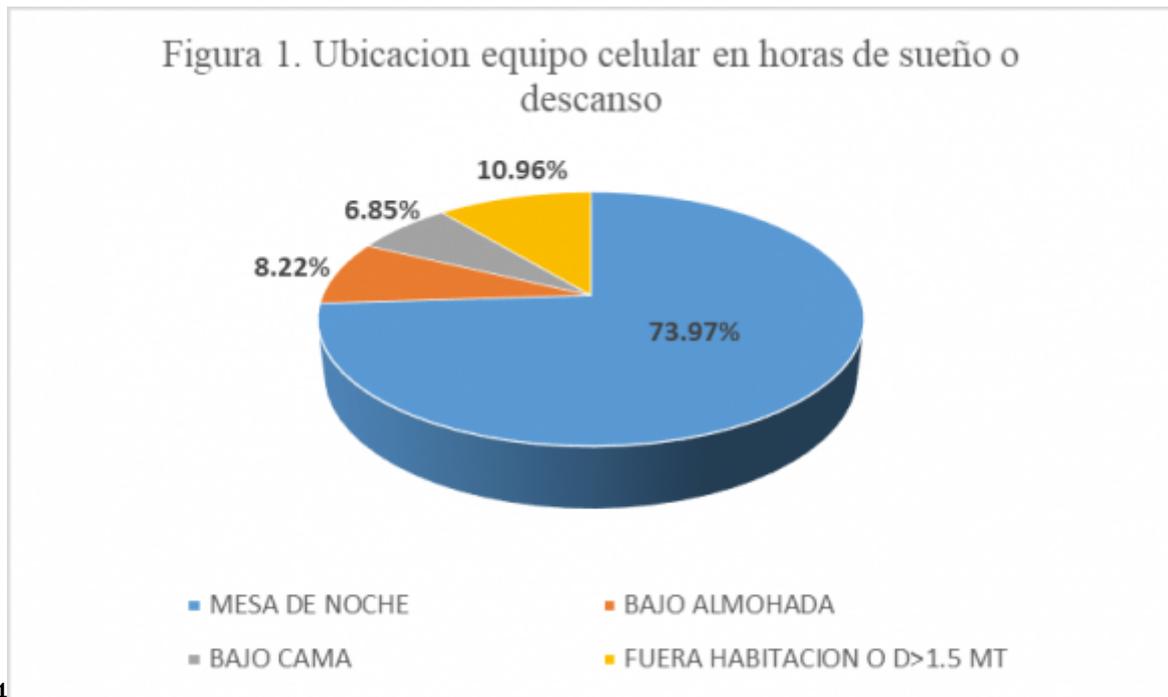
2

Figure 2: Figure 2 :



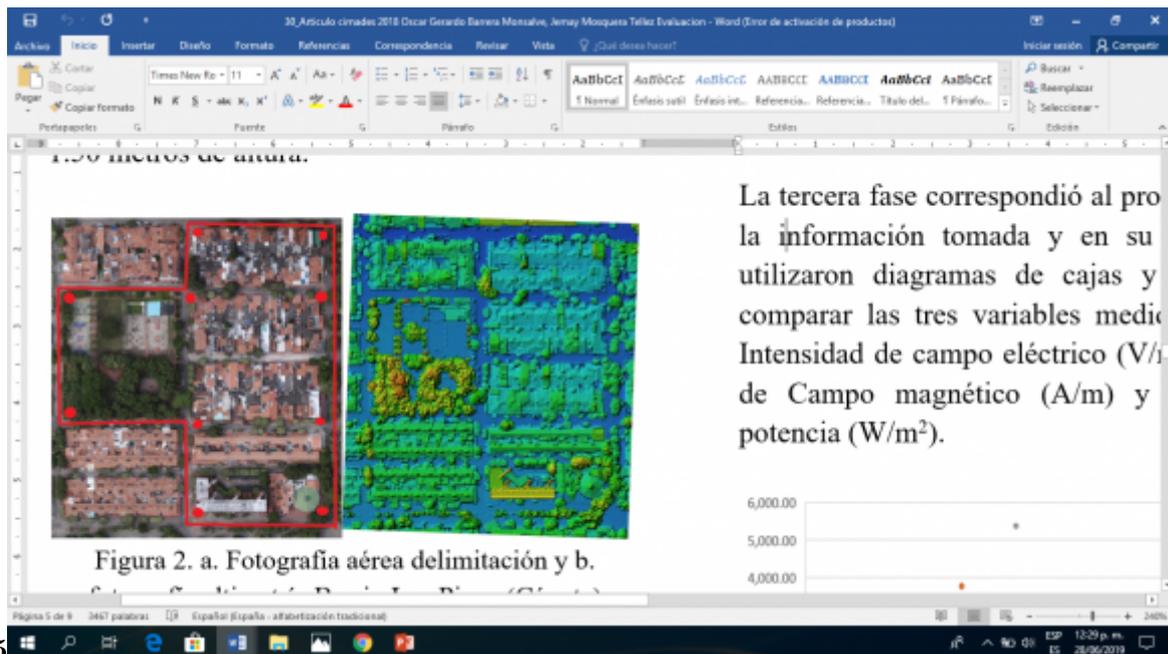
3

Figure 3: Figure 3 :



4

Figure 4: Figure 4 :



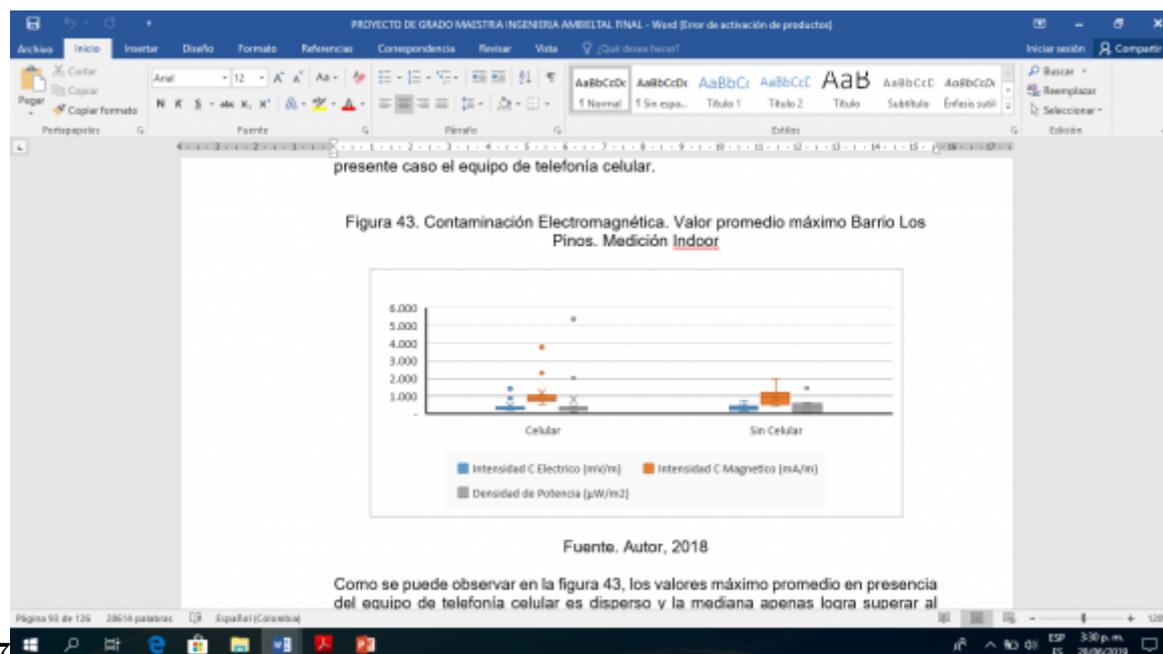
5

Figure 5: Figure 5 :



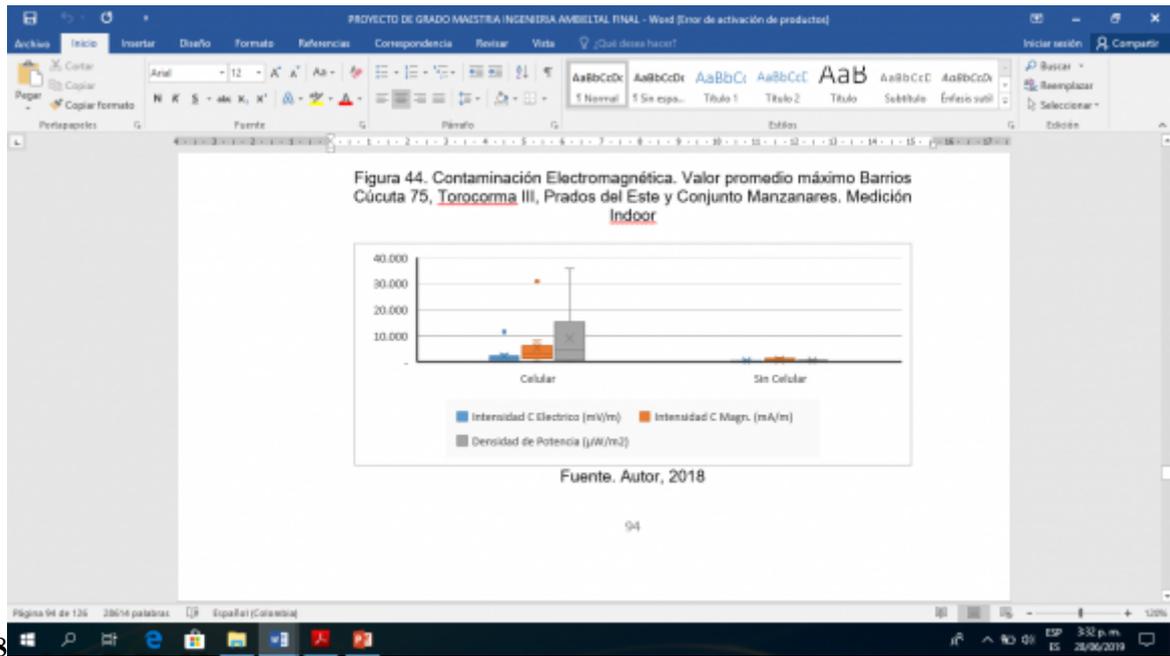
6

Figure 6: Figure 6 :



7

Figure 7: Figure 7 :



8

Figure 8: Figure 8 :



9

Figure 9: Figure 9 :

- 228 [Méndez et al. ()] , N R Méndez , R M Méndez , G Cobiça . *Contaminación Electromagnética Salud e Internet.*
229 *Rio de Janeiro: Instituto Nacional de Metrologia, Normalização e Qualidade Industrial* 2008. 2.
- 230 [Revista de ciencias sociales ()] , 10.31876/rcs. <https://doi.org/10.31876/rcs> *Revista de ciencias so-*
231 *ciales* 2020. 26 (3) p. .
- 232 [Díaz and Talero Niño ()] *Análisis de propagación electromagnética en espacios cerrados: Herramienta software*
233 *en Matlab para predicción y simulación*, E Castellanos Díaz , J B Talero Niño . 2005. p. .
- 234 [Base de datos de la UIT sobre indicadores mundiales de las telecomunicaciones/TIC ()] *Base de datos de*
235 *la UIT sobre indicadores mundiales de las telecomunicaciones/TIC*, [https://itu-news.itu.int/es/](https://itu-news.itu.int/es/3780-Telefonos-moviles-ya-son-casi-7000-millones-br-Tenemos-casi-todos-un-telefono-note.aspx)
236 **3780-Telefonos-moviles-ya-son-casi-7000-millones-br-Tenemos-casi-todos-un-telefono.**
237 **note.aspx** 2015. Unión internacional de telecomunicaciones (UIT).
- 238 [Mundial et al. ()] ‘BBND.P2?end=2016&start=2016&view= map. A. Isoglio. La economía basada en el
239 conocimiento: discusiones conceptuales sobre los cambios ocurridos a escala global desde la década de 1970’.
240 Banco Mundial , Sir-Afi , Databank . 10.14482/indes.29.2.330. [https://dx.doi.org/10.14482/indes.](https://dx.doi.org/10.14482/indes.29.2.330)
241 **29.2.330** *investigación & desarrollo* 2016. 2021. 29 (2) p. .
- 242 [Barrera Monsalve Y et al. ()] ‘Contaminación ambiental por ondas electromagnéticas no ionizantes producto
243 de tecnologías inalámbricas en ambientes al aire libre’. O Barrera Monsalve Y , J Mosquera , Téllez .
244 10.21789/22561498.1404. <http://dx.doi.org/10.21789/22561498.1404> *Mutis* 2018. DoiI. 8 (2) p. .
- 245 [Barrera ()] *Contaminación Ambiental por Ondas Electromagnéticas No Ionizantes producto de tecnologías*
246 *inalámbricas en espacios habitables de descanso*, O Barrera . 2018. Univ. de Pamplona (trabajo de maestría)
- 247 [Directrices sobre la medición y la predicción numérica de los campos electromagnéticos para comprobar que las instalaciones de t
248 *Directrices sobre la medición y la predicción numérica de los campos electromagnéticos para comprobar*
249 *que las instalaciones de telecomunicaciones cumplen los límites de exposición de las personas*, 2018. Unión
250 internacional de telecomunicaciones (UIT). p. . (IUT-T K.61)
- 251 [Cepal ()] ‘Economía digital para el cambio estructural y la igualdad’. Cepal . *Comisión Económica para América*
252 *Latina y el Caribe* 2013. p. 16.
- 253 [Álvarez-Ovallos et al. ()] ‘Estudio del efecto de los campos electromagnéticos sobre la producción de biomasa
254 en *Saccharomyces cerevisiae* variedad Rhône’. A Álvarez-Ovallos , E Amado-González , A Quijano-Parra , A
255 . *Revista de la Facultad de Ciencias Básicas*, 2014. 12 p. .
- 256 [Tomitsch and Dechant ()] ‘Exposure to Electromagnetic Fields in Households Trends From’. J Tomitsch , E
257 Dechant , E . *London Journal of Research in Science: Natural and Formal* 2006 to 2012. 2015. (36) p. .
258 (Bioelectromagnetics)
- 259 [Eslava-Pedraza et al. ()] ‘Generación de mapas de contaminación por material particulado mediante sistemas
260 embebidos: caso de estudio en Cúcuta (Colombia)’. J E Eslava-Pedraza , F A Martínez-Sarmiento , A J
261 Soto-Vergel , E J Vera-Rozo , D Guevara-Ibarra . 10.22335/rlct.v13i3.1433. [https://doi.org/10.22335/](https://doi.org/10.22335/rlct.v13i3.1433)
262 **rlct.v13i3.1433** *Revista Logos Ciencia & Tecnología* 2021. 13 (3) p. .
- 263 [Cuevas and Díaz ()] *La historia de la matemática un factor imprescindible en la elaboración de una propuesta*
264 *didáctica. El caso del concepto de función*, A Cuevas , J Díaz . 2014. *El Cálculo y su Enseñanza*. p. .
- 265 [Gallego and Serna ()] *Lineamientos para le gestión del riesgo de las áreas urbanas expuestas a las radiaciones*
266 *electromagnéticas emitidas por las estaciones base de telefonía móvil estudio de caso*, L M Gallego , Serna .
267 2011. Municipio de Cartago Valle. p. 17.
- 268 [Monografías sobre la evaluación de los riesgos carcinogénicos para humanos Agencia Internacional para la Investigación sobre el
269 ‘Monografías sobre la evaluación de los riesgos carcinogénicos para humanos’. *Agencia Internacional para la*
270 *Investigación sobre el Cáncer (IARC)*, 2013. 112.
- 271 [Mundial ()] Banco Mundial . *Science, Technology and Innovation Capacity Building Partnerships for Sustainable*
272 *Development*, 2010.
- 273 [Paredes-Chacín et al.] A J Paredes-Chacín , A Inciarte González , D Walles-Peñalosa . *Educación superior e*
274 *investigación en Latinoamérica transición al uso de tecnologías digitales por Covid-19*,
- 275 [Espitia et al. ()] ‘Percepciones sobre innovaciones tecnológicas en el Ejército colombiano’. A A Espitia , J A
276 Agudelo , T Ramírez , T . 10.22335/rlct. <https://doi.org/10.22335/rlct> *Revista Logos Ciencia &*
277 *Tecnología* 2021. 13 (2) p. .
- 278 [Puentes et al. ()] ‘Planificación de posicionamiento satelital multiconstelación en entornos urbanos’. M Puentes
279 , D Rueda , R Ramos , C Barrios . 10.18273/revuin.v18n3-201900. *Rev. UIS Ing* 2019. 18 (3) p. .
- 280 [Ley ()] ‘Por la cual se moderniza el Sector de las Tecnologías de la Información y las Comunicaciones -
281 TIC, se distribuyen competencias, se crea un Regulador Único y se dictan otras disposiciones’. Ley .
282 <https://www.funcionpublica.gov.co/eva/gestornormativo/norma> *Congreso de la República de*
283 *Colombia*, 1978 de 2019. p. 98210.

11 V. CONCLUSIONS

- 284 [Por la cual se reglamenta el artículo 35 de la Ley Agencia Nacional del espectro ()] ‘Por la cual se reglamenta
285 el artículo 35 de la Ley’. *Agencia Nacional del espectro* 1978 de 2019. 2020. p. 4. (Resolución 000134 de 2020)
- 286 [Hernández et al. ()] ‘Proyecto Ondas Electromagnéticas’. L J Hernández , F Quiroga , K Medina Y , L M
287 Guerrero . *Hospital Fontibón Empresa Social del Estado* 2008. p. 6.
- 288 [Quintana and Sepúlveda ()] A Quintana , O Sepúlveda . *Niveles de radiación de campo electromagnético*
289 *presentes London Journal of Research in Science: Natural and Formal en las antenas WIFI Omnidireccionales*,
290 2013. 40.
- 291 [Recomendaciones para limitar la exposición a campos eléctricos, magnéticos y electromagnéticos (hasta 300 GHz) ()]
292 *Recomendaciones para limitar la exposición a campos eléctricos, magnéticos y electromagnéticos (hasta*
293 *300 GHz)*, 1998. p. 28. (Comisión Internacional para la Protección Contra la Radiaciones No Ionizantes
294 (ICNIRP))
- 295 [Sampieri ()] R Hernández Sampieri . *Metodología de la investigación. Sexta Edición. Editorial Mc Graw Hill*
296 *Education. 540 p*, 2014.
- 297 [Gutiérrez-Portela et al. ()] ‘Security perspective of wireless sensor networks’. F Gutiérrez-Portela , F Almenárez-
298 Mendoza , L Calderón-Benavides , E Romero-Riaño . 10.18273/revuin. *Rev. UIS Ing* 2021. 20 (3) p. .
- 299 [Castellanos et al. ()] ‘Tecnología y bienestar’. J Castellanos , J R Carreño , Y W Hofacker . 10.18273/revuin.
300 *Rev. UIS Ing* 2019. 18 (1) p. .
- 301 [Zafra-Mejía et al. ()] ‘The relationship between atmospheric condition and human mortality associated with
302 coarse particulate matter in Bogotá (Colombia)’. C A Zafra-Mejía , J P Rodríguez-Miranda , H A Rondón-
303 Quintana . 10.22335/rlct. <https://doi.org/10.22335/rlct> *Revista Logos Ciencia & Tecnología* 2020.
304 12 (3) p. .