Tree Damage
Caused by Radiofrequency Radiation

Exemplary Observations from 2005 to 2021 in Germany

Cornelia Waldmann-Selsam

To Lotte, Fabian, Felix and Caroline

Contents

Title image: Forchheim, railway station, maple tree 2015

Tree observations between 2005 and 2021 in Germany indicate a causal link between radiofrequency radiation exposure and tree damage. Based on these observations, I would like to show you examples from different cities and municipalities.

After the publication of the Bamberg Appeal 2004, in which 130 medical doctors warned against the continued expansion of mobile phone networks, numerous residents who were affected by the radiation from nearby mobile phone base stations asked the physician-led initiative for advice and help. As a result, we visited affected people in their homes, recorded their symptoms and performed RF radiation measurements. While visiting these patients, we have noticed since about 2005 that symptoms in our patients frequently started at around the same time when nearby trees also started to change and develop damage. Deciduous and coniferous trees as well as shrubs were affected. We became very concerned when we observed crown damage on just one side of a tree, which was the side facing a mobile phone station, as well as the contrast between damaged trees in front of a house – with line of sight to a base station – and healthy trees in the back of a house – without line of sight to an RF transmitter.

Tree health is affected by a wide range of factors: heat, drought, frost, soil composition, soil sealing, road salt, air and soil pollutants as well as pests. However, these factors cannot explain crown damage starting on one side only and damaged trees in the vicinity of water bodies.

We asked various tree experts for advice: “Which type of causes would have to be considered for crown damage starting on one side?” Experts replied that root damage on one side due to underground engineering work could be a cause. Other causes were not know to them. Only in the vicinity of industrial facilities, a possible impact by industrial emissions should be considered.

The head of an urban landscape department said in a conversation in May 2006: “For 2 to 3 years we have observed vitality disorders for which I have no explanation.” This statement encouraged us to further investigate this suspicious tree damage.

Dr. H. Eger, Dipl.-Ing. F. Maierhofer, Dr. V. Schorpp, expert meteorologist W. Sönning (Dipl.-Met.) and I compiled references regarding the effects of electromagnetic fields on plants. We were overwhelmed by the knowledge already available to date.

About 1920 electrical engineers discovered that trees act as receiving antennas of radio waves. A tall poplar tree made it possible to receive radio signals from the Eiffel Tower, which was located 300 km (185 mi) away.

About 1950 the biological effects of ultra short waves (wavelength 1.5 m / 5 ft) on plants were studied at the Institute of Forestry, Botany and Tree Physiology of the University of Freiburg. The researchers found effects on the frequency of cell division and chromosome mutations – well below current exposure limits.

In the 1980s the electrical engineer and physicist Dr.-Ing. W. Volkrodt documented forest damage in 32 locations caused by microwave radio systems, radar stations as well as radio and television broadcasting transmitters – from the Feldberg mountain in the Black Forest to the Würmberg and Brocken in the Harz Mountains.

Dr. A. Bernatzky – a renowned expert of tree protection, nature conservation and green space planning working for the City of Frankfurt as well as the regional council of Wiesbaden/Darmstadt – observed as early as 1985 crowns damaged only on the side of the tree facing an RF transmitter, in particular, within the radius of exposure of television broadcasting repeaters. In the 1994 edition of his textbook “Tree Ecology and Preservation,” he published information on the spectrum of electromagnetic fields and microwave radio systems. He included research reports as well as observations and shielding experiments by Ermer, an engineer (with illustrations).

In 2000 a summary of the study "Studies on the Effects of Radiofrequency Fields on Conifers" was published. Scientists of the universities of Wuppertal and Karlsruhe investigated a total of 451 one-year-old seedlings of three species of conifers. From October 1999 to May 2000, the plants were exposed to a frequency of 383 MHz (pulsed, equivalent to TETRA signal). Plants were watered whenever necessary. Pinus pumila reacted to exposure with a slightly enhanced growth rate and a reduced chlorophyll a/b ratio. The number of dead plants at the end of the experiment was significantly increased in all three species. The complete study and a second study from 2001, in which effects on coniferous seedlings were also found, have not been published to date. Yet a nationwide network of TETRA base stations for BOS Digital Radio (for authorities and organizations with safety- and security-related tasks) has been deployed in the meantime.

From 2004 different research groups have published effects on germination, growth and cellular metabolism in laboratory experiments.

Research findings and observations that have been emerging since the 1930s as well as our own on-site visits to damaged trees provided the impetus to our tree documentations over many years, including RF measurements, and our study. **In the vicinity of all mobile phone base stations we visited, we found RF radiation-related tree damage.** To prove this statement, I would like to present a larger number of examples.

Contrast between Radio Shadow and Radiofrequency (RF) Radiation Exposure

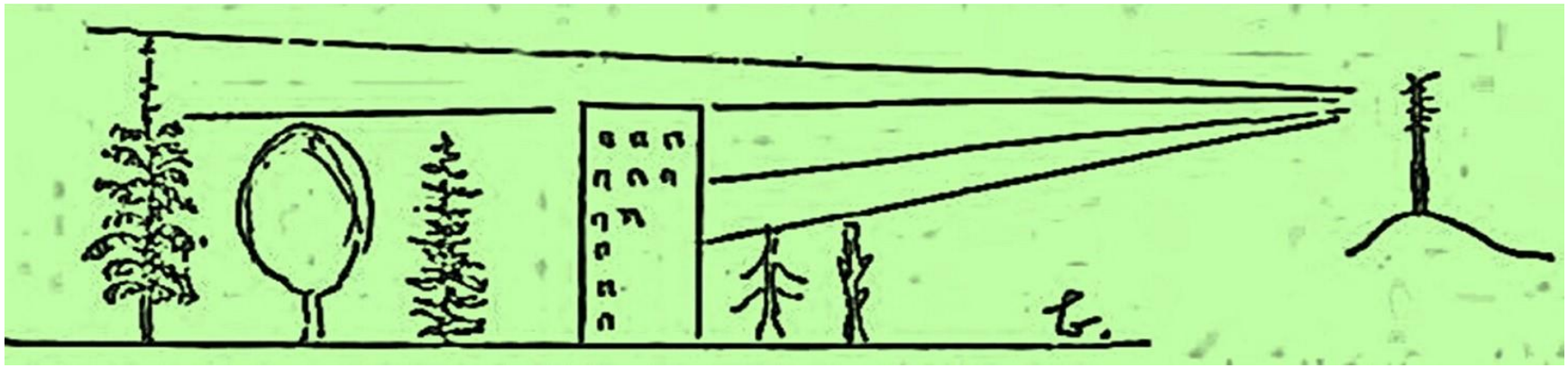


Figure 172: Tree damage caused by electromagnetic waves. Trees in front of a building die because they are exposed to electromagnetic waves from an RF transmitter. In the shadow of the building, trees grow undisturbed; however, branches that grow above the roofline will also die because there the building does not act as a protective barrier. [Illustration by Bernatzky]

Illustration from the textbook “Baumkunde und Baumpflege [Tree Ecology and Preservation],” Bernhard Thalacker Verlag, 1994, expanded 5th edition Dipl. Hort. Dr. phil. nat. Aloys Bernatzky – landscape architect, expert in tree protection and nature conservation, pioneer in urban ecology – made these observations within the radiofrequency field of radio and television broadcasting transmitters.

From 2005 we made the same observations like Bernatzky in the surrounding areas of all mobile phone base stations we visited.

06 OCT 10: Schlüsselstraße/Mußstraße, hornbeam trees (view from northwest). From the south, the radiation from the mobile phone base station at the concert hall strikes this area (distance 190–230 m / 630–755 ft). In the street to the right (Mußstraße) facing the mobile phone base station, the measurement showed 300 µW/m²; in the street to the left (Schlüsselstraße) with no direct line of sight due to the building, the measurement was 10 µW/m².

28 OCT 15: Schlüsselstraße/Mußstraße, hornbeam trees (view from northwest). The hornbeam trees along Mußsstraße street (right) are removed because they failed to thrive. In the vicinity of the concert hall, numerous trees have sustained damage.

06 SEP 201: Weihenstephan, Lange Point 10, Bavarian State Research Center for Agriculture with mobile phone base station (view from southeast), pear tree and walnut tree in radio shadow. Plane tree exposed.
Measurement: at pear tree 30 µW/m², at plane tree 1470 µW/m².
Exposed trees in other directions are also damaged.

Five Mobile Phone Base Stations at the Weihenstephan Science and Research Campus

Section UK 50-35, Landshut, Bavarian State Office for Survey and Geoinformation.
Added: Six mobile phone base stations (yellow) with the main beam directions of the antennas (from EMF Database of the German Federal Network Agency), as of 2016.

Campus: Schießplatz (1),

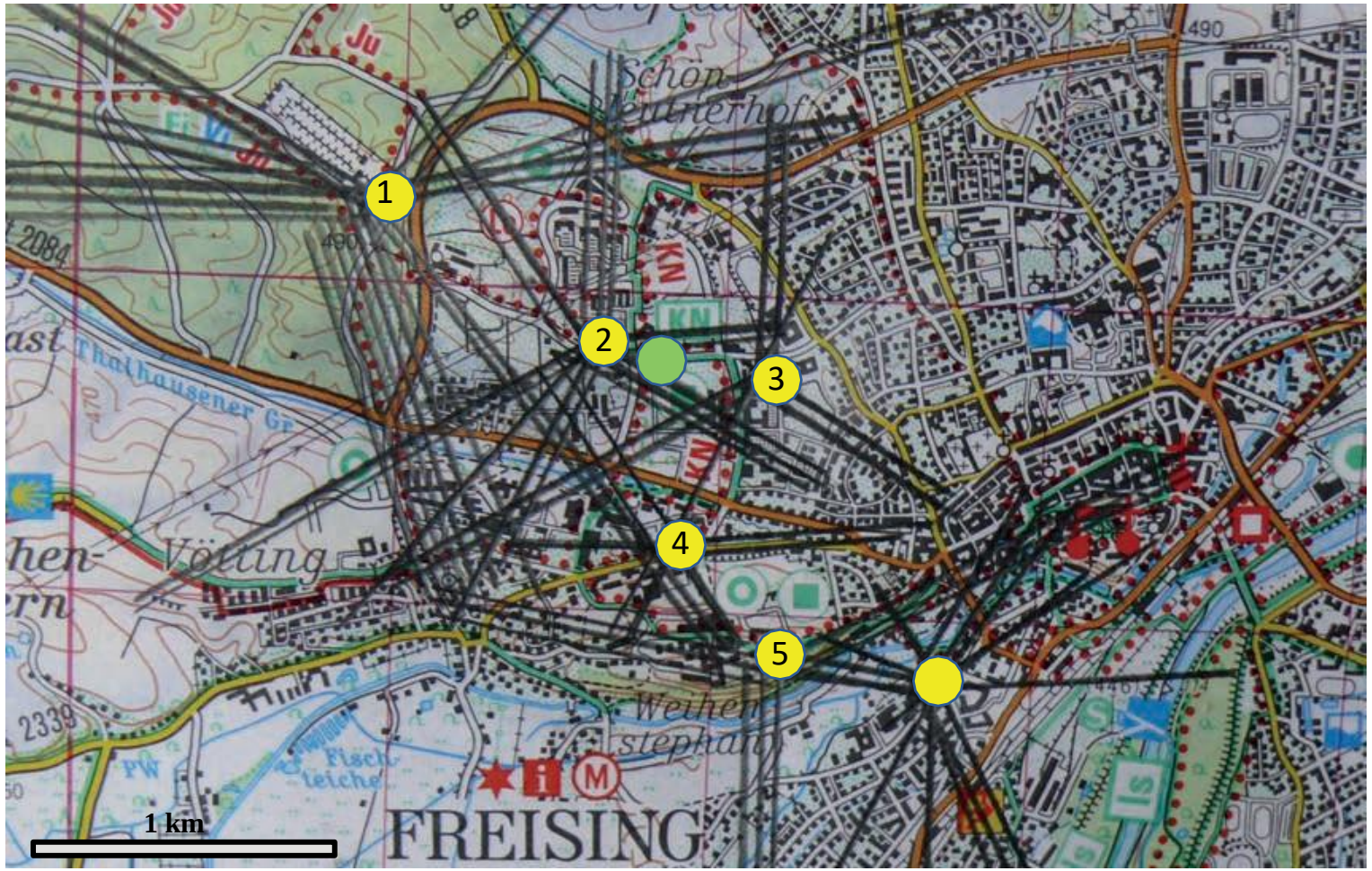
Lange Point 10 (2),

Am Staudengarten 14 (3),

Vöttinger Str. 38 (4),

Am Hofgarten 10 (5)

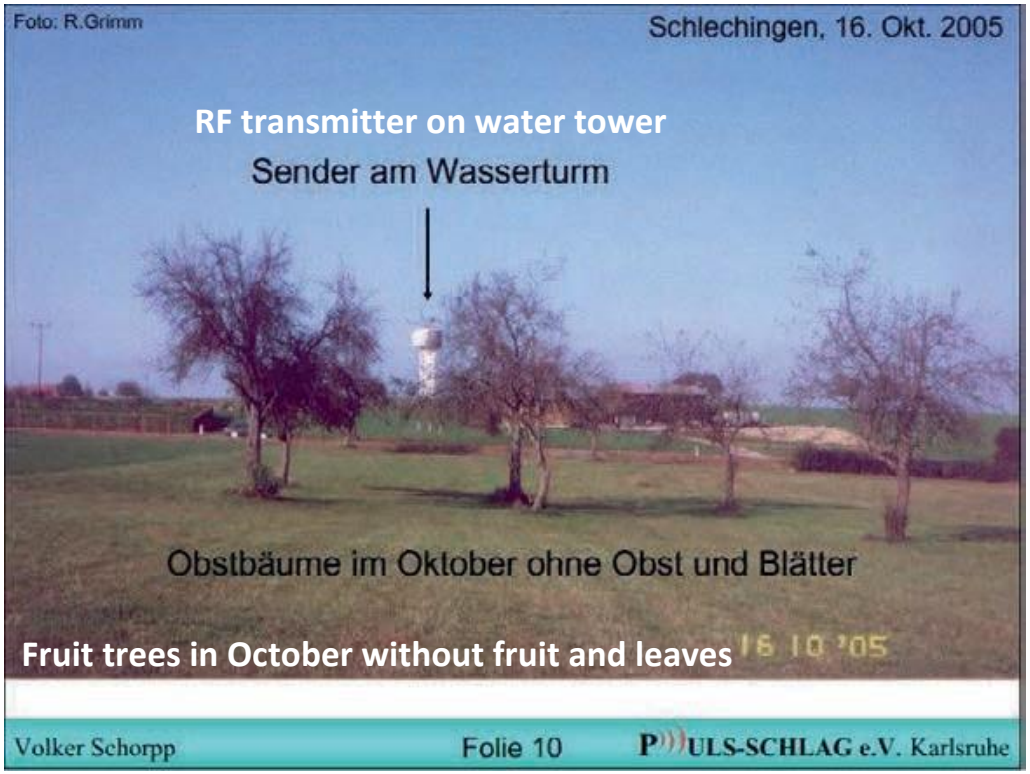
Plane tree (green)



Mobile phone base station Hauptstr./ Habsburgerstr.: a nearby beech tree had the top removed

26 OCT 19: Freiburg, Hauptstraße. Beech tree and yew tree on the left in radio shadow of building "Biology I" and "Zoological Exhibition." The red oak tree to the right is in the direct line of sight of the mobile phone base station Hauptstr./ Habsburgerstr. (distance ca. 80 m / 262 ft). Measurement in front of the Department of Pediatric Psychiatry: **1960 µW/m²**. In 2021 the beech tree still had foliage on the 14th of October.

Schechingen and Laubach in the District of Ostalbkreis, 2005

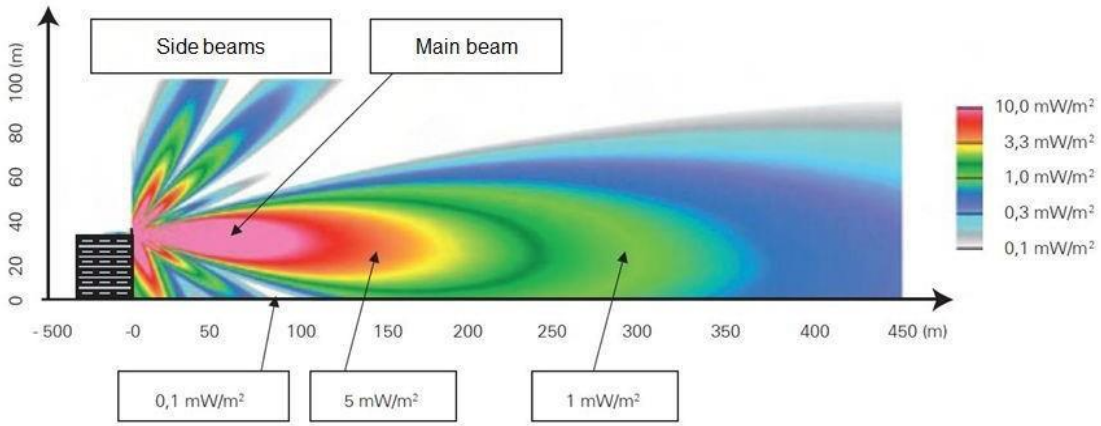


Fruit trees **with** direct line of sight to a mobile phone base station

Fruit trees **without** a direct line of sight to a mobile phone base station

In a given case, late frost, trunk and root injuries, site conditions as well as pests must be considered. Rolf and Rosa Grimm, however, have systematically surveyed all mobile phone base stations in their area from 2000 and have documented the health of the trees photographically. In the vicinity of every mobile phone base station, they found damaged trees or forests. At the same time, they found thriving trees in areas with low ambient RF radiation levels and without any direct line of sight to a mobile phone base station.

Dr.-Ing. Dipl.-Phys. Volker Schorpp showed these pictures in his presentation at the workshop of the Federal Office for Radiation Protection on 02 August 2006 (see p. 12).



Vertically focused beam pattern of a sector antenna

The simulation to the left shows the radiated power distribution of a mobile phone base station antenna in space. Besides the main beam, which covers long-range areas, side beams are emitted at certain angles to cover short range areas.

Source: LfU

Illustration from "Elektromagnetische Felder im Alltag," a publication by the Bavarian State Office for the Environment and Baden- Württemberg State Institute for the Environment, Survey and Nature Conservation (2009)

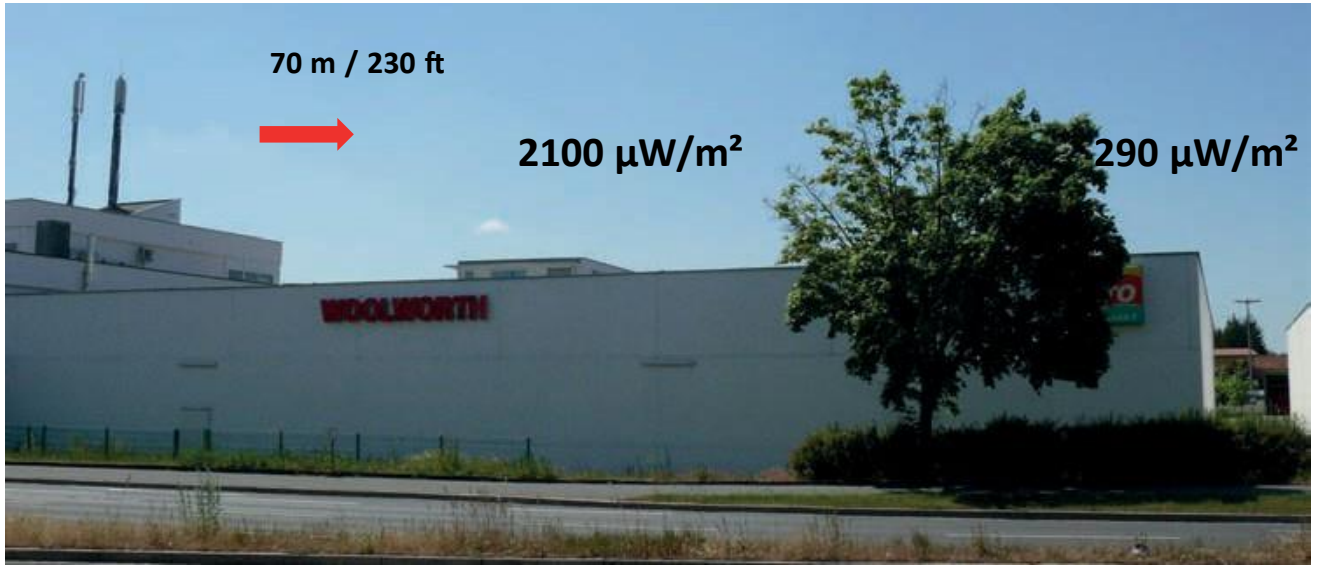
The emissions from a sector antenna produce a main beam (lobe) and side beams (lobes) that are focused vertically and horizontally. A sector antenna usually covers a sector of 120°. Antennas for BOS Digital Radio mostly radiate in all directions. Main beam directions of sector antennas as well as their installation height, number and safety distances can be accessed at the EMF Database by the German Federal Network Agency: https://www.bundesnetzagentur.de/DE/Vportal/TK/Funktechnik/EMF/start.html

Focused beams, reflection, diffraction, scattering, interferences as well as attenuations by buildings and trees all lead to a non-uniform distribution of radiofrequency electromagnetic fields. This may explain why trees in the vicinity of mobile phone base stations are damaged at varying degrees. From 2003 when the third generation (3G) or UMTS (Universal Mobile Telecommunications System) mobile network started operating, within a very short period of time, a new type of tree damage emerged across all of Europe – even at very low RF radiation levels. This goes to show that field strength alone is not the only relevant factor that affects plants. In laboratory experiments, it has been found that plant responses can be differentiated with respect to frequency, bandwidth, pulse sequence, modulation, polarization, field strength and exposure duration. Since every molecule has charges, they can be influenced by electromagnetic fields and their function can become altered.

Life on earth has evolved under the influence of naturally occurring electromagnetic fields and waves. Technically generated electromagnetic fields interfere with genetic, biochemical and physiological processes in humans, animals and plants.

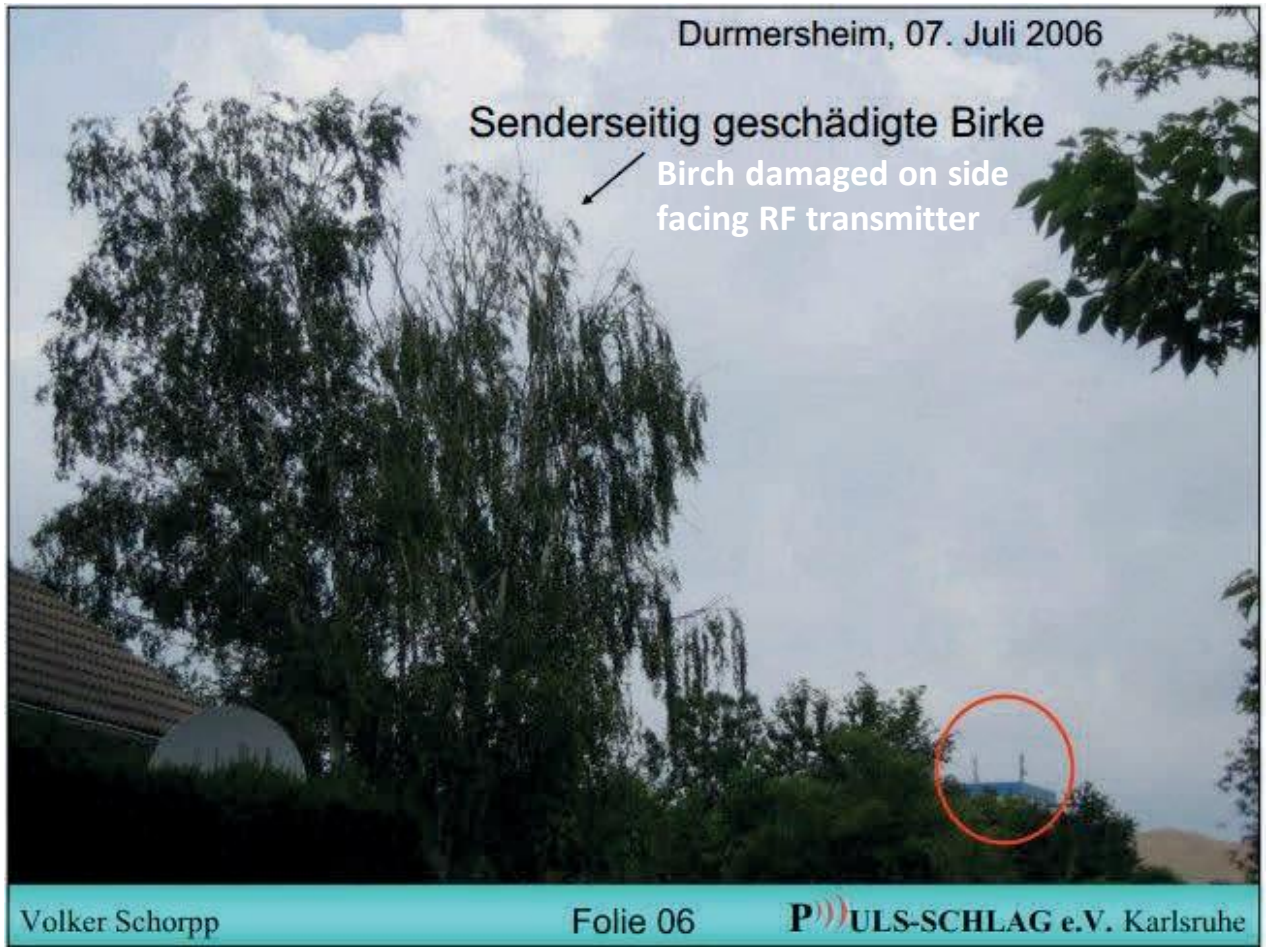
Crown Damage Starting on One Side in Individual Trees and Pairs of Trees

We found crown damage on all four sides of trees: north, south, east and west. On the side facing RF transmitters, leaves turned prematurely yellow or brown and fell off as early as June. In subsequent years crowns became more and more transparent on the side facing an RF transmitter. Outer branches died off. The damage progressed from the outside to the inside. The opposite side, facing away from an RF transmitter, has often remained intact for many years, while the incident radiation is attenuated by leaves or needles. RF radiation is absorbed and scattered. Depending on the distance and height of a given RF transmitter, initially only parts of a tree crown or entire sides are damaged. At the website of the Kompetenzinitiative, many examples from the City of Bamberg are available. This is why this presentation only shows a few trees from Bamberg. For many trees we documented the development over several years – often until they were cut down. Today I will mostly show only one picture from the time series.



04 JUN 15: Bamberg, Berliner Ring, maple tree, No. 3 in Group 1 from the study "Radiofrequency Radiation Injures Trees around Mobile Phone Base Stations." Measurements were carried out with the broadband RF meter HF 59B, omnidirectional antenna UBB27_G3 (27–3300 MHz), by Gigahertz Solutions. In 2021 an additional RF meter was used: Safe and Sound Pro II (200 MHz – 8 GHz) by Safe Living Technologies. For the study, a telescopic rod was frequently used to be able to measure at a height of 6 m. With more accurate testing equipment such as an RF spectrum analyzer, measurement results may even be higher (because there are many mobile phone network technologies for which broadband RF meters cannot detect the entire bandwidth).

2006



This image was shown by the physicist **Volker Schorpp, who also has a PhD in electrical engineering,** in a short presentation at the **workshop of the German Federal Office for Radiation Protection "Health Effects of Electromagnetic Fields of Radiofrequency Radiation – Case Reports"** in Oberschleißheim/ Neuherberg on 02 August 2006. He provided evidence for a causal link between tree and forest damage and chronic radiofrequency radiation exposure (mobile phone base stations, radar, microwave radio systems, terrestrial radio and television broadcasting transmitters).

His presentations from 2006 and 2011 as well as his investigations are available at: http://www.puls-schlag.org/dr-volker-schorpp.htm

Six medical doctors submitted documents about a large number of people who are adversely affected by radiofrequency radiation and reported about their medical observations.
http://www.emf-forschungsprogramm.de/veranstaltungen/protokoll_fallbeispiele_111206.html

The following examples show crown damage starting on one side of trees from 2006 to 2021.
The first three examples were documented by people affected by radiofrequency radiation.

Foto: E. Weber

Munich, 2006

Munich, mobile phone base station at Von-Kahr-Straße 61, conifer (view from west), Zwiedineckstr./August-Horch- Str.

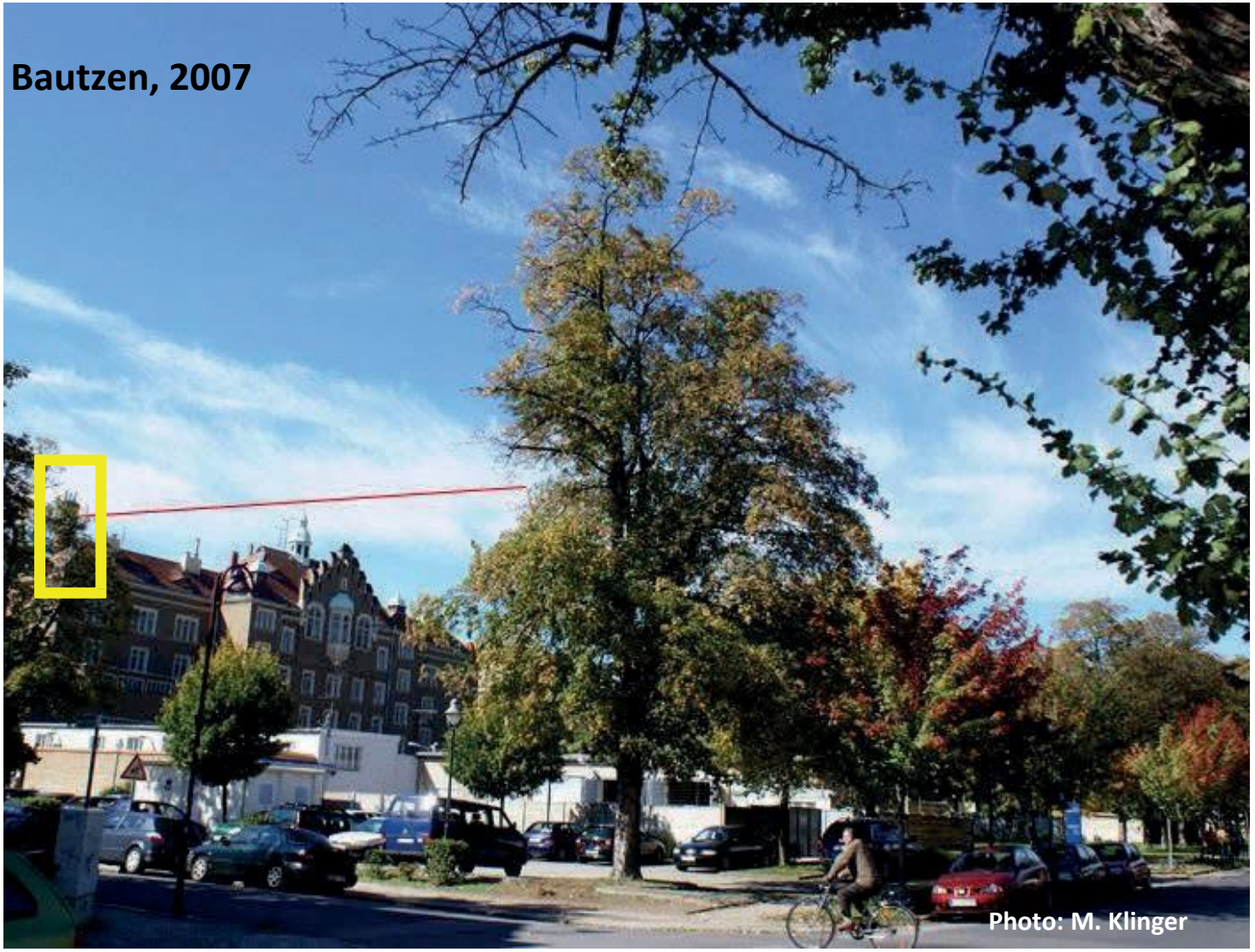
Distance to RF transmitter 95 m (312 ft)

2001: initial operation of mobile phone base station

2004 SEP: addition of UMTS

End of JUN 2005: The apple tree in the garden of a local resident, E. Weber, started losing many leaves. Later trees in her residential area started looking the same. She discovered numerous trees with noticeable damage and documented them photographically.

Mobile phone base station at the chimney of the courthouse



The IT administrator at the office of the Bautzen district attorney took a photo of this linden tree, which is located in the line of sight to the chimney at the Bautzen courthouse.

Schwarzenbach am Wald-Straßdorf, Nailaer Straße, two sycamore trees (from S)

Two sycamore trees (from SE), after trees were cut back

Forest owner Monika Schuberth-Brehm from Frankenwald became suspicious in June 2006 when two sycamore trees started turning brown on one side only. In 2004 a new mobile phone base station had started operating at a distance of 750 m (2460 ft). She documented the development of these trees from 2006 to 2013 and informed the forestry office, mayor, parliamentarians, and ministries. In 2008 she showed this site to me. Additional photos of these sycamore trees can be found in the observation guide by expert forester Breunig (Dipl.-Forstw.) Reports from Schorpp and Weber as well as a letter to Prime Minister of Bavaria Seehofer regarding Schuberth-Brehm are available at funkfrei.net (Report 3,21).

St. Ingbert, 2007

15 SEP 07: St. Ingbert, Am Mühlental, mobile phone base station, Exit "St. Ingbert West" and damaged beech tree on one side only (distance ca. 200 m / 656 ft). The site registration from 5 December 2019 shows 33 mobile phone base station antennas and one other RF transmitter (probably TETRA).

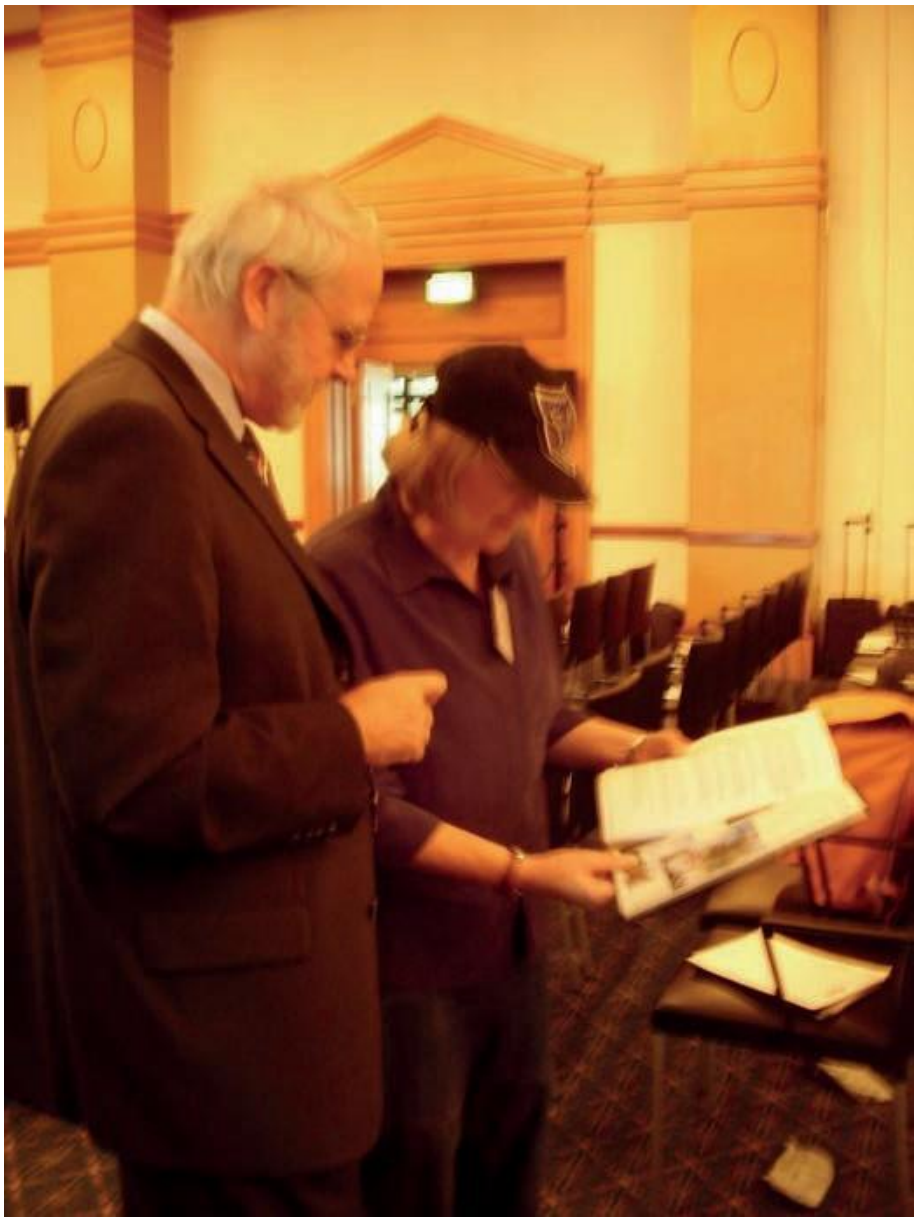
In the vicinity of the mobile phone base station, there were other damaged beech trees and several had already been cut down. Prof. Dr. Karl Richter showed the damaged beech trees to me.

Bamberg, mobile phone base station,
Hauptsmoorstr. 26a
Height: 26.6–31.1 m, 18 sector antennas

08 JUL 08: Maple tree damaged on one side only.
It had already been cut back.

07 AUG 10: Damage gets worse, tree cut back again. In winter 2010/2011 the tree was cut down.

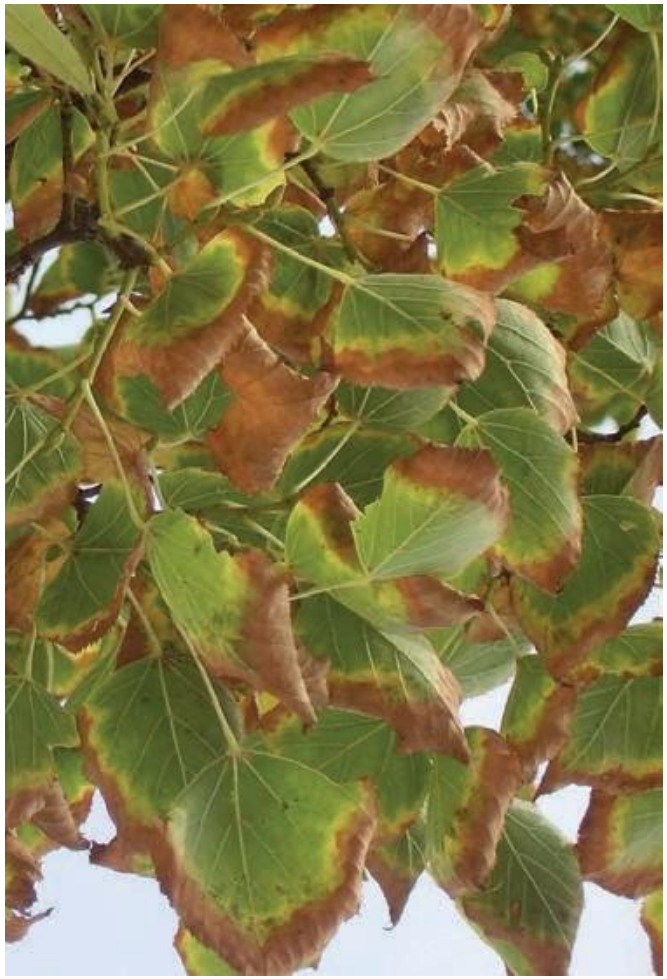
In the vicinity of this mobile phone base station, numerous damaged trees could be found. Besides crown damage starting on one side, there were also differences between the upper and lower parts of these tree crowns. In the radio shadow of buildings, trees were healthy – just like in the drawing by Bernatzky.



Berlin, 2008

Ms. E. Weber from Munich shows Prof. Dr. W. Weiss from the German Federal Office for Radiation Protection her documentation of damaged trees in the vicinity of the mobile phone base station at Von-Kahr-Str. 61 in Munich.

Ms.Weber, a Munich resident who has been affected by mobile phone base station radiation, attended the public event at which the results of the German Mobile Communication Research Programme (DMF) were presented in Berlin on 17/18 June 2008. During a break, she showed Prof. Dr. W. Weiss, German Federal Office for Radiation Protection, and Prof. Dr. A. Lerchl, a member of the German Commission on Radiological Protection from 2009, her photos of the damaged trees in the vicinity of the mobile phone base station at Von-Kahr-Str. 61 in Munich.

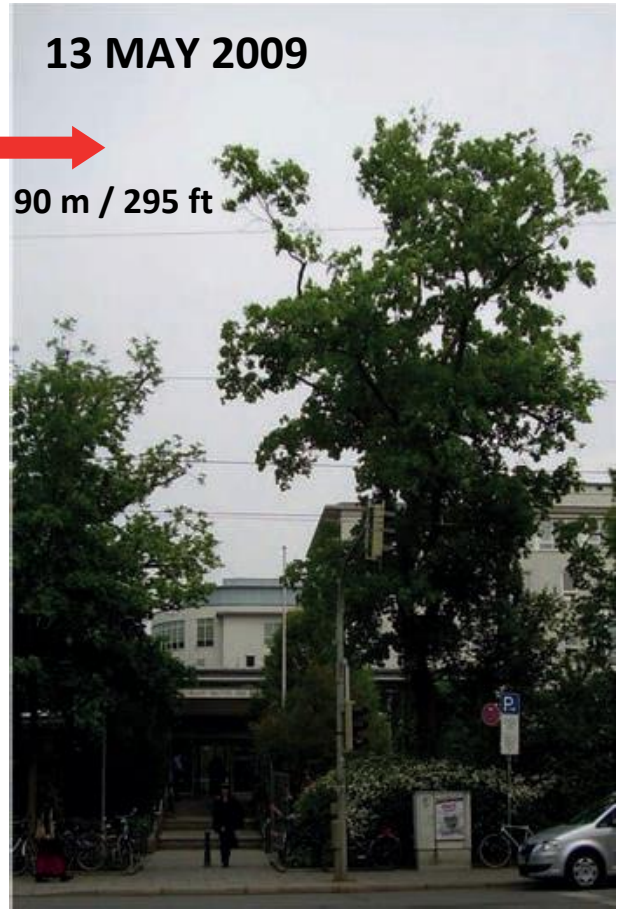


17 AUG 08: Memmelsdorf, Seehof Palace, gardener's house, linden tree

24 JUN 08

The linden tree is located at a pedestrian walkway in front of the gardener's house of the palace. The leaves had brown edges.

Site at Ismaninger Str.
6 antennas



Munich, Klinikum rdl,
Norway maple (view from W)

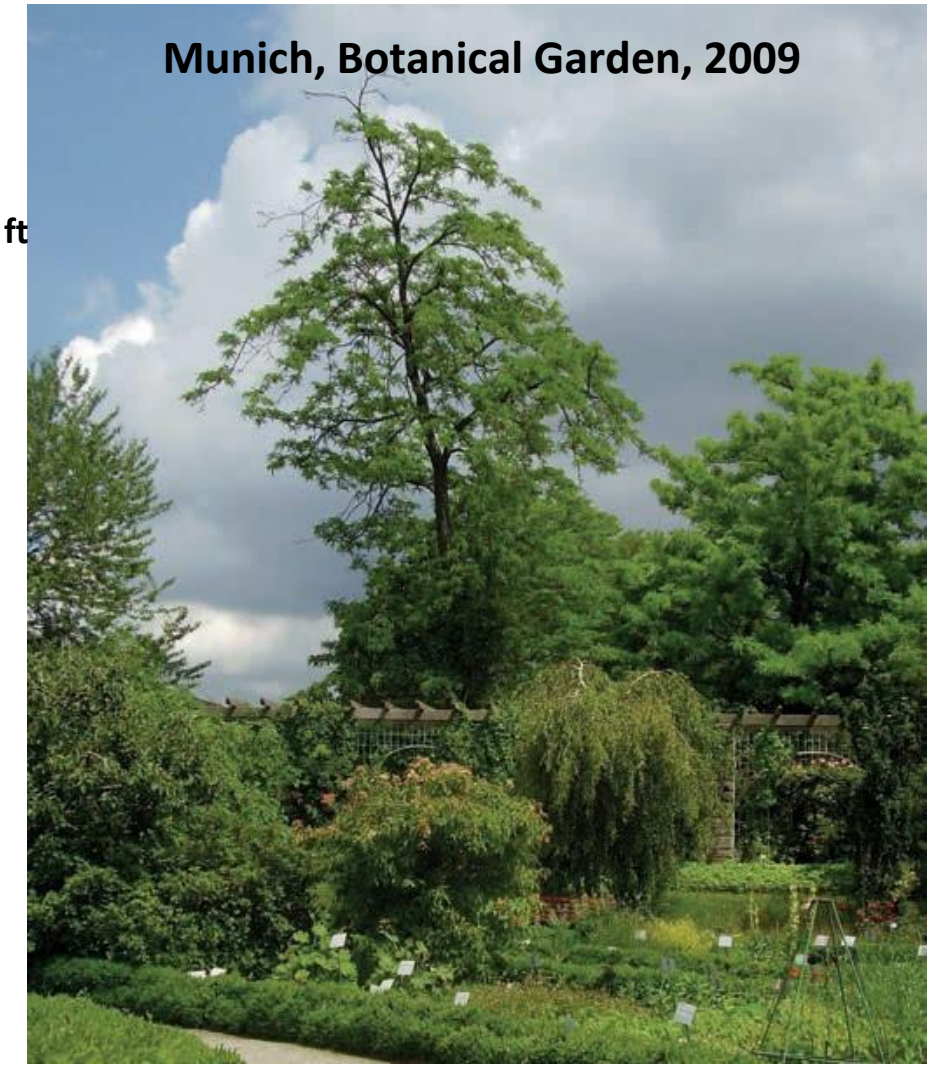
Increase in crown damage

Maple tree cut down
Measurement: **3800 µW/m²**

Munich, Klinikum rechts der Isar, Technical University of Munich (TUM), Ismaninger Str. main entrance. Three Members of the Bavarian Landtag participated in a walk to the damaged trees in the vicinity of the hospital on 29 June 2011. On 29 July 2011 they contacted the Bavarian State Office for the Environment and Health with a request for investigation. No investigation was launched. The damaged maple tree was cut down. The mobile phone base station has been upgraded to 24 antennas in 2021.

Measurement on 20 SEP 21: **88,000 µW/m²**

ca. 330 m / 1080 ft



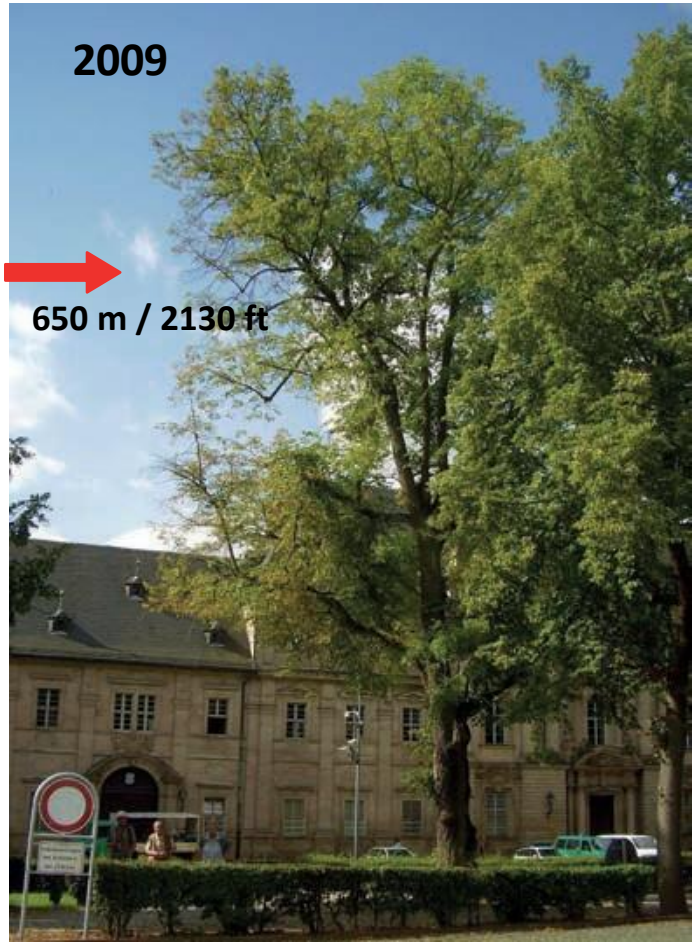
26 JUN 09: View from Botanical Institute of LMU University of Munich toward mobile phone base station at bureau of standards on the occasion of a visit by Prof. Dr. S. Renner

26 JUN 09: Botanical Garden, honey locust (view from west)

Munich, Botanical Garden, 2012

03 AUG 12: View from west across Botanical Garden. The tall trees, the tulip tree and the honey locust tree show clear signs of damage – more to the left than to the right side. From the left side (north), the trees are exposed to RF radiation from four sector antennas located at the bureau of standards.

Measurement at café:
4580 µW/m²

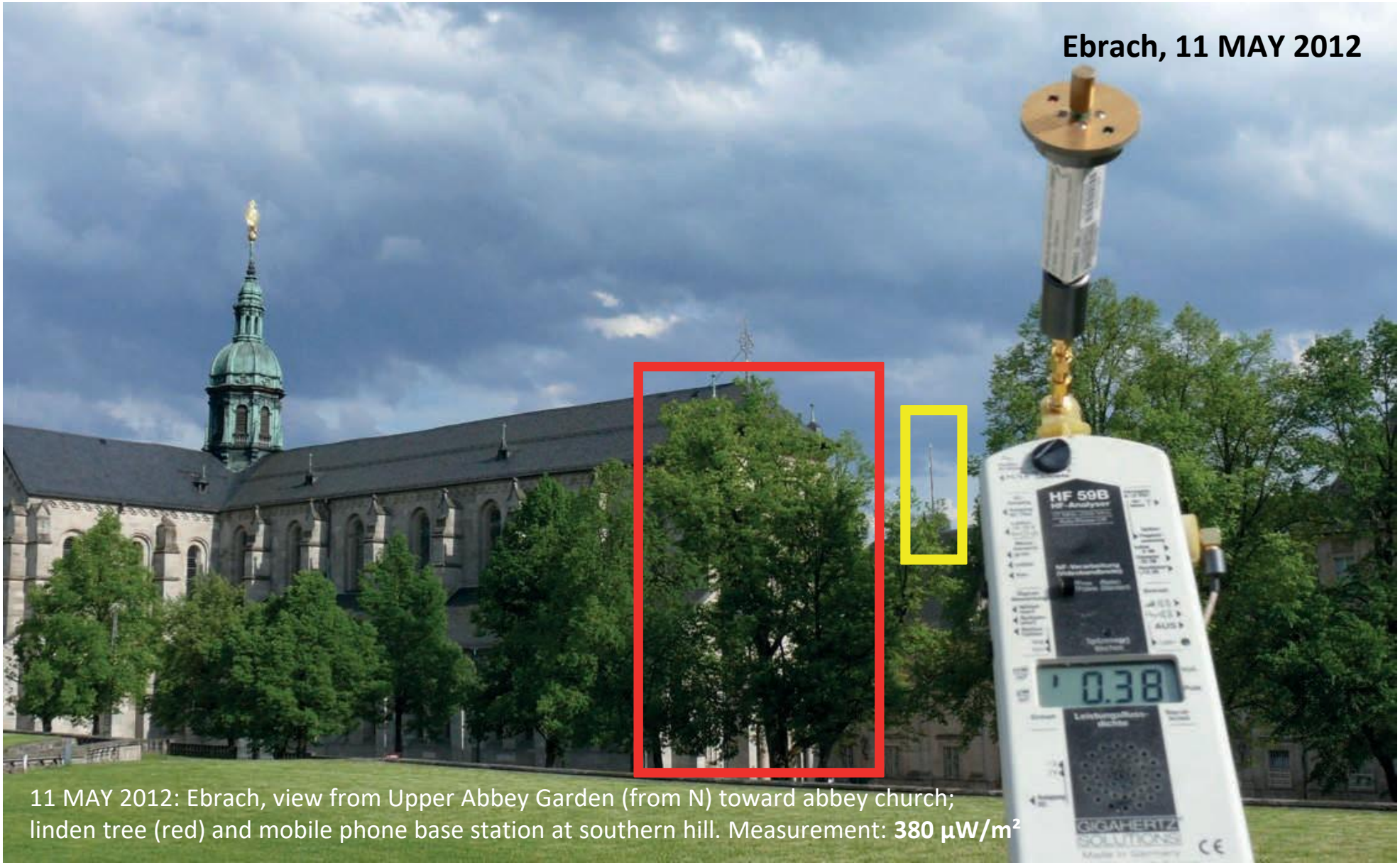


30 JUL 09: Ebrach, linden tree (from NE)

06 AUG 12: Crown damage increases

05 SEP 14: The linden tree was cut down.

Ebrach, linden tree (2009–2014)



11 MAY 2012: Ebrach, view from Upper Abbey Garden (from N) toward abbey church; linden tree (red) and mobile phone base station at southern hill. Measurement: **380 µW/m²**

St. Blasien,
District of Waldshut, 2009

ca. 1 km / 3280 ft

Mobile phone
base station
above St. Blasien

09 SEP 09: St. Blasien, near cathedral, a pair of trees at creek, premature leave fall on side of tree facing mobile phone base station

Schaufling, Bavarian Forest, 2009

9 SEP 09: Access road to Asklepios Klinik Schaufling (644 m / 2113 ft above sea level), two beech trees

From the east, the beech trees are exposed to RF radiation from radio and TV transmitters, microwave radio systems and mobile phone base station antennas on the Brotjacklriegel mountain (1011 m / 3317 ft above sea level).
Total height: 125 m (39 ft)
In 2001 conversion to Digital Radio Broadcasting (DAB), additions 2009 and 2011, from July 2016 addition of DAB +.
In October 2006 initial operation of Digital Video Broadcasting DVB-T, from March 2019 DVB-T2.

09 NOV 08: Photo Wikipedia, see photo credits

Trees are receiving antennas for electromagnetic fields.

Schaufling, Asklepios Klinik, Bavarian Forest, 2009

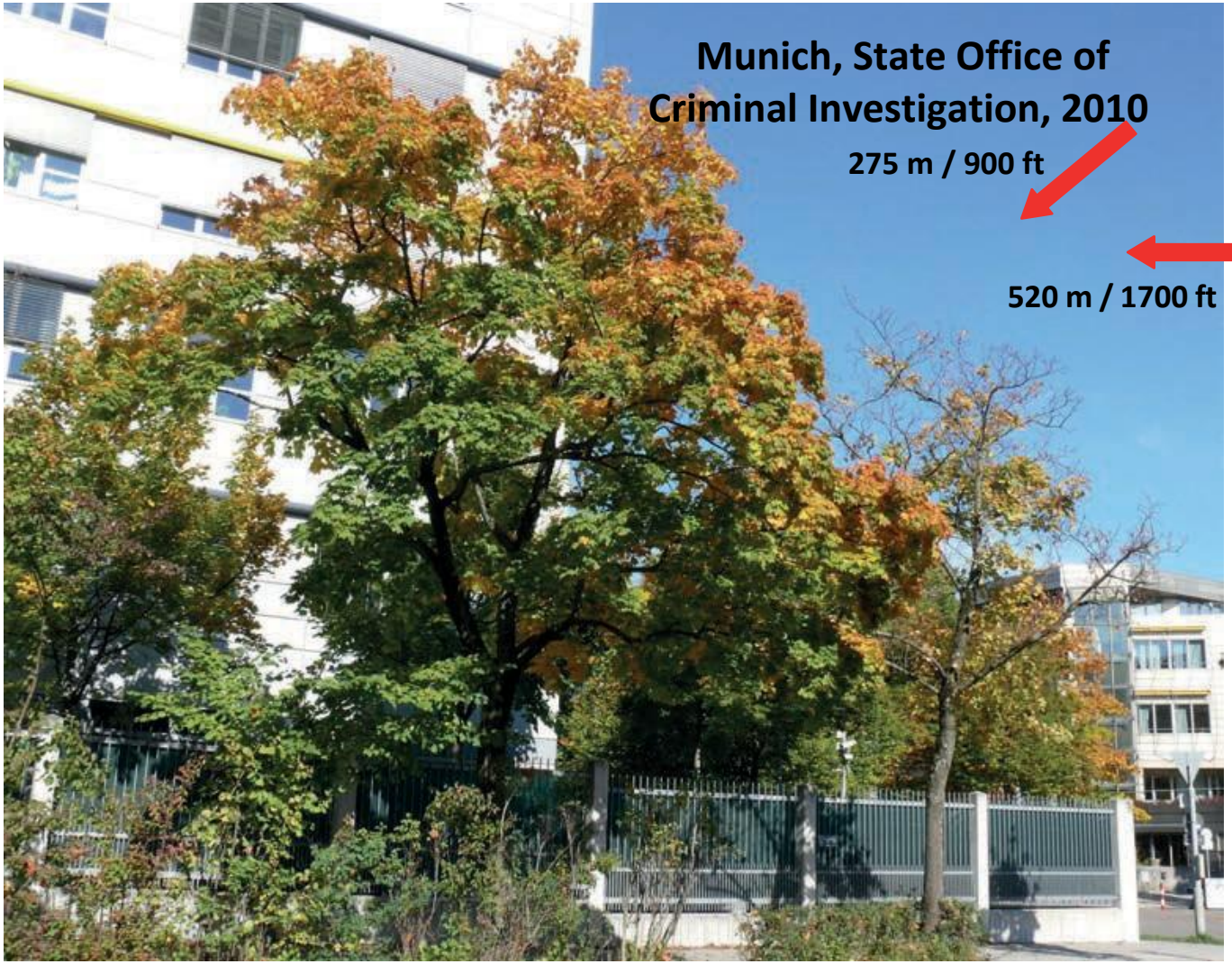
19 SEP 09: Schaufling, Asklepios Klinik, beech tree in clinic garden

Measurement in air: **240 µW/m²**

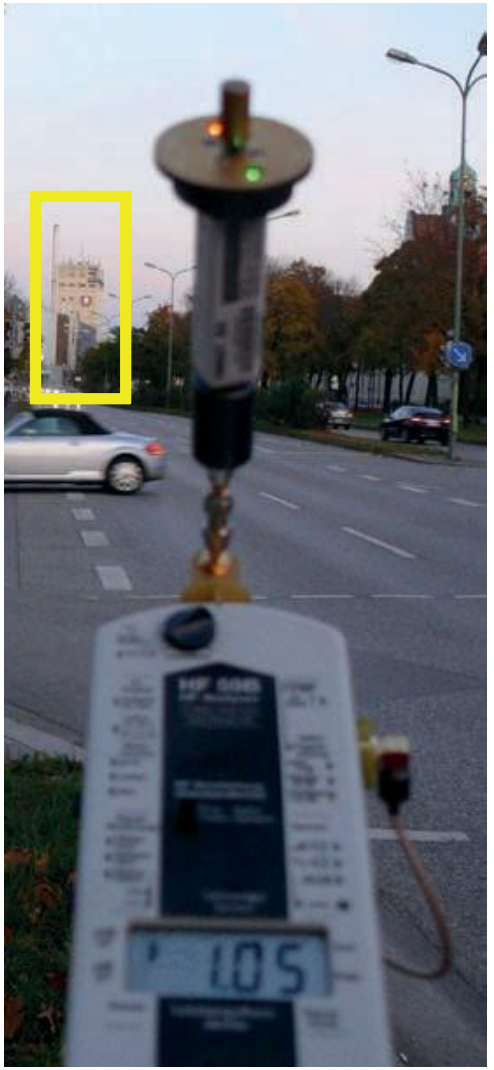
Measurement value increases when antenna touches trunk

In the garden surrounding the Asklepios Klinik, several beech trees showed signs of damage at their crowns or trunks. When we touched the trees with the antenna of the RF meter, we could listen to radio. The radio and TV broadcasting tower Brotjacklriegel is located 12 km (7.5 mi) away. The tree trunk measurement cannot be used quantitatively because the RF meter is calibrated for measurements in air. However, the significant increase of the measurement result shows that beech trees are receiving antennas for electromagnetic fields. Electrical engineers already knew this 100 years ago.

In areas with low ambient RF radiation levels, we observed no measurement differences between non-contact (in air) and contact-based (tree trunk) measurements.



09 OCT 10: Munich, State Office of Criminal Investigation, Marsstraße, two maple trees in a green strip. There is a direct line of sight to two mobile phone base stations: Spatenbrauerei (520 m / 1700 ft) and Telekom Blutenburgstraße (275 m / 900 ft).



21 OCT 10 Measurement: **1050 µW/m²**

28 SEP 11: Garmisch-Partenkrichen, railway station, two Norway maple trees (view from east), direct line of sight to mobile phone base station. The trees have similar site conditions. The northern maple tree has already lost leaves.
The remaining leaves are brown. The southern tree still has its dense foliage. It is shielded by the maple tree to its right.
The shape of the tree is striking. The tree no longer grows in height.

Mobile phone base station Bahnhofstraße

16 SEP 11: Ringberg mobile phone base station (1045 m / 3428 ft above sea level) with 17 sector antennas

21 SEP 09: 2x 20°, 21°, 4x 70°, 2x 80°, 170°, 2x 180°, 210°, 280°, 337°, 340°, 350°

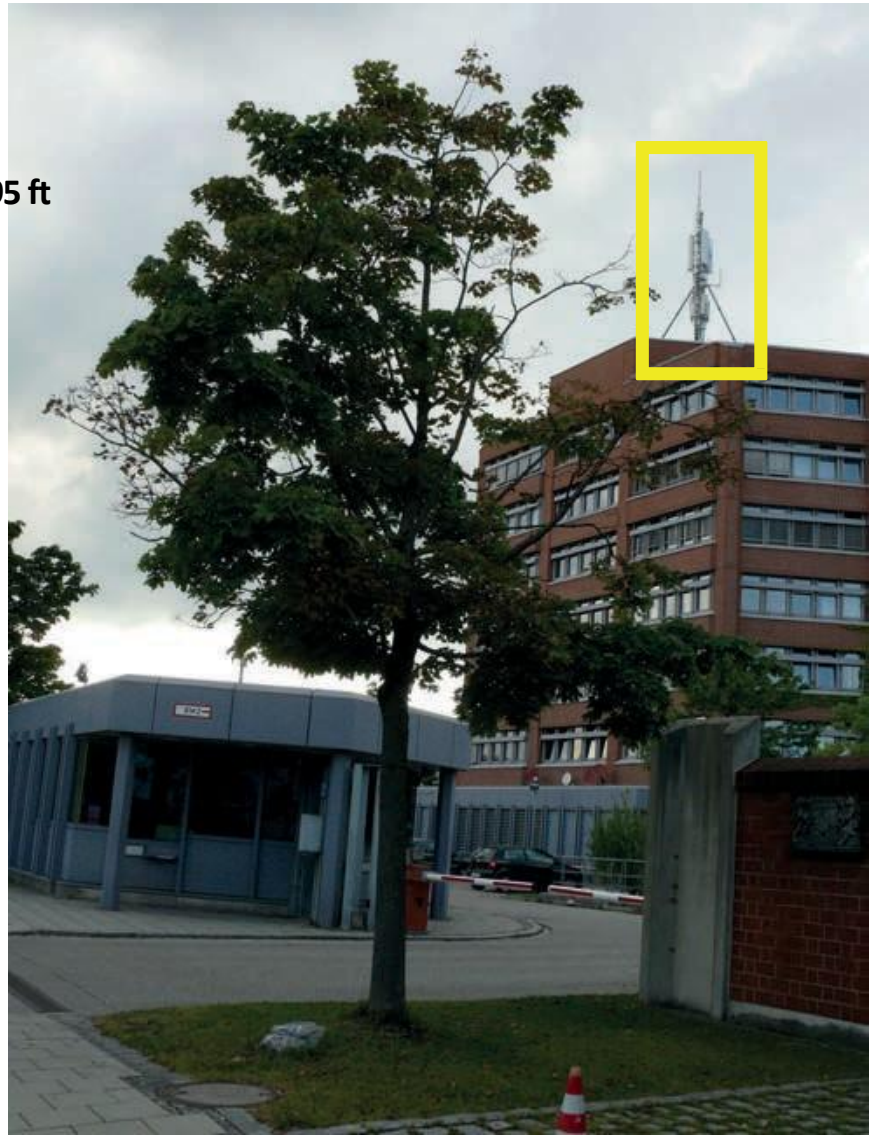
Tegernsee, 2011

14 SEP 11: Tegernsee lake, marina, castle/Bräustüberl
(727 m / 2385 ft above sea level)

The distance between the Ringberg mobile phone base station and the marina is 3 km (1.9 mi).

Measurement on 26 SEP 14:
60 µW/m²

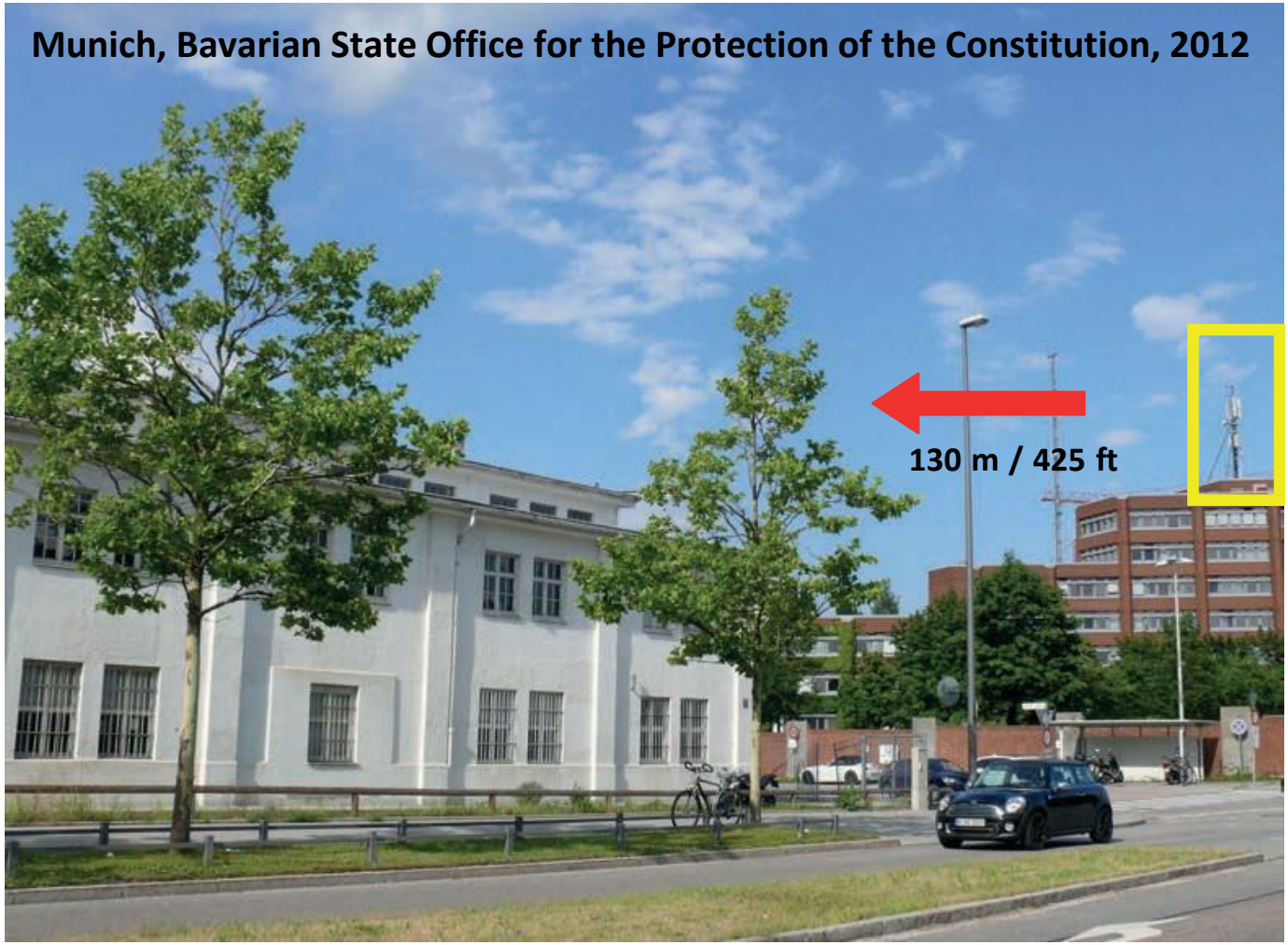
03 AUG 12: State Office for the Protection of the Constitution, southwest corner



03 AUG 12: Gate at the State Office for the Protection of the Constitution, Knorrstr. 139, Mobile Phone Base Station 1

Munich, 2012
Bavarian State Office for the Protection of the Constitution

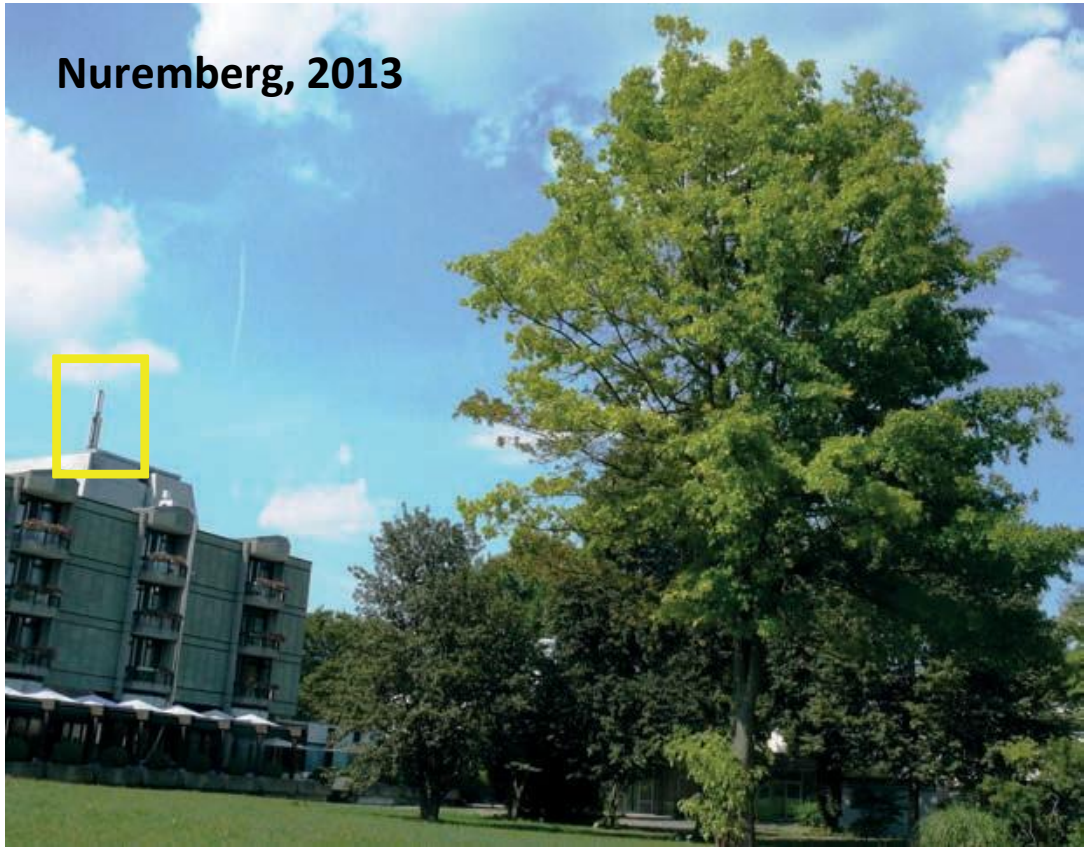
Police Station 47 / Milbertshofen



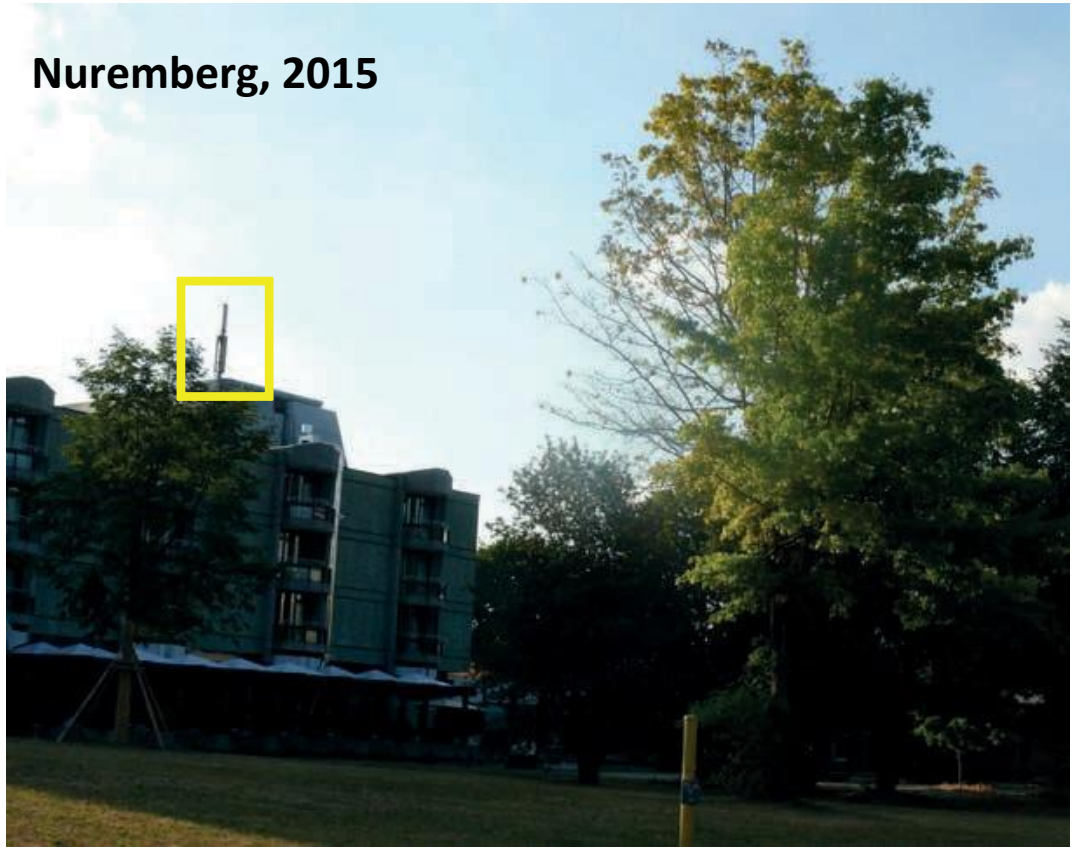
03 AUG 12: Max-Diamand-Straße, mobile phone base station at State Office for the Protection of the Constitution, two plane trees

03 AUG 12: Oak tree, distance ca. 190 m / 620 ft

In the vicinity of the Bavarian State Office for the Protection of the Constitution, additional trees showed signs of damage.



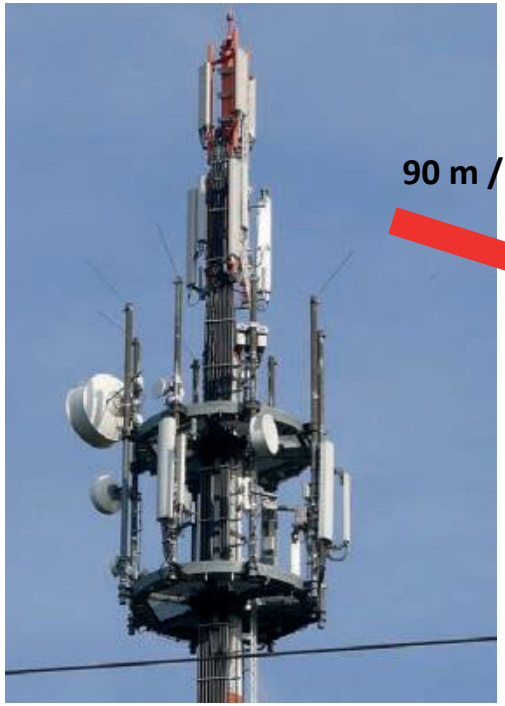
30 AUG 13 Luitpoldhain, red oak tree (view from SSE) with direct line of sight to mobile phone base station



03 AUG 15: The crown damage on one side progressed rapidly. Two years later the red oak tree was cut down.

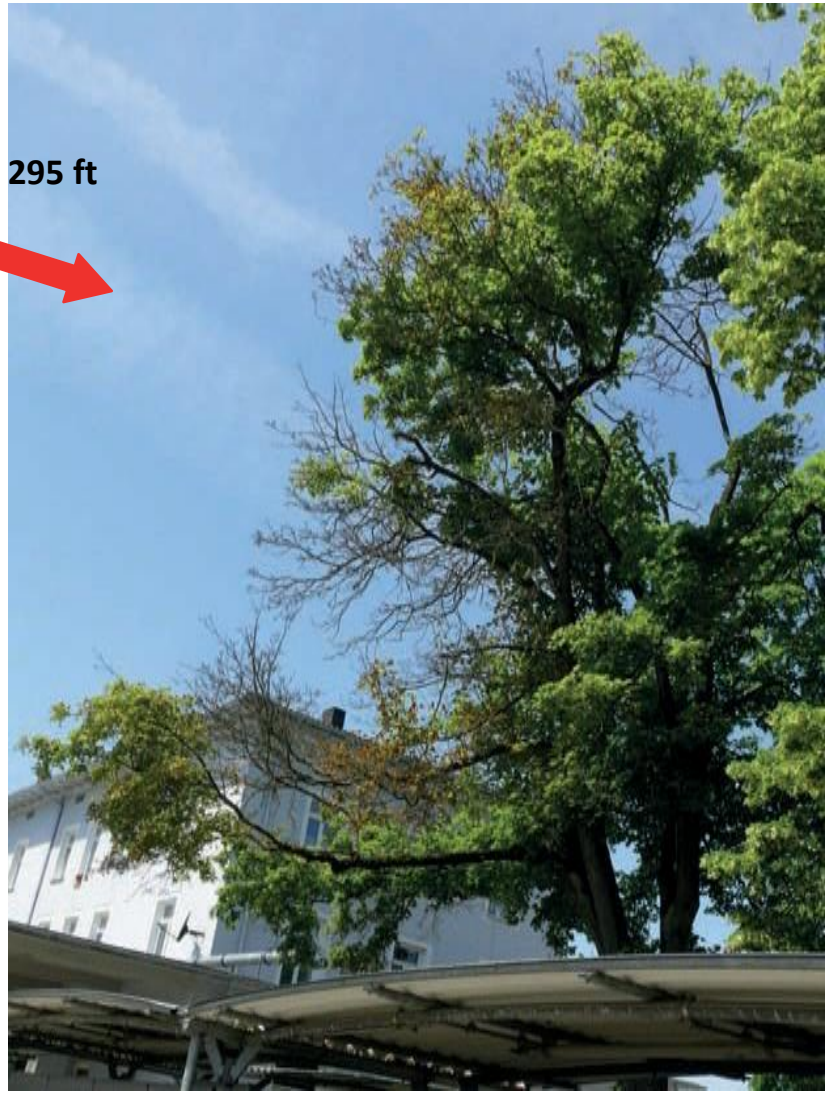
Site registration no. 620798, accessed August 2013: installation height 18.99–21.09 m, **6 sector antennas**: 2 x 90˚, 2 x 210˚, 2 x 330˚

Site registration no. 620798 from 26 April 17: installation height 18.5–20.9 m, **15 sector antennas**: 5 x 90˚, 5 x 210˚, 5 x 330˚



90 m / 295 ft

Neuburg an der Donau, 2014



11 JUN 14: Railway station, maple tree (view from E)

Brown leaf edges at side of mobile phone base station

11 JUN 14: Burgheim, Georgistraße, maple tree (view from S)

View from west toward maple tree shows line of sight to the mobile phone base station in the center of the municipality (distance ca. 145 m / 475 ft).

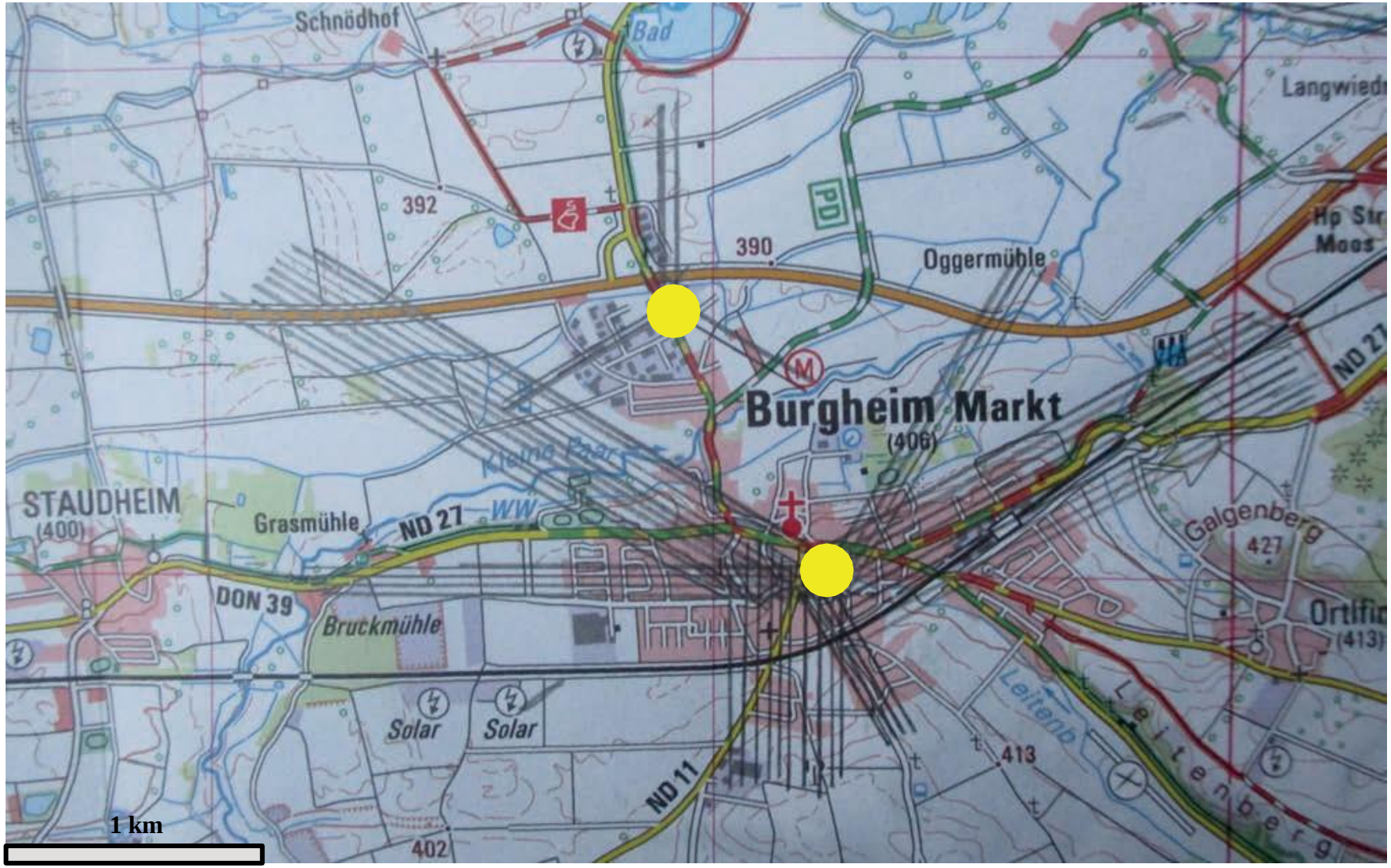
Measurement: **5040 µW/m²**

From 2003 the residents of Burgheim have been concerned about an increased incidence of cardiovascular and tumor diseases as well as cases of death in the vicinity of the mobile phone base station.

Despite requests for an official investigation by medical professionals, no such investigation was carried out. On the contrary, the mobile phone base station has gradually been upgraded.

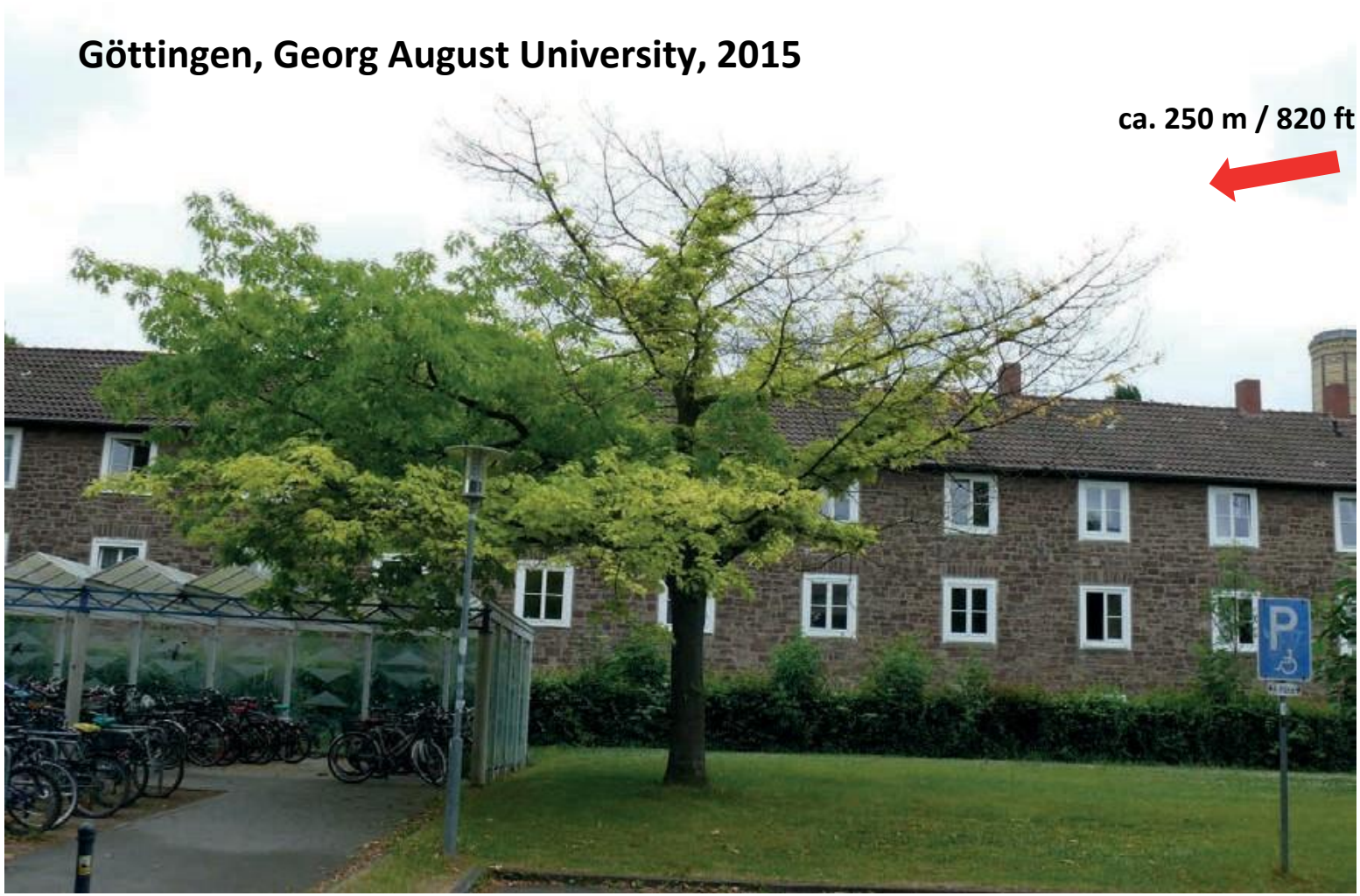
2005: ca. 8 sector antennas
2013: 18 sector antennas
2022: 42 sector antennas

Two Mobile Phone Base Stations in Burgheim with a Total of 48 Sector Antennas



Section UK 50-34, Bavarian State Agency for Digitization, High-Speed Internet and Surveying (LDBV). Added: locations of mobile phone base stations with the main beam directions of the sector antennas

Göttingen, Georg August University, 2015

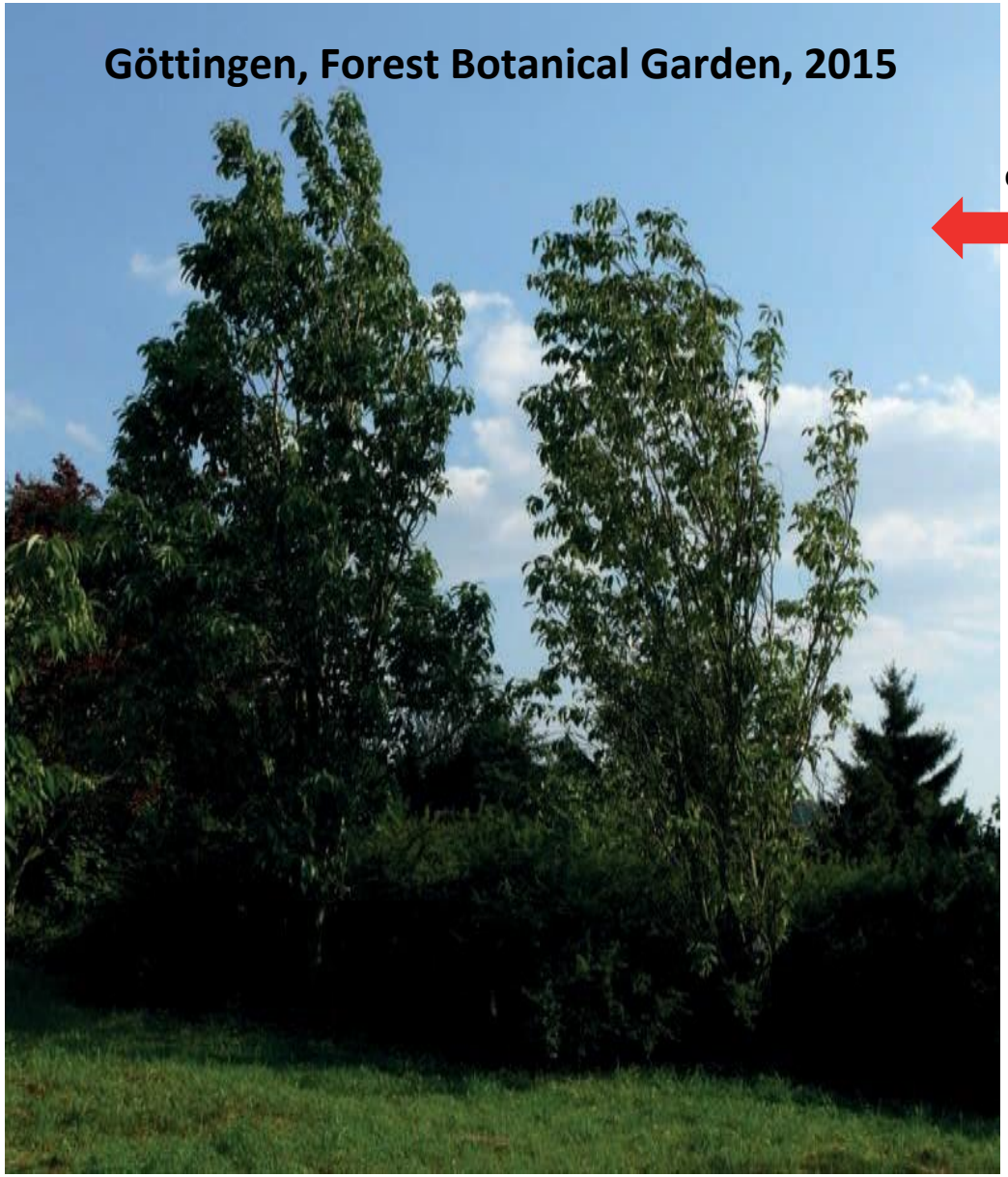


10 JUL 15: Göttingen, University, red oak tree to the east of the Blue Tower (view from W)
Measurement: **1030 µW/m²**

To the right and at the top no leaves, some of the remaining leaves yellow, grows in width not in height. The main beams of the three 0° sector antennas from the mobile phone base station on the multi-use building strike this read oak tree.

Mobile phone base station on multi-use building at central square of university "Platz der Göttinger Sieben"

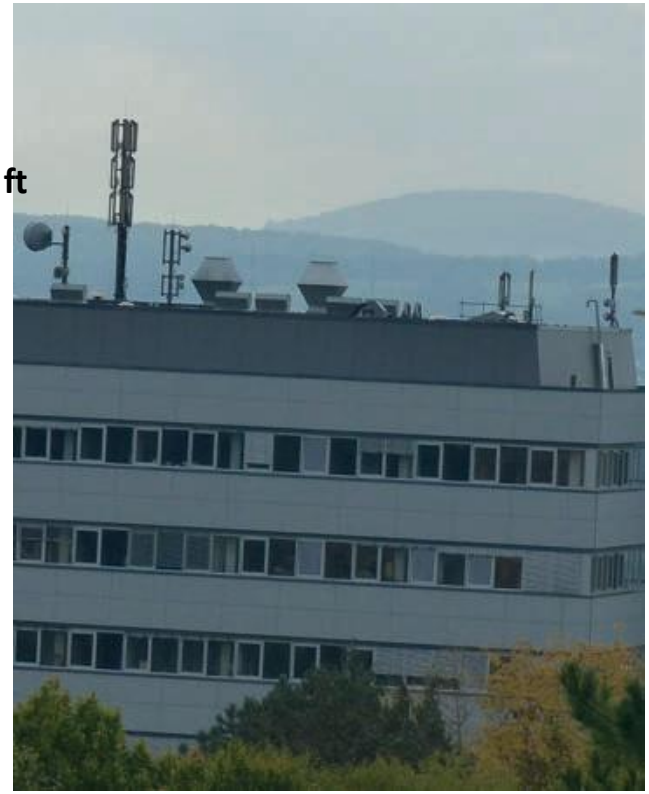
Göttingen, Forest Botanical Garden, 2015



70 µW/m²

ca. 180 m / 590 ft

1010 µW/m²



21 AUG 15: Göttingen, Forest Botanical Garden, Beech Quarter, two Japanese ornamental cherry trees (view from N)

There is a line of sight between the trees and the high-rise building of the Institute of Forest Sciences (distance ca. 180 m / 590 ft).

The measurements were taken at a height of 6 m (20 ft), using a telescopic rod at the east and west side of this pair of trees.

Göttingen, Forest Botanical Garden, 2016–2021

The ornamental cherry tree to the right has lost its leaves prematurely.

Part of the ornamental cherry tree to the right is dead.

The ornamental cherry tree to the right was cut down.

Beech Quarter, two Japanese ornamental cherry trees (Prunus serrulata 'Amanogawa')
Mobile phone base station on the high-rise building of the Institute of Forest Sciences
Height: 36–42 m, 20 antennas: 3 x 60°, 2 x 90°, 5 x 180°, 2 x 210°, 6 x 300°, 2 x 310°.

2016

Abstract

In the last two decades, the deployment of phone masts around the world has taken place and, for many years, there has been a discussion in the scientific community about the possible environmental impact from mobile phone base stations. Trees have several advantages over animals as experimental subjects and the aim of this study was to verify whether there is a connection between unusual (generally unilateral) tree damage and radiofrequency exposure. To achieve this, a detailed long-term (2006–2015) field monitoring study was performed in the cities of Bamberg and Hallstadt (Germany). During monitoring, observations and photographic recordings of unusual or unexplainable tree damage were taken, alongside the measurement of electromagnetic radiation. In 2015 measurements of RF-EMF (Radiofrequency Electromagnetic Fields) were carried out. A polygon spanning both cities was chosen as the study site, where 144 measurements of the radiofrequency of electromagnetic fields were taken at a height of 1.5 m in streets and parks at different locations. By interpolation of the 144 measurement points, we were able to compile an electromagnetic map of the power flux density in Bamberg and Hallstadt. We selected 60 damaged trees, in addition to 30 randomly selected trees and 30 trees in low radiation areas (n=120) in this polygon. The measurements of all trees revealed significant differences between the damaged side facing a phone mast and the opposite side, as well as differences between the exposed side of damaged trees and all other groups of trees in both sides. Thus, we found that side differences in measured values of power flux density corresponded to side differences in damage. The 30 selected trees in low radiation areas (no visual contact to any phone mast and power flux density under 50 $\mu W/m^2$) showed no damage. Statistical analysis demonstrated that electromagnetic radiation from mobile phone masts is harmful for trees. These results are consistent with the fact that damage afflicted on trees by mobile phone towers usually starts on one side, extending to the whole tree over time.

https://www.diagnose-funk.org/download.php?field=filename&id=1336&class=NewsDownload
https://kompetenzinitiative.com/wp-content/uploads/2019/08/Trees-in-Bamberg-and-Hallstadt-Documentation-2006-2016.pdf

The starting point of the study was the repeated observation of crown damage starting on one side of a tree for which there was no plausible explanation. However, it was noticed that the side at which the damage occurred was facing one or several mobile phone base stations in direct line of sight.

For **Group 1** of the study, we selected 60 trees from Bamberg and Hallstadt (Germany) with damage on one side only. On-site visits revealed that the damaged parts of the tree crown were always in the line of sight to a mobile phone base station.

Broadband measurements of the power density were on average **2000 µW/m²** at the damaged side and at the opposite, undamaged sides **200 µW/m²**. In all 60 cases, there was a significant difference. The incident radiation is attenuated by the crown of a tree. One part of the radiofrequency electromagnetic fields is absorbed by leaves and needles, another part is reflected and scattered.

For **Group 2** of the study, 30 trees were selected randomly. Thirteen of these trees had a damaged crown. And the crowns in 6 of those trees were damaged on only one side, which was the side in direct line of sight to an RF transmitter. Five trees sustained damage on more than one side with direct lines of sight to several RF transmitters. Furthermore, there was a spruce tree with direct line of sight in which the growth of the crown was impaired as well as another tree that had dead parts of its crown removed. On the sides exposed to RF transmitters, we measured on average an RF radiation level of **1600 µW/m²** and on opposite sides **600 µW/m².**

Seventeen trees of the group were not damaged and there was no line of sight to any RF transmitter. The RF radiation measurements were between **8** and **50 µW/m²**. The measurement difference between opposite sides of a given tree was at maximum **20 µW/m²**.

For **Group 3** of the study, 30 trees in areas with low ambient RF radiation levels – in the radio shadow of buildings, hills or other trees – were selected. No damage was found in the crowns of those trees. And there was no line of sight to any RF transmitters. RF measurements were carried out on two opposite sides. RF radiation levels were between **3** and **40 µW/m²**. The measurement difference between opposite sides of a given tree was at maximum **10 µW/m²**.

The following characteristics of trees damaged on one side could not be explained by heat, frost, drought, soil composition, soil compaction and sealing, road salt, air and soil pollutants or pests:

1. Damage always started on one side of a given tree. The direction of the sky did not matter.
2. Damage started at previously healthy trees from a certain point in time.
3. Damage increased from the outside to the inside in the course of several years.
4. Damage occurred both in favorable and unfavorable locations.
5. Leaf edge necrosis, similar to that seen in cases of road salt exposure, was also observed in meadow locations without any road salt exposure.
6. Adjacent trees of different species were also damaged.
7. Damage occurred without any external signs of an infestation by insects, fungi, worms or viruses.

In all trees with crown damage on one side, there was a direct line of sight to an RF transmitter (Group 1 and a part of Group 2). None of the tree crowns without any damage had a line of sight to an RF transmitter (Group 3 and the remaining part of Group 2).

The statistical analysis justifies the suspicion that radiofrequency electromagnetic fields, emitted by mobile phone base stations, cause tree damage.

Tree damage occurred well below current RF exposure limits for mobile network radiation. We requested additional scientific studies to examine the suspected effects.

Excerpt from Conclusions: “The occurrence of unilateral damage is the most important fact in our study and an important argument for a causal relationship with RF-EMF, as it supplies evidence for non-thermal RF-EMF effects. This constitutes a danger for trees worldwide. The further deployment of phone masts has to be stopped. Scientific research on trees under real radiofrequency field conditions must continue.”

Overview of the data from the study

Radiofrequency radiation injures trees around mobile phone base stations

Waldmann-Selsam, Balmori–de la Puente, Breunig, Balmori, 2016

https://www.researchgate.net/publication/306435017_Radiofrequency_radiation_injures_trees_around_mobile_phone_base_stations

The 120 studied trees were selected according to three criteria.

1. Selection of trees with unilateral crown damage in line of sight to a mobile phone mast (Table 4)				
60 crowns				
60 crowns in line of sight to mobile phone mast(s) on one side	Side facing a phone mast Ø 2000 µW/m²		Opposite side Ø 200 µW/m²	60 Damage on one side

2. Random selection of trees (Table 5)				
30 crowns				
13 crowns in line of sight to mobile phone mast(s) in one or more directions	Side facing a phone mast Ø 1600 µW/m²		Opposite side Ø 600 µW/m²	6 Damage on one side 5 Damage on more than one side 1 No growth in height 1 Partly trimmed down
17 crowns without line of sight to a mobile phone mast	Any side min. 8 µW/m²	Range of measurements * 0–20 µW/m²	Opposite side max. 50 µW/m²	No visible damage

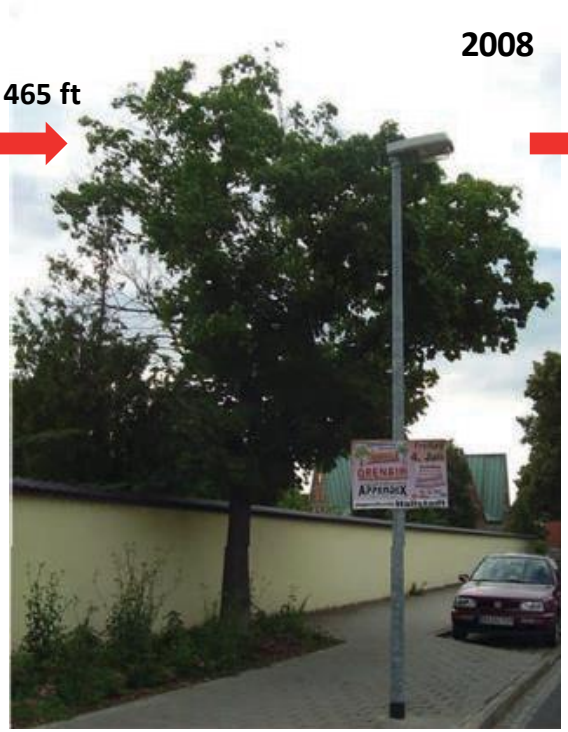
3. Selection of trees with low ambient RF radiation levels and without line of sight to a mobile phone mast (Table 6)				
30 crowns without line of sight to a mobile phone mast	Any side min. 3 µW/m²	Range of measurements * 0–10 µW/m²	Opposite side max. 40 µW/m²	No visible damage

***The difference between the measurements on two opposite sides of the same tree is referred to as range of measurements.**

No. 14 from Group 1 (Table 4), Norway Maple Tree (Acer platanoides), Hallstadt, Königshofstraße/Friedhof (2008–2019)

142 m / 465 ft

Mobile phone base station no. 671234



02 JUN 08: Norway maple tree (from SE)
Line of sight to mobile phone base station Landsknechtstr. 23 a (distance 142 m / 465 ft)

05 OCT 15: Norway maple tree (from E)
Measurement height: 6 m / 20 ft

Left: 3380 µW/m²
Right: 500 µW/m²

19 SEP 19: Norway maple tree (from E)
After dead branches were removed

No. 56 from Group 1 (Table 4), Douglas Fir (Pseudotsuga menziesii), Bamberg, B 22/Strullendorfer Straße (2007–2019)

2007

24 JUL 07: Douglas fir (from S)
Line of sight to mobile phone base station

Site no. 671069, Gutenbergstr. 20

2008

25 DEC 08: Douglas fir (from SE)
Distance: 356 (1170 ft)

2012

25 MAR 12: Douglas fir (from SE)

2019

13 MAR 19: Douglas fir (from SE)

On **26 SEP 15** measurements at height of 6 m (20 ft)

Left: 60 µW/m²

Right: 1720 µW/m²

No. 2 from Group 3 (Table 6), Hornbeam Trees (Carpinus betulus), Bamberg, Schlüsselstraße (2010–2017)

2010

06 OCT 2010: Hornbeam trees (view from NW)

2012

27 AUG 12: Hornbeam trees

2015

28 OCT 15: **Measurements**

2017

27 AUG 12: Hornbeam trees

Measurements on 28 OCT 2015, no line of sight to mobile phone stations: **left: 10 µW/m²** **right: 8 µW/m²**

On 07 November 2019, cases from the 2016 study – regarding crown damage on only one side found in Berlin, Darmstadt, Munich, Göttingen, Freiburg and Brussels, developmental issues in young trees as well as the development of clearings due to RF radiation exposure over time – were presented at the International Workshop "Environmental Effects of Electric, Magnetic and Electromagnetic Fields: Flora and Fauna" of the German Federal Office for Radiation Protection.

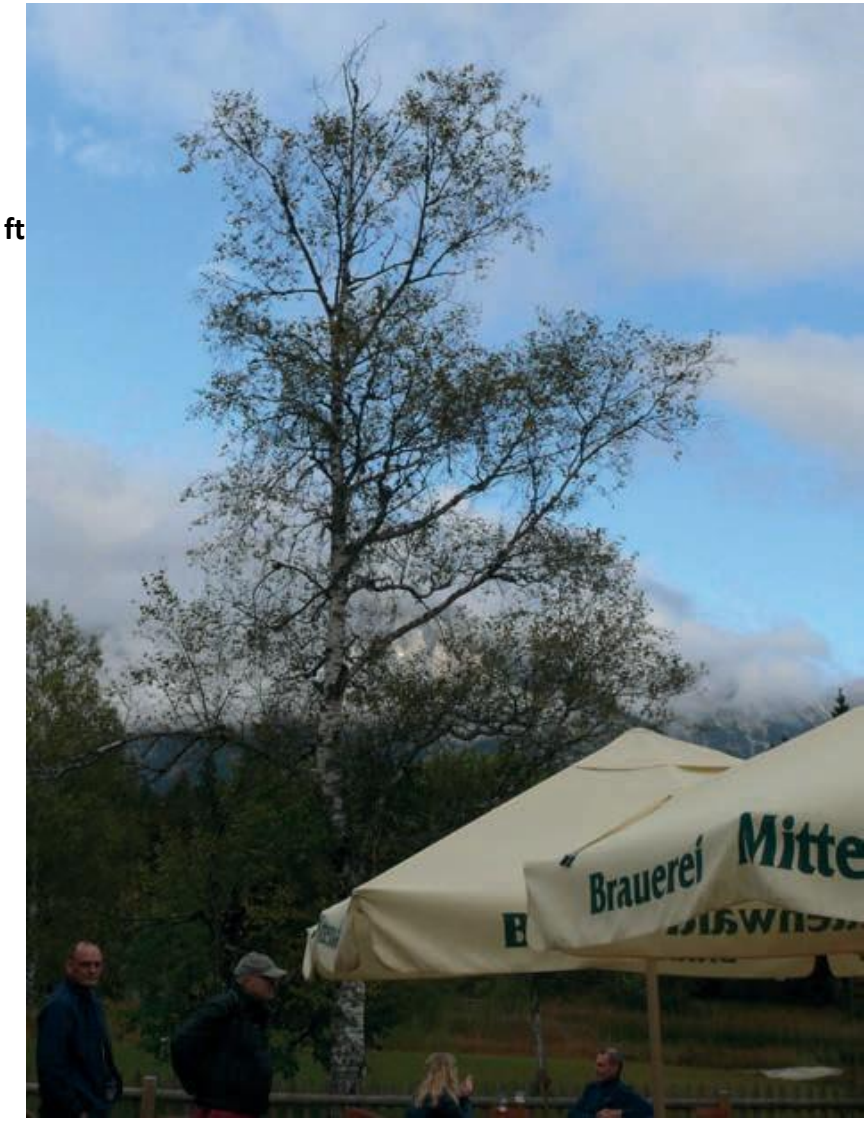
https://kompetenzinitiative.com/wissenschaft/international-workshop-radiofrequency-radiation-injures-trees

15 OCT 16: Mittenwald, chapel and mobile phone base station at Lautersee lake

Site registration no.: 69016082

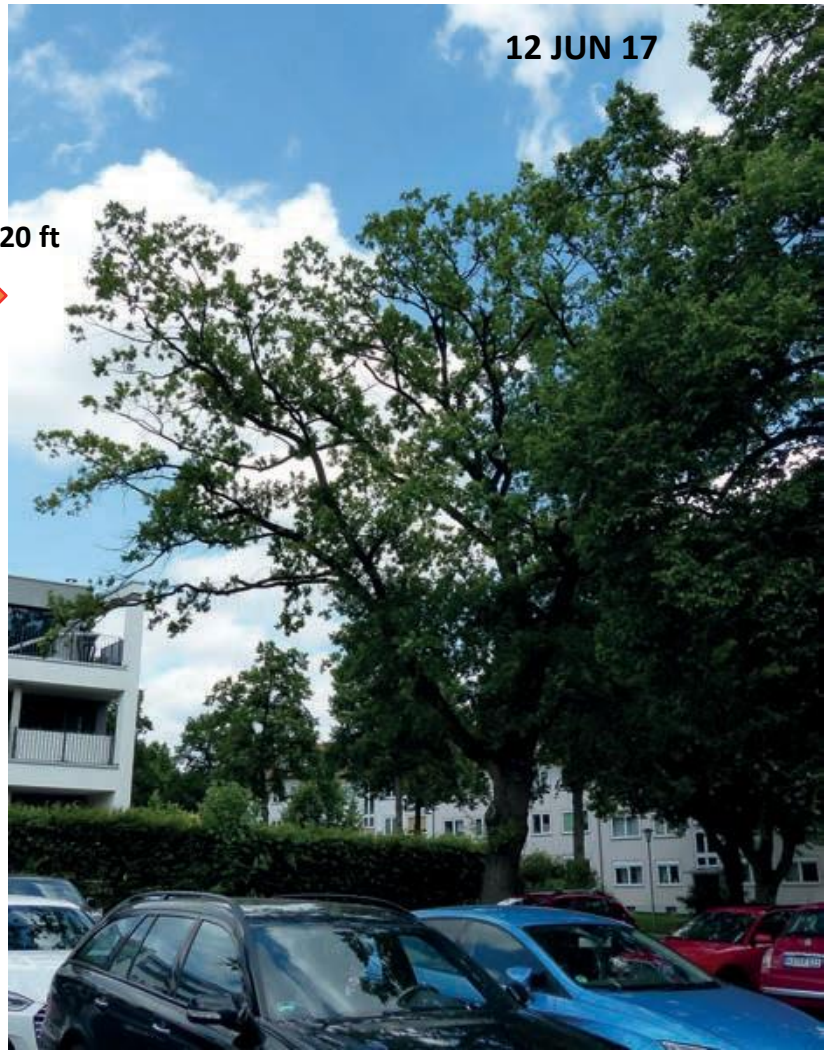
04 JUL 18:
Height: 8.5 m / 28 ft
3 x 20°, 3 x 20°

ca. 70 m / 230 ft



Lautersee lake, assymetric birch tree (view from west)

Mobile phone base station at city nursery

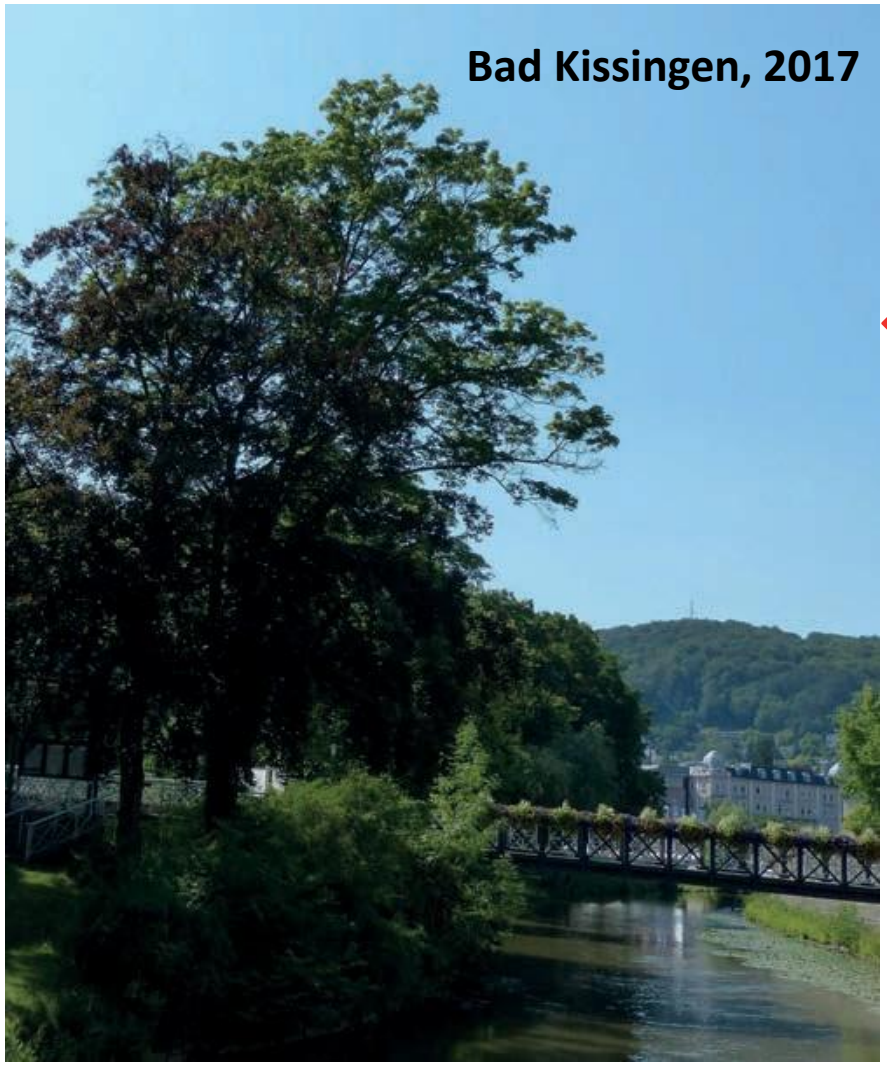


Oak tree (from S), parking lot, east to city nursery. There is a line of sight between the mobile phone base station and the city nursery (distance 250 m/ 820 ft).

In October the oak tree had been pruned. Measurement at parking lot: **2830 µW/m²**.

07 AUG 17: Bergpark Wilhelmshöhe (view from castle), copper beech tree. In 2019 this tree was removed.

The distance to the mobile phone base station Im Druseltal 12 at a higher elevation is ca. 1.4 km (0.9 mi).



19 JUL 17: Bad Kissingen, Luitpoldpark
Maple tree at the Franconian Saale river near Arkadensteg
(view from SE)

**330 m /
1080 ft**

Mobile phone base station near Theaterplatz (height 30–48 m) and TETRA base station at eastern hill

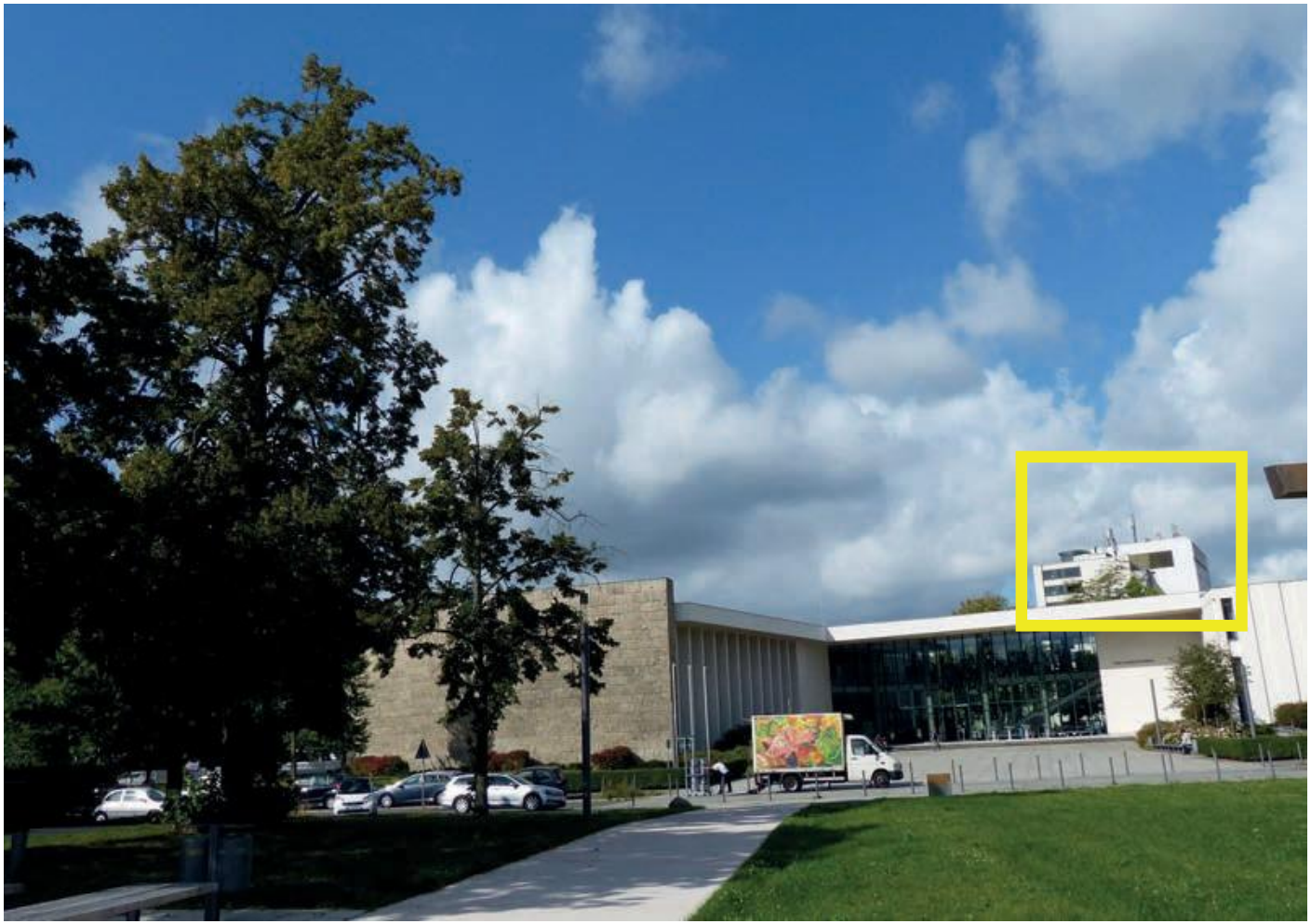
Site registration no.: 660012

09 NOV 09:
21 sector antennas

18 APR 16:
27 sector antennas

11 SEP 18:
33 sector antennas

Berlin, 15 SEP 17



Free University Berlin, Garystraße, two linden trees on a lawn

Measurement: 11,940 µW/m²

https://www.weisse-zone-rhoen.de/b%C3%A4ume-in-stadt-und-land/berlin-dokumentation-2017/

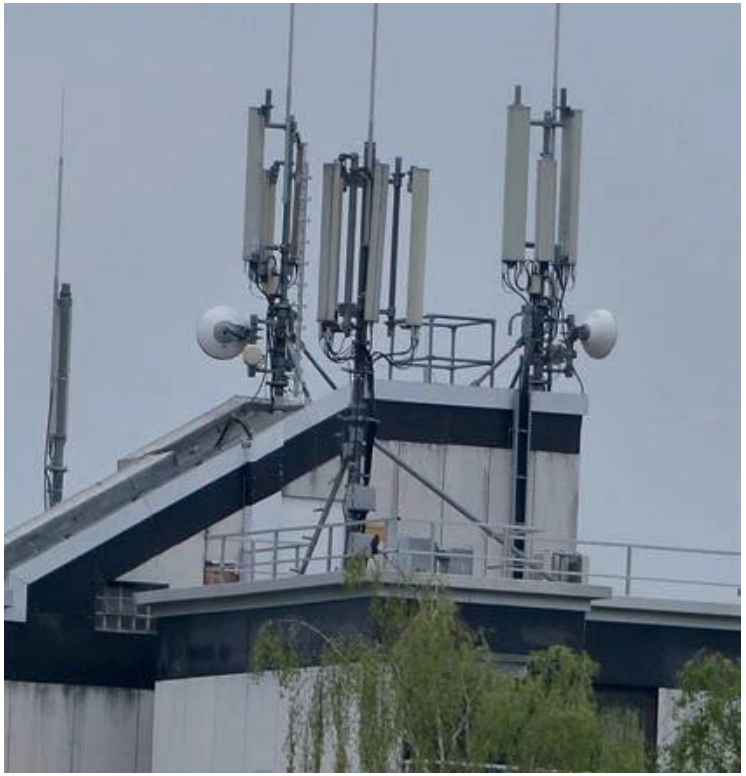
Jena 2017

14 OCT 17: Jena, Jahnstraße, beech tree near Leutra creek view from (S). From E and SE, the beech tree is exposed to mobile phone base station radiation.

Three mobile phone base stations: Leutragraben, Ernst- Abbe-Platz and Jentower
Numerous trees along the Leutra creek show signs of major damage.

07 AUG 18: Ringaustr., Waldorf school, sycamore tree (from SE), advanced damage, left and right side still show differences

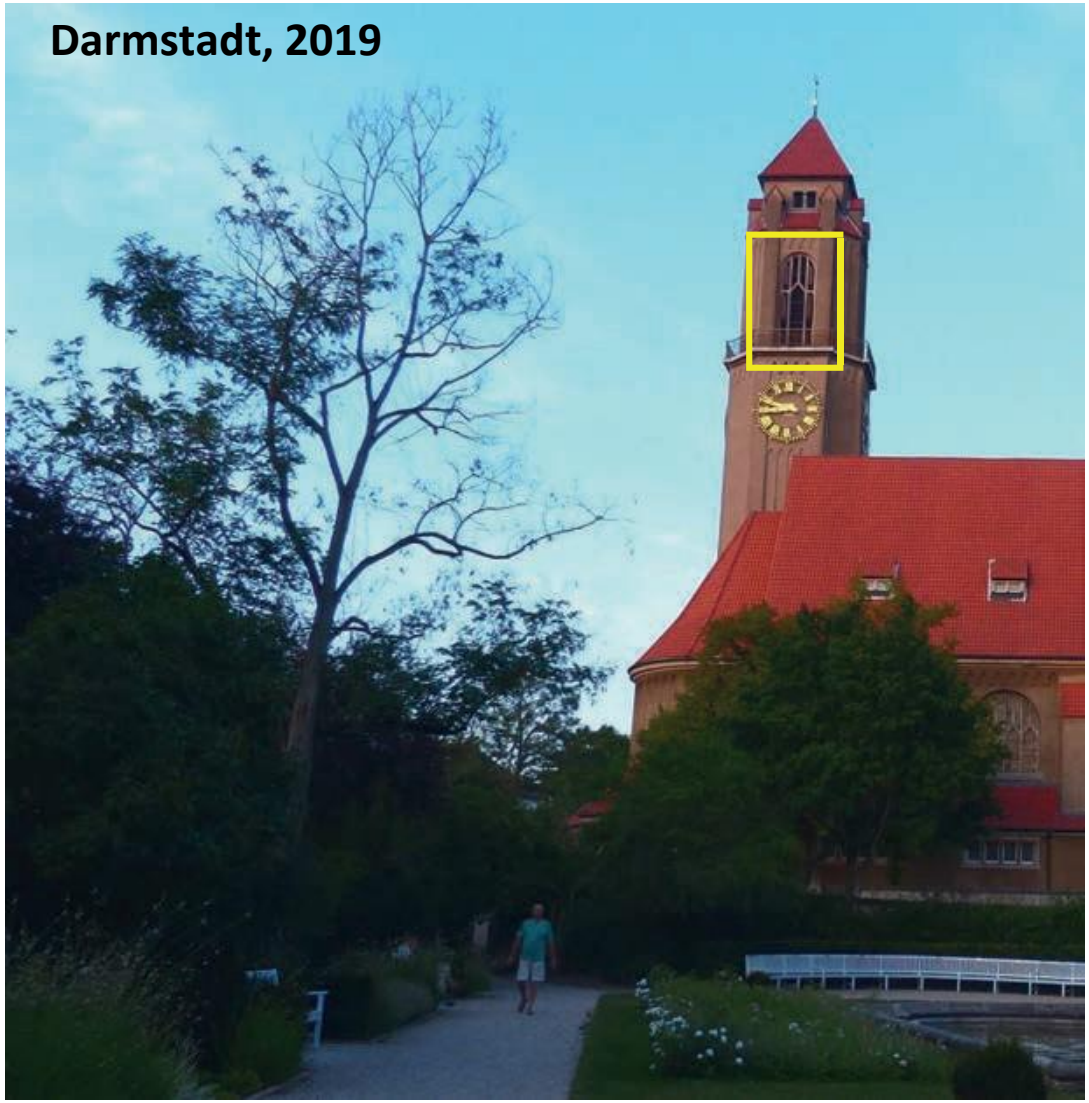
07 AUF 18: The same sycamore tree seen from SW. There is a line of sight to the mobile phone base station Kurhausstraße. The distance is 310 m (1015 ft).



Mobile phone base station Kurhausstraße

23 APR 21: Ringaustraße/Taunusstraße, sycamore tree from previous picture (marked with red rectangle), birch tree heavily pruned due to crown damage (view from SW), distance ca. 340 m (1115 ft)

Measurement: **7570 µW/m²**



25 JUL 19: Darmstadt, St. Paul's Church (view from W), locust tree

The mobile phone base station in the church steeple radiates in all directions: north, east, south and west.

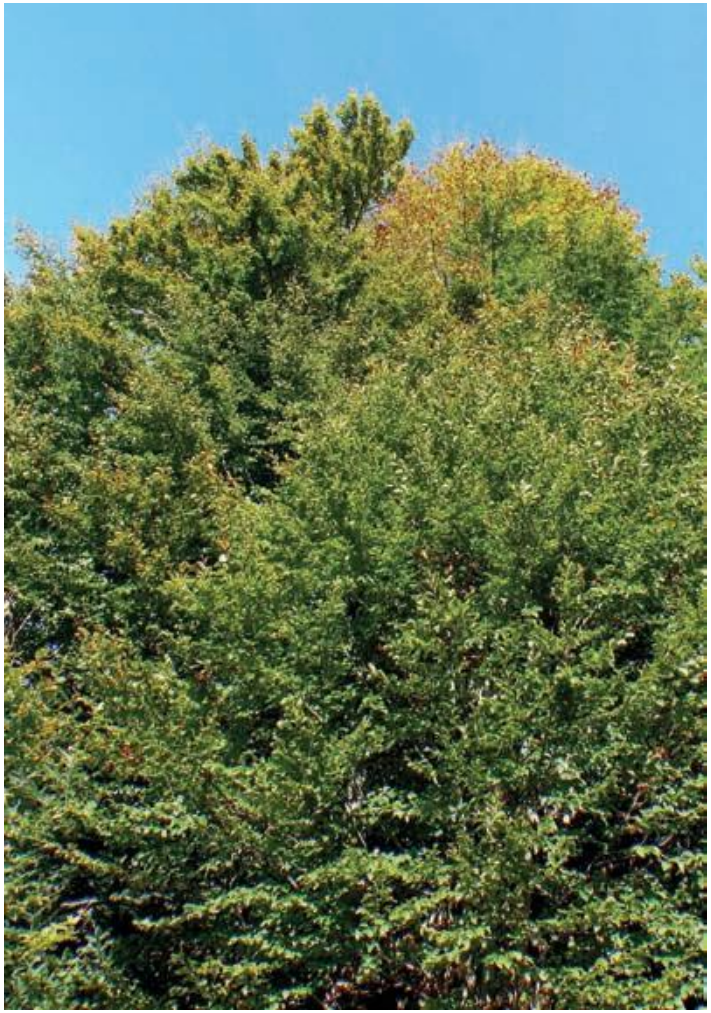
We observed damaged trees in all directions. Measurement in front of the administrative building of the Protestant Church of Hesse and Nassau: **3370 µW/m²**.

Site registration no. **200368 10 FEB 17: 28 sector antennas** (7 x 0°, 7 x 90°, 7 x 180°, 7 x 270°).
29 SEP 20: 56 sector antennas (14 x 0°, 14 x 90°, 14 x 180°, 14 x 270°)

Trees with Dense Foliage at Locations with Low Ambient RF Radiation levels in 2019

25 JUL 19: Darmstadt, Soderstr., sycamore, beech, linden trees

10 SEP 19: Frankfurt, Mendelsohnstr. 42, beech tree



25 OCT 19: SE of Freiburg-Günterstal, beech tree

In the second dry and hot summer, trees with dense foliage could be found in the radio shadow of buildings or mountains.

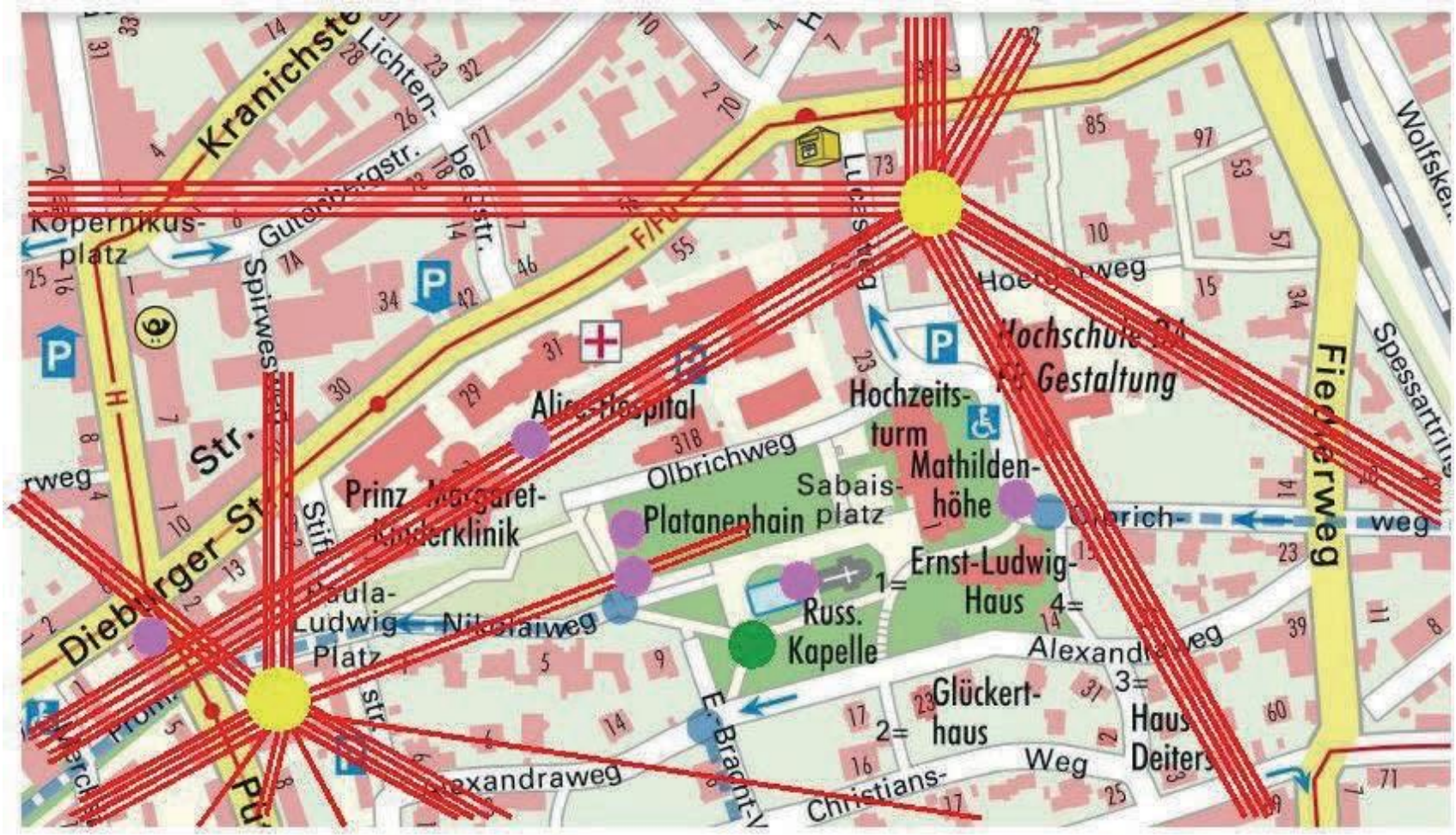
Darmstadt, 2020

16 AUG 20: Darmstadt, Mathildenhöhe, oak tree (from SW). From the damaged north side of the oak tree, there is a line of sight to the mobile phone base station Dieburger Straße (distance ca. 260 m / 850 ft).

Measurement at Russian Chapel:
620 µW/m²

Other trees also show signs of damage.

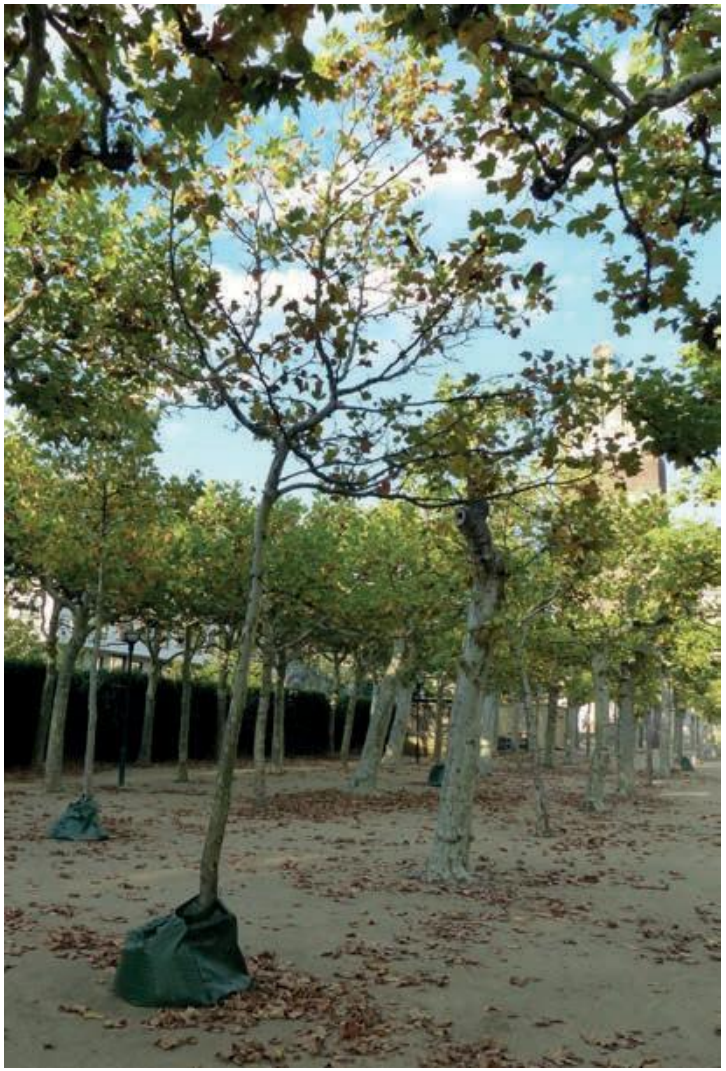
Darmstadt, Mathildenhöhe, Recognition as a World Heritage Site by the Unesco in July 2021



Section from city map, https://stadtatlas.darmstadt.de/, added: mobile phone base stations with main beam directions, measurement sites (purple), location of oak tree (green)
Mobile phone base station Pützerstraße: installation height 29.9–32.8 m; **22 sector antennas**: 4 x 0°, 2 x 70°, 4 x 120°, 150°, 2 x 190°, 210°, 4 x 240°, 3 x 310°;
Mobile phone base station Dieburger Straße: installation height 40.4–42.9 m; **27 sector antennas**: 5 x 0°, 4 x 30°, 5 x 120°, 4 x 150°, 4 x 270°, 5 x 240°

Darmstadt, Plane Tree Grove at RF Radiation Intersection of Two Mobile Phone Base Stations

23 JAN 20:
Measurement at the southwest corner of the plane tree grove:
6240 µW/m²



02 SEP 19:

The replanted plane tree has already lost many leaves despite irrigation.
Based on the assumption that soil compaction is the sole cause of the damage sustained by the plane trees, efforts are currently (January 2022) under way to dig trenches for aeration and irrigation. It is to be feared that the plane trees will not grow well despite these efforts.

27 SEP 20:
Ravensburg,
Wilhelmstraße/
Frauenstraße,
sycamore tree
(view from NO)

Mobile phone base station in the Blaserturm tower

Installation height:
47.3 m (155.2 ft),
12 sector antennas:
2 x 5°, 2 x 80°,
2 x 140°, 2 x 180°,
2 x 230°, 2 x 320°.

The two main beams of the two 80° sector antennas sweep across this street section of Wilhelmstraße.

Bad Königshofen, 2020

11 OCT 20:
Bad Königshofen,
Dr.-Ernst-Weber-Str.,
high school /music
school, two sycamore
trees (view from SE)

Mobile phone
base station
Ottelmanns-
häuser Str. 3

Mobile phone base station on top of the institutes of chemistry

23 DEC 19:
Height: 31 m (100 ft),
9 sector antennas

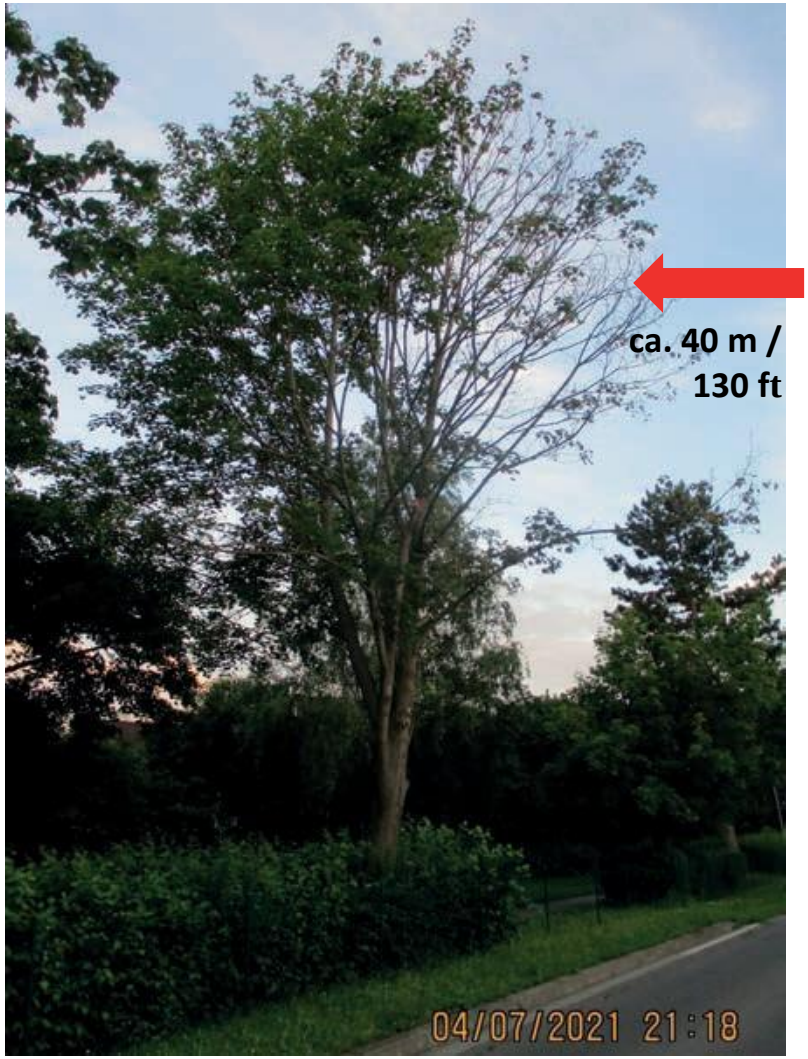
15 JUN 21: Frankfurt, Riedberg Campus, two chestnut trees

Measurement: 16,900 µW/m²

03 JUL 21:
Mobile phone tower above Nackenheim

Height:
22.9–43.6 m,
33 sector antennas,
2 additional RF transmitters

Lörzweiler street, group of locust trees

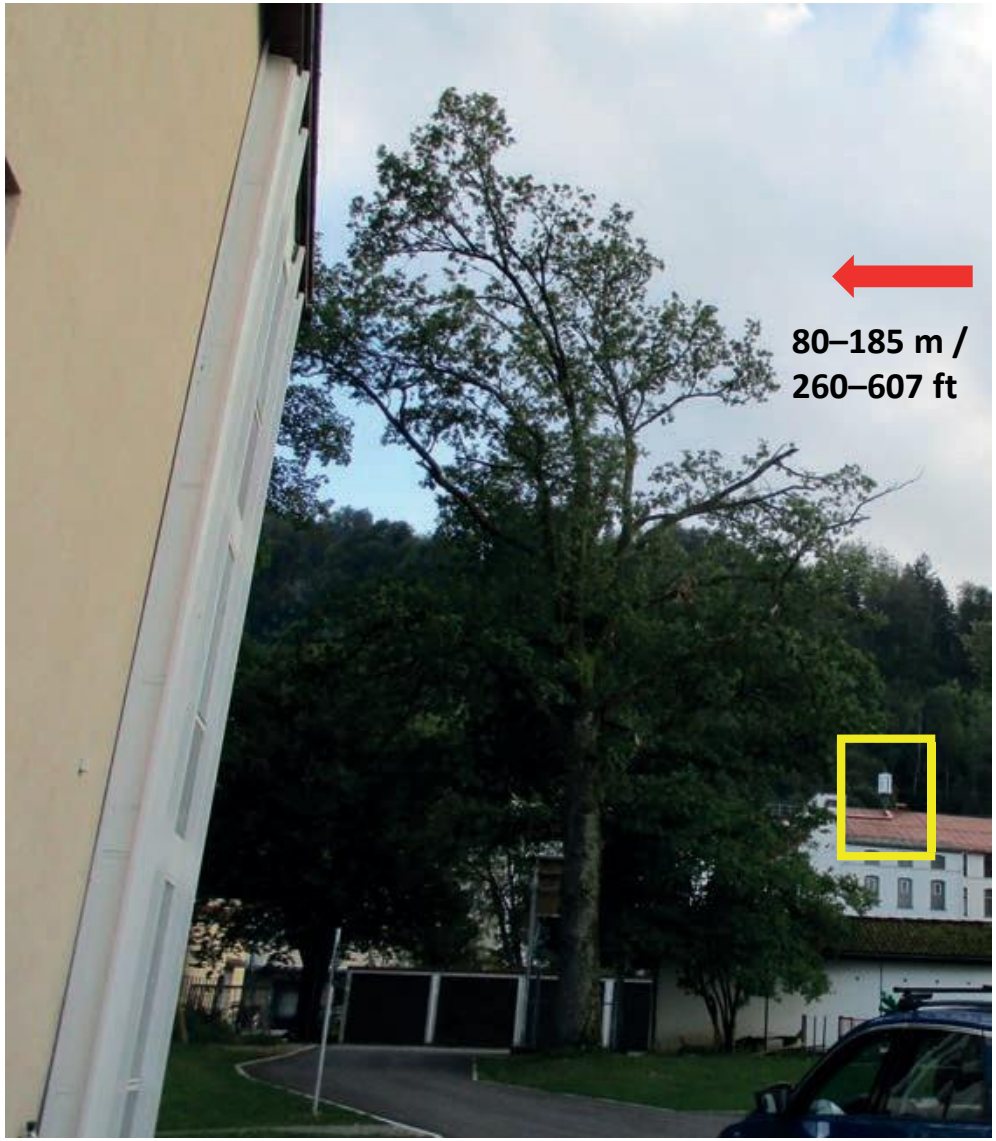


04 JUL 21: Nierstein, Pestalozzistraße, maple tree

The same maple tree with mobile phone base station Pestalozzistr./ Gutenbergstr., height: 25 m (82 ft), 24 sector antennas. The foliage density of the birch tree differs from top to bottom.

Nürtingen, 2021

07 JUL 21: Nürtingen, Carl-Benz-Straße, maple tree



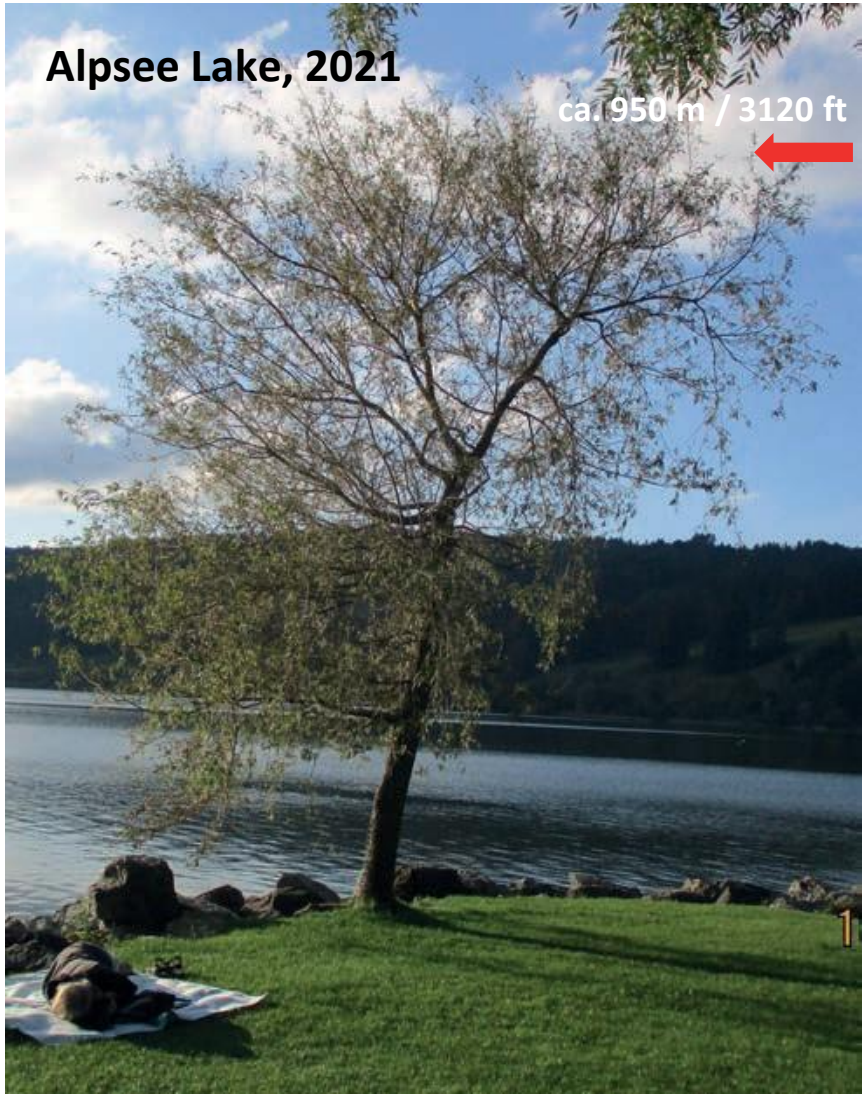
Immenstadt, 2021

17 SEP 21: Immenstadt, Obere Kolonie, oak tree (view from north),
Measurement: **9250 µW/m²**

On top of a company's roof, Gottesackerstraße 2 (746 m / 2448 ft above sea level), there are 33 antennas from two mobile phone networks installed, no.: 540274 and no.: 541064.

On the right side of this street, new residential houses were built.

The people who live here are exposed to very high levels of RF radiation.



18 SEP 21: Alpsee lake, eastern bank, asymmetric willow tree (730 m /2395 ft above sea level).
There is a line of sight to the mobile phone base station Zaumberg.

Mobile phone base station Zaumberg (841 m / 2759 ft above sea level)
2 x 180°, 2 x 245°

Alpsee lake, East Bank Promenade, oak trees (730 m / 2395 ft above sea level).
There is a line of sight to the mobile phone base station Zaumberg.

Mobile phone base station divided between two lamp posts:
7 x 70°, 7 x 190°, 4 x 60°, 4 x 200°

Sycamore avenue, to the east of the mobile phone base station.
Several trees had to be cut down in the last years.

Measurement to the west of the mobile phone base station: **55,000 µW/m²**

Testing equipment: Safe and Sound Pro II (200 MHz – 8 GHz)

Herrischried, Southern Black Forest, 2021

04 SEP 21 Herrischried, Hummellochweg/ Im Bündtenfeld, birch tree (from S)
Measurement: **1700 µW/m²**

1.5 km / 0.9 mi

Mobile phone base station with 37 sector antennas and TETRA

1 km / 0.6 mi

Kappellenstraße, spruce stand (from NE)

Measurement
at south side:
76.0 µW/m²

13 OCT 21: Ibach, willow trees, south of the town hall, at the east side of the street (view from east). The foliage of the willow tree facing south is sparse, the one facing north is dense. Between Unteribach and Oberibach, there were quite a few decidious and coniferous trees whose crowns started to show signs of damage on one side.

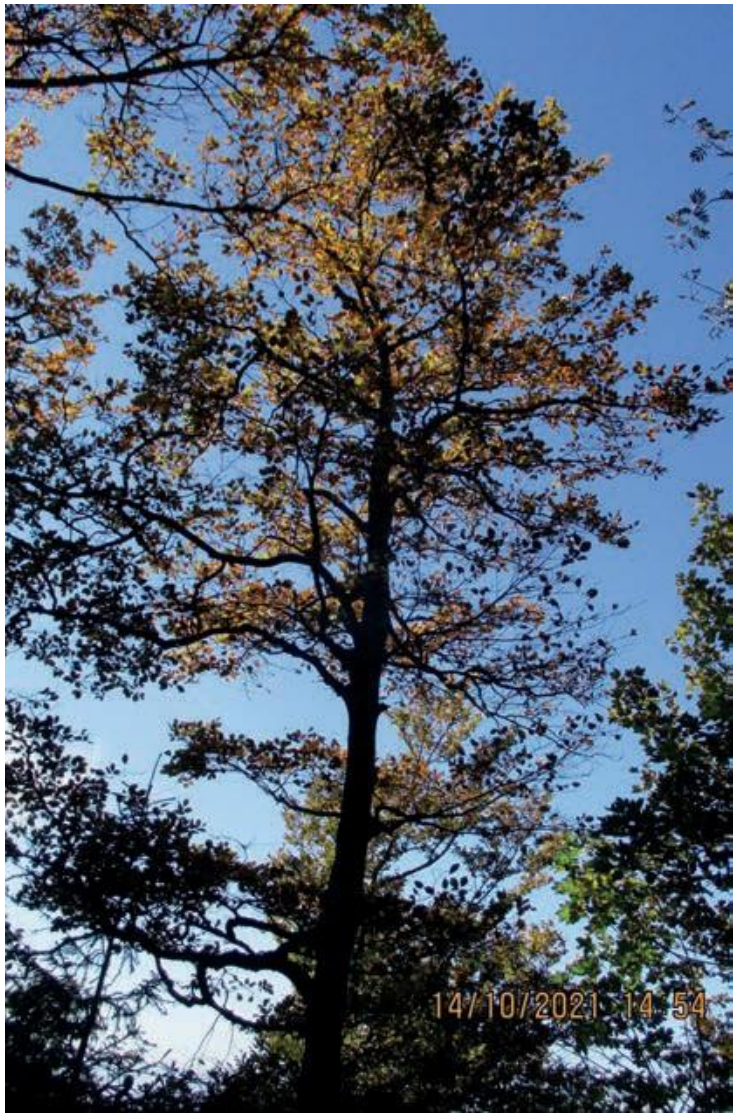
Measurement
at north side:
21.4 µW/m²

Munich, 2021

170 m / 560 ft

20 SEP 21:
Munich,
Hacker Bridge,
3 hornbeam trees

The beech tree to the left is shielded by the beech trees in front of it.



This beech tree is exposed to the RF radiation from the transmitters on the Feldberg mountain.

Mobile Phone Base Station Radiation from Two Directions

Görwihl, Southern Black Forest, 2021

13 OCT 21: Görwihl, Kirchstraße/Hauptstraße, linden tree (view from west). Crown damage at north and south side. The tree crown is exposed to RF radiation from transmitters in Görwihl and Etzwihl.

Tree Damage in the Vicinity of Water Bodies

Orthophoto map, Dietrich Photogrammetrie, 31 May 02

Bamberg, Aerial Image of Buger Spitze, 2002–2020

Bavarian State Agency for Digitization, High-Speed Internet and Surveying, 2020

Bamberg, Buger Spitze between the left and right arm of the Regnitz river. The Buger Spitze is located in the path of the main beams of two 240° antennas (since 2020, four antennas) from the mobile phone base station Gutenbergstr. (distance: 1.9 km / 1.2 mi) and the main beam of one 240° antenna from the mobile phone base station Geisfelder Str. in the Hauptsmoorwald forest (distance: 3.5 km / 2.2 mi).

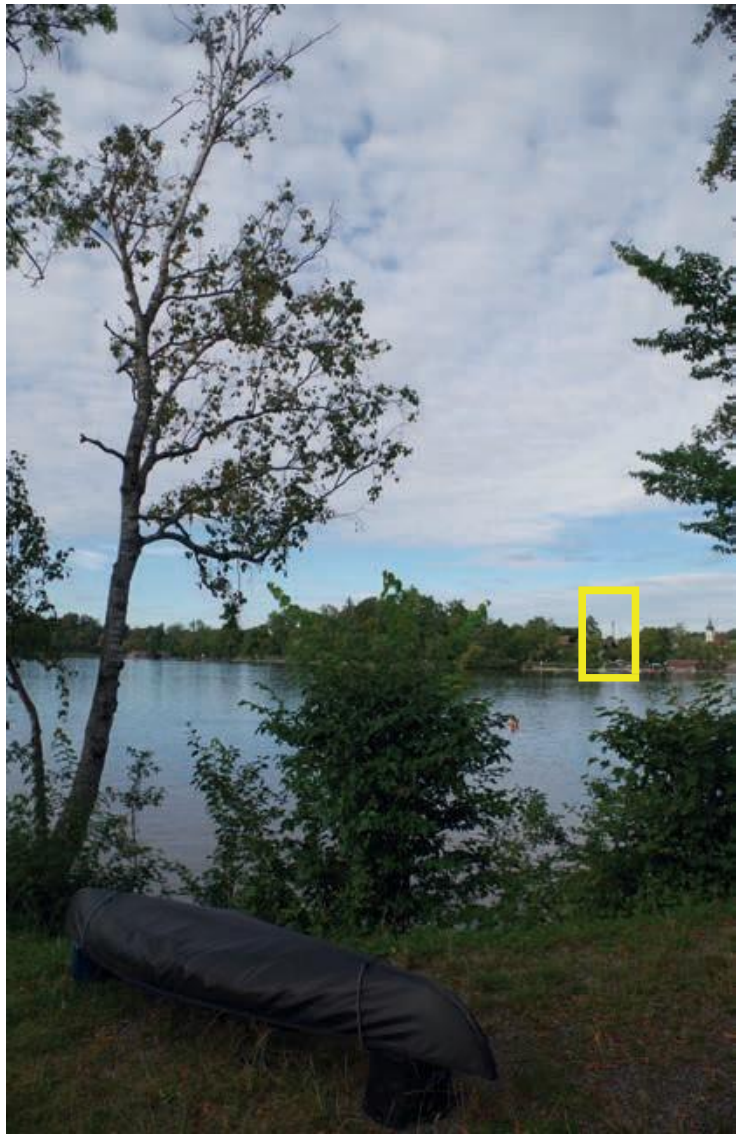
Seehausen at Staffelsee Lake, Camping Site Halbinsel Burg, 2020

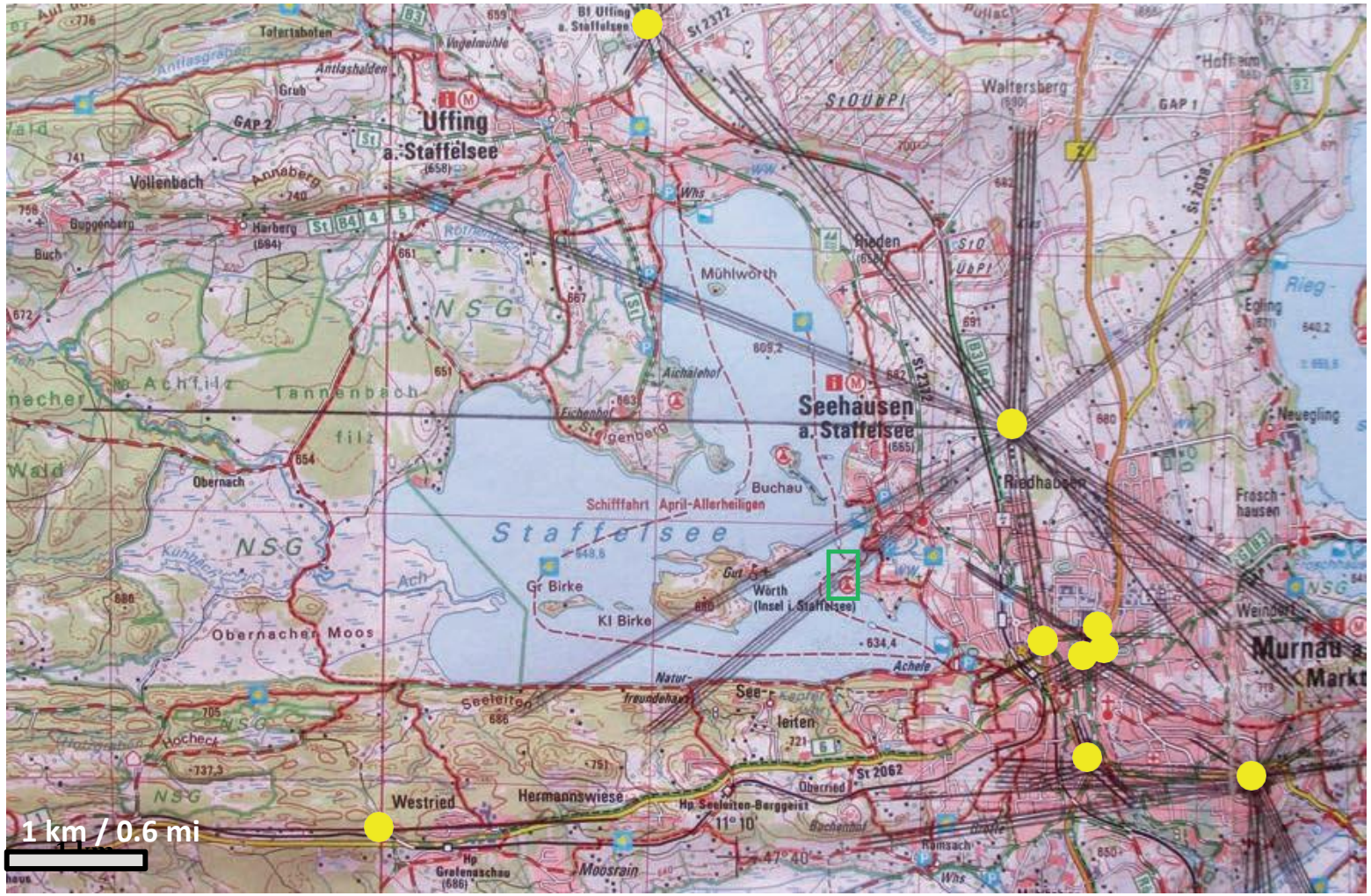
25 AUG 20: View from Camping Site Halbinsel Burg across Staffelsee lake toward Seehausen with mobile phone base station.

At the Camping Site, there are numerous damaged deciduous trees. Quite a few trees had to be cut back.

The distance to the mobile phone base station in Seehausen is ca. 1.5 km (0.9 mi).

Measurement at the lakeside: **200 µW/m²**





Section UK 50-49, Pfaffenwinkel, Bavarian State Agency for Digitization, High-Speed Internet and Surveying
Added: locations of mobile phone base stations with the main beam directions of the sector antennas, camping site (green).
The site registration from 02 FEB 22 shows an upgrade of **48 antennas.**

Mobile phone mast Seehausen (686 m / 2250 ft above sea level)
Height: 36.1–43.8 m,
36 antennas (2020)

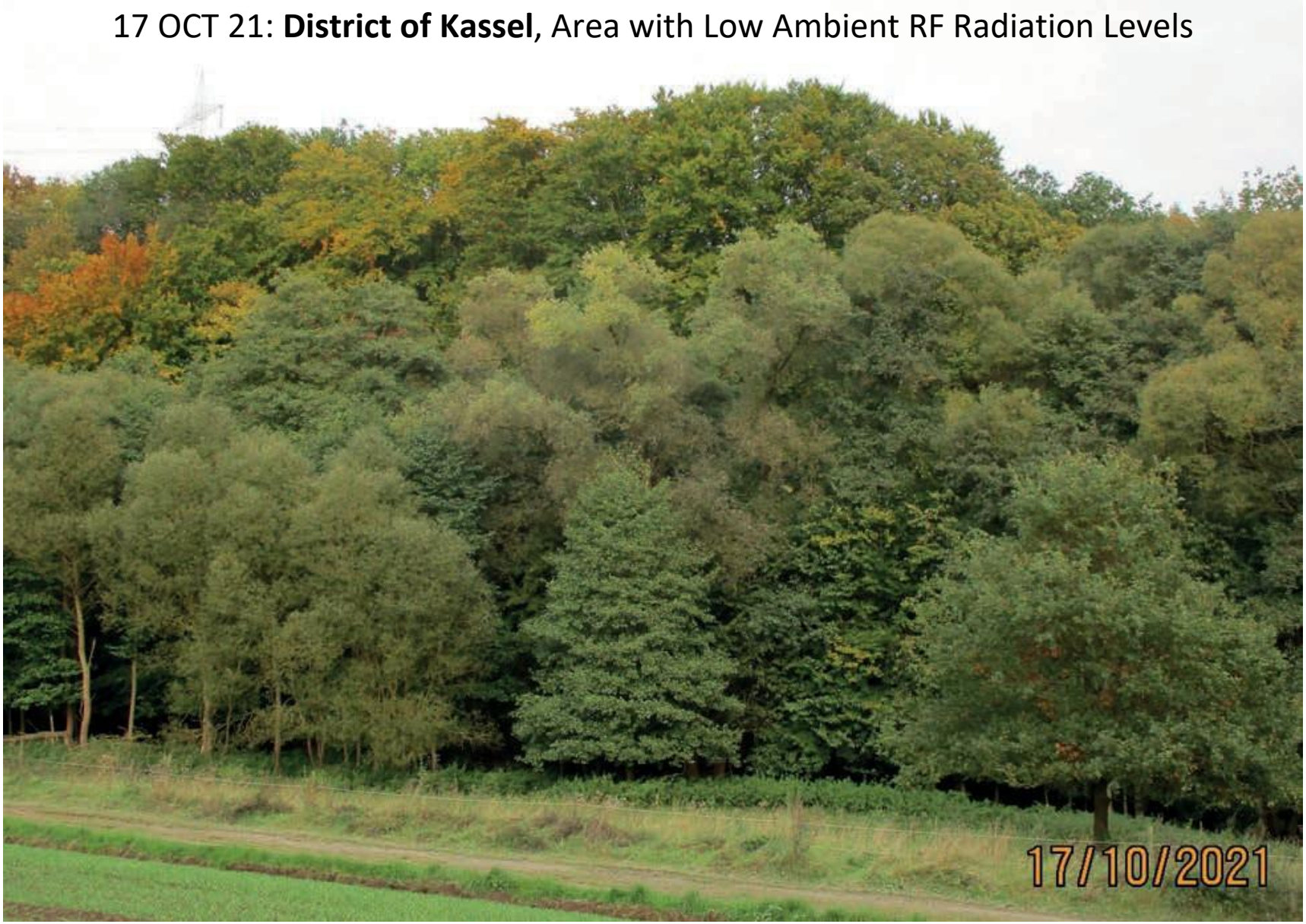
Trees with Dense Foliage in Areas with Low Ambient RF Radiation Levels, 2021

23 JUL 21: Kassel, Arnimstraße, beech tree

12 OCT 21: Rickenbach/Altenschwand, sycamore tree

25 OCT 21: Kassel, Ihringshäuser Str., birch tree

17 OCT 21: **District of Kassel**, Area with Low Ambient RF Radiation Levels



Forest Damage

Massive Intervention at the Geisberg Mountain 2021

19 FEB 21: photo from the newspaper *Fränkischer Tag*,
https://www.fraenkischertag.de/gemeinde/bamberg/massiver-eingriff-am-geisberg-art-17479

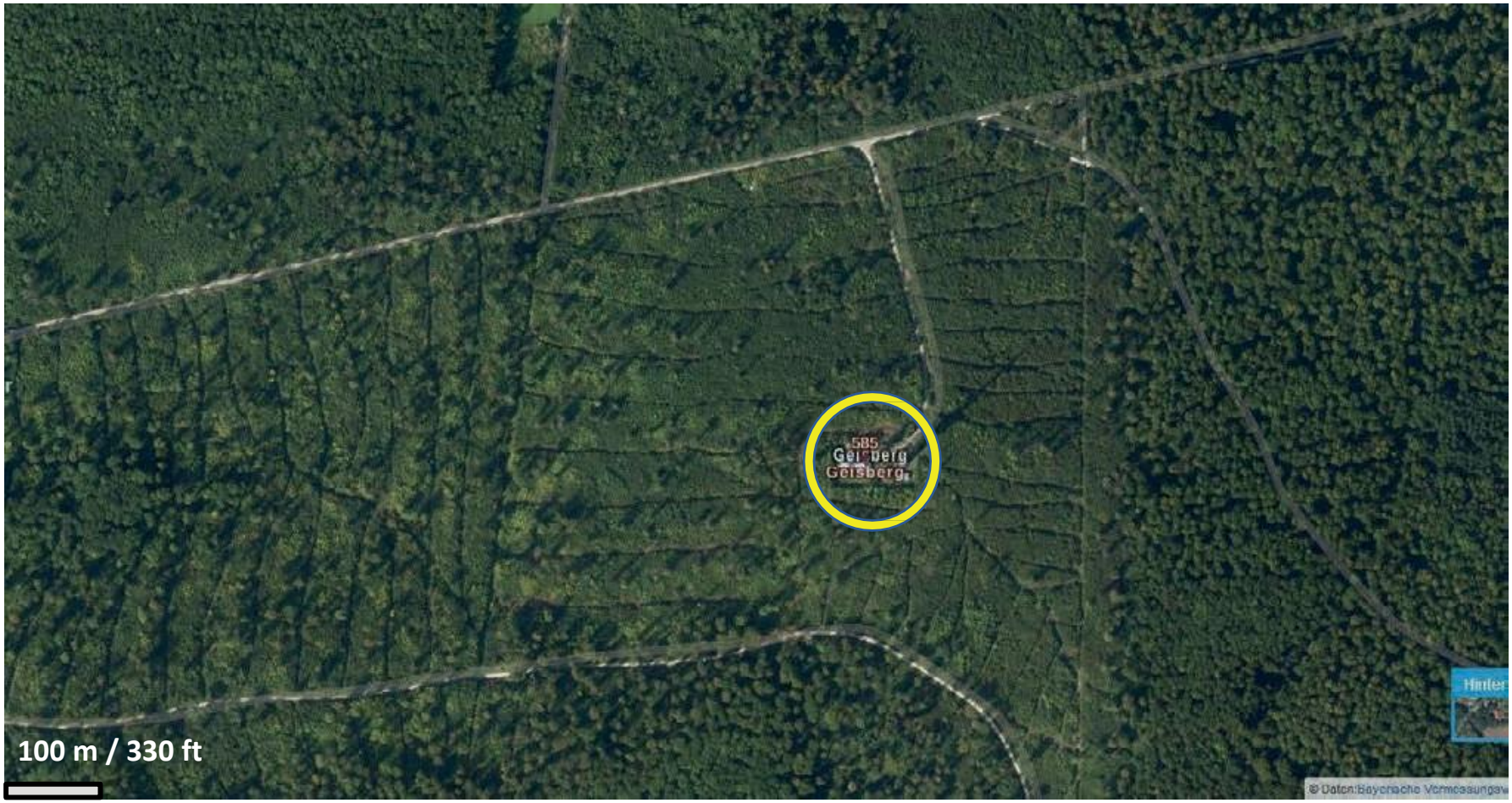
LKR Bamberg – **Hundreds of thick beech trees** were cut down in the Geisberg forest in January. Nature lovers are alarmed. The trees, however, were heavily damaged and were about to die.

21 FEB 21: https://www.fraenkischertag.de/lokales/bamberg/garten-freizeit/massiver-eingriff-in-den-geisberger-forst-art-17075

Damage to the beech trees on the Geisberg mountain were already clearly visible in September 2009.

15 SEP 09: View from Zeegendorf on the south side of the Geisberg mountain. The beech trees at higher elevations were clearly damaged. They were exposed to RF radiation from the radio broadcasting and microwave radio transmitters as well as mobile phone base station antennas on the Geisberg mountain (585 m / 1919 ft above sea level) and from the radio broadcasting and microwave radio transmitters as well as mobile phone station antennas on the Bamberg/Kälberberg mountain (558 m / 1831 ft above sea level, distance: 3.7 km / 2.3 miles). The entire Geisberg mountain and a large portion of the Geisberg forest are located at the most southern part of the Fauna Flora Habitat Reserve of Albtrauf from Dörnwasserlos to Zeegendorf (FFH No. 6032-371).

Geisberg Mountain, Aerial Image 2020



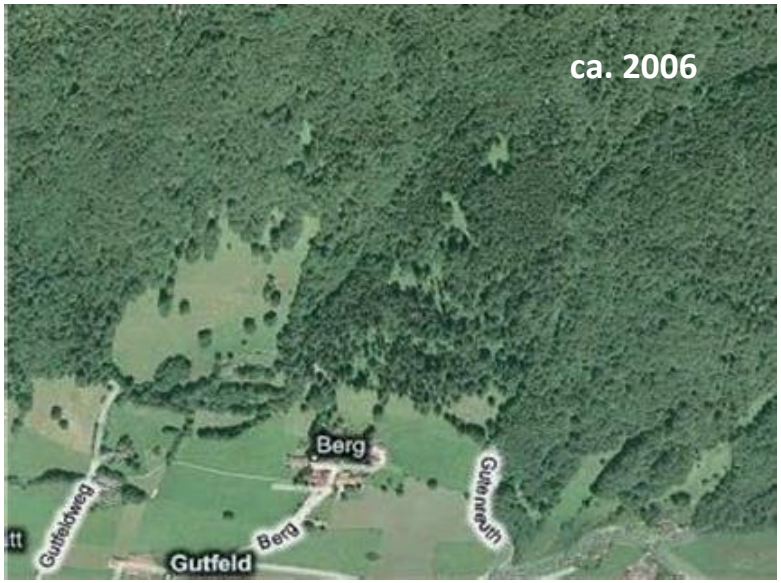
Aerial image, Bavarian State Agency for Digitization, High-Speed Internet and Surveying, BayernAtlas. Geisberg forest with radio broadcasting and microwave radio transmitters as well as mobile phone base station antennas. In 2020 many dead beech trees on the mountain plateau had already been cut down.

Site registration from 24 MAR 21: installation height 49–101 m; 18 sector antennas (3 x 15°, 3 x 90°, 3 x 120°, 3 x 220°, 3 x 230°, 3 x 320°); 10 other RF transmitters

Newly Discovered Clearing in the Forest East of Rottach-Egern (2006–2009)

On the train and bus rides to those affected by RF radiation, we observed new clearings in forested areas. In September 2011 we noticed clearings in the mountain forests of the Mangfallgebirge Mountains, Chiemgau and Berchtesgaden Alps as well as in the Werdenfels region. The comparison of previous aerial images revealed that these clearings had developed between ca. 2006 and 2009. And comparing the antenna maps with the aerial images revealed that in the vicinity of each mobile phone base station damage to the forest had occured.

16 SEP 11:
Ringberg mobile
phone base station



Perspective view, bing maps
At the slope above the Municipality of Berg,
small clearings are emerging.

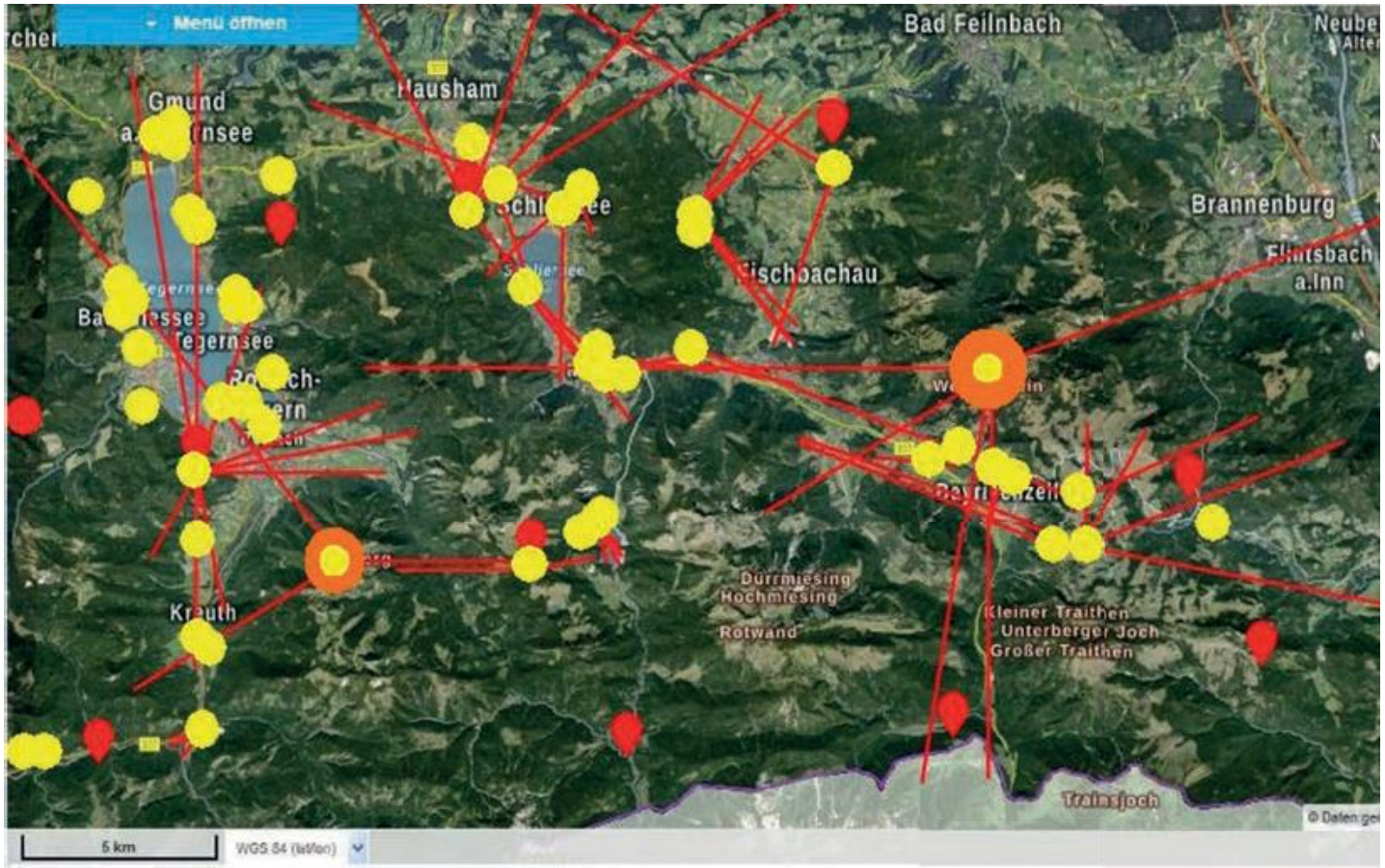
Orthophoto, State Office for Survey and Geoinformation, 2009
A large clearing has developed in the mountain forest. In this area,
the main beams of four 70° sector antennas strike the slope.

Ringberg tower on 21 SEP 2009: **17 sector antennas** (2 x 20°, **4 x 70°**, 2 x 80°, 170°, 2 x 180°, 210°, 280°, 337°, 340°, 350°) and 3 x other RF transmitters

Ringberg tower on 18 MAY 2015: **30 sector antennas** (3 x 0°, 3 x 20°, **4 x 70°,** 5 x 80°, 4 x 90°, 170°, 7 x 180°, 210°, 280°, 350°) and 3 x others plus TETRA

In the path of the main beams of the other sector antennas, damage to trees or parts of the forest could also be observed. In spite of this damage, the mobile phone base station was upgraded to have 30 sector antennas. And a TETRA base station was also added.

The forests in the southern part of the District of Miesbach are exposed to the radiation from numerous RF transmitters (mobile phone base station antennas, digital radio broadcasting, digital video broadcasting, microwave radio, TETRA for BOS Digital Radio).



Aerial image, Bavarian State Agency for Digitization, High-Speed Internet and Surveying, 2018

Added: **mobile phone base stations (yellow),** some with main beam directions, **BOS base stations (red)**.

In addition, RF radiation is also emitted from the **Wendelstein mountain to the east (orange),** 1794 m (5886 ft), through digital audio broadcasting (since 1995) and DVB-T (since 2005, previously analog) and from the **Wallberg mountain (orange),** 1618 m (5308 ft), through DAB+ (since DEC 2017, previously analog)

The aerial images commissioned by the Bavarian State Office for Survey (taken every 3 years) show the increase in damaged forests. The distribution of the damaged areas points to a contribution by RF transmitters.

Rhön Biosphere Reserve, Bubenbarder Stein, 2014–2017

07 SEP 17: View from the Scheppenbachtal valley at the Wasserkuppe mountain (950 m / 3120 ft) and Bubenbarder Stein mountain (759 m / 2490 ft), tree damage visible from a distance

RF transmitters at the Wasserkuppe mountain.
The radome is no longer in operation.

ca. 4 km / 2.5 miles

31 JUL 14: Section from the mountain ridge

The main beams of two 340° sector antennas of the mobile phone base station at the Wasserkuppe mountain strike the Bubenbarder Stein mountain at a distance of ca. 4 km (2.5 miles). To the southwest, the mobile phone base station radiation strikes the north slope of the Nallenberg mountain (6.5 km / 4 miles). The forester in charge was unable to explain the tree damage in this area.

07 SEP 17:
Bubenbarder Stein, beech trees

In 2014 foresters announced that there are almost no beech trees with normal foliage left in the Rhön area.

At the Wasserkuppe mountain, there are also TETRA transmitters for BOS Digital Radio besides mobile phone base stations and microwave radio systems.

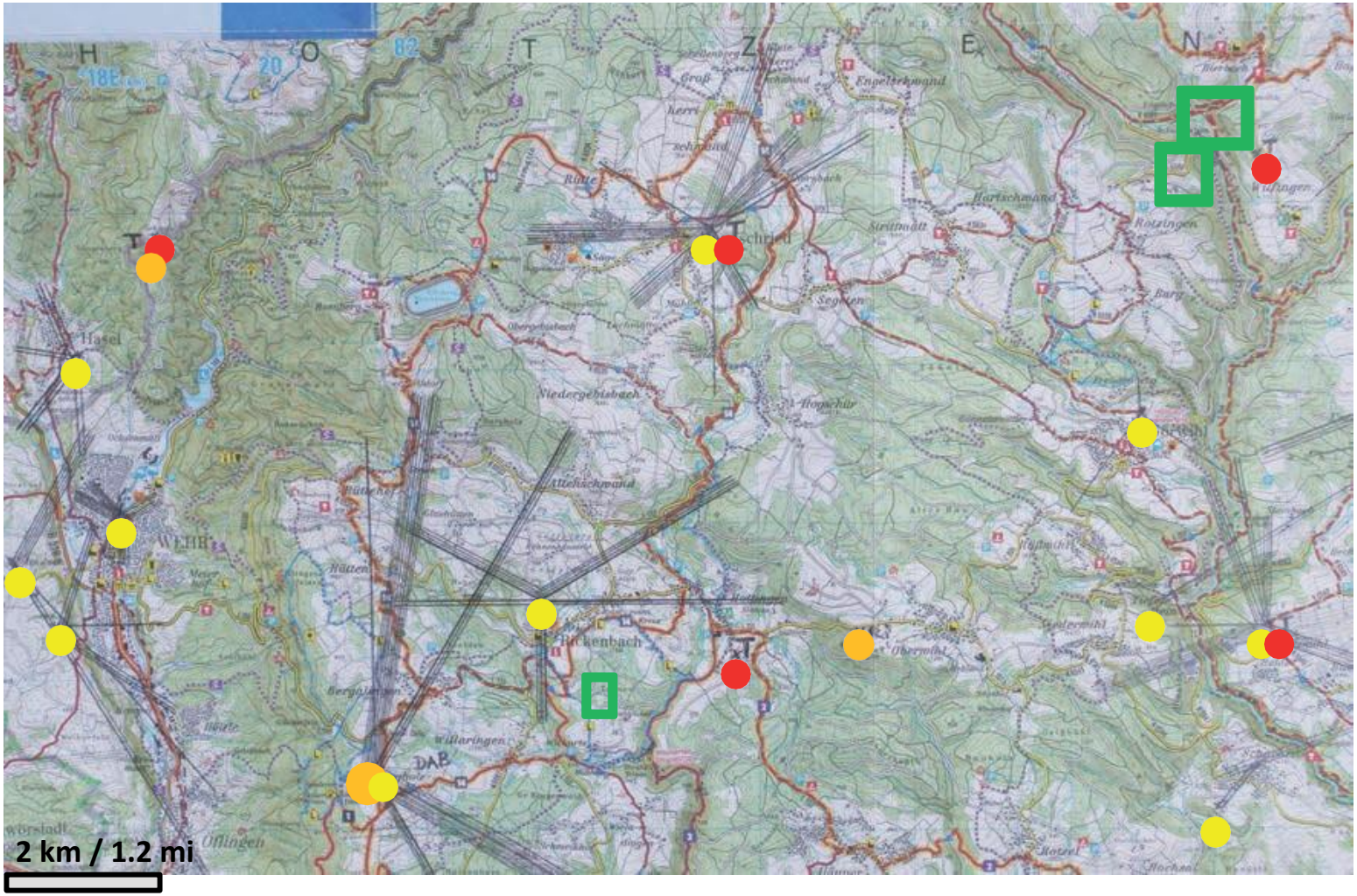
At the Heidelstein mountain, the analog TV transmitter was replaced with digital TV (DVB-T) in May 2006. And in November 2017, the TV transmitter was converted to a DVB-T2 system.

Four Examples from the District of Waldshut in the Southern Black Forest, 2021: Contrast between Exposed and Non-exposed Mountain Forests

05 SEP 21: Wittenschwand. This western slope is exposed to mobile phone base station radiation from three antennas of a mobile phone base station south to Wittenschwand (distance ca. 1.5 km / 0.9 mi).
In this forest area, a clearing has developed.

13 OCT 21: Oberibach. No radiation from a mobile phone base station strikes this southern slope.

Areas of Wehr, Bergalingen, Herrischried, Rickenbach, Görwihl, Etzwihl and Wilfingen



Section from a map of the District of Waldshut, bike routes, State Office for Geoinformation and Land Development.
Added: mobile phone base station sites (yellow) including main beam directions of sector antennas, TETRA base stations (red), other RF transmitters (orange), listed forest areas (green)

Forest Edge to the Southeast of Rickenbach, 2021

Mobile phone base station of Rickenbach, view from south, from forest edge

12 OCT 21: Forest edge south of Rickenbach, oak tree (from S), distance ca. 1 km (0.6 mi), damaged crown. Measurement: **1050 µW/m²**

12 OCT 21: Forest edge. Beech tree located south of the oak tree. Significant damage in its crown.

The forest to the south and southeast of Rickenbach is heavily damaged. RF levels from different directions are superimposed.

Forest Areas to the West and North of the TETRA Base Station in Dachsberg-Wilfingen, 2021

TETRA base station
with site registration
from 08 SEP 09

Height: 50.5 m (165 ft)

ca. 900 m / 2950 ft

View from K6598 , near Krembach, to the south.
TETRA radiation strikes the slope from the east.

At the eastern slope, both deciduous and coniferous trees are damaged, have died or were already cut down.

View from southeast toward bare slope near Lochmühle. The slope is located north of the TETRA base station.

Distance between RF transmitter and slope: ca. 900 m (2950 ft)

The TETRA base station of the BOS Digital Radio Network (for authorities and organizations with safety- and security-related tasks) was installed and started operating even though two unpublished studies in 1999/2001 had observed harmful effects in conifer seedlings with an RF radiation exposure at 383 MHz (equivalent to TETRA signal). Only a summary was published.

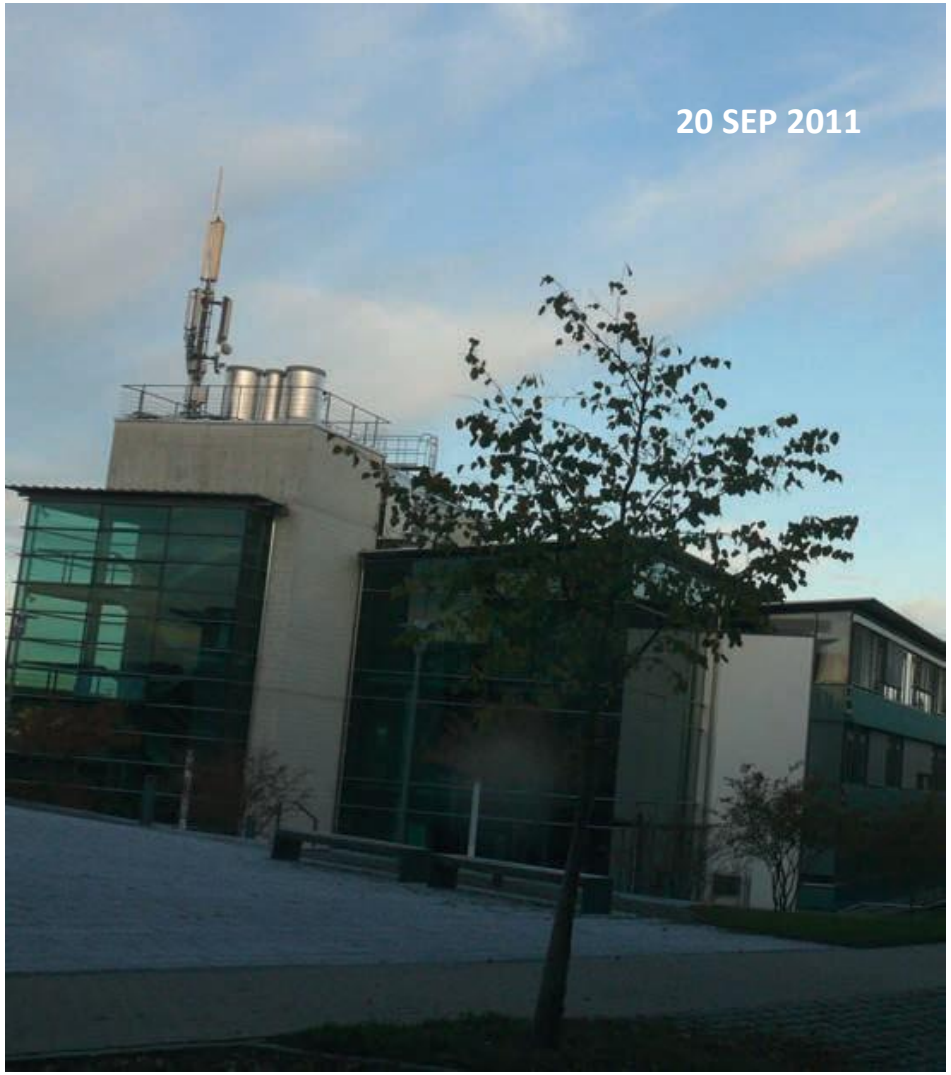
The Development of Young Trees is Disrupted by RF Radiation Exposure – Examples of Linden Trees Munich, 2008–2017

Munich, linden trees (from west) with mobile phone base station Von-Kahr-Str.61
On the left side of the street, the linden tree has not grown for 9 years.
On the right side of the street, the linden tree (framed in green) is located below any main beams. The tree grows in width.

Site registration no.: 530853
2000/2001: initial operation of GSM; SEP 2004: addition of UMTS; 2006: change in technology; 2012: addition of LTE 1800; 2015: addition of LTE 811.

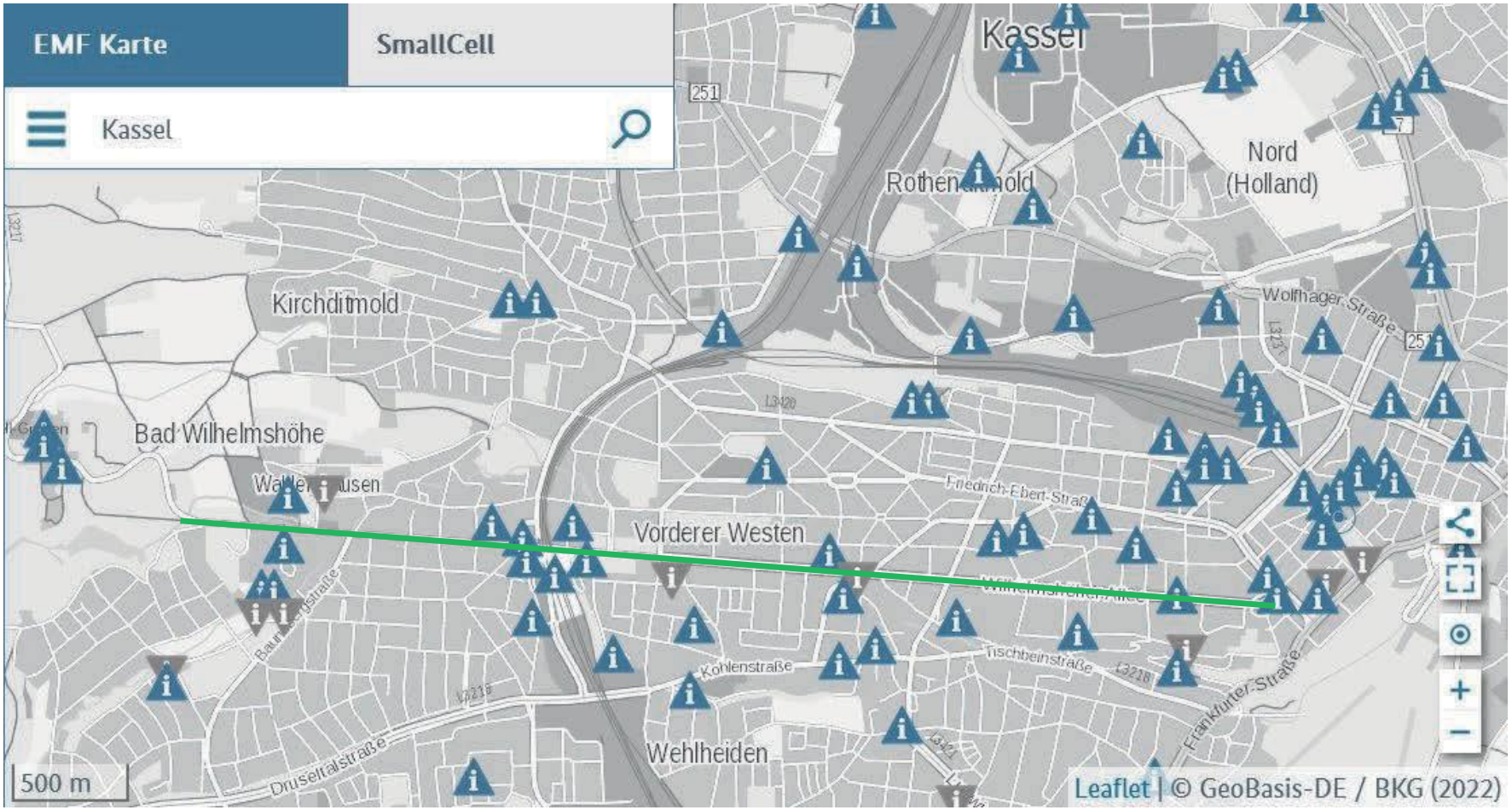
Last registration from 06 MAY 15: installation height 12.9 m; 12 sector antennas (4 x 80°, 4 x 200°, 4 x 320°)
Horizontal safety distances between 3.75 and 7.89 m, vertical safety distances between 0.94 and 2.08 m

Weihenstephan, 2011–2016



Weihenstephan, Lange Point 10, Bavarian State Research Center for Agriculture, linden tree
Measurement: **5760 µW/m²**

Kassel, Wilhelmshöher Allee



EMF map section from the EMF database of the German Federal Network Agency with locations of mobile phone base stations. In the Wilhelmshöher Allee (major avenue, highlighted in green) mobile phone base station antennas radiate from different directions, resulting in a non-uniform distribution of RF radiation. In summer 2016 numerous damaged linden trees were noticed, as well as large differences between individual trees.

Redevelopment of Wilhelmshöher Allee – Premium Project of Federal Program "National Projects of Urban Development" 2019/2020


27 MAY 19: Linden tree, Schwälmer Brotladen


27 MAY 19: Linden tree, Schweizer Hof


17 AUG 20: Linden tree, near Hessian Broadcasting Station (hr) (visible in the background left from tree)

Press release of the city: "The Wilhelmshöher Allee, which connects the Bergpark with the city center, is a striking traffic and visual axis that shall be revived. Several individual initiatives are planned to accomplish this. There will be 225 new linden trees planted and existing trees will be restored.“ In 2018/2019 new linden trees were planted. It is of concern that they will not grow well because of the ambient RF radiation levels. There were already signs of damage as early as 2019.

Conclusion

Trees make the impact of radiofrequency radiation visible.

The following pieces of evidence justify the suspicion that – besides previously considered contributing factors – electromagnetic fields also affect trees: documented observations from 2005, assessments of aerial images, a published study from 2016 regarding crown damage starting on one side with the title "Radiofrequency Radiation Injures Trees around Mobile Phone Base Stations“ as well as scientific findings that have been emerging since the 1930s.

Tree damage on only one side cannot be explained by climate change.

Tree damage in the vicinity of mobile phone base stations has been observed at RF radiation levels well below current exposure limits.
Exposure limits were set without considering plants.

An immediate scientific review of this serious suspicion in actual real-life settings is urgently called for. And as long as the suspected effect cannot be ruled out, it should be forbidden to upgrade existing RF transmitters or to install any new ones.

Summarized Review

Life on earth has evolved under the influence of naturally occurring electromagnetic fields and waves (static electric and magnetic fields, cosmic radiation, sferics, ELF electromagnetic resonances or Schumann resonance). The electromagnetic fields technically produced for the past 100 years are superimposed on the natural electromagnetic fields and interfere with genetic, biochemical and physiological processes in humans, animals and plants.

Effects of radiofrequency electromagnetic fields (from radar, microwave radio systems, radio and television broadcasting) on plants have been proven for the past 90 years. https://kompetenzinitiative.com/wp-content/uploads/2019/08/waldmann-selsam_forschungsbericht-pflanzen_2010-1.pdf

Dr.- Ing. Wolfgang Volkrodt, electrical engineer, physicist, and longtime head of development at Siemens was a versatile inventor with 150 patents to his name. He researched and documented forest damage in many locations caused by radiofrequency radiation from radar, microwave radio systems as well as radio and television broadcasting transmitters. **Volkrodt found that a new radar station had started operating in spring 1984 on the Wasserkuppe mountain and that its RF emissions had caused a sudden and unexpected forest dieback across the southwest slope of the Stirnberg mountain (distance ca. 6 km / 3.7 mi).**

He suspected that the reception of the radiofrequency electromagnetic fields (via the antenna function of the trees) and their conduction to the roots would affect the fine rootlets and the balance of ionic charges in the soil. After fiber-optic technology had been discovered and with all the facts we had at that time, data transfer technologies should have been converted to cable as quickly as possible. Volkrodt had hopes for a reasonable decision when he wrote in 1987: “Historians will refer to this period of the wireless plight from about 1975 to 1990 as a small, temporary “technical incident.” Thanks to the introduction of fiber-optic technology, it could be eliminated quickly and consistently.

His poster presentation at the International Congress of Forest Decline Research held in Friedrichshafen on 2 October 1989 showed the devastating consequences for various mountains, including Ochsenkopf and Schneeberg (Fichtelgebirge Mountains), Wasserkuppe and Stirnberg (Rhön Mountains), Würmberg (Harz Mountains) as well as the dense network of microwave radio systems in Bavaria.

In 1989 Volkrodt sent his forest surveys of 32 radiofrequency transmitters to ministries and universities.
https://www.diagnose-funk.org/aktuelles/artikel-archiv/detail?newsid=1764 (right navigation bar)
The refusal by the Federal Minister of Research and Technology Dr. Riesenhuber on 28 February 1990 to launch any review and the disinterest of forest scientists in this subject matter proved fatal for future developments.

On 27 September 1990 the German Commission on Radiological Protection (SSK) released a statement that “Point-to-Point Microwave Radio and Radar Waves Do Not Cause Any Forest Damage,” without having conducted any investigations into damaged forests within the reach of RF transmitters in Germany.

In its statement, the SSK referred to studies by Joos, Masumy, Scheingruber and Stäger on radio and TV broadcasting stations in Switzerland. These studies, however, did not examine microwave radio systems and radar.

From 1992 thousands of antennas for D- and E-Netz mobile phone networks (2nd generation or 2G) were installed in Germany, often connected by microwave radio systems.

120 m / 400 ft

In August 1993 Dr. Josef Schildt observed a maple tree in Kaarst-Büttgen, Postweg 40, that developed a damaged crown on one side.

At a distance of 120 m (400 ft), a mobile phone base station on the Küpper silo tower had gone into operation.

In **1994 Bernatzky** added a chapter on electromagnetic fields, propagation properties of microwave radio systems, current research reports, shielding experiments and documented line-of-sight radio wave corridors by Dipl.-Ing. Ermer to the revised 4th edition of his technical book "Tree Ecology and Preservation."

Figure 178: Corridors caused by electromagnetic waves of microwave radio systems, TV and radar (Photo: Ermer)

In the 1994 Forest Damage Report from Bavaria, the authors admit their helplessness regarding damage in oak trees: “Yet only barely 10% of the lost foliage can be explained by pest damage; the foliage of oak trees not affected by pests has also gotten significantly worse. The poor performance of oak trees – despite their broad ecological amplitude – has not yet been explained.”

In **1996 Balodis et al.** showed that the growth of pine trees had been inhibited since the initial operation of the Skrunda radar transmitters in 1970: In 29 areas, they analyzed tree growth retrospectively based on growth rings for the period from 1959 to 1988. **In all exposed areas, the growth of pine trees was inhibited.** This effect begins after 1970, which coincides with the time the Skrunda radar installations started operating, and continues to be observed for the entire subsequent study period. Numerous other environmental and anthropogenic factors were considered, but none of those had any significant impact on tree growth.

Schmutz et al. examined 4-year-old spruce trees and 3-year-old beech trees for 3.5 years, while the trees were exposed to RF radiation at a frequency of 2450 MHz (not pulsed) and with a power density between 0.007 W/m² and 300 W/m². They found no visible damage, no effect on crown transparency and no effects on the functioning of photosynthesis, despite some significantly different levels of chlorophyll concentration during the study period. However, the concentration levels of calcium and sulfur significantly decreased with increasing power density in the beech trees in the first two years. By the third year, there was no significant difference among the exposed groups with regard to their calcium concentration levels, but in absolute terms continued to decrease in comparison to previous years. Sulfur concentration levels decreased with increasing power density during all three years.

In the 1996 publication, Schmutz concluded that a risk assessment would only be possible after additional research. On 1 January 1997 German lawmakers set legally binding exposure limits (26th BImSchV). Scientific findings regarding plants were not considered in this guideline.

In 1999 at the international seminar convened by the WHO, ICNIRP and the German Federal Office for Radiation Protection on the “Effects of Electromagnetic Fields on the Living Environment,” there was an urgent call for research projects: “By comparison, influences of these fields on plants, animals, birds and other living organisms have not been properly examined. Given that any adverse impacts on the environment will ultimately affect human life, it is difficult to understand why more work has not been done. There are many questions that need to be raised: ... it seems that research should focus on the long-term, low level EMF exposure for which almost no information is available. ... Specific topics that need to be addressed include: ... EMF influences on agricultural plants and trees” (excerpt from Proceedings of the International Seminar, p. 7/8)

The German Federal Office for Radiation Protection, however, did not commission any research projects in this regard.

Only the Ministry of Culture and Science of North Rhine-Westphalia supported studies between **1999 and 2001** on the effects of **383 MHz (TETRA signal, later used for BOS Digital Radio).** Scientists of the universities of Wuppertal and Karlsruhe investigated a total of 451 one- year-old seedlings of three types of conifers. From October 1999 to May 2000, the plants were exposed to a frequency of 383 MHz (pulsed, equivalent to TETRA signal).
http://www.boomaantastingen.nl/EMF_and_conifers%5B1%5D.pdf

The plants under study were watered whenever necessary. The researchers observed a slightly enhanced growth rate in pinus pumila, but a decrease in the chlorophyll a/b ratio. **In all three types of conifers, the number of dead trees was significantly higher in the exposed groups.** A summary was published in 2000. **The complete study and a second study from 2001, in which effects on coniferous seedlings were also found, have not been published to date – despite repeated requests.**

The announced studies to review early findings were not carried out. Yet a nationwide network of TETRA base stations for BOS Digital Radio (for authorities and organizations with safety- and security-related tasks) has been deployed.

From 2003 with UMTS (HSPA) the third generation of wireless mobile telecommunications technologies has been installed.
From 2003 the incidence of unusual and inexplicable tree damage rapidly increased across Europe.

From 2004 various research groups found effects of radiofrequency electromagnetic fields (as used in wireless telecommunications technologies) on plants in laboratory experiments. The effects vary depending on frequency, pulse sequence, modulation, polarization, exposure duration and field strength of the applied radiofrequency electromagnetic fields.

On **2 August 2006 Dr.-Ing. Dipl.-Phys. Volker Schorpp** presented evidence for a causal link between damaged trees and forests and chronic exposure to radiofrequency radiation (mobile phone networks, radar, microwave radio systems, terrestrial audio and video broadcasting) at a symposium of the German Federal Office for Radiation Protection in Oberschleißheim. http://www.puls-schlag.org/download/Schorpp-BfS-02-08-2006.pdf

On **13 November 2007 Dr. A. Dehos, German Federal Office for Radiation Protection,** replied to a request for comment as follows: "**Regarding potential effects of radiofrequency electromagnetic fields on plants, science has not yet provided any clear evidence. Likewise, I also don't give priority to this question."**

Between 2006 and 2016 numerous new RF transmitters started operating: DVB-T, BOS Digital Radio, DAB+, WIMAX, LTE and others. One technical detail is important here. In Germany, DVB-T (Digital Video Broadcasting Terrestrial) uses Orthogonal Frequency Division Multiplex Modulation. The main principle of this modulation is the distribution of information on several thousand carrier frequencies located right next to each other. A channel is 7.8 MHz wide. The amplitude is also changing constantly.

On **18 February 2011** in Baarn, NL, the first symposium on "The Effect of Electromagnetic Radiation on Trees" took place. This was organized by the City of Alphen aan den Rijn together with the Bomencentrum Nederland.
https://ehtrust.org/wp-content/uploads/effect-of-emf-on-trees-2011-02-18-1.pdf or https://vimeo.com/25270604

In September **2013 the observations of the Physician Initiative** were described **in the article** "Baumschäden im Umkreis von Mobilfunksendeanlagen **[Tree Damage in the Vicinity of Mobile Phone Base Stations]**" in the journal umwelt medizin gesellschaft.
https://kompetenzinitiative.com/wp-content/uploads/2019/08/Tree-damages-in-the-vicinity-of-mobile-phone-base-stations.pdf
https://kompetenzinitiative.com/wp-content/uploads/2019/08/Baumsch%C3%A4den-im-Umkreis-von-Mobilfunksendeanlagen.pdf

In 2016 the study **"Radiofrequency Radiation Injures Trees around Mobile Phone Base Stations,"** which has been carried out by two biologists, an expert forester (Dipl.-Forstw.) and a medical doctor, was published.
https://www.researchgate.net/publication/306435017_Radiofrequency_radiation_injures_trees_around_mobile_phone_base_stations
https://www.diagnose-funk.org/download.php?field=filename&id=1336&class=NewsDownload

In **2017** the **observation guide "Tree Damage Caused by Mobile Phone Base Station Radiation"** by **expert forester Helmut Breunig (Dipl.- Forstw.)** was published.
https://kompetenzinitiative.com/new-observation-guide-tree-damage-2/
https://www.diagnose-funk.org/forschung/wirkungen-auf-tiere-pflanzen/pflanzen/wirkungen-auf-baeume/beobachtungsleitfaden

Between 2017 and 2021 numerous RF transmitters were upgraded, converted or newly installed to increase data transfer rates and improve mobile phone reception:

- **Addition of LTE Advanced, 5G type of systems and 5G at mobile phone base stations**
- **Conversion of DVB-T to DVB-T2 HD**
- **Densification of networks for digital audio broadcasting and conversion to DAB+**

Examples from 2017 show that the current development is very dangerous. Numerous damaged trees will not be able to withstand storm, snow and rain. Municipalities will run into problems with providing road safety as is their duty.
https://kompetenzinitiative.com/wp-content/uploads/2019/08/C-Bayern_gef%C3%A4hrliche_Baumsch%C3%A4den_2017.pdf

Examples from the 2016 study, showing the development of damage over time, were presented at the International Workshop "Environmental Effects of Electric, Magnetic and Electromagnetic Fields: Flora and Fauna" of the German Federal Office for Radiation Protection.
https://kompetenzinitiative.com/wissenschaft/international-workshop-radiofrequency-radiation-injures-trees/

The German Federal Office for Radiation protection has continued to do nothing about potential effects on trees.

In **2021 Prof. Dr. A. Thielens, University of Gent,** provided reasons for the necessity of scientific research concerning animals and plants in his statement **for the European Parliament** on "Environmental Impacts of 5G — A Literature Review of Effects of Radiofrequency Electromagnetic Field Exposure of Non-human Vertebrates, Invertebrates and Plants."

In the introduction of the statement by the German Federal Office for Radiation Protection from 19 March 2021, it says: "According to current scientific understanding, there is no scientifically verifiable evidence available that would point to a risk for animals and plants through the exposure to radiofrequency electromagnetic as well as ELF and static electric and magnetic fields below official exposure limits."

This statement has been disproven by the research findings over the last 90 years and 675 references listed in Part 2 of the three-part review by Levitt, Lai and Manville.

Levitt BB, Lai HC, Manville AM. ***Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: how species interact with natural and man-made EMF*****, Rev Environ Health 2021**

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University of Göttingen: The pine tree grows horizontally to stay below the main beams of the sector antennas.

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