



GLOBAL JOURNAL OF RESEARCHES IN ENGINEERING: F
ELECTRICAL AND ELECTRONICS ENGINEERING
Volume 14 Issue 3 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Hazard of Electromagnetic Fields in Biosphere

By Marko S. Markov

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GJRE-F Classification : FOR Code: 090699



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Hazard of Electromagnetic Fields in Biosphere

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I. INTRODUCTION

The contemporary science has enough evidence that the life originated and developed in the presence of a number of physical factors with terrestrial and space origin including magnetic and electromagnetic fields. One of the most important factors is the Geomagnetic field, formed during the geological evolution of the planet. At the same time, the Earth has been exposed to the influence of ionizing and nonionizing radiation. Due to space limitations, the evolutionary role of magnetic fields will not be a subject of discussion in this paper. However, we will continue our discussion having in consideration the presence in biosphere of natural magnetic and electromagnetic fields.

During the last 120 years the biosphere has been exposed to increasing number and variety of electromagnetic fields related to discovery of industrial methods for generating electricity and further innovations in technology, communication, transportation, home equipment, and education.

More than 45 years ago brilliant Soviet magnetobiologist Yuri Kholodov wrote a book "Man in the magnetic web". (Kholodov, 1976) Long before occurrence of mobile communications, Kholodov pointed out that the entire biosphere is immersed in the ocean of the electromagnetic waves.

During the last quarter of century voices became raised that electromagnetic fields (EMF) might be detrimental for biosphere and human life. After 1976 two serious problems immersed in the public health discussion – potential hazard of low frequency EMF from power and distribution lines (in the late 1970's and 1980's) and mobile communications (mobile phones, Wi-Fi Internet, base stations) that utilize high frequency

EMF and represent a serious hazard for public health today. Today the mankind participates in a global experiment conducted by the industry without regulation, rules and control.

The reaction of the American newsmedia, politicians and society to publication of Wertheimer and Leeper (1982) was so strong that in 1992 the Congress of the USA passed Energy Policy Act and dedicated 60 million of dollars for investigation of the potential hazard of electricity for human health. Unfortunately, after 5 years and 41 million dollars spent the conclusion was "we do not have conclusive evidence to link electromagnetic fields to cancer initiation". It would be fair to say that this failure is result of the fact that the project due to the lack of general direction of the research and funding the individual study proposals (it was coordinated by 7 different institutions and had a chairman representative of the society who was never seen before at such meetings).

The hazard of EMF is discussed mainly from the view point of mobile communication and the effects on biosphere are usually neglected. A quarter of century ago, the man-made EMF were named as "factor of new ecology" because of the substantial, even unnoticeable action on the entire biosphere. (Markov, 1988).

II. MOBILE COMMUNICATIONS AND WIFI TECHNOLOGIES

I was astonished attending in 1997 the Second World Congress of Electricity and Magnetism to hear from the Chairman Prof. Andersen that in 2010 more than 75% of the World communication will be wireless. It sounded as an unbelievable dream.

However, the industry went even further. By the 2010 in the USA, 285 million mobile phone subscribers have been registered (for a little bit more than 300 million inhabitants). As of August 2013 there were 210 millions cell phone in Brazil (with population of 193 millions). The estimate for the world is more than 5 billion mobile phone users at approximately 7 billion people living on this planet.

Having this in mind, the evaluation and prediction of the potential adverse effects from using wireless communications (any mobile device, including), especially by children, becomes a question of crucial importance. The twenty-first century is marked with exponentially increasing development of technologies that provide wireless communications. To the pollution of the atmosphere with radio and TV signals, not only

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satellite communications but also any varieties of the Wi-Fi networks are added.

It is not well known fact that a cellular telephone delivers a power density of radiofrequency radiation about 2 billion times greater than occurs naturally in the environment. Since the mobile phones are designed to operate at the side of the user's head, a large part of the transmitted energy is radiated directly into that person's brain. Therefore, the absorbed energy potentially could cause within the brain dangerous and damaging biological effects. The small cellular telephones effectively deposit large amounts of energy into small areas of the user's head and brain.

The fast development of satellite communications, followed by wireless communications and recently WiFi technology dramatically changes the electromagnetic environment. To continuous action of complex and unknown (by sources, amplitudes, frequencies) electromagnetic fields is exposed entire biosphere and every organism living on this planet. We usually neglect this complex that includes radio and TV transmissions, satellite signals, mobile phones and base stations, wireless communications.

The search for specificity of the WiFi technology can point to the following:

- Popular technology that allows an electronic device to exchange data wirelessly (using RF EMF) over a computer network, including high-speed Internet
- A device that use Wi-Fi can connect to a network resource such as the Internet via a wireless network access point. Such an access point has a range of about 20 meters indoors and a greater range outdoors.

As a result

- Brains of 7,000,000,000 people are exposed to unknown spectrum of EMF
- There is no criteria for hazard levels
- No monitoring
- No research
- No prevention

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I want to make clear in the beginning of this paper that my fear from the potential hazard of the mobile communication is related more to the non-

thermal effects of this physical factor, unknown to mankind until half a century ago.

Speaking on the potential hazard of Wi-Fi technologies, one should not forget that it includes not only mobile phones but also more importantly all means of emitters and distributors of Wi-Fi signals, mainly antennas, base stations and satellites. In many public locations, own systems are introduced in order to facilitate the work performance. Well, this might be understood. However, why Wi-Fi communications are secured in the subway tunnels? When I was writing this paper, the USA news media are discussing the possibility to allow use of mobile devices during the flight. It obviously requires high and oriented power to which are exposed all passengers in the trains and planes. Just to make comfortable the users of mobile devices. It is forgotten that in the conditions of confined subway tunnels and planes, to use mobile signal significant increase of the delivered power of the signal is needed.

Well, one may agree or disagree with the idea that use of mobile communication devices is hazardous for his health. But the point of hazard for entire biosphere, including humans should not be missed. We are not talking here for the hazard of devices, but for the hazard of means of delivery the signals. It would be plausible to remind once again the words of Kholodov that we exist in the ocean of electromagnetic waves. From newly born baby to the century old gentlemen – everybody is exposed to unknown and frequently changing combination of EMF.

Now, let look what the science is doing in clarifying the situation so important for mankind. The major guidelines established by the engineering community, IEEE (Institute of electrical and electronic engineers) in 2005 and ICNIRP (International commission on non-ionizing protection) in 2009 provide approach and terminology which are not acceptable for physics and biological communities, but nevertheless remain the guiding rules (mainly for the industry). One can only wonder how is possible to speak about potential "health effects" of RF instead of "health hazard". The misuse of the term "health effect" completely neglects the fact that a physical/chemical factor could have either positive (beneficial) or negative (hazard effect). I am suspicious that this is done by purpose not to alarm the general public about the hazard of use microwave radiation in close proximity to the human brain.

It has been pointed elsewhere (Markov, 2006) that the engineering committees statement that "Nonthermal RF biological effects have not been established" basically are guiding science and society into wrong direction. To decline possibility of nonthermal effects is not reasonable, but more important is that they mixed "effect" and "hazard". During the last half a century laboratory and clinical research was performed

that indicate the possibility of non-thermal effect, even in greater degree than thermal effects. Israel et al. correctly pointed out that even definition of thermal effect by these international bodies is not accurate. (Israel et al., 2013).

It should be reasonable to mention that this problem is not new. It was noted in 1995 by Kane "Never in human history has there been such a practice as we now encounter with the marketing and distributing of products hostile to the human biological system by an industry with foreknowledge of those effects." (Kane, 1995) What may be added to this powerful statement – R. Kane was high level Motorola executive.

One of the first papers on the absorption of electromagnetic energy was published by Schwan and Piersol, in which they connected this absorption with the tissue composition (Schwan and Piersol, 1954) It is important to note that tissue composition is a very complex one and varies from organ to organ, from person to person. From biophysics point of view the energy absorption also depends on the depth of penetration for the specific frequency range (for 825-845 MHz the penetration depth into brain tissue is from 2 cm to 3.8 cm). (Polk and Postow, 1986).

Fourthly years ago Michaelson (1972) wrote "It should be understood that a cumulative effect is the accumulation of damage resulting from repeated exposures each of which is individually capable of producing some small degree of damage. In other words, a single exposure can result in covert thermal injury, but the incurred damage repairs itself within a sufficient time period, for example hours or days, and therefore is reversible and does not advance to a noticeable permanent, or semi-permanent state. If a second exposure or several repetitive exposures take place at time intervals shorter than that needed for repair, damage can advance to a noticeable stage."

In other words, the repeated irritation of a particular biological area, such as a small region of the brain, can lead to irreparable damage. Given the existence of energy absorption "hot spots" then each damaging exposure to radiofrequency radiation provides a new opportunity that the damage will become permanent. Part of the problem is that an exposed person would never know of the penetration and damage.

Interestingly enough, the basic science from the 1950's to 1990's reported evidence that high frequency EMF can have harmful effects on human organisms and especially on human brain. It has been even detailed in respect of the frequency range: 900-2500 MHz. Number of studies had pointed out that electromagnetic energy in the 900 MHz region may be more harmful because of its greater penetrating capability compared to 2450 MHz, therefore more energy in the 900 MHz frequency range is deposited deeply within biological tissue. In 1976 Lin concluded that 918 MHz energy constitutes a

greater health hazard to the human brain than does 2450 MHz energy for a similar incident power density. (Lin, 1976).

It has been reported that diathermy applications consistently show that electromagnetic energy at frequencies near and below 900 MHz is best suited for deep penetration into brain tissue. The depth of penetration is noticeably greater at this frequency range, which includes the portable cellular phone frequencies as compared with higher frequencies. What is also important, it was proven that deep tissue heating is obtained without detecting significant heating in the surface tissues. By their nature the frequencies that provide the best therapeutic heating would also be frequencies that could be most hazardous to man in an uncontrolled situation. High absorption in inner tissue such as the brain occurs while fat and bone absorption is many times less. (Johnson and Guy, 1972).

Let me remind the readers that these studies have been performed and published before mobile communications technologies originated. At once, everybody forget this information. An obvious question arises: If science had developed such knowledge decades ago why today these questions are not at the priority list for research? We would point here two major reasons: The political power of the industry and the failure of the scientific community.

For more than half a century, a very serious group of policy makers and even scientists are playing around the term SAR. The Specific Absorption Rate given in terms of Watts per Kilogram (W/Kg) or milliwatts per gram (mW/g), is assumed to provide a measure of absorbed energy in a given tissue. *Absorption, not delivery*. This term is particularly advantageous for the industry since the energy absorption in biological bodies and specific organs is non uniform and frequency-dependent. However, up today SAR is more often used to describe the energy generated by the source of the electromagnetic field (EMF). One can only wonder how a device may be characterized by SAR. *Let repeat, the specific absorption rate (SAR) identifies the amount of energy that is absorbed in a gram of tissue.*

The inappropriate use of the SAR leads proponents of WiFi technology to affirm that since there is not heating of brain by radiofrequency EMF, there is no hazard for the human brain, completely neglecting the fact that most of biological effects are non-thermal. We are convinced that the safety standards would need to be restated in terms of internal energy absorption.

III. EMF IN BIOSPHERE

Very often the news media discuss how dangerous electromagnetic/magnetic field might be for human health, especially in relation to cancer initiation. The hazard should be considered in respect to the continuous exposure to electromagnetic fields in

workplace and/or occupational conditions, while at the same time short, controlled exposure to specific electromagnetic fields makes possible therapeutic benefit.

Concentrating on human health, today science practically neglects the possible ecological effects of RF-EMF. I personally prefer using the term "biosphere" instead "ecology" since it includes not only wild life, but human population, as well. However, it will be used the term ecological for easy understanding the effects in living nature.

Many ecological endpoints (e.g. fertility, reproduction and growth) studied at the level of the individual animal, are crucial from an ecological point of view. It should be pointed that the ecology studies all living organisms, at all organizational levels (i.e. from the smallest molecular system to the largest ecosystem levels). By definition ecology focuses on the higher organizational levels of populations, communities and ecosystems.

This field of research is of crucial importance for the understanding of mechanisms of interaction between complex ecosystems and the environment. (Cucurachi et al, 2012). Animal studies have still been identified as a major research agenda point by the WHO (Van Deventer et al., 2011). The WHO stated that high priority in the field should be given to research on the effects of RF-EMF on development and behavior, on ageing and reproduction of animal subjects. The result of these studies might be ecologically interpreted, because they include ecologically relevant endpoints.

It is important to remember that the entire biosphere exists at "optimal" conditions. This means that when the perturbations in the existing factors (in increase and decrease of the values) could be compensated to certain extent. If, however, the changes are strong enough, the compensation could not be possible.

The most comprehensive review of the lower band MW EMF ecological effects was published by (Cucurachi et al, 2012) using two databases: ISIWeb of Knowledge and Google Scholar. In overall 65% of the studies reported a statistical significant effect of RF-EMF on ecological relevant endpoints. The most represented groups include vertebrates, (predominantly rats, mice and rabbits), then birds and plants. Articles which report significant effects of RF-EMF were found more frequently in the case of birds, insects (i.e. mostly honey bees and fruit flies) and plants.

Interestingly enough, many studies on birds were performed in the laboratory. Amongst the more recent laboratory studies, evidence of an effect of RF-EMF on mortality and development of embryos was in all cases found at both high and low dosages. In all field studies was found a significant effect of RF-EMF on breeding density, reproduction or species composition.

The animal systems commonly used in laboratory studies include rats (Wistar albino rat and Sprague Dawley rat), mice (Balb/c and Balb/c/f), rabbits (White New Zealand Rabbit), rhesus monkeys (Macaca mulatta). A total of 27 experiments (43%) showed no significant results of an impact of RF-EMF under the physical and experimental settings used. The power density ranged from 0.6×10^{-6} to 20 mW/cm^2 , which was the maximum value measured for MW CW exposures.

A large share of the studies on vertebrate animal models focused on changes in behavior as a result of exposure. This choice may be related to investigating of possible influences of RF-EMF on the behavior and cognitive performance of humans, who use mobile phone devices in close proximity to their heads. Some commonalities between human and rat response to noxious substances have been explored by other fields of science. Lai et al. (1994) suggested that rats suffer from a deficit in spatial working memory function when exposed to RF-EMF (50% decreased performance compared to control).

The articles by Lee et al. (2009, 2012) and Imai et al. (2011) are the only studies focusing on the impact of the frequencies network standards found in 3G mobile communication (Collins and Smith, 2001), working with protocols like wideband code division multiple access (W-CDMA) or CDMA. All experiments, on mice and rats, did not have any observable adverse effect on development, reproduction or mutation of tested subjects. These studies represent the first attempt to investigate the effects of wireless communication on health.

The influence of the earth's natural magnetic field or that of superimposed artificial magnetic fields on plants has been known for many years. Static magnetic fields, in fact, have been proven to have a beneficial impact on the stimulation of growth and germination of plants (Dulbinskaya, 1973; Pittman, 1965; Savostin, 1930), or inhibitive impact depending on the species and their physiological state (Krizaj and Valencic, 1989). According to Soltani et al. (2006), until now no proper physiological explanation has been provided for the described effects, though the biological effects of weak static MF do not depend only on the physical conditions of the exposure, but also on the environmental conditions in place.

In most of the field studies information for the values of local magnetic field(s) is missing. One anecdotal example might be found in experience from former Soviet Union: It was decided to bring in the area of Kursk corn from Kazaxstan know with higher yield. However, the yield in new place failed in 50%. Nobody paid attention that in Kursk the value of geomagnetic field was 2 Gauss, while in Kazaxstan only 0.5 Gauss. When returned back, the seed slowly (within 3 years) returned to previous yield.

Probably here I should mention the report of Pavlovich(1976) who place in a mu-metal container a colony of microorganisms with 24 hours reproduction cycle. At day 7 he observed mutation in the culture. The reason? This container shields the colony from ambient magnetic field. Several generations grew in conditions of absence of usual magnetic field and started to search for accommodation to new condition and find this way in mutation.

The analyzed literature considered that plants are continuously exposed to RF-EMF as they cannot avoid them, by moving away from the source of emission. In total, 16 studies and 29 experiments were selected by Cucurachi et al. (2012) based on the ecological relevance of the endpoints studied.

The frequency investigated ranged from as low as 10 MHz to 2450 MHz with power density from 0.015 mW/cm² to 50 mW/cm². A Latvian group of researchers (Balodis et al., 1996; Magone, 1996; Selga and Selga, 1996) focused on the area of Skundra, Latvia, where a radio location station had been operating for 20 years. The three studies provide a unique experience of a complete set of experiments and field studies conducted around a radio station in the short as well as in the long term. The studies also assessed RF-EMF effects at different distances from the station. As a result, the non-thermal RF-EMF under investigation indicated that the effects of short term exposure (i.e. up to five days) are dependent on the stage of growth of great duckweed at the time of exposure.

The vegetative growth of young plants decreased as a consequence of exposure, while it even accelerated in the case of older plants. The exposed population of adult plants was on average growing 150% more than the control unexposed samples. The effects of RF-EMF emitted by the radio station were analyzed using retrospective tree ring data in Balodis et al. (1996): a significant negative correlation between the measured electric field at specific sample locations and the mean relative additional annual increment of pines has been identified. Selga and Selga (1996) found significant cytological and ultra-structural changes in exposed pine needles and cones.

A connection between exposure and very rapid molecular stress responses was made in the studies performed by Roux et al. (2006, 2008) focusing on the molecular responses of tomato plants. The study was based on the use of several stress related transcripts (e.g. energy charge and protease inhibitor). Great differences were found in the exposed population compared to the control (up to 300%). The data supports the evidence that plants respond to exposure as they would respond to any other injurious treatment. Even though the RF-EMF used was non-thermal and the total power used was low, results, as the authors commented, are strikingly similar to those found when plants are wounded, cut or burned.

To summarize: The number of studies finding effects was highest for plants (90%) and insects (90%), lower for birds (70%), other vertebrates (56%) and other organisms (50%). In all the available field studies significant effects of RF-EMF were found. In laboratory experiments, birds and vertebrate animal subjects were in most cases tested at higher frequencies than smaller organisms (e.g. fruit flies) and plants.

One serious obstacle in evaluating effects of EMF in biosphere and even in laboratory is insufficient reporting of the parameters of the study which makes difficult, if not impossible to compare results from different studies. Some studies only provided the frequencies of the RF-EMF emitting device and one dosage parameter (e.g. power density in mW/cm²). A limited number of studies supplied the full list of physical parameters needed for an adequate description of the exposure (e.g. modulation, spatial connotation of field, polarization, field pattern and measuring techniques). The reporting of the measured or extrapolated power density values and relative electric field values were discordant and no precise information was given on measurement or calculation procedures. Also relevant biological parameters such as size of the target, tissue dielectric properties, geometry, and relation to polarization are often neglected. In a critical review of 56 reports, Colbert et al. (2008) found that only 2 papers correctly explained 10 parameters of the exposure.

The ICNIRP guidelines (1998, 2010) provide limiting values as basic restrictions and reference levels for the exposure of humans to RF-EMF. These guidelines have been adopted by most European countries which have imposed limits (EU Commission implantation Reports, 2008). There are currently no guidelines for the exposure of biodiversity to RF-EMF. The available data has so far been inadequate to judge whether the ICNIRP guidelines and other environmental standards should be the same or significantly different from those appropriate to protect human health.

No clear relationships, in fact, could be declared between dosage and effects because of a wide variety of exposure strengths, durations, conditions, frequencies, time between exposures, assessment methods, measurement systems, replications efforts, and adequate dosimetry. Some authors consider that in the older laboratory studies the interpretation of results needs to be filtered by the consideration of a lack of control of temperature. In the other studies the balance of experimental evidence points towards a non-thermal effect of RF-EMF exposure.

At the current state of our knowledge, there is an urgent need for repetitions of experiments and field studies by other research groups in order to confirm the presence/absence of effects. ICNIRP statement of (2010), suggests that results can only be accepted 'for health risk assessment if a complete description of the

experimental technique and dosimetry are provided, all data are fully analyzed and completely objective, results show a high level of statistical significance, are quantifiable and susceptible to independent confirmation, and the same effects can be reproduced by independent laboratories' (Repacholi and Cardis, 1997).

Experiments evaluating the impact of newer wireless technologies (e.g. WiMAX, WLAN and WiFi), together with studies analyzing new generations of mobile phone technologies (e.g. 3G and 4G) would shade some light on the impact of these technologies for ecosystems. To our knowledge solely the study on mice by Lee et al. (2009) investigated the possible impacts of these technologies. In order to minimize the uncertainties as efficiently as possible a number of situations with limited number of studies should be investigated: the long-term monitoring of selected species and/or ecosystems, field studies under a controlled system of exposure, laboratory studies following given recommendations, and studies on important ecological groups, other than those here analyzed, would be a solid base on which to focus future studies.

The physical parameters usually reported regarded the measured level of power flux density and specific absorption rate (SAR). These parameters were either measured using probes or specific detectors or were based on the information of the manufacturers of the exposure devices. All the reported physical parameters varied greatly across studies. The estimated SARs ranged between 0.001 W/kg and 140 W/kg. I wonder what actually means "estimated SAR". Let me point that SAR means specific absorption rate. In other words this is characteristic of the specific absorption of the energy in the target tissue or organ. Since biological systems are effectively non-linear systems it is hard to accept that the term "estimated SAR" represents a term to be believed.

SAR was introduced as an attempt to evaluate the energy deposition in a given tissue with the presumption that the RF effects are only thermal. This definitely leads in wrong direction, since plenty of studies demonstrated non-thermal character of interactions between RF EMF and living tissues.

IV. ELECTROMAGNETIC HYPERSENSITIVITY (EHS)

There is a small fraction of human population that is supersensitive to exposure to EMF. Even having in mind that it is 1-3% of population, it is important that public health system take care for these people. On the other hand, studying the adverse reactions of these people, scientists might pay more serious attention to entire civilization. This problem is real, the attitude of science and industry – not. What the science says: "The symptoms are real, but what causes them is a mystery".

The industry is even more severe: "It is just psychology, nothing is real". The same mantra is propagated by WHO, ICNIRP and numerous expert committees. Dr. Dariusz Leszczynski (private communication) wrote: "I have the feeling that this mantra was introduced to the EMF research area few years ago for the sole purpose to "get the EHS people off our backs". Designers of this mantra assumed that by showing compassion for the suffering of EHS people they will alleviate tensions that exist between EHS sufferers and decision-makers."

Let discuss here the problem of identifying the EHS and helping the victims. First of all, EHS is not a well defined ailment. The list of symptoms claimed to be caused by EMF is long and very unspecific. The same symptoms can be caused by a variety of factors, including simple, life accompanying, stress. Distinguishing which stressor is responsible for EHS symptoms might be challenging even for well trained general practitioners. Therefore, patients are referred to psychologists and psychiatrists. This leads to generation of research studies that by design are unable to detect EHS. Using methods of psychology or psychiatry will not answer whether biochemically physiology of our body is affected by the exposure to EMF.

Unfortunately, the diagnosis of EHS is difficult because we all are exposed to enormous variety of EMF that surround every living creature. It is not only wireless communication-emitted radiation, but a whole range of professional utilities and home appliances. It will be fair to say that we are surrounded by the ocean of EMF with different amplitudes, frequencies and duration of action. Due to increasing development of new and new means and devices for WiFi communications, the entire world population is participating in a global "experiment: without control and protocol of the study. (Markov and Grigoriev).

Since we do not know what might be the physical parameters of exposure that triggers EHS symptoms it is difficult to identify the specific EMF source that causes the problem. But this should not be the reason to claim the lack of causality between EHS and EMF. The existence of EHS is a simple fact of life. The only question is what exposure parameters are sufficient to trigger EHS. For every radiation type, every chemical, every environmental pollutant there exist sub-populations of people who are more sensitive than others. This phenomenon, known as individual sensitivity, is encoded in our genetic diversity. Ironically, the only case where the individual sensitivity is denied is when it affects the interests of the wireless communications industry.

V. RECENT DEVELOPMENT

At the end of March 2014 The European Commission organized a workshop in Athens, Greece on EMF electromagnetic fields and health effects

focused on public awareness, conciliating scientific findings and uncertainties in policy making. The event included presentations from various parties from the European Commission, WHO, public authorities, industry, operators, environmental and consumer associations and academia. The goal of the conference was to reach a common approach for the future in order to respond to public concerns about electromagnetic fields, to enhance information dissemination and discuss new studies and scientific evidence in relation to EMF, and to identify knowledge gaps needed for sound policy making. In this context, the new SCENIHR draft opinion on EMF and potential health effects was presented. SCENIHR, the Scientific Committee on Emerging and Newly Identified Health Risks, has been charged with providing reports for the European Commission and Members of the European Parliament which may be relied upon by all participating governments. Furthermore the 500 million citizens of Europe are relying on SCENIHR's review.

Unfortunately, SCENIHR's review clearly cherry picked their own research and promoted it as gold standard while heavily criticizing Lennart Hardell's research." The Hardell Group published five ground breaking studies in 2013, that are the first to correlate mobile phone usage with incidences of brain tumors over a 20+-year period of time, longer than any other epidemiological studies. They found a clear correlation between cell phone usage and two types of brain tumors, acoustic neuromas and the deadliest of all brain cancers, gliomas. While the Hardell's studies have been accepted prior to 2013, including taking into consideration when the IARC scientists almost unanimously voted for the 2B "possible carcinogen to humans" classification for the entire RF EMF Spectrum, now situation changes. In my opinion it happened after the long delay of the final report of the INTERPHONE multinational study leads to separation of the participants in the project into two groups. One may wonder how the multiyear project that supposed to be conducted under same protocol can lead to completely different opinions.

The scientific dispute brings to the scene the highest court in Italy which favoured Hardell's position over the 2010 Interphone Studies, considering Hardell's studies more reliable and independent than the Interphone study which had been part funded by the mobile phone industry.

Moreover, Paolo Rossi, Italian Ministry of Health said, "Children should not use mobile phones as a toy". I completely agree with such position. Unfortunately, while mobile phones were a tool for communication a decade ago, now the different WiFi items might be seen in the hands of children as young as 3 years.

For years scientists have been offering incomplete, inconsistent and contradictory information, leading to confusion for the public and policy makers,

resulting in members of the public seeking justice via the courts. "There is a lack of responsibility taken with policy makers saying they are relying on government and industry funded scientific reports from scientists. Then these same scientists say it is the duty of policy makers to protect public health. At the same time, important reports fail to do a thorough review of literature on non-ionizing electromagnetic fields (EMF) and biological health effects. Only selected papers were evaluated using ambiguous criteria. Most of the following publications since 2007 were not considered by SCENIHR.

a) *Genetic Effects*

- RFR: 114 papers (65% reported effects)
- ELF EMF: 59 papers (83% reported effects)

b) *Neurological Effects*

- RFR: 211 papers (68% reported effects)
- ELF EMF: 105 papers (90% reported effects)

c) *Oxidative Status*

- RFR: 106 papers (88% reported effects)
- ELF EMF: 110 papers (88% reported effects)

Lai and Levitt said, "It is outrageous to ignore any effect of EMF exposure on human health and a crime to humanity not to recommend any action to curtail the exposure."

"The world urgently needs to be informed that these five papers by the esteemed Hardell Group were dismissed and ignored by Schüz, by IARC, by WHO, and as we witnessed in Athens, by SCENIHR," Eileen O'Connor stated. "These papers have been placed directly into the hands of the EU Commission along with the report from Lai and Levitt outlining hundreds of missing research papers demonstrating positive results in the hope that policy makers can hold SCENIHR accountable."

She said "'Failure is not an option.' These are the famous words from the Apollo 13 control room chief officer Gene Kranz and these words have followed me since meeting him in 1999." The rocket scientist continued, "Our European Community is being irradiated by microwaves; people are becoming ill and suffering with many conditions including electrosensitivity. The World Health Organization has also declared a possible correlation to cancer in humans. It's not rocket science. It's just common sense and sound science."

Eileen O'Connor stated: "*As of March 28, 2014 representatives of the telecom industry, government officials, and WHO scientists absolutely, irrefutably have the latest science from Hardell and know that Hardell himself is calling for RF to be classified a Group 1 carcinogen. The clock has now started ticking on liability. No more excuses. SCENIHR, The industry, the*

EU Commission, and WHO are now fully informed.“ Once adopted, this opinion will update previous Scientific Committee opinions of 19 January 2009 and 6 July 2009 in light of newly available information.

VI. PRECAUTIONARY PRINCIPLE

Generally speaking, we do not know if or to which extent the WiFi radiation alters physiology of normal, healthy organisms. The situation became more complex when we are asking about the influence on children, on aging adults or sick individuals.

Every evaluation of the “hazard” as well as every standard for the permissible level of exposure should be done following the precautionary principle: If we do not know that a given food, drink, medication, physical, or chemical factor is safe, we should treat it as potentially hazardous.

If this approach is applicable in so many areas of life, in production of food and drinks, in approval of medications, why it is not applied in the EMF generating devices? My own explanation is that the regulatory organs neglected the potential hazard of exposure to EMF of living creatures – from microorganisms to elephants, to humans.

The hazard issue is frequently represented as “controversial”, and it is absolutely incorrect. It is not controversial issue, it is conflict of interest of industry on one side and mankind and environment on the other.

It is remarkable that IARC (International Agency of Research on Cancer) in the summer of 2011 classified radiofrequency electromagnetic fields as possible cancerogene.

It is not too late yet to recognize the potential hazard from electromagnetic fields acting in biosphere and especially on the human population. Scientists and policy makers should recognize that especially with development of satellite and wireless communication, all living creatures in the biosphere are exposed to continuous action of electromagnetic fields.

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