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STUDENT PAPER

Cross sectional survey on risk perception about health effects of electromagnetic fields

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Presented by: Hiroaki Miyagi

We conducted cross sectional survey to general public via online questionnaires in order to elucidate the levels of their risk perception on EMF exposure and the influential factors to them, and to test hypothesis that evidence-based information would mitigate the levels. The levels of knowledge were inversely related to the levels of risk perception. However, in some cases, providing information was not necessarily linked to mitigation of the levels of risk perception.

Introduction

Exposure levels to electromagnetic fields in our daily lives are very low, and there are no substantiated evidences that such exposure causes adverse health effects. However, there are some people concerned about such effects. In this study, we conducted cross sectional survey to general public via online questionnaires in order to elucidate the levels of their risk perception on EMF exposure and the influential factors to them, and to verify hypothesis that evidence-based information would mitigate the levels.

Materials and methods

We recruited total 1,000 general public in each age groups (20s to 60s) in both genders and asked them to answer online questionnaires (including levels of knowledge about the nature of EMFs and its biological/health effects; sources of information on health effects of EMF, and their trust to the sources; and levels of risk perception on the health effects).

Results

Levels of knowledge on the nature of EMF were somewhat higher in male than in female. There was higher ratio of showing “I am concerned” to health effects of EMF in female than in male. When provided official information (such as one from World Health Organization), the ratio of showing “I am concerned” was reduced. However, the ratio of “I am not concerned” was also reduced and “I am not sure” was increased.

Discussion and conclusion

Regarding health effects of EMF, the levels of knowledge were inversely related to the levels of risk perception. However, in some cases, providing information was not necessarily linked to mitigation of the levels of risk perception. As there are some people with vague anxiety on health effects of EMF, it is necessary to develop appropriate methods to provide evidence-based information, focusing on such people.

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Average values of ELF MF due to HV power lines in Slovenia

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Presented by: Blaz Valic

The average values of extremely low-frequency magnetic fields (ELF MF) generated by high-voltage power lines (HV PL) were determined for the entire territory of Slovenia using a novel approach since existing methods are not feasible for such large areas. The results were determined for the average loads of HV PL in the period from 2006 to 2017. The average ELF MF was higher than 0.1µT in 1 percent of the territory of Slovenia. After initial calculation of the ELF MF for each HV PL separately the new method enables relatively

fast calculation for arbitrary loads or changes in the power distribution network such as reconstruction of a HV PL.

Introduction

Data about the average values of the extremely low-frequency (ELF) magnetic field (MF) due to high-voltage (HV) power lines (PL) enable, on one hand, objective communication with the public about actual exposures to ELF MF generated by power distribution network, and epidemiological analysis of different diseases, especially different types of cancer. Therefore, the average values of the ELF MF were determined for the entire territory of Slovenia due to the operation of all HV PL and cables. We decided to analyze the average values of the ELF MF as epidemiological studies shows that long-term averages are more important than the current or maximum values.

Materials and Methods

Register of HV PL

The register of the HV PL was prepared to enable later calculation and determination of the spatial distribution of the ELF MF in the vicinity of the HV PL on the entire territory of Slovenia. The following data for each HV PL were obtained from national power grid company:

- nominal voltage and current;
- data about the load in the period from 1. January 2006 to 31. December 2017;
- geometry of each PL pylon and conductor arrangements;
- locations of all PL pylons;
- data about the exact catenary of each segment of all PL.

For most of the segments the catenary was available in the form of 3D lines in shape format, but for some PL, we generated those lines either from an array of points obtained by LIDAR, from the information of the sag for each segment of the PL or from the values of the tension in each segment of the PL.

The load was available as the working and reactive energy transferred in each 15 minutes, the values of electric currents in the conductors of all HV PL for every 15 minutes were calculated from this information. Geometric daily, weekly, monthly and total mean (from 1. January 2006 to 31. 12. 2017) values were calculated for each HV PL.

Methodology to calculate the total values of the ELF MF

The value of the ELF MF due to all HV PL at one location is the result of the contributions of all nearby HV PL. When summing the contributions together it is important to remember that the ELF MF is a vector quantity and therefore the total value depends not only on the amplitude of each contribution but also on their direction and the angles between them. Typically, when calculating the value of the ELF MF, a numerical model is created that contains all sources and thus calculates the total value of the ELF MF for the selected loads of sources. With the available programs and computational capacity such a calculation is not feasible for large areas. In addition, this approach requires recalculation if there is change of one HV PL or if we can determine the total value of the ELF MF for other loads of power distribution network. In order to be able to determine the ELF MF for different load conditions, for example at nominal loads, actual maximum loads, average day or annual loads, special conditions such as one HV PL failure…, a specific methodology and appropriate algorithms have been developed and validated, which enable the calculation of the total ELF MF based on the values of the ELF MF of individual sources. Before calculating the total ELF MF, the once calculated ELF MF values of one individual source at nominal load can be easily scaled to the desired load, which enables relatively easy and fast calculation of the ELF MF for any condition of the power distribution network.

Four different algorithms to determine total value of the ELF MF were analyzed. The first algorithm takes the higher value of two contributions as the total value of the ELF MF at one point (MAX algorithm), whereas the fourth algorithm takes the sum of both values (MAX + MIN algorithm) as the total value of the ELF MF at one point. The other two algorithms calculate the total value by adding a lower value multiplied by a specific weight factor to the higher value (MAX + 0.3 MIN, MAX + 0.6 MIN). In reality the total value of the ELF MF can never be higher than the sum of both sumands, so the fourth MAX + MIN algorithm is conservative. In order to evaluate all four algorithms, various real world scenarios were analyzed where cumulative effects of several HV PL occur, e.g. intersection of two HV PL or parallel course of two and three HV PL. Figure 1 presents an analysis of one such case, namely the case of the intersection of two 110kV two-system HV PL. The color scale shows the deviation of the estimated ELF MF determined by all four new algorithms from the actual of ELF MF determined by usual numerical modeling procedure. Green means that there is practically no deviation, the more the color is red, the more the estimated value is overestimated and the more the color is blue, the more the estimated value is underestimated. It can be seen that the MAX algorithm is the least conservative of all four algorithms as it overestimates the ELF MF the least but it underestimates it on several locations, while the MAX + MIN algorithm overestimates the value on some areas and never underestimates it. Information regarding the deviation of the estimated value from the actual value is provided also by black and red contours. The black contours represent the limits of 0.1, 0.4 and 1μT for the actual value, and the red contours for the estimated value. For the MAX + MIN algorithm red contours never lies inside black contours, which means that estimated values overestimate actual values. Using the MAX algorithm, red contours often or even predominantly lie within black contours. The analysis showed that the most realistic results for different conditions is given by the MAX + 0.6 MIN algorithm, which was chosen as the optimal algorithm. Subsequent feasibility analysis showed that calculations could be performed according to all 4 algorithms, which allowed later sensitivity analysis, ie whether the choice of algorithm affects the result of epidemiological analyzes.

Results

The ELF MF generated by all HV PL was calculated for the entire territory of Slovenia with the 10m grid. Calculations of the ELF MF of each HV PL was done at the nominal load of HV PL up to the distance from the HV PL, where the value of the ELF MF drops below 0.05μT.

On Figure 2 the total value of the ELF MF of several HV PL around one transformer stations are presented for nominal loads. The total value of the ELF MF was determined by the new algorithm. Figure 3 shows the total value of the ELF MF of all HV PL on the entire territory of Slovenia for the average load for the period 2006 – 2017. The total value of the ELF MF was higher than 0.1μT on slightly less than 2 million points. This represents the area of 200km^2, which means that on around 1 percent of the territory of Slovenia the total value of the ELF MF is 0.1μT or higher. Figure 3, where the total value of the ELF MF on the entire territory of Slovenia is shown for the average load for the period 2006 – 2017 also demonstrates that the amount of the areas with increased value of the ELF MF is small. It can be seen that on the vast majority of the territory of Slovenia the value of the ELF MF due to HV PL does not reach the value of 0.1μT.

Conclusions

Availability of the data of the ELF MF for the entire territory of Slovenia for all HV PL enables different health risk assessments of the population living in the vicinity of HV PL. A novel approach and appropriate algorithms were developed to calculate and combine the contributions of the ELF MF from several sources. After initial calculation of the ELF MF for each HV PL separately the new method enables relatively fast calculation of the total ELF MF and therefore the exposure assessment of the population.

Therefore analyzes of various ELF MF exposures are possible in a short time (eg annual average value in each of the last 10 calendar years, maximum loads in the last 10 years, maximum daily, weekly or monthly average loads…), it also enables analyzes of for different scenarios like failure of one HV PL and correspondingly increased loads on other HV PL, construction of a new HV PL, reconstruction of a HV PL and other similar scenarios.

The newly developed method to determine the total ELF MF was validated on some smaller areas by comparing the results obtained by the new method and the results obtained by traditional numerical modeling where all sources are included in one model. The calculated values were also compared with the measurements, and both comparisons were is good agreement and showed the expected deviations of the results within the measurement uncertainty.

Figures

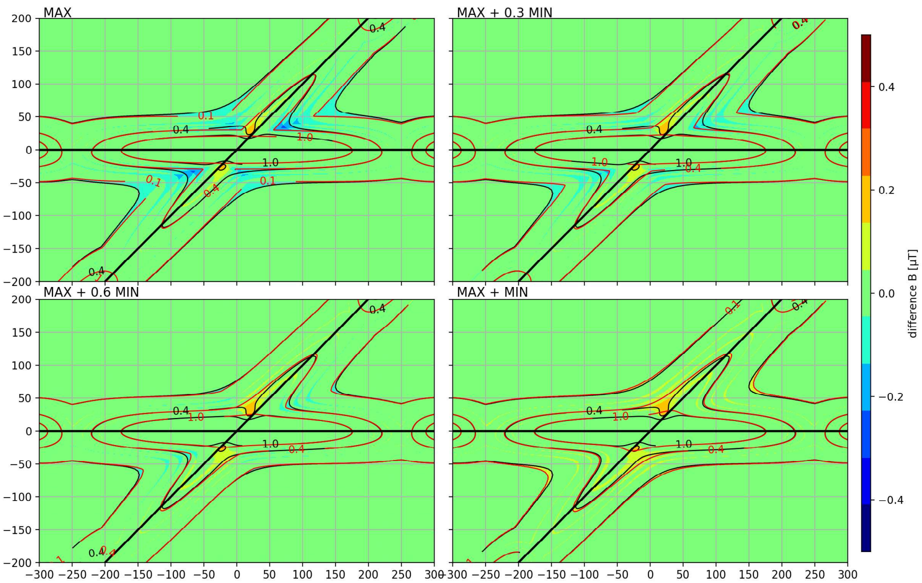

Figure 1. Comparison of results obtained by all 4 algorithms to determine total value of ELF MF for a case of intersection of two 2×110 kV PL of type barrel under the nominal load of 650 A. The color scale shows the deviation of the estimated ELF MF values determined by all four new algorithms from the actual value of ELF MF determined by the usual numerical modeling procedure. The black contours represent the limits of 0.1, 0.4 and 1 μT for the actual values, and the red contours for the estimated values.

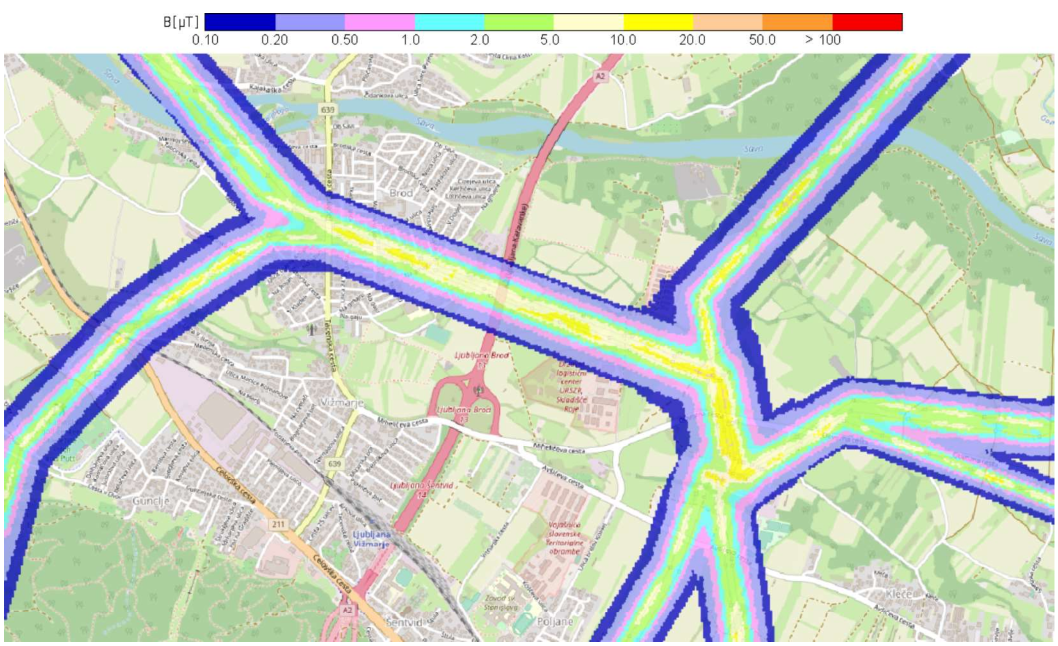

Figure 2. Total value of ELF MF of several HV PL around one transformer stations for nominal load.

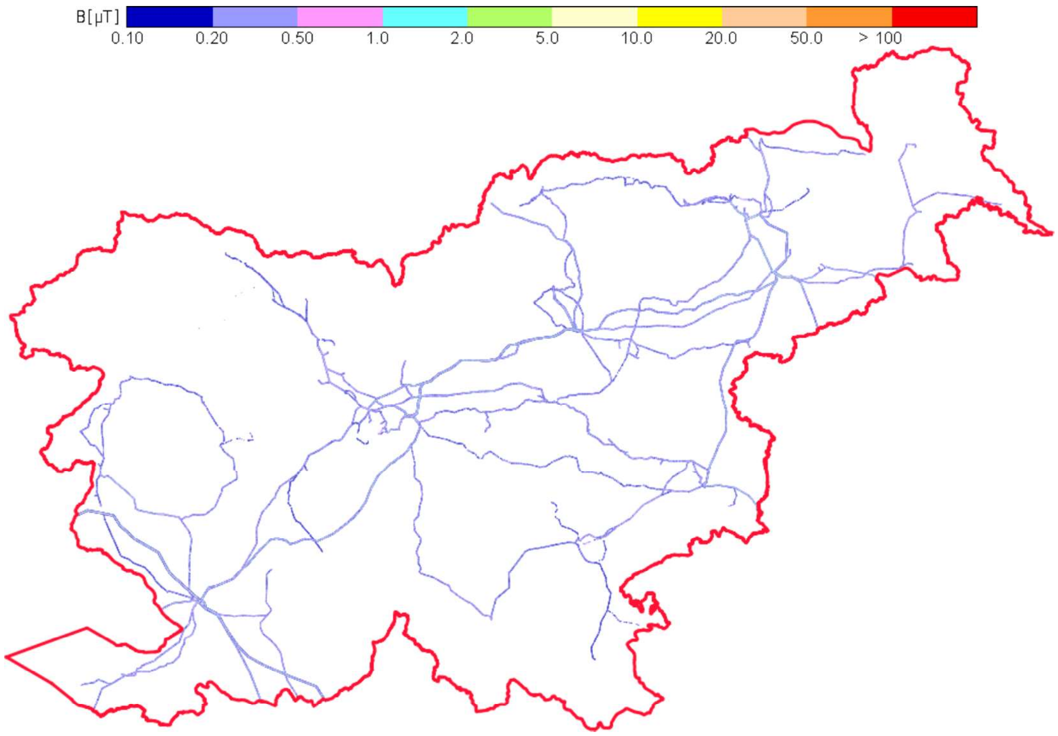

Figure 3. Total value of ELF MF of all HV PL on the entire territory of Slovenia for the average load for the period 2006 – 2017.

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Global questionnaire survey to researchers on standardization of experimental protocol for safety assessment of radiofrequency electromagnetic fields

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Presented by: Akira Ushiyama

There is no unified method for evaluating the toxicity of electromagnetic fields and assessing health risks. To develop standardization of experimental protocol for the safety assessment of EMFs, we conducted an internet survey of researchers to investigate their attitudes toward the standardization method. In this presentation, we report the results of a survey conducted on the radio frequency range. As a result, most of the researchers agreed that there should be a standardized method. However, it also became clear that some opinions overlapped, and opinions differed on what each respondent considered to be the standardized method.

Aim

Research that aims to clarify the effects on human health of electromagnetic fields (EMF) has been examined for more than 30 years. However, health risks have been remained due to the uncertain experimental