ORIGINAL PAPER

NECESSITY OF GIS SYSTEM FOR ELECTROMAGNETIC FIELD MANAGEMENT IN GALATI

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Abstract. *Nonionizing radiation-emitted by power lines, radios, TVs, cellular phones, microwave ovens, and many other sources-consists of longer wavelengths have the ability to do permanent damage at the cellular level. Geographic Information Systems in Electromagnetic Fields Modelling should be encouraged as a valid support to the monitoring EMF exposure in Romania. Galati's population living near sources of electromagnetic fields must know it could affect their health and their property value. In a future in Galati will be created a database with sources of radiofrequent radiation such as UMTS (Universal Mobile Telecommunications System) base stations, radio/television broadcast transmitters and high voltage power lines. Radiofrequent waves are electromagnetic radiation with wavelengths exceeding 1 mm. They comprise radar, radio and television waves and also industrially and domestically used microwaves of frequency 2,450 MHz.*

Keywords: *GIS, electromagnetic field, urban areas.*

1. INTRODUCTION

Non-ionizing radiation-emitted by power lines, radios, TVs, cellular phones, microwave ovens, and many other sources-consists of longer wavelengths that can have less power, and has mistakenly been assumed to be harmless, apart from its ability to heat tissue. Human civilization has encircled the earth and infused the atmosphere with these non-ionizing bands in ways that don't exist in nature-using abnormal exposure strengths and unusual characteristics such as alternating current, digital signalling, modulation, and odd wave forms-all without understanding the full bioeffects.

The human anatomy is resonant with-or acts as perfect antenna for- FM (Frequency modulation) radio frequencies, and that our bodies reach peak absorption in the ultra-high frequency (UHF) ranges, right where television and cellular-phone transmissions occur. The FCC (Federal Communications Commission) standards for radio-frequency emissions are based on thermal effects, or the RF's (Radio Frequency) ability to heat tissue, in the same way a microwave oven cooks food. But the case for non-thermal hazards from RF's is substantial. Decades of research have found alarming effects: numerous cancers, immune system suppression, and birth defects, among others. Some research has found detrimental effects based on frequency alone, not on power density. And bio-electromagnetic researchers often note puzzling "nonlinear effects," which indicate that the most profound bio-reactions occur at the lowest exposures. This body of research argues for fewer towers [1].

The mechanisms behind electromagnetic wave propagation are diverse, but can generally be attributed to reflection, diffraction and scattering. Most mobile wireless communication systems operate in areas where there is no line of sight path between transmitter and receiver. Due to multiple reflections from various objects, the electromagnetic waves travel along different paths of varying lengths. The interaction between these waves causes multipath fading at a specific location, and the strengths of the waves decrease as the distance between the transmitter and receiver increases [2].

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In the last years, the attention of the public community on this phenomenon has developed, especially because of growing use of hand made sources such as cellular phones, which have become an essential part of business, commerce and society. Moreover the advent of third generation systems will extend the use of most forms of communication technologies, including fax, e-mail and Internet access. The wide spread of communication infrastructures brings with it a natural increase of transmission signals in several areas, in particular in urban environments. A data model it is important to represent the sensible area from an electromagnetic point of view. The risk analysis has to take into account a plethora of information related to several territorial aspects in order to have suitable knowledge about phenomena. There are several methods which can be used to model the radiation emitted from conductors: Biot-Savart Law, Maxwell Equations, equivalent charges method. The Biot-Savart Law is used to determine the magnetic field caused by a current in a closed path. Hence, this method is suitable for the transmission lines in a closed loop but not for overhead transmission lines which are in alignment. The Maxwell Equations and the equivalent charges method are suitable to model or compute the electromagnetic radiation caused by overhead transmission system. However, more assumptions have to be made when the Maxwell Equations are applied and computations are more complicated than the equivalent charges' method. As both methods produce very similar results with the same level of accuracy, after consultation with the chief environmental engineer in a local power supply company, the equivalent charges method is selected.[3]

GIS was used to identify and locate environmental risk factors associated with Lyme disease in Baltimore County, Maryland [4]. With GIS it is much easier to combine epidemiology data and ecological data to model and predict disease spread and transmission. At a national level, GIS has been used to help design a surveillance system for the monitoring and control of malaria in Israel [5]. On a global scale, the National Aeronautics and Space Administration (NASA) established the Global Monitoring and Disease Prediction Program at Ames Research Center to identify environmental factors that affect the patterns of disease risk and transmission [6]. The program developed predictive models of vector population dynamics and disease transmission risk using remotely sensed data and GIS technologies and applied them to malaria surveillance and control [7].

A monitoring project of electromagnetic pollution named „GPS-GIS integrated system for electromagnetic pollution" has been realised in Altofonte (IT), near the metropolitan area of Palermo [8]. Another study was done in Hong Kong since 1997 [3]. In Italy, Regional Environmental Protection Agency, ARPA Piemonte, study the results of radiofrequency field monitoring in Torino: the variation of the electromagnetic field strength is evaluated as a function of the height from the ground, the location in the urban area and the frequency, separating the contributions of the different sources (broadcasting antennas and radio base stations for mobile phones) [9].

2. GEOGRAPHIC INFORMATION SYSTEM

Several of the studies have focused on electromagnetic fields from high voltage power lines close to people's residences. This study showed that calculated magnetic field exposure, estimated from distance to power lines, agreed fairly well with direct measurements of exposure. Exposure assessment in epidemiology is a time consuming and difficult task. On site distance measurements are extremely time consuming, expensive, and difficult to include in larger epidemiological studies. The best solution is to use map measurements in a monitoring project of electromagnetic pollution. The study of GIS has emerged in the last decade as an exciting multi-disciplinary endeavour, spanning such areas as geography, the environmental sciences and computer science [10].

GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies [11].

GIS is a technological field that incorporates geographical features with tabular data in order to map and analyze assess real-world problems. The data (or at least some proportion of the data) is spatial, in some way referenced to locations on the earth. Coupled with this data is usually tabular data known as attribute data, generally defined as additional information about each of the spatial features. GIS can operate on many levels. On the most basic level, GIS is used as computer cartography, i.e. mapping.

There are two primary types of data that are used in GIS. A geodatabase is a database that is in some way referenced to locations on the earth. Geodatabases are grouped into two different types: vector and raster. Vector data is spatial data represented as points, lines and polygons. Raster data is cell-based data such as aerial imagery and digital elevation models. Coupled with this data is usually data known as attribute data. Attribute data generally defined as additional information about each spatial feature housed in tabular format. Documentation of GIS datasets is known as metadata. Metadata contains such information as the coordinate system, when the data was created, when it was last updated, who created it and how to contact them and definitions for any of the code attribute data [12].

Data in a GIS is spatially-referenced based on its geographic component and therefore can be overlaid with other geographic data. Fig. 1 illustrates the concept of layering geographic data. Individually, each layer of data reveals a limited amount of information, but when superimposed, the composite reveals great complexity.

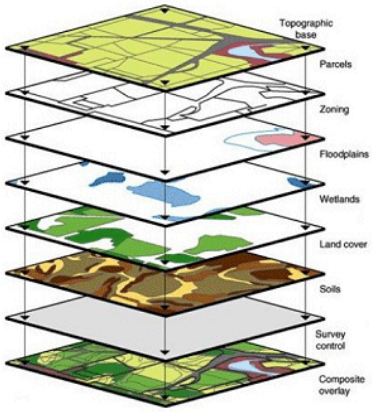

Fig. 1. The concept of layering geographic data.

Many geodatabases have custom functions that allow the spatial data to be manipulated and queried using SQL (Structured Query Language), for example to find all the residents of an area within an exposure zone for a potential environmental hazard. However the spatial data in some geodatabases can only be accessed by using specialized client software.

3. EXPERIMENTAL

Many digital map layers were necessary to perform this research. One is representing location of the residences. The other is a line coverage representing the location of the high voltage power lines in the study area. The accurate mapping of these data was the most

important step that was performed in preparation for this research. Epidemiologists use maps to log locations, encode associations, and study the spread of disease [13]. Add to the map the ability to undertake spatial analysis through advances in geographic information tools, and the result is a technology that is well suited to track disease. Studies that quantify lead hazards [14], model exposure to electromagnetic fields [15], and monitor air- and water-borne diseases all benefit from the development of technologies in geographic information science [11].

Computer simulations linked to GIS systems allow public safety officials, scientists, and the general population to understand the effect of the various phenomena in their areas of interest and to design appropriate mitigation plans. GIS in Electromagnetic Fields Modelling should be encouraged as a valid support to the monitoring activities related to this phenomenon in Romania. GIS Query Language must be a fruitful combination of GIS technology and visual languages, which have the double advantage of assisting electromagnetism experts in the measurement tasks, and facilitating non-expert users who might be interested in the level of EMF pollution in a given area.

Galati's population has reached in 2008 more than 340000 peoples. The public community living near sources of electromagnetic fields must know it could affect their health and their property value. In a future we plan a database with sources of radiofrequent radiation such as UMTS base stations; radio/television broadcast transmitters and high voltage power lines. The town of Galati will be divided into districts. In each district a grid of points must be fixed, chosen to be representative of the investigated area (their number depends on the dimensions and on the number of the district inhabitants). At these points, measurements at three different heights will be done: lower floors (ground floor, 1st floor), intermediate floors (2–5 floors) and higher floors (5–10 floors), in order to evaluate the trend of field strength with the height from the ground. For each site, the comparison between theoretical values and measured data will be done.

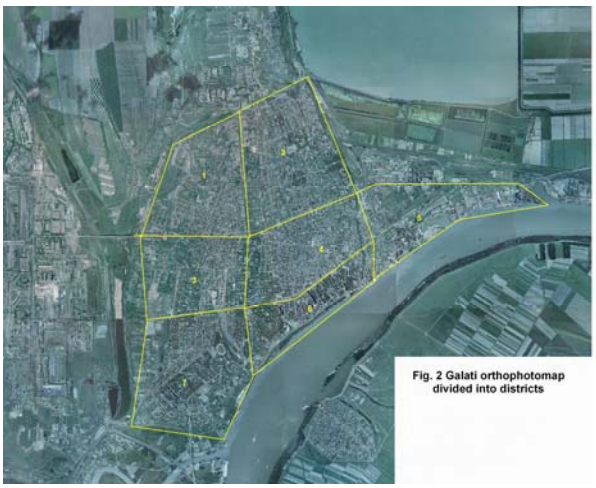

Fig. 2 Galati town orthophotomap divide into districts.

There are two options: first of them is to use Galati town orthophotomap (Fig. 2). We presented a proposal for division of town. Another option is to use many shapefile, containing building map, streets map, and railroads map (Fig. 3), with other proposal for division of town. Over any of them we will overlap theoretical values and measured data.

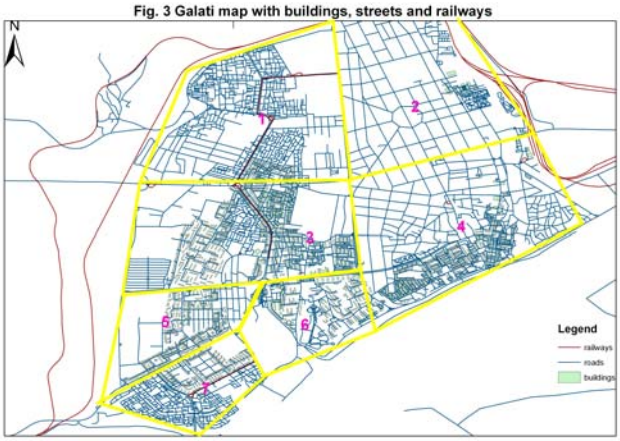

Fig. 3. Galati map with buildings, streets and railways.

MEASUREMENT INSTRUMENTS

The instruments necessary are:
(1) EMF RF Radiation Field Strength Power Meter 1MHz - 8GHz Wide frequency range: 1MHz to 8GHz (useful to 10GHz) with following parameters (Super Wide dynamic range 60dB; High sensitivity -55dBm to 0 dBm (25mV/m to 14.8V/m); Peak power density measurement 1.5uW/m^2 to 0.58W/m^2; LCD digital Histogram and Bar display to display power density level; Ultra fast colour LED 8 segment level display for easy signal level indication, Continue wave (AM, FM) and High speed Burst RF(GSM, TDMA, CDMA, Wi-Fi, WiMAX).
(2) GPS – Garmin GSMmap 60CSx
(3) GIS Workstation or Mobile GIS Workstation for the used data management.

The surveyed data represented the frequency range 100 kHz–3GHz.

Most of radio base station sites for mobile phones in town will be georeferred in order to make a theoretical evaluation of the exposure levels to electromagnetic fields.

Two fundamental digital map layers are necessary to perform this research. One is a point coverage representing location of the residences. The other was a line coverage representing the location of the high voltage power lines in the study area. The accurate mapping of these data is the most important step that must be performed in preparation for this research. The second base mapping task involved identifying all of the high voltage transmission lines in the study area, obtaining some key attribute information about them, and creating a positional accurate digital map layer containing this information.

Relating the geocoded residences to nearby power line features necessitated the measurement of the distance between all of the residence points to their nearest power line segment. This will be performed using the NEAR command in ArcEditor 9.2 or ArcInfo 9.3 (ESRI). The search radius for this operation will be set wide enough so that all of the residence points match to a power line feature.

In geodatabase, behind each shapefile or feature class, will find an attribute table containing:

- positional data, using STEREO 70 reference system;
- punctual measurements of electric field values
- Another data.

This attribute table can be manipulated and queried using SQL, in order to extract helpful data. Furthermore, this database could be completed with results of a survey on health effects of the 340.000 inhabitants of the area and 5 km radius around Galati.

This database model could be imitated by other urban agglomerations in Romania.

4. CONCLUSIONS

The primary benefit of Global Information Systems (GIS) is the ability to interrelate spatially multiple types of information assembled from a range of sources. These data do not necessarily have to be visual. Shape files are helpful for interpolating and visualizing many other types of data, e.g. demographic data. Many study and research models rely on the ability to analyze and extract information from images by using a variety of computer available research tools and then express these findings as part of a project with images in a variety of layers and scenes.

Within a geographic information system (GIS) a spatial database is one component that can be used to store and manipulate data. Typically a complete system will also include client software to view and edit the data stored within the database. Within a spatial database, spatial data is treated as any other data type. Vector data can be stored as point, line or polygon data types, and may have an associated spatial reference system.

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