

## METHODS FOR MONITORING ELECTROMAGNETIC POLLUTION IN THE WESTERN BALKAN ENVIRONMENT

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**Abstract:** During the recent years, in relation with man's continuously changing environment, the problem about the complex monitoring of electromagnetic pollution attracts the increasing attention of both scientists and national authorities. The topicality of the problem lies in the increasing interest towards the local-, regional-, and global-aspect study and control of the augmenting electromagnetic pollution caused primarily by anthropogenic activity. The negative effects of this influence are being felt already, whereas many of the processes are developing quickly and are of irreversible nature. The need of receiving regular and accurate information about the occurring changes in environmental electromagnetic radiation appears.

This report represents a first attempt to create a unified strategy for the West Balkan countries which would provide for effective monitoring of anthropogenic and natural electromagnetic pollution. The possibilities and prerequisites for this are analyzed, paying specific attention to the major methodological problems, measurement programs and algorithms, data base composing, some engineering equipment issues, economic aspects and more.

### Introduction

One of factors for energy pollution of environment is an electromagnetic field (EMF). As a result of exceptional wide application of electromagnetic energy in different areas of human activity towards existing sources of natural electric and magnetic field at Earth, atmospheric electricity and galactical and sunny radiation they are added EMF from artificial origin. It is fact that their level in a number of cases considerably exceeds level of EMF from artificial sources. EMF is biological active factor and by that reason fields with artificial origin can be harmful to environment, human health, live organisms and plants. That necessitate as study of different effects from those EMF mainly upon human health as a ways for regulation and control of their level.

In this connection it is necessary to be found decisions of problem for environment pollution from EMF. This problem became undivided part from global ecological problem on Earth.

Monitoring of environment regarding electromagnetic factor put seriously theoretical, technical and organizational tasks and it is connected directly with problems for protection of peoples and environment from unfavorable influence of EMF in wide frequency band from 0 Hz to 300 GHz. At present there is stable tendency in technological and technical improvement of telecommunication means radiating electromagnetic energy and enlarging its number. It is mastered new frequency bands, enlarged net of radio connections (including mobile) and radio transmission. It is grow number of TV transmitters, radio stations and other services for control and communications. Growth of energy potential of technical means became on account reinforcement power of transmitters, enlargement of their concentration on the territory of build-up territories and increasing efficiency of different types transmitted antennas. All that brings to make worse electromagnetic situation in environment.

For importance of problem connected with electromagnetic pollution of environment in its health and ecological aspect it is testify a big number of scientific projects for study influence of EMF upon human health, growth of live organisms and plants. And in normative aspect – strict norms and regulation approved by WHO and the European parliament.

## Definition of problem

In connection with measures for protection of population and interest of society to effects of EMF radiation, World Human Organization (WHO) started in 1996 an international project "*Biological Effects of Static and Time-varying Electromagnetic Fields*". Bulgaria is active member of project since 1997 when is founded Bulgarian National Program Committee. Committee activities are connected with protection of population and working peoples from dangerous effects caused by EMF radiation.

To ensure protection of population European Council approved and issued *Recommendation (1999/519/EC)* for limitation submission of population to EMF radiation with frequencies from 0 Hz to 300 GHz, which have to be received like a minimum requirements from all EU member - countries. Every country – member can accept and realize also more strict requirements when it is necessary. Other basic normative document is *Directive 2004/40/EC* for protection of workers issued by the European Council and European parliament with obligation every country member of EU to realize them like minimum requirements not later than 2008.

*Influence of low frequency EMF on human health* is manifested mainly in:

- Effects upon immunity system;
- Control and regulation cell's growth;
- Effects upon hormonal mechanism in central nerve system and brain;
- Effects upon development of embryo;
- Condition of blood vessels.

## Objectives of scientific research

Within the framework of EU program "SEE-ERA.NET" for finance of mutual scientific projects at the Western Balkan countries in environment area team of scientists from Bulgaria, Macedonia, Croatia and Slovenia proposed research project "Development of strategy and methodic for EMP monitoring from natural and anthropogenic sources for Western Balkan area" which was approved and financed by agreement "INTAS Ref. Nr 06 - 10374". Separated members of that team in one or other stage are worked long time for subject-matter [1-16].

Object of project is development of strategy for integrated GIS-based monitoring of electromagnetic pollution on data base received from ground, aerial and orbital based systems. Proposed project will be created new approach giving evaluation for potential influence of electromagnetic pollution (EMP) mainly upon human health and nature on the territory of Western Balkan countries and neighbor countries.

**Under monitoring of EMP** has to understand system for surveillance and warning of change level and creating critical situations which are harmful and dangerous for human health, flora and fauna.

It has foreseen to be created multitargeted information system, which consists the main three directions:

- ✓ Surveillance of level of electromagnetic radiation giving opportunity to be separated its changes caused by influence of natural and anthropogenic factors;
- ✓ Evaluation of physical condition of natural environment;
- ✓ Forecast of nature condition and evaluation of the same forecast.

That required:

- definition and evaluation of main rulers and factors for risky levels and vulnerability from EMP taking account requirements of an European Union, national legislations and experience, received on bases study definition of problem from participated in working team experts;

- development of dynamic strategy (not only static presentation of EMP data and it's influence), using different sources data for EMP (ground and airspace) and optimal criteria for their collection, processing and connection with data from GIS-base;

- submission of that strategy to users from countries which are potentially already put under EMP influence in order decrease dangerous influence, prevention and more clear information for such kind phenomena and development of more detailed evaluation of that influence.

## Approach and main stages for task decision

It is proposed onstage parallel method for realization of study. The task is divided on subtask and there are formed separated teams (groups) for their development:

- Team for analysis, evaluation and proposals concerning synchronization of national legislation in accordance with EU requirements
- Team for analysis and choice of an optimal concerning parameters and number equipment for airspace segment for measurement and control of electromagnetic fields with natural and anthropogenic origin;
- Team for definition of requirements for equipment's specifications, choice of points, cyclogrames of work and data collection during ground electromagnetic measurements in defined points at the territory of participant countries;

- Team for design a model of a Geodatabase for monitoring of electromagnetic pollution;
- Team for organization of two seminars/workshops concerning subject of project.

On fig.1 is shown an outline of the main data sources for GIS-based system, obtained from ground measurement complex, aerial and space based segments. Every one of them consist set of equipment and systems for measurement, provisional processing and transmission of data from EMF measurements on ground surface, in air and in ionosphere plasma on satellite orbits.

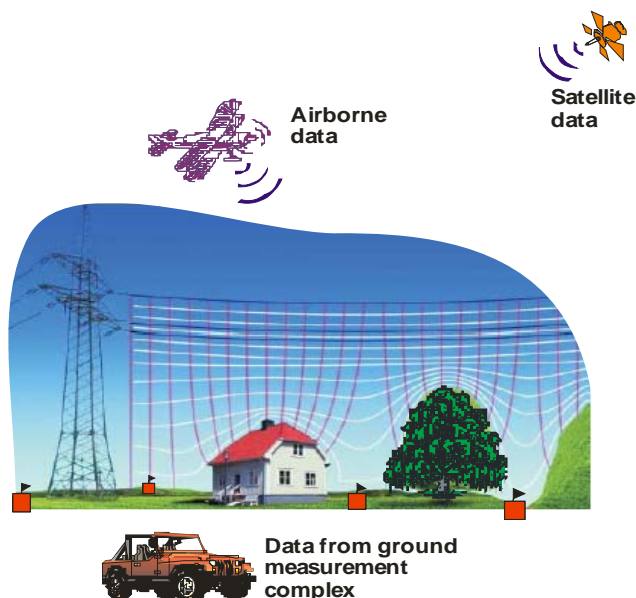


Fig. 1.

**Ground measurement complex** carries out and collect data from electromagnetic measurements in order characterization, evaluation and analysis of electromagnetic pollution sources at defined territories in participated countries.

*Technical specification of ground complex* for measurement parameters of natural and anthropogenic electromagnetic field involves three subtasks:

A. *Equipment composition* – selection of equipment for measurement parameters of electromagnetic field according to acting EU standards and norms for measurement parameter, measurement units, dynamic range, measurement accuracy and etc.

B. *Number and configuration of measurement stations* – configuration of structure ground measurement complex (GMC), in principle consisting peripheral measurement posts (PMP) and central post (CP), such as its number and arrangement in investigated area.

C. *Algorithms and cyclogrames of measurements* – synthesis of an optimal algorithms and cyclogrames for measurement and registration of data, guarantied possibly highest efficiency.

**Aerial based measurement complex** (Aerial segment - AS) for measurement EMF components has aim to provide parallel supporting measurements, offering information mainly for saturation of separate frequency bands of electromagnetic spectrum with electromagnetic radiation. During flight of measurement complex over defined points from territory of built-up areas and out there is integral effect from ground – based sources of electromagnetic radiations and changes of their intensity. The main task of AS is measurements and control of electromagnetic fields with the aid of aerial based means like airplanes, helicopters, balloons and dirigibles. The use of that means provided overcoming of the bigger part from limitations by application of traditional ground based technologies for ecological control. Their advantages are defined from the next circumstances:

- Wider area of monitoring territory;
- Possibility for monitoring of defined regions and objects with determined regularity in different bands of electromagnetic spectrum day and night in different meteorological conditions;
- Possibility for receiving images - maps with high resolution in information capabilities in operational plan.
- Connection of obtained EMF data to geographic coordinates.

**Space based measurement complex** (Space segment - SS) involves measurement of EMF components from several satellites flying first of all at ionosphere orbits (with heights to ~ 1000 km). Main objective of SS is implementation of observation for ionosphere interferences caused by human activity

(anthropogenic impact). Such kind interferences can exercise influence on environment, weather and climate. It is foreseen use of data from acting orbital satellites with suitable equipment and working cyclograms for study and evaluation of next effects as:

- Evaluation importance of artificial electromagnetic waves in comparison with an artificial;
- Geographical map of intensive radiations;
- Correlation of interferences with industrial areas;
- Geographical map of thunder - storms activity;
- Their correlation with industrial areas;
- Their influence upon global warm;
- Evaluation of interferences in charged particles as result from artificial influences;
- Their relation to influence of thunder-storms.

As an example for that purpose is acting at the moment satellite DEMETER. On his board work also electromagnetic complex *ICE*, one of its additional tasks is connected with problems of "Space weather and the electromagnetic environment of the Earth".

SS can play also essential role during receiving of key information for study influence of human activity upon ionosphere. It is planned to be evaluated artificial emission of ionosphere caused by powerful ground very low frequency (VLF) transmitters and radiation from high voltage power supply net, to be clarify how they influence to natural balance of ionosphere and also to be evaluate how thunders warm ionosphere. However it is planned to be determined location in height so called "height thunders", also called Red Sprite or Blue Jet. It is interesting to be clarifying if global warm can bring to catastrophic growth number of thunders in atmosphere.

Data from correlated measurements of electromagnetic fields components in range from 0 Hz to 300 GHz, with natural and anthropogenic origin in accordance with the diagram shown on fig.1 gives possibility for monitoring realization of electromagnetic fields distribution and their changing in time and space.

#### **Geo base data**

Natural condition and exploration level of natural resources defined ecological problem on territory for which has been evaluated electromagnetic pollution. During the recent decade, in the framework of a multidisciplinary project for studying the effects of environmental factors on lung cancer on the territory of the four counties Suffolk, Nassau and Schoharie, State of New York and Tolland (**Long Island Breast Cancer Study Project**) the development of GIS (GIS-Health) for Long Island is included. GIS-H is the first system of its kind using only ground-based measurements, one of whose purposes is to reveal the relationships between EM exposure and lung cancer.

At present project has been provided complex application of information received by ground measurement complex, airspace segment, reserved and institutional databases integrated in united geo base data. It ensures integration and laying one over other all kind of data as the only condition is they to have geospatial character. That allows regularly performing objective control and evaluation of sources and level of electromagnetic pollution at a given territory. Creation of geo base data has been necessary as for integrated management of received attributive information as for visualization, statistical processing and analysis which are accessible only in GIS – environment. By that means will be realized:

- regular expert cartographic analysis of the potential and real threat created by the various sources of electromagnetic pollution;
- model studies, related with the development of criteria and recommendations for reducing the risk of electromagnetic pollution and for the territory's sustainable development;
- express and unbiased control of the electromagnetic pollution reduction measures, applied by the local bodies and the non-government organizations.

#### **Results of project's development**

*Development of strategy for integrated GIS based monitoring of EMP;*

*Preparation of project offer for participation in FP7 competition "Monitoring of EMP from natural and anthropogenic sources for Western Balkan area", involved other countries from Western Balkan and EU.*

*Conduct pilot measurements of EMP on the territory at least two capitals of countries which participated in project.*

*Comparison of received preliminary experimental results by use of prepared software programs. With the aid of such software is visualized as localization of correspondent source electromagnetic radiation as distribution curves of radiation connected with electromagnetic pollution. One possible for use software product is AldeMap – developed by Italian company Aldena. It is software with GIS - core for localization sources of electromagnetic radiation.*

*Proposal for creation of the Balkan electromagnetic fields association (BEMFA) on bases of acting in Republic of Bulgaria foundation "Faraday" – non-ionizing radiation and electricity which is main body of Bulgarian National Program Committee for International project „Electromagnetic fields". Synchronization of*

efforts for countries taking participation in project for realization policy of EU, WHO and other international organizations as harmonization of standards, introducing new legislation, investigation risk from EMP, such as applying principals of warning approach.

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