GIS TECHNOLOGIES FOR POLLUTION RISK ASSESMENT BASED ON ELECTROKINETIC BIOREMEDIATION TECHNOLOGIES

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Motivation

The paper presents an ensemble of software modules, integrated in a single platform, suitable for oil products based pollution risk management through processes of identification, analysis, monitoring/systematic reporting of soil and groundwater pollution risk factors, through execution of plans to reduce pollution by means of involvement of some innovative in-situ technologies based on ***electrokinetic bioremediation****.*

Several aspects dealing with the use of GIS technologies to monitor both the pollution and restoration issues as well as some preliminary information on a data model generation able to collect and manage an extended range of information that may be spatially integrated are discussed.

Also, presents some preliminary tests in the field experimental (362 Park, Valea Voievozilor, jud Dambovita) area regarding the influence of some operating parameters (applied potential (0-300V), electrodes type (graphit, etc), electrodes distribution (star, polygonal, etc)) on the degradation rate of some organic compounds as contaminant agents with permanent recording of soil water content, pH.

Experimental

Software implementation will use modalities that are similar to those met in the specific reference European methodology, integrating the application of geographical information systems (GIS) through specialized modules (with ESRI – ArcGIS- ArcView) and the involvement of imagistic controlling that will provide significant information on the health state of a specific area towards an interested authority and will contribute to take strategical and tactical decisions in order to prevent and to act by means of planning, budgeting and monitoring of the economical/social performance. The obtained values of the indicators of soil and groundwater oil pollution will be represented at territorial scale, so that the pollution risk assesment digital maps will be obtained; on their basis critical areas will be evidenced in the case of pollution and the information maintenance/updating will be kept in a spatial database, a history of these interest values being able to be built. Due to the complexity of the analysis, the deep approach of each distinct component is necessary, so that it is to be able to optimally contribute within the entire ensemble towards application of a hazard-vulnerability-risk assessment methodology at the impact level of soil and groundwater pollution for the specific pilot area selected for the analysis.

Results and discussion

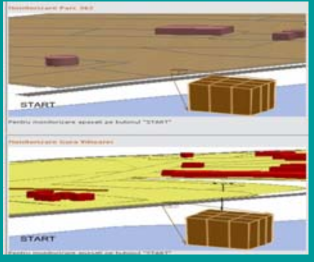


Figure 1 – Monitoring areas

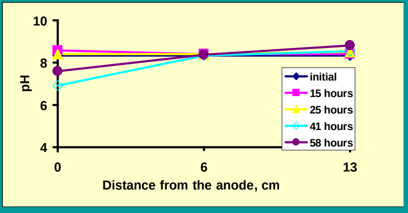


Figure 2 – The change in soil pH under the effect of dc electrical field

The applied electrical field determined the change of soil pH and humidity, as Figures 2 and 3 show.
The following electrochemical reactions at the electrodes take place:

-at the anode: $2\,H_2O \rightarrow 4H^{+} + O_2(g) + 4\,e^{-}$

-at the cathode: $2\,H_2O + 2\,e^{-} \rightarrow 2\,OH^{-} + H_2\,(g)$

that significantly influence the soil pH and further the direction of electroosmotic flow and also the sorption/desorption of the organic pollutant.

Thus, after 41 hours of electrical treatment the soil pH near the anode dropped to 6.9 and near the cathode it increased to about 9 from the initial value of about 8.2.

The soil moisture decreased near the electrodes as compared with the middle region.

Under the action of electrical field, the oil content in the anode region was reduced and it increased towards the middle and cathode regions, especially for the first 25 hours of electrical treatment, which is also consistent with the variation of current in time.

After that, however, it has been evidenced a relatively contrary movement . Usually the oil content peak is placed in the middle region. These facts suggest that the change of the soil pH in time under the influence of electrical field may produce a migration of the ionized phenol towards the anode and thus a decrease of the concentration around the cathode.

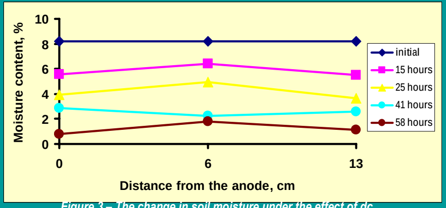


Figure 3 – The change in soil moisture under the effect of dc electrical field

Figure 4 – Experimental area

The use of GIS technologies

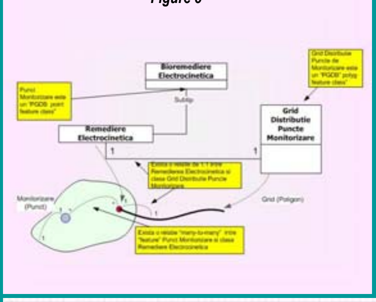
Innovative accelerated in-situ remediation technologies will be provided to decontaminate (based on bacterial innoculus and electrokinetic dispersion) soil and groundwater. Through integration of the information provided by software tools and remediation technologies, elaboration of an assesment methodology of cost-profit ratio and risk are in view, that are significant for interested stakeholders (scientific, industrial, public/administrative ones) to build a definition framework for a best practice in the field.

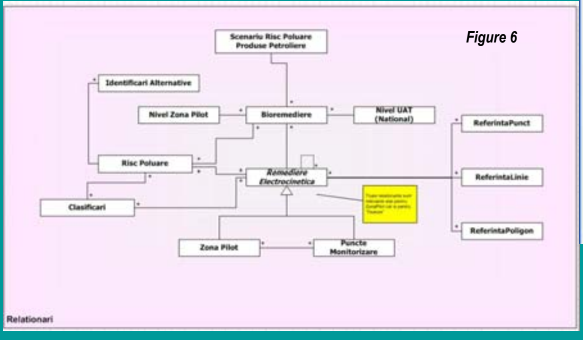
In-situ remediation technologies using direct currents with electrodes placed on each side of the contaminated soil separates and extracts the organic contaminants form soils and groundwater.The location of each electrode is displayed in the site layout as-built drawing contained in Figure 5.

Software implementation will use modalities that are similar to those met in the specific reference European methodology, integrating the application of geographical information systems (GIS) through specialized modules and the involvement of imagistic controlling that will provide significant information on the health state of a specific area towards an interested authority and will contribute to take strategical and tactical decisions in order to prevent and to act by means of planning, budgeting and monitoring of the economical/social performance. The obtained values of the indicators of soil and groundwater oil pollution will be represented at territorial scale , so that digital maps will be obtained; on their basis critical areas will be evidenced in the case of pollution and the information maintenance/updating will be kept in a spatial database, a history of these interest values being able to be built..

The concepts of the Data Model are illustrated in Figure 6 and some important aspects and design criteria of the technology for field implementations are presented.

Figure 5





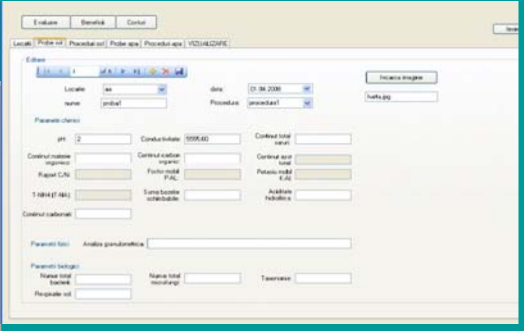


Figure 7 – Data Entry App Screen

Conclusions

- ***There have been evidenced the presence and action of the electroosmotic flow under the influence of the electrical field, materialized in a significant change of soil pH in the electrodes regions, that also affect the electromigration of phenol.***
- ***The low content of moisture in the soil hinders the efficient migration of the pollutant agent towards electrodes and this may be the reason of the concentration of phenol in the middle region of the cell.***
- ***Further detailed investigations will be performed for a deeper understanding of the processes and to optimize the technological parameters to achieve a better removal rate.***
- ***The application of GIS provides a mean to integrate the various data layers involved in the organization, analysis and graphical display of the relationships between spatial and attribute data of critical variables and parameters, with a good potential for application in soil remediation issues, too.***

Acknowledgements

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