

PROPOSED TOOL FOR SOIL MONITORING FOR OLIVE OIL MILLS WASTES DISPOSAL AREAS

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SUMMARY: Wastes disposal on soil, apart from progressive degradation, may cause serious problems to the surrounding environment and thus, soil quality should be monitored. The monitoring of soil properties and quality characteristics should be undertaken mainly by local authorities and governmental services as well as, by the disposal areas owners. Since waste composition is dependent on their origin, specific quality indicators for each waste type should be established and monitored periodically. For this, the development of appropriate monitoring tools, specific for each waste type or for a group of similar waste types will significantly contribute to the effective monitoring of soil quality at wastes disposal areas.

In the framework of the LIFE+ project “Strategies to improve and protect soil quality from the disposal of olive oil mills’ wastes (OOMW) in the Mediterranean-PROSODOL”, a tool for soil monitoring was developed which includes a set of soil indicators, appropriate for OOMW disposal areas and a software application for the continuous monitoring of soil quality.

1. INTRODUCTION

Having collected more than 1,000 soil samples and analyzed them for almost 23 parameters, eight soil parameters, namely pH, electrical conductivity, total polyphenols, organic matter, total nitrogen, available phosphorous, exchangeable potassium and available iron were selected as being the most suitable to describe soil degradation due to OOMW disposal.

The users of the monitoring tool can enter measurements of the indicator chemical parameters at various time intervals and soil depths and monitor the fluctuation of the values through time. Results are indicated through predefined diagrams that have orange and red zones depending on the degree of alert that needs to be signaled to the users. The users can enter more than one olive oil disposal area and can also export the data into a spreadsheet format so that they can be used with other applications. The monitoring system tool application also has extra functionality giving the user the ability to search measurements with certain criteria and produce reports based on the query results, including all the graphic displays (diagrams) of each of the parameters.

The whole application was designed and implemented with the Microsoft .NET framework enhanced with the capability of monitoring one or even more measurements on different waste disposal areas, and capable of use for a larger scale services, rather than private use only

(backing up and restoring measurements data via XML¹). The system which is thus able to evaluate the degree of soil degradation risk in the vicinity of the wastes disposal areas, has been realized to support 4 different languages (English, Greek, Italian and Spanish) and it is available for free download from the Web site of the project (www.prosodol.gr).

2. THE SOIL MONITORING SYSTEM APPLICATION TOOL

2.1 Chemical Parameters

In the PROSODOL project, the development and implementation of a soil monitoring system was necessary, in order to enhance the control of targeted areas, as well as others with similar activities, by monitoring several basic chemical parameters which reflect the wastes' disposal activity in the areas of interest. The aim of the Soil Monitoring System is to provide to the end users (public or private body) a handy tool for evaluating the degree of risk in the vicinity of the waste disposal areas.

The design process of the Soil Monitoring System Application tool consists of three basic principles.

- Need to specify the most important chemical parameters for evaluating the degree of risk of the waste disposal areas
- Need to specify the limits and range of risk levels (range of values), corresponding to "red" and "orange" flag zones.
- Design an interface that satisfies specific user needs, such as inserting, editing & searching functionalities of waste disposal areas chemical measurements, as well as graphically presenting the risk assessment results.

Eleven chemical parameters were selected in the end based on their ability to be used as indices to define soil's pollution (Table 1). Furthermore, the limits and the value range of the risk zones (red – high risk, orange – moderate risk) are denoted in the specific table columns (written references that contributed to estimate those ranges are presented to References section).

Table 1 - Chemical parameters including their limits, red and orange zone ranges. Parentheses correspond to the bibliography.

Chemical Parameters	Orange zone	Red zone	Limits
Electrical Conductivity (mS/cm)	> 2-4	> 4	0.2-40
Organic Matter %	> 5.0	> 20	0.05-55
Total phenols (mg/kg)	> 40	> 150	0.1-700
Total Kjeldahl Nitrogen (%)	> 0.3		0.02-3.00
Available P-Olsen (mg/kg)	29-59	> 60 (potential high P mobility)	1-500
Exchangeable K (cmol/kg)	> 1.2-2.0	> 2.0	0.1-30
Available (DTPA)-Fe (mg/kg)	> 20-40	> 100	1-400
Total Cr (mg/kg)	64-200	> 200	5-1000
Total Ni (mg/kg)	30-100	> 100	5-500
Total Mo (mg/kg)	3-4	> 4	1-200

¹ <http://www.w3schools.com/xml/default.asp>

pH	> 8.0	> 8.5	4.0-9.5
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In order to evaluate the degree of risk in the vicinity of a waste disposal area, a user needs to insert values to some or all of the above chemical parameters, and evaluate graphically the results upon an XY point diagram, where the red and orange risk zones are also presented.

2.2 Soil Monitoring System Application Main Functionalities

2.2.1 Insert Measurement

A user needs to insert measurement data, such as location properties, date recording information, area coordinates that the measurement(s) took place, as well as inserting chemical parameter values, and submit them to the system tool. This is done by clicking on the Insert Measurement button in the main screen or by following the Menu bar items Measurements -> Insert. The screen interface for inserting such information is showed in Figure 1 below.

The screenshot shows the 'PROSODOL - Monitoring System' window with the 'Insert Measurement' tab active. The interface includes the following fields and values:

- Area Code/Name: NF1.1
- Date: (empty dropdown)
- Location:
 - Prefecture: N. Fokas
 - Village: (empty)
 - Description: Municipality of Nikiforos Fokas
 - Latitude: 35.321534
 - Longitude: 24.412785
- Depth in cm: 24
- Chemical Parameters:
 - Electrical Conductivity (mS/cm): 1.01
 - Organic Matter (%): 3.92
 - Total Phenols (mg/kg): (empty)
 - Total Kjeldahl Nitrogen (%): (empty)
 - Available P-Olsen (mg/kg): (empty)
 - Exchangeable K (cmol/kg): 4.4
 - Available (DTPA)-Fe (mg/kg): 0.8 (with error message)
 - Total Cr (mg/kg): (empty)
 - Total Ni (mg/kg): (empty)
 - pH: (empty)

A red error message box is overlaid on the 'Available (DTPA)-Fe' field, stating: "Available (DTPA)-Fe must be between 1-400 mg/kg." The status bar at the bottom of the window reads "Inserting measurement data." and there is a "Submit" button at the bottom right.

Figure 1. The Insert Measurement Graphical User Interface of the Soil Monitoring System Application tool.

The figure shows that whenever the user tries to insert a value in a field of the insert form, the system disallows to enter values that exceeds certain range limits or conditions that were previously described and considered in the system functionality. When input measurement information passes all constraints and preconditions, only then a user can submit the data to the system tool.

2.2.2 Edit Measurement

A user also needs to edit measurements data, in case of mistake or change of conditions near the targeted area, re-submitting the information to the system tool. The system provides such functionality and it may be done by clicking on the Edit Measurement button in the main screen or by following the Menu bar items Measurements -> Edit. The screen interface for editing such information is showed in Figure 2.

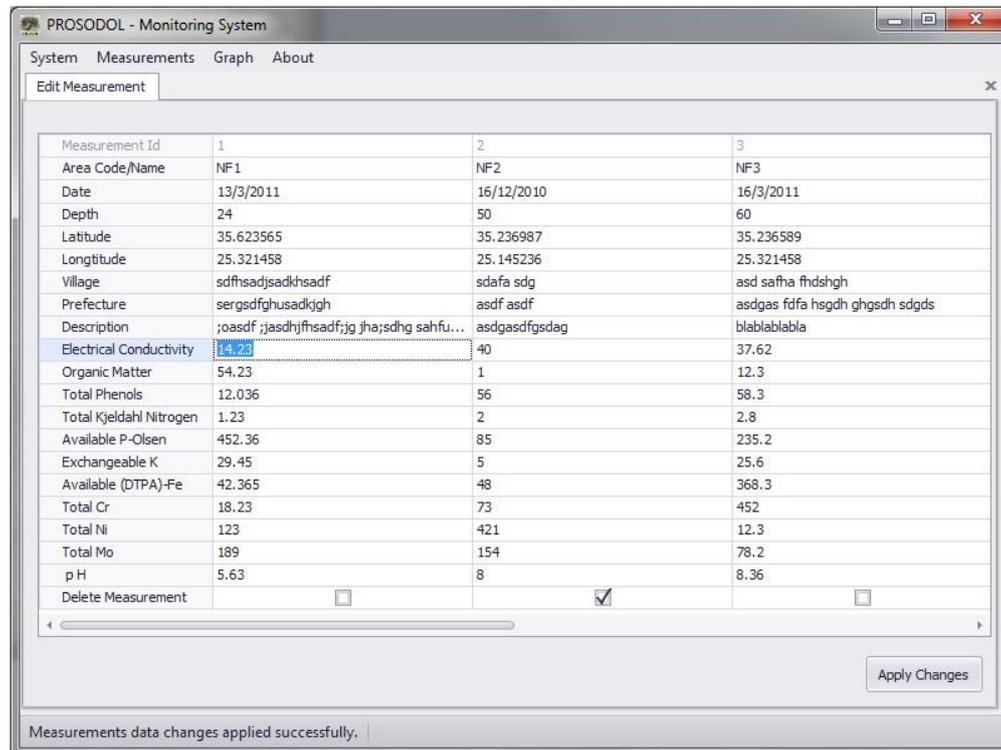


Figure 2. The Edit Measurement Graphical User Interface of the Soil Monitoring System Application tool.

This figure shows that a user may edit according to all preconditions and constraints talked about earlier in this report, any measurement field attribute, value or text description, before applying the changes to the system tool. Moreover the system provides the user the ability to delete a whole measurement from its database (or dataset) by just clicking the box under a measurement column, the Delete Measurement field. Then a tick is placed to the bottom filed for a specific measurement and after applying changes to the system (button click), any data information concerning that measurement is deleted from the monitoring system tool. results upon an XY point diagram, where the red and orange risk zones are also presented.

2.2.3 Search Measurements

A user also needs to search for measurements data of targeted areas, submitting selected only information, configuring certain measurement fields, and search for measurements that are stored in the system with specific only information. The system provides such functionality and it may be done by clicking on the Search Measurement button in the main screen or by following the Menu bar items Measurements -> Search. The screen interface for inserting such information is showed in Figure 3.

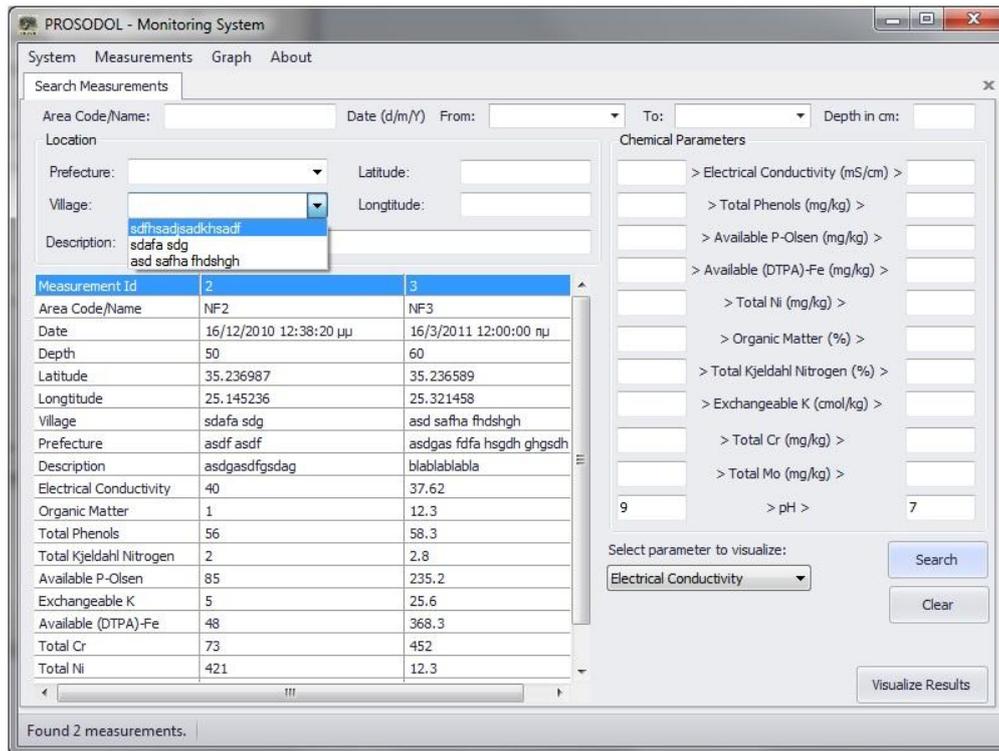


Figure 3. The Search Measurements Graphical User Interface of the Soil Monitoring System Application tool.

As showed in the figure, a user may parameterize the search of measurements according to his needs. It was considered as a very useful functionality to add at this point of visualizing the search results. A user may select the parameter to visualize at the bottom right area of the screen and then click on the Visualize Results button in order to see the search results graphically. In the next section the Graph visualization is briefly described.

2.3 Soil Monitoring System Application Supporting Functionalities

2.3.1 Graphic Visualization

The inserted chemical parameters values which are stored in the systems database, can viewed graphically on a XY diagram, presenting in the most meaningful way if the corresponding measurement exceeds or is inside the parameter limits (risk degree).

There are two ways which the user may view graphically the inserted measurements. The first one is provided by the system by clicking on the Graph button in the main screen, and then choose the desired Chemical parameter (ex. Graph -> Electrical Conductivity submenu, Graph -> Total Phenols submenu), and the system will visualize in a tab the selected chemical parameter values for all of the stored measurements (Figure 4a).

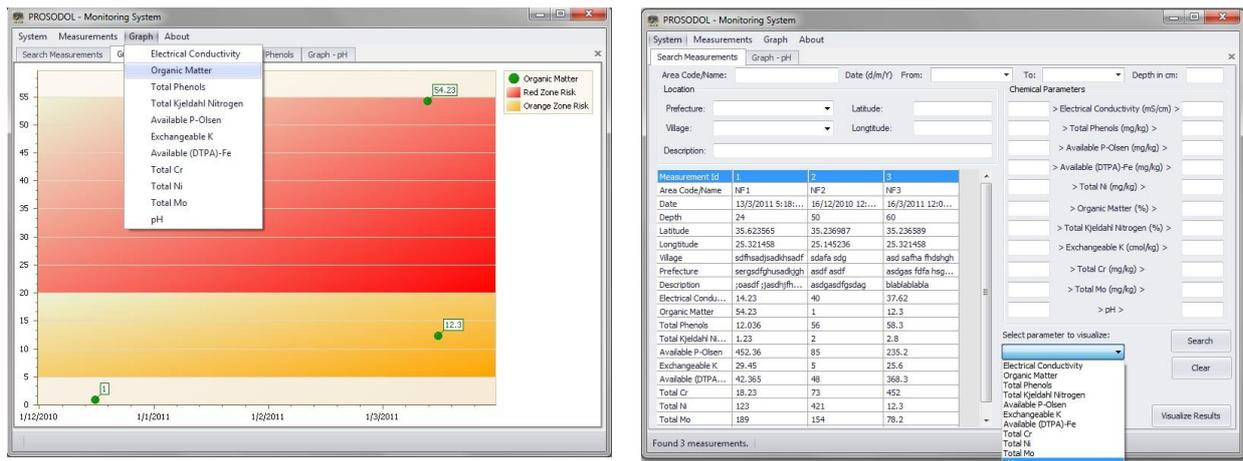


Figure 4. **Left:** Graphic Visualization for all stored measurements showing some of them in the red and orange risk level zone. **Right:** Graphic Visualization for user defined measurements (from search results).

The second way was described in the previous subsection. The search results may be visualized in a graph if the user selects the preferred chemical parameter and click the Visualize Results button (Figure 4b).

2.3.2 Exporting Search Results

The soil monitoring system application tool has an extra functionality of exporting measurements in Excel File format. A user not only can search measurements with certain criteria and needs, but also can export the search results information (measurements found) in a Excel File Format (Microsoft Office Excel 2003 document and Microsoft Office Excel 2007 document). This functionality is only available (enabled) if the search form is opened, and the dialog box while clicking the Export as Excel Document menu (Figure 5).

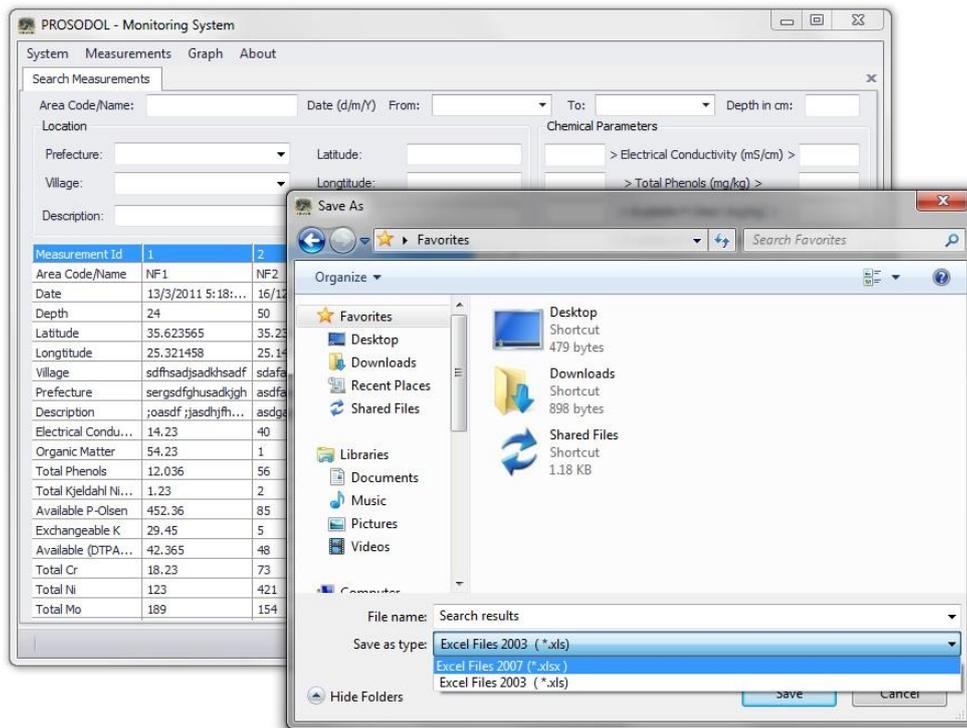


Figure 5. Exporting search results functionality from the application's system menu, as a Microsoft Excel file format.

2.3.3 Printing Reports

The monitoring system application tool has also another supporting functionality, the one of measurements printing report. A user not only can search measurements with certain criteria, but can print as well the search results (measurements found), actually all the visualized graph chemical parameters information on paper. A preview of this process is presented in Figure 6.

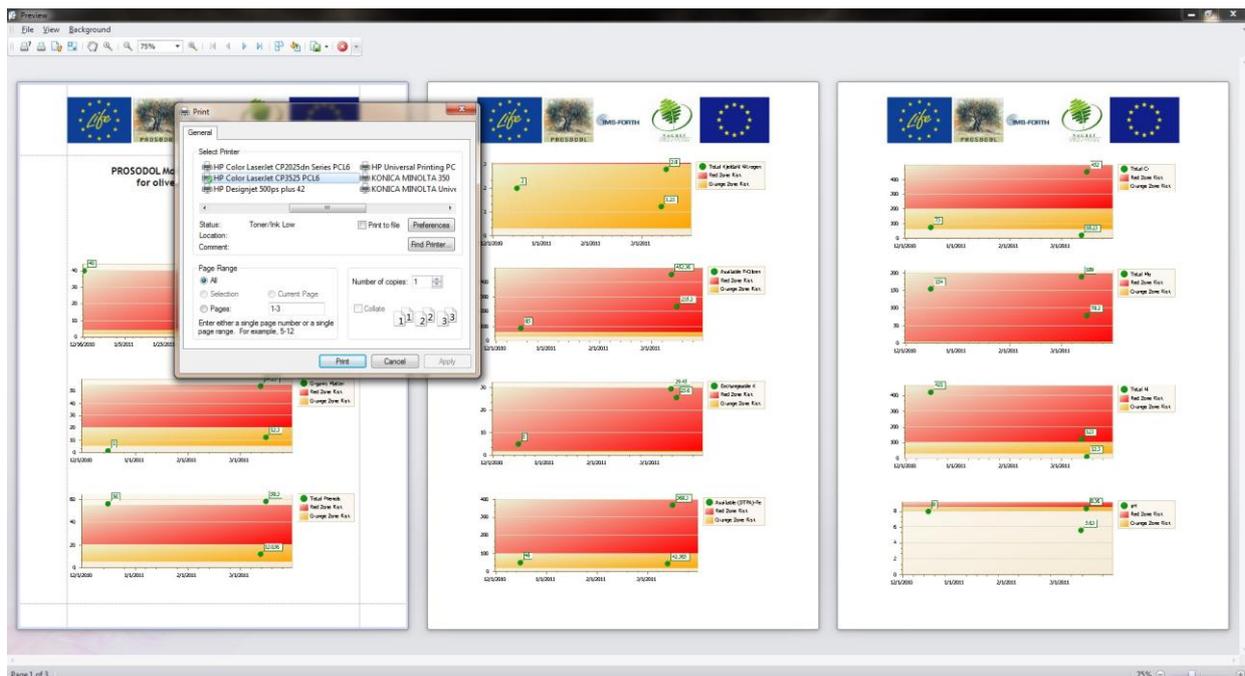


Figure 6. Measurement's report available for printing.

3. CONCLUSIONS

This paper is about developing a soil monitoring system which will enhance the control of targeted areas as well as, others with similar activities, by monitoring several basic chemical parameters which will reflect the wastes' disposal activity of the areas. A user, even a public or a private service need to monitor measurement results of targeted areas in order to evaluate the degree of risk in the vicinity of the waste disposal areas.

In the light of the above, it is anticipated that the proposed tool for soil monitoring will contribute to periodical monitoring of degraded areas as well as of areas where OOMW are used for irrigation and thus, to the early identification of potential threats for soil quality, to the undertaken of necessary measure and means and thus, conservation and protection of natural resources.

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