

CONSIDERATIONS ON MONITORING THE STATE OF SOIL AND VEGETATION POLLUTION IN THE AFFECTED AREAS

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Abstract: *Soil pollution by organic and inorganic contaminants has been recognized as an important issue in many industrial areas of the nations. In addition, naturally all occurring contaminants from radiological Earth sources and human and animal wastes (nutrients and pathogenic bacteria) impact soil and sediments. There is a wide range of types of soil contamination, and an equally large scale of methods and approaches to soil monitoring. This paper will present practical considerations such as how the data will be used, the data's required accuracy and precision, staff, and instrumentation available for the analysis also play a part in the selection of appropriate soil contamination monitoring using automated equipments.*

Keywords: *Soil, pollution, vegetation*

1. Introduction

Soil pollution has enormously increased during the last decades due to the intensive use of biocides and fertilizers in agriculture, industrial activities, urban waste and atmospheric deposition. Its occurrence is related to the degree of industrialization and intensity of chemical usage. Soil pollution causes decrease in soil fertility, alteration of soil structure, disturbance of the balance between flora and fauna residing in the soil, contamination of the crops, and contamination of groundwater, constituting a threat for living organisms. [1]

The soil is the place where all pollutants, air powders, the toxic gases transformed by rain into the atmosphere are met, so that the soil is most exposed to the negative effects of these substances. The infiltration waters impregnate the soil with pollutants by training deep, polluted rivers infect flooded or irrigated surfaces, and almost all solid residues are stored by agglomeration or only discarded on the ground.

The soil can be polluted directly through waste spills on urban or rural land, or from fertilizers and pesticides dumped on farmland and indirectly, by filing polluting agents initially ejected into the atmosphere, the water of the rains contaminated with pollutant agents "washed" from the contaminated atmosphere, the transport of pollutant agents by the wind from one place to another, the soil infiltration of water contaminated.

Soil pollution is closely linked to: atmospheric pollution, hydrosphere, due to the natural circulation of matter in the ecosystem. The irrational methods of soil administration have severely degraded its quality, caused its pollution and accelerated erosion. [2]

Nowadays, soil degradation includes a number of processes, ranging from soil erosion to soil contamination, which reduce the capability of soil to work as a base for vegetation roots.[3]

Environmental remediation and restoration focus on the development and implementation of strategies geared to reverse negative environmental impacts. Anthropogenic activities often perturb environments and severely limit their capacity for regeneration.

Recently, environmental monitoring has become even more critical as human populations increase, adding ever-increasing strains on the environment. There are numerous examples of deleterious environmental changes that result from population increases and concentrated human activities. [4]

2. Materials and methods

Based on the analysis of soil samples, statements regarding the soil quality, soil pollution, biological activity of the soil, the expected behavior of a soil and its suitability for a particular

purpose are possible. Physical and chemical parameters can be determined based on the samples which give direct or indirect information on the specific question. The comparison of the parameters in various depths provides information on the soil stratification and also on the distribution of water and nutrients or pollutants in the soil, as well as the depth of anthropogenic influences. [5]

Typical aims are:

- Receiving information about soil structure / the soil stratification
- Information on nutrient and humus content of a soil
- Information on occurrence, frequency, and activity of soil organisms including pests
- pH-value determination of the soil
- Determination of the particle size distribution for the basic characterization of a soil
- Determination of parameters of the water and air balance (for example pore volume, hydraulic and pneumatic conductivity, retention curve)
- Determination of mechanical soil parameters to evaluate the stability of the soil (e.g. pressure sensitivity or shearing resistance)
- Chemical analysis for the detection of harmful and hazardous substances in soil

The possibilities for the analysis of soil samples are very diverse. Accordingly, diverse is the application range for soil sampling within the scientific and economical sector.

- Agriculture
- Forestry
- Soil science includes soil ecology
- Geology
- Hydrology
- Monitoring, evaluation and remediation of legacies of pollution
- Building sector [5]

Several approaches to soil contamination monitoring include chemical, geophysical, and biological techniques. Chemical techniques are used to measure specific organic, inorganic, or radioactive contaminants in the soil using instruments, such as a gas chromatograph, atomic absorption spectrometer, or mass spectrometer. Geophysical techniques examine changes in physical properties of the soil and the contaminants to address large areas of soil contamination. [6]

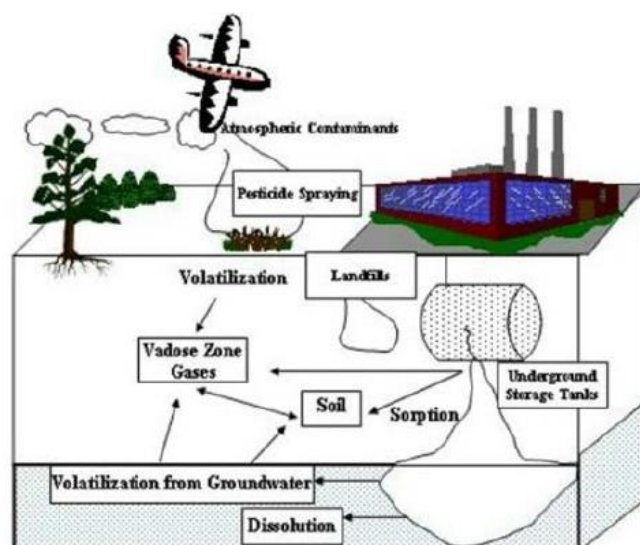


Fig. 1. Soil contamination comes from multiple sources and is impacted by processes such as sorption to soil particles and volatilization into the vadose zone

Soil can become contaminated with a wide range of pollutants from various sources other than land disposal of waste. Contaminants may be applied directly to the soil, as is the case with pesticides. Alternatively, chemicals in the soils can occur as a result of air pollutants that fall out as wet or dry deposition and settle on aquatic or land surfaces. An example is shown in figure 1 is the contamination of aquatic sediments from the deposition of hydrophobic chemicals emitted from hazardous waste incinerators. These pollutants fall out of the air onto lakes and are eventually trapped on the aquatic sediments where they can reside for many years.[6]

Environmental monitoring using aptamer-based biosensors has grown attention due to unique advantages originated from aptamers which could specifically bind to the diverse target molecules from small molecules to bacteria shown in figure 2. By employing various sensing methodologies and platforms, application of aptasensors in real samples exhibited promising results. There are many challenges, however, that need to be overcome for commercial application. This paper provides the most recent updates on the application of aptasensors in real samples, including water and soil samples for various target molecules. Additionally, challenges yet to be addressed for practical applications of aptasensors have been discussed.[7]

Graphical abstract

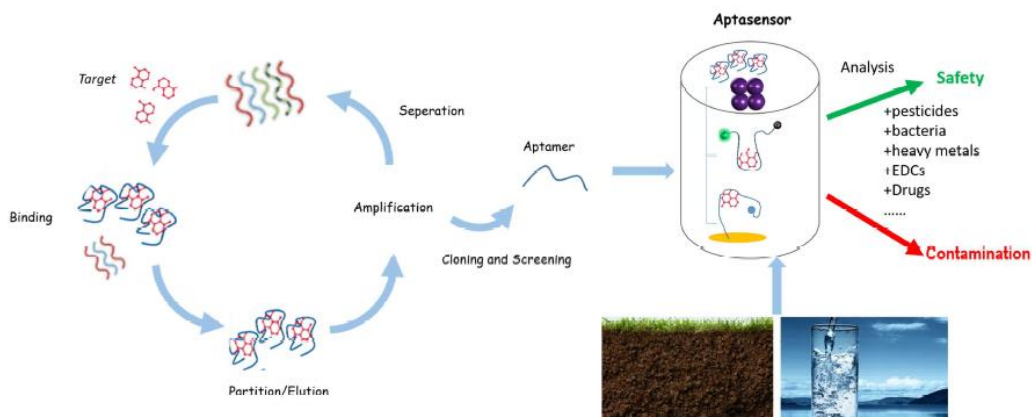


Fig. 2. Graphical abstract Aptamer-based environmental biosensors: from selection aptamer to detection samples

3. Results

The company ZigBee produces one device with the development and implementation of a grid of self-powered multi-functional probes (MFPz) for small-scale measurements of different soil properties, as being part of a wireless sensor network presented in figure 3. The measurement principle is based on the heat-pulse method for soil moisture and water flux measurements and in a Wenner array for soil electrical conductivity. To promote the deployment of these sensing devices across large areas, such as irrigation fields, the ZigBee standard has been adopted as a multi-hop, ad-hoc network enabler. The core of the MFPz device is a wireless microcontroller (with a built-in ZigBee stack) that builds upon an IEEE 802.15.4 radio device. A 7.2Ah NiHM battery that is charged by a solar panel powers the MFPz device. Experimental results have proved the reliability of the MFPz, regarding power consumption, connectivity and data agreement with known soil samples, as a cost-effective solution for environment monitoring.[8]

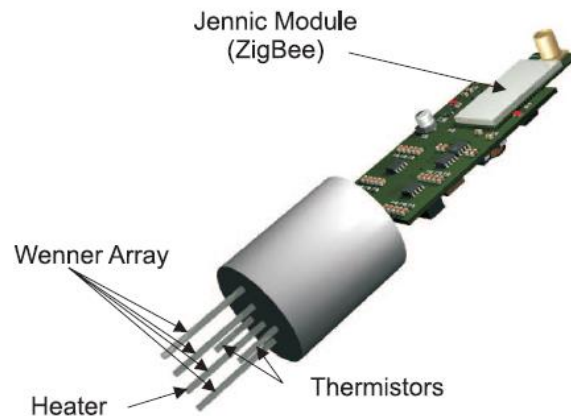


Fig. 3. The MFPz device: At bottom the probe with heater needle, thermistors needles, and Wenner array needles. In the upper part the electronic circuit with RF module (ZigBee)

The company Avigse presents the hydraulic sampling system represented in figure 4 that is designed to collect 0-6" and 6-24" soil samples. The system is powered by an electric over hydraulic power system. The full cycle time for the system is 10-12 seconds (down and up). This sampling system includes the 12-volt power system with control box and power cables, a 30" hydraulic cylinder attached to a channel iron presented in figure 5, 2 stainless steel probe bodies (one slotted and one solid), two quicktatch collars and three replaceable tips (5/8", 3/4" and wet tip), 2 heavy duty (Chromoly) probe bodies (one slotted and one solid), quicktatch collars and two replaceable tips (wet and dry tip). Spare parts and accessories included are 1 electric solenoid, 1 spare hydraulic solenoid and 1 control box along with a probe cleaning brush and handle shown in figure 6.



Fig. 4. Electric-hydraulic power system



Fig. 5. Hydraulic cylinder bolted to channel iron



Fig. 6. Spare parts and accessories – 1 electric solenoid, 1 hydraulic solenoid and 1 control box, 1 probe cleaning brush and handle

The inventors Keith W. Wendte and Brian T. Adams are inventors of the soil monitoring system which is provided with a sensing shank, and a first sensor coupled to a leading edge of the sensing shank. The first sensor is configured to output first signals indicative of a pressure exerted on the first sensor by soil as the sensing shank is driven through the soil along a direction of travel. The soil monitoring system also includes a frame forming a channel oriented in a substantially vertical direction relative to a surface of the soil, and a carrier coupled to the sensing shank and disposed within the channel. The soil monitoring system further includes an actuator extending between the frame and the carrier. The actuator is configured to linearly drive the carrier in a reciprocating motion to vary a penetration depth of the sensing shank within the soil.[9]

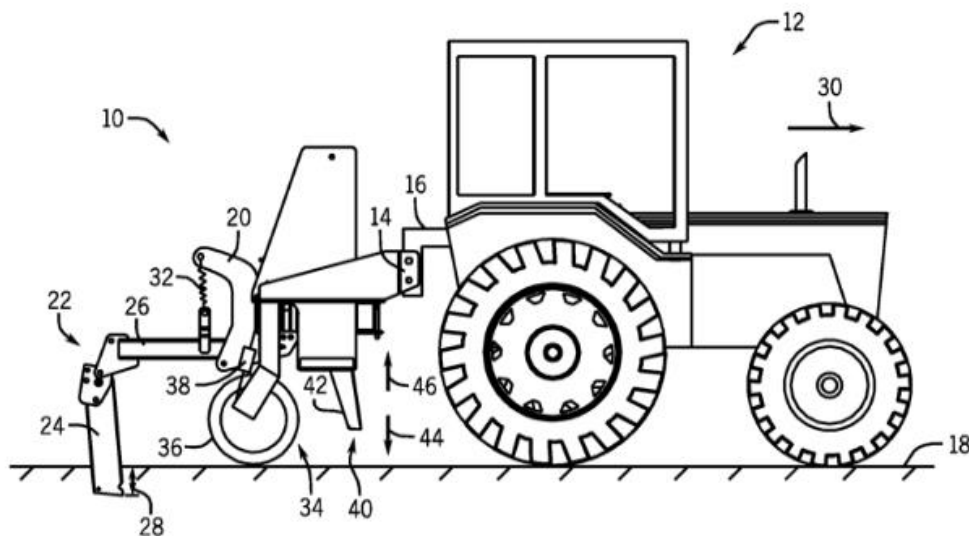


Fig. 7. A side view of an exemplary agricultural implement system, including a tow vehicle and an agricultural implement

Gilson Company produces hydrometer analysis of soil which is widely used in testing distribution of soil particle sizes. Testing is performed with specific products and required sedimentation methods to determine silt and clay fractions. Basic equipment needed for hydrometer analysis in conformance with ASTM D7928, ASTM D422 and AASHTO T 88 standards include Stirring Apparatus, Soil Hydrometers, Hydrometer Sedimentation Cylinder, Sodium Hexametaphosphate, and a Constant Temperature Bath. Soil specimens are mixed in a solution of water and sodium hexametaphosphate.

- **Sodium Hexametaphosphate** is a dry powder dispersion agent used in mixing soil sample solutions.
- **Dispersion Cup** for Soil Dispersion Mixer with 1L capacity to hold soil samples for testing.
- **Soil Dispersion Mixer** thoroughly mixes soil samples with mixing blade.
- **Sedimentation Cylinder**, also called a hydrometer jar, is used with the soil hydrometers for testing suspended solids.
- **Soil Hydrometers** measure suspended solids during testing. Select from models with range of 0.995— 1.038 or -5—+60 g/L.
- **Constant Temperature Bath** maintains uniform temperature in hydrometer testing. [10]



Fig. 8. Hydrometer analysis of soil

The ACE company EmS produces fully automatic Oedometer soil consolidation testing machine that comes loaded with the new environmentally Electro-mechanical Servoactuation (EmS) technology. Silent, compact and highly performing, the ACE EmS testing system can be run with ingenious software that can connect up to 60 units with just one PC, enabling to expand laboratory gradually and seamlessly. The Oedometric test determines the rate and magnitude of soil consolidation when restrained laterally and loaded axially. The ACE EmS can complete the whole test in fully automatic mode by selecting the load (stress), offering a practical and accurate way to obtain reliable results without any need for manual intervention, reducing the risk of human error.

- Can pilot up to 60 ACE EmS units from one single PC with user able to select single or multiple unit batches.
- Once the software is installed and linked to the first ACE EmS, it is easy to add more units by enabling the associated LAN communication (IP address) without complications or costs.
- Calibrations of displacement transducers and load cells are stored as txt file and easy to recall, up to 10 calibration points can be recorded for each channel.[11]



Fig. 9. Oedometer soil testing machine

4. Conclusions

Soil analyses lead to more informed fertiliser decisions, reducing risks and increasing farm profitability in the long term and reveal the amount of plant-available macro-nutrients in the soil and where soil nutrients are in the soil profile, which nutrients could be yield limited.

Acknowledgments

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