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Applications of proximal gamma ray soil sensor systems

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Introduction
The use of proximal soil sensors is gradually increasing for various scientific and commercial purposes. EM/EC and GPR systems can be considered rather common used, gamma ray soil sensors are relatively new. From a base in geology, the development of mobile proximal gamma ray sensor systems in the 1990s caused a shift towards soil property mapping. These passive systems are capable of measuring gamma ray energy that is emitted by soil and rocks on-the-go. Typically, a gamma ray sensor measures the energy spectrum from 0 to 3000 keV of the radiation that reaches the surface. Primary components of the energy spectrum are the decay products (nuclides) of 232Th, 238U, 40K, 137Cs. Approximately 95% of the measured radiation originates from the top 30 cm of the soil.
Applications
The gamma ray soil sensor system the Mole has been applied for almost 10 years. Time for a brief overview of applications. These can be divided in information derived from the “raw” nuclide data/maps and soil property maps. Nuclide maps show the spatial variation of soil nuclide values. The values can be applied as an indicator for soil homogeneity as a quality sign. The nuclide maps are also useful in finding soil abnormalities or disturbances. This is for instance the case at dump spots, old brooks, garbage locations, archaeological sites or deposits of dredging. The latter can be an important feature in the search for contamination sites. Examples of direct correlation between radioactive nuclides and pollution, e.g. heavy minerals, are scarce, but some positive cases were reported. Mole technology is also applied by Russian scientists in order to find out what the current degree of 137Cs contamination is in fields that were hit by the Tsjernobyl disaster. Finally, the Total Count is often a good discriminator for soil types.
In general, strong correlations exists between the nuclides and physical soil properties such as clay- and sand content, grain size and organic matter and the more stable soil nutrients as magnesium, potassium, calcium, phosphates and pH. Via this statistical fingerprinting process soil property maps of the top soil can be created from gamma ray sensor data. The ability to map the variation of soil properties within a field let to several applications in agriculture, recreation and nature. Applications that involve soil quality and/or soil fertility, precision agriculture and irrigation. Numerous cases can be reported where soil quality is of importance. E.g. bulb growers use the maps to control the barrenness of the soil (in terms of low organic matter content), the same applies for soccer pitches and golf courses. In the production of garden bushes and trees a specific texture is often required to obtain good results. Mole maps were applied in numerous precision agriculture applications such as variable liming, fertiliser application, planting and seeding, herbicide application, et cetera. The soil property maps can be applied in running pedo-transfer functions and to predict the variation of these properties.
Conclusion
Several examples of the usefulness of high resolution soil maps from gamma ray soil sensors systems were highlighted. The nuclide variation maps as well as the composed soil properties have proven to be of assistance in various soil related issues and decisions. Gamma ray soil sensors can become an important tool for anyone that is concerned with top soil related management. Further applications are expected in wine production and issues of erosion and water management, almost certain in combination with different technology.