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Development of an Expert System for Dimensional and the Resolution of Soil Texture using Data Mining Concept

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Abstract: Expert systems have recently attracted the attention of agricultural scientists for application in a variety of information development and transfer situations. These computer software systems are designed to simulate one or more of the ways that a human expert uses his or her knowledge and experience in making a diagnosis or a recommendation. We believe that knowledge-based systems offer considerable potential to help us organize and transmit problem-solving expertise. This should foster and stimulate application of agronomic knowledge in concepts rather than as simple facts or observations as in the past. Expert systems are useful for us in agronomy and soil science and probably in agriculture and biological science. Soils vary greatly in their nature and extent of development depending on the environmental setting in which they have evolved. For example under arid conditions, nature does very little to alter the parent material from which the soils have developed. On the other hand, under tropical conditions the soils differ so much from their parent material that an identification of the original parent rock is very difficult.

Key words*:* Expert System, Data Mining, Soil, Soil types, Climate, Parent materials

I. INTRODUCTION TO SOIL

Soil and land, through related, are two different entities. Land is two dimensional entity representing geographical area and landscape, while soil is a three-dimensional body with length, breadth and depth and is hidden below the land surface. Described that without life there is no soil and without soil there is no life on the earth planet it is no wonder that the astronauts landing on the moon searched for evidence of soil samples to make detailed studies for an evidence of life [14]. Mentioned that the soil is a surface covering on most of the earth’s land area, an aggregation of unconsolidated mineral and organic particles produced by the combined action of wind, water and organic decay, soil are formed from hard rocks, materials and accumulated organic residues [20].

At any specific location on the surface of earth, at least five factors are acting simultaneously to produce soil. These are parent material, Climate, Relief, Biosphere and Time or age. These factors are not equal significance in development of different soils. Although some of them may be more effective in determining nature of soils under a particular set of conditions, all of them are inter-related and complement one another. Here [13] expressed the relationship of these five factors to the soil properties by the equation s=f (cl, b, r, p, t) where S is any soil property, e.g. organic matter content of surface horizons, pH, soil texture, f is function of or dependent upon, cl is climate, b is biosphere (vegetation, organism, man), r is relief or topography, p is parent material and t is time or age. It was mentioned and given importance that the Soil Information System (SIS) it is a computerized database system containing a wide range information on soil and related land[21]. It is a system where soil and related data can be organized, stored, retrieved, analyzed and processed to make it accessible to the end user in the form of maps and tables, SIS is based on a database obtained through remote sensing and ground survey in combination with Geographic Information System (GIS) and Decision Support System (DSS) it has immense potential in planning, judicious management, conservation and sustainable use of soil, land and crop resources. Recently [16], the awareness that soil and land evaluation are an important basis for sustainable land use and management has increased and led to the introduction of "soil quality" as a basic concept of soil monitoring. Reference [17] cited that the physical properties of a soil play an important role in determining its suitability for crop production.

II. SOIL FORMING FACTORS

Parent material, climate, topography, biological factor and time are soil forming factors continue to affect soils even on "stable" landscapes. Materials are deposited on their surface, and materials are blown or washed away from the surface. Additions, removals, and alterations are slow or rapid, depending on climate, landscape position, and biological activity. Reference [25] stated that the soil properties which have the most influence are the physical ones, namely the properties that control the soil water content. It considered the effective soil depth as the main property, since this is directly related to water availability by the roots [18].

A. *Parent material:*

Parent material, from which soil develops, comes from many different sources. This is due to the fact that parent material is not static. Soils form in parent material that is not just bedrock weathered in place. Parent material is classified based on its mode of transportation: ice, water, gravity, wind, lakes and oceans, or in place.

B. *Climate:*

Soils vary, depending on the climate. Temperature and moisture amounts cause different patterns of weathering and leaching. Wind redistributes sand and other particles especially in arid regions. The amount, intensity, timing, and kind of precipitation influence soil formation. Seasonal and daily changes in temperature affect moisture effectiveness, biological activity, rates of chemical reactions, and kinds of vegetation [2]. As per the findings of the study conducted by the Indian Agricultural Research Institute (IARI) New Delhi, with every 10C increase in temperature throughout the growing period of the crop, the overall wheat production may be lost by 4 to 5 million tones.

C. Biological:

According to (Jenny, 1994), on physically disintegrated limestone rock of the central Alps, Dryas octopetala and Carex firma are the pioneers of vegetation. Their roots hold the soil particles together, check erosion, and thus permit the beginning of soil-profile formation. Carbon dioxide from root excretion and from microbiological decomposition of plant material increases the Solubility of the carbonates.

D. Time :

It [11] has given an interesting account of the changes in soil properties that have taken place in the course of centuries.

III. CHARACTERISTICS

Although the accuracy of a soil map may be increased with increasing data points, intensive field surveys are expensive and time consuming. Due to high spatial variability of soil characteristics, large numbers of sampling points are required to generate an accurate high-resolution soil map. Furthermore, the accuracy is affected by the quality of the data, which to a great extent, depends on the field experience or the soil surveyors [28].

A. Soil colour:

It is often the first impression one has when viewing soil. Striking colors and contrasting patterns are especially memorable. The Red River (Mississippi watershed) carries sediment eroded from extensive reddish soils like Port Silt Loam in Oklahoma. The Yellow River in China carries yellow sediment from eroding losses soils. As the primary minerals in soil parent material weather, the elements combine into new and colorful compounds. Iron forms secondary minerals with a yellow or red color, organic matter decomposes into black and brown compounds, and manganese, sulfur and nitrogen can form black mineral deposits. These pigments produce various color patterns due to effects by the environment during soil formation.

B. Soil structure:

It is the arrangement of soil particles into aggregates. These may have various shapes, sizes and degrees of development or expression. Soil structure affects aeration, water movement, resistance to erosion and plant root growth. Structure often gives clues to texture, organic matter content, biological activity, past soil evolution, human use, and chemical and mineralogical conditions under which the soil formed.

C. Soil texture:

It refers [4] to sand, silt and clay composition. Soil content affects soil behavior, including the retention capacity for nutrients and water. Sand and silt are the products of physical weathering, while clay is the product of chemical weathering. Clay content has retention capacity for nutrients and water. Clay soils resist wind and water erosion better than silty and sandy soils, because the particles are more tightly joined to each other. In medium-textured soils, clay is often translocated downward through the soil profile and accumulates in the subsoil.

D. Soil resistivity:

It is a measure of a soil's ability to retard the conduction of an electric current. The electrical resistivity of soil can affect the rate of galvanic corrosion of metallic structures in contact with the soil. Soil resistivity values typically range from about 2 to 1000 Ω·m, but more extreme values are not unusual [23].

E. Soil horizons:

The naming of soil horizons is based on the type of material the horizons are composed of; these materials reflect the duration of the specific processes used in soil formation. They are described [5] and classified by their color, size, texture, structure, consistency, root quantity, pH, voids, boundary characteristics, and if they have nodules or concretions.

IV. EXPERT SYSTEMS

An expert system is a computer program that simulates the judgment and behavior of a human or an organization that has expert knowledge and experience in a particular field. Typically, such a system contains a knowledge base containing accumulated experience and a set of rules for applying the knowledge base to each particular situation that is described to the program. Sophisticated expert systems can be enhanced with additions to the knowledge base or to the set of rules. Reference [24] described expert systems have gained importance for data collection, organization, transmission, and recommendation. These systems are especially helpful for authority and decision makers when data collection, interpretation and recommendation are needed. Reference [1] mentioned Expert systems can be used in all sectors have also been used in areas related to the environment. Among these, soil erosion is a process requiring intense knowledge for decision makers, Expert system approaches help reduce effort and time in facilitating the process. It [9] stated expert systems preserve and disseminate knowledge efficiently at reasonable costs. Example [17] confirmed that Expert systems are promising technologies that manage information and provide the required expertise.

V. DATA MINING

Data mining or Knowledge Discovery in Databases (KDD) is the nontrivial extraction of implicit, previously unknown, and potentially useful information from data. Knowledge discovery in databases (KDD) is the process of identifying a valid, potentially, useful and ultimately understandable structure in data. Example [6] stated that data mining has been used to analyze large data sets and establish useful classification and patterns in the data sets. "Agricultural and biological research studies have used various techniques of data analysis including, natural trees, statistical machine learning and other analysis methods". Reference [29] described in terms of technology, expert system in education has expanded very consist microcomputer to web based.

VI. EXPERT SYSTEM WITH DATA MINING

Data mining is the process of analyzing data to detect useful structure that can be re-used for gain. Expert systems encode an expert's experience and knowledge as a set of rules so that this can be re-used, also for gain. Expert System construction is what [15] refers to as "loosely coupled" in the sense that the database is not fully "expert deductive database system". Example refers which is tightly coupled to the database. Deductive databases comprise facts (database relations) and deductive rules which are general properties or constraining properties of the database relations. Example [10] stated that the Database mining involves the extraction of implicit, "interesting" information from a database. Machine learning algorithms typically used in data mining have been applied to learn rules for an expert system based on examples provided by experts refers [27].

VII. EXPERT SYSTEM APPLICATIONS

The spectrum of applications of expert systems technology to industrial and commercial problems is so wide as to defy easy characterization. The applications find their way into most areas of knowledge work. They are as varied as helping salespersons sell modular factory-built homes to helping NASA plan the maintenance of a space shuttle in preparation for its next flight. The Expert System Applications areas are: Agricultural, Accounting and Finance, Business, Chemical, Computer, Construction, Engineering, Education, Insurance, Medical, Military, Troubleshooting and many others. CROPPRO It [8] was developed to aid farmers in four major areas of crop production such as: crop management problems, pest control, financial considerations, and tutoring on various crop topics. DELTA [19] aids maintenance personnel in the identification and correction of faults in diesel electric locomotives. The Smidth Cement Kiln Controller [30] uses "fuzzy logic" to control the production of cement. COMAX reference [3] incorporates the knowledge of a model of cotton production to provide advice on the growing and management of this crop. SPEX [12] assists scientists in planning laboratory experiments in the area of molecular biology. MYCIN was developed to capture the knowledge of an expert on infectious blood diseases [26].

VIII. EXPERT SYSTEM WITH CROPS

Rice-Crop: Doctor: National Institute of Agricultural Extension Management has developed an expert system to diagnose pests and diseases for rice crop and suggest preventive/curative measures. AGREX: Center for Informatics Research and Advancement, Kerala has prepared an Expert System called AGREX to help the Agricultural field personnel give timely and correct advice to the farmers. These Expert Systems find extensive use in the areas of fertilizer application, crop protection, irrigation scheduling, and diagnosis of diseases in paddy and post harvest technology of fruits and vegetables. CUPTEX [22]. This Expert System has been developed for cucumber production management under plastic tunnel.

XI. FUTURE RESEARCH STRATEGY

Expert system will certainly be the key to success for future Agriculture systems.

a. A decision support system that allows for the integration of multiple soil expert systems and support modules that include natural language processing functions of the future systems.
b. If any natural calamities occur like Tsunami or Large earthquake (which measured 7.8 on the Richter scale, caused movement along 270-mile section of fault that ranged from 6 feet to 16 feet), Rock and soil types can make a big difference in an earthquake, then immediately Find out the properties of the soil and feed into the Expert System which can give the good recommendation for the cultivation purpose, as well as showing the comparison between before and after the said natural calamities.

X. CONCLUSION

Expert System is one of the major area in Artificial Intelligence which providing better result in all the field like Agricultural, Accounting and Finance, Business, Chemical, Computer, construction, Engineering, Education, Insurance, Medical, Military. Soil Expert System is providing the better recommendation for different crop, pest control, suggestion for manure and etc. Expert Systems Benefits: Improved Decision Quality, Increased Output and Productivity, Decreased Decision Making Time, Increased Processes and Product Quality, Enhancement of Problem Solving and Decision Making, Improved Decision Making Processes. Problem Areas Addressed by Expert Systems: Interpretation systems, Prediction systems, Diagnostic systems, Design systems, planning systems, monitoring systems.

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