Reducing the number of agricultural enterprises in rural areas of agricultural land, providing water and transportation facilities, land consolidation will be important part of rural development. The means of land consolidation is the regulation of economic activities in rural areas by the public and again to the land consolidation activities only assemblies of land should not be regarded as these activities should be noted as an important social project.

Finally, in order to determine all the consequences mentioned above, partition of agricultural land and the land as regards the kind of the savings shows that there are major structural problems facing in Turkey.

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РАЗРАБОТКА ИНФРАСТРУКТУРЫ ПОЧВЕННОГО ОБСЛЕДОВАНИЯ НА ОСНОВЕ ГИС ДЛЯ УКРУПНЕНИЯ ЗЕМЕЛЬНЫХ УЧАСТКОВ В ЦЕЛЯХ СЕЛЬСКОХОЗЯЙСТВЕННОГО ЗЕМЛЕПОЛЬЗОВАНИЯ (НА ПРИМЕРЕ РАЙОНА СЕЙДИШЕХИР)

DEVELOPING GIS BASED SOIL SURVEY INFRASTRCTURE FOR LAND CONSOLIDATION FOR AGRICULTURAL MANAGEMENT; A CASE STUDY SEYDISEHIR

Ключевые слова: *географическая информационная система, почвенное обследование, проектирование базы данных, укрупнение земельных участков.*

Укрупнение земельных участков является неотъемлемой частью устойчивого экологического и сельскохозяйственного управления в сельских районах. Представлено как перепланирование земельных участков с учетом их характеристик. Почвенное обследование является одним из основных этапов процесса укрупнения участков, поскольку оно определяет класс почв. Для связи результатов почвенного обследования и укрупнения участков требуются база данных и картографические инструменты для пространственного анализа. В настоящее время важная роль в управлении данными, подготовке инфраструктуры и визуализации данных укрупнения участков с учетом данных почвенных обследований принадлежит географической информационной системе (ГИС). Обсуждается проектирование базы данных почвенных обследований, которая позволяет управление данными на основе ГИС. Создаваемая база данных также будет использоваться для отображения и анализа результатов почвенных обследований как инфраструктурных данных для укрупнения земельных участков. Представлены техническая структура и детальное проектирование базы данных.

Keywords: *Geographical Information System, soil survey, database design, land consolidation.*

Land consolidation is an essential part of the sustainable environmental and agricultural management in rural areas. Land consolidation can be described as rearrangement of land of land areas considering the land attributes. Soil survey is one of the main processing step in land consolidation to determine the soil classes. Establishing relationship between soil survey results and land consolidation area is requiring a database and mapping tools for spatial analysis. At this point, Geographical Information Systems are playing an important role in the field of data management, preparation of data infrastructure and visualization in land consolidation considering soil survey data. In this study, a database design is constituted for soil surveys to establish a GIS based data management platform. Constituted database also will be used to mapping and analyzing of soil survey parameters as a data infrastructure for land consolidation processes. The technical structure and detailed database design is presented.

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1. INTRODUCTION

Land consolidation is an important part of agricultural and rural areas development. Improving land-use conditions are increasing the economic status in the field of agricultural facilities. Land consolidation is generally associated with fragmented lands. Small and fragmented lands are decreasing the efficient use of lands. Therefore, land consolidation is being necessary in order to provide effective use of lands in agriculture. Many countries are realized land consolidation to solve economic, environmental and social problems of rural areas. Usually, land consolidation emphasizes the reconstruction of agricultural districts according to the needing.

Sustainable Land consolidation concept is generally used in literature to emphasize the importance of the land protection after consolidation. Protecting the land consolidation are provided with any legislations arranged by many countries. However, beside of the legislations, knowledge based systems should be used to provide sustainability. Knowledge based systems have importance both land consolidation process and after.

To develop a GIS based system for agricultural management, a set of questions are proposed by Fountas (2004). The questions were formulated based on Management Information Systems (MIS) and Information Systems (IS) theories (Capron and Perron, 1993). A well-structured MIS has to cover a set of questions, called "the five W's and an H, (Mittra, 1986; Koory and Medley, 1987). These are;

- What information is needed?
- When is the information needed?
- Who needs it?
- Where is it needed?
- Why is it needed?
- How much does it cost?

The answers to these questions are defining the structure of the system. The system functions, requirements, techniques and other related structures can be defined considering the answers. In this concept, Geographical Information (GIS) systems can be used in land consolidation processes due to the data management and planning platform of GIS (Wang et al, 2010). Land consolidation requires to work with large amount of data as like land, land property, soil survey, agricultural attribute and project data. Thus, analyze, manage, vizualizate and view functions are required to combine all data in GIS platform (Aslan et al, 2002). GIS platforms are providing efficient tools which are guiding to planners in land consolidation process. Because of the large amount of data in different file formats and fields, it is necessary to integrate all data in GIS platform.

One of the important stages of land consolidation is soil survey. Soil survey data are important to access economic analysis and planning the lands according to the physical and chemical parameters (Carmelo et al, 2013). Soil survey data involves laboratory results and land observations together with the geographical position of sample points. Soil survey values are guiding to the rearrangement of lands and must be associated with land and property attributes. Soil survey data should be stored in database system due to the large amount of laboratory analysis and land observation data.

In this study, a GIS based database is developed to store soil survey data to establish analysis and management infrastructure with using land consolidation in Seydişehir district of Konya. Data types and parameters are examined to constitute database in GIS concept to provide mapping and visualizing of soil survey data. Attribute query and graphic illustrations can also be generated with constituted database.

2. STUDY AREA

The soil survey database is constituted for Seydişehir which is located in Konya city in Turkey. Soil survey process is generated for 146 sample points and 6 profile benchmark. Project area, profile benchmarks and sample points are given in Figure 1.

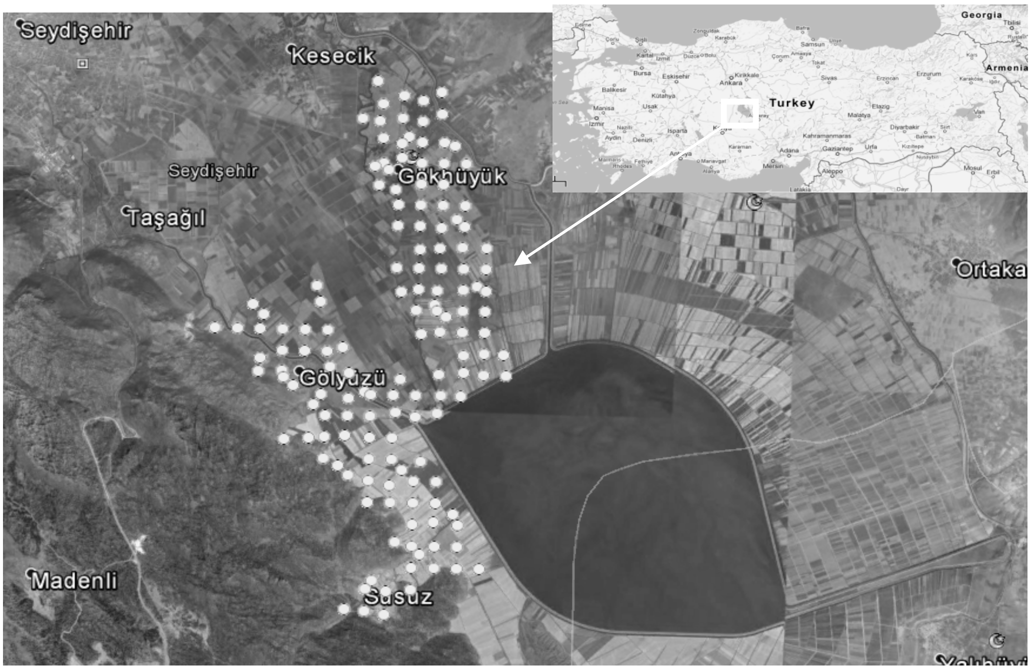

Figure 1a. Project Area

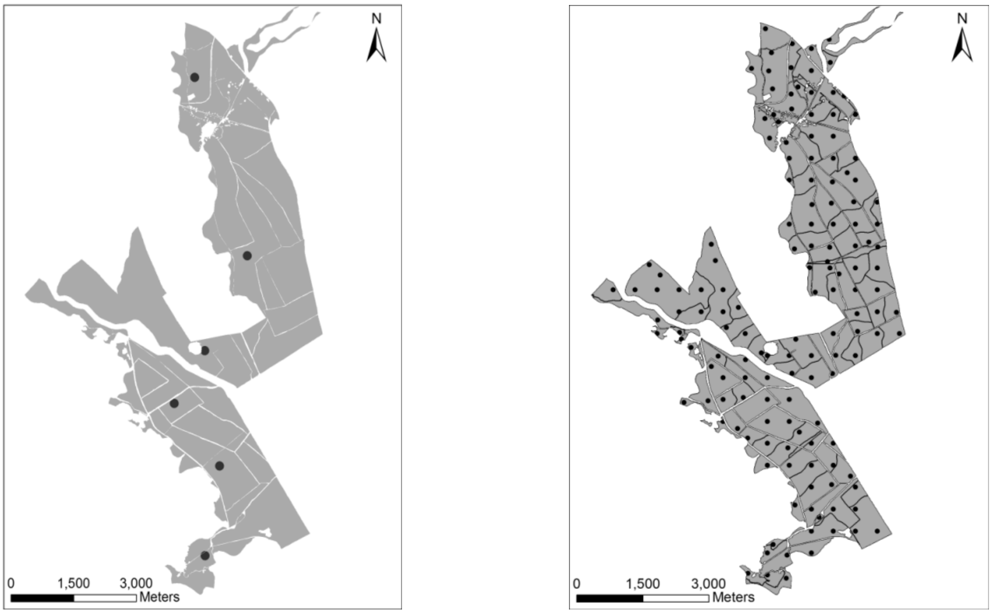

Figure 1b. Profile benchmarks and sample points

3. SOIL SURVEY DATABASE DESIGN

Developing a database for soil survey results are required to define the data types. Data types are playing an important role for mapping in Geographical Information System softwares. The data types and the parameters of the soil survey are given both soil benchmark profile and laboratory analyzes results in Table 1-3.

Soil survey, database and mapping are related fields for assessment of land and planning of land use. Thus, soil survey results are required a combination of database and mapping technologies. Geographical Information systems are providing effective tools to realize the combination of data, database, analyze and mapping techniques. Using soil survey data in land consolidation requires feature type, attribute table and relationship between these data types. Relationships are providing visualization of soil survey data and queries. In Figure 2, feature types, attribute tables and relationships are given.

Table 1

Profile Attributes

Parameter Name	Data type
Profile Number	Integer
Profile X Coor.	Double
Profile Y Coor.	Double
Profile Location	String
Date	Date
Project Number	Integer
Alkalinity	Integer
Boron	Double
Drainage	Double
Stoniness	Double
Usage Status	Double
Rocky	Double
Slope	Double
Erosion	Double
Dry color	Double
Wet color	Double

Table 2

Sample Point Attributes

Parameter Name	Data type
Sample Point Number	Integer
Sample Point X Coor.	Double
Sample Point Y Coor.	Double
Depth	Integer
pH	Double
Salt	Double
Lime	Double
Sand	Double
Silt	Double
Clay	Double
Structure	String
Ca	Double
Mg	Double
Na	Double

Table 3

Profile Laboratory Attributes

Parameter Name	Data type	Parameter Name	Data type
Profile Number	Integer	Cr	Double
Profile X Coor.	Double	Cu	Double
Profile Y Coor.	Double	Ni	Double
Profile Location	String	Zn	Double
Date	Date	Hg	Double
Project Number	Integer	Pb	Double
Laboratory number	Integer	Cd	Double
Depth	Double	Cr	Double
Organik Material	Double	Water saturation	Double
Azote	Double	$CACO_3$	Double
Organic Carbon	Double	Salt	Double
Inorganic Carbon	Double	Sand	Double
K	Double	Clay	Double
P	Double	Silt	Double
Pb	Double	Ca+Mg	Double
Cd	Double	Active $CACO_3$	Double

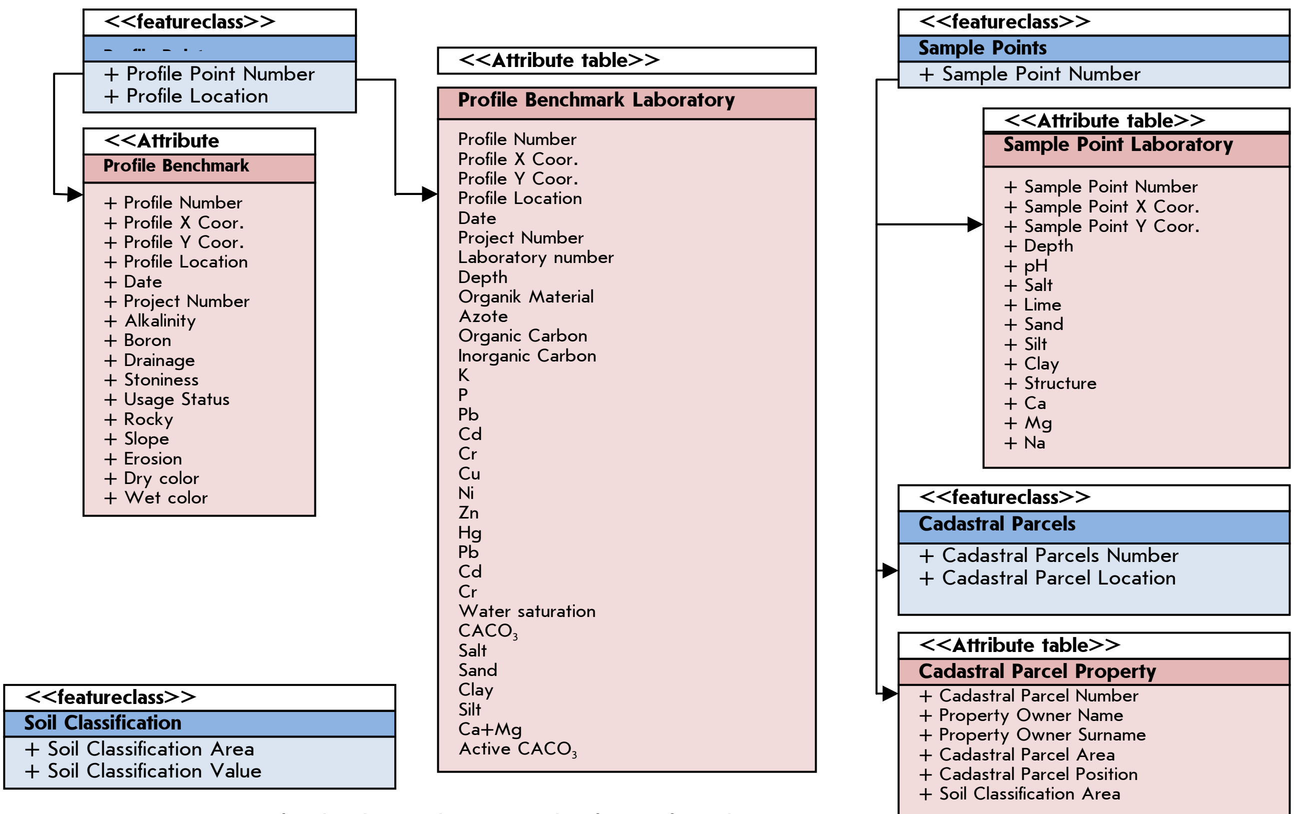

Figure 2. Sample database design and relationships between feature class and attribute table

4. VISUALIZING SOIL SURVEY DATA

Visualization of soil survey data are required a relationship between vector and attribute data. Because of soil survey data are being measured at specific points, the measured values are represented as point vector with a (X,Y) coordinate. The visualization of coordinates and attribute table is given in Figure 3.

At this point, soil survey data are representing the attribute data of the points. For mapping purposes, data type of the attribute data is important to realize numerical analysis. Data types are usually being specified when importing the soil survey data to prevent mistakes and data lose. Thus, conversion process is a vital part of constituting databases. In GIS softwares, there are several tools to convert attribute data to any format as like *dbf*, *xml*, *database table* and *xls*. Attribute data formats can be used according to the software and database type.

Databases are the core object of the GIS systems thanks to the data storage, data management, accessibility via web and supported wide range of data types. Databases are being called in GIS concept as Geodatabase which is including geographic value both raster and vector format and attribute data inside. Geodatabase constitution can be realized with GIS software tools or any database management software as like Access, MySQL and Oracle. GIS softwares are including database connection tools to retrieve data from distributed database or local database through internet. Thus, the database support of the GIS software and database functions are being related.

In this study, MySQL database is used to store soil survey data to benefit from MySQL data management tools with ArcGIS-MySQL integration. Soil survey results being converted from Excel columns to MySQL tables. Each measured soil survey parameters are imported by considering the data type into MySQL database.

Soil survey data can be visualized by using any spatial analyze tools in GIS softwares. One of the commonly used spatial analyze is density maps. Density mapping techniques are using interpolation methods to visualize data as raster image format. Density maps can be produced for each soil survey parameter in study area. In Figure 4a, 4b, 4c and 4d, pH, Salt, P and F density values are represented.

Density maps can also be produced considering the sample depths. Because of soil survey examples are being measured in different depths, comparison of the same soil survey data according to the depths can be visualized. In figure, pH density maps are given in 0-20 cm, 20-40 cm and 40-90 cm depths. In Figure 5a, 5b and 5c, pH values are represented according to the depths.

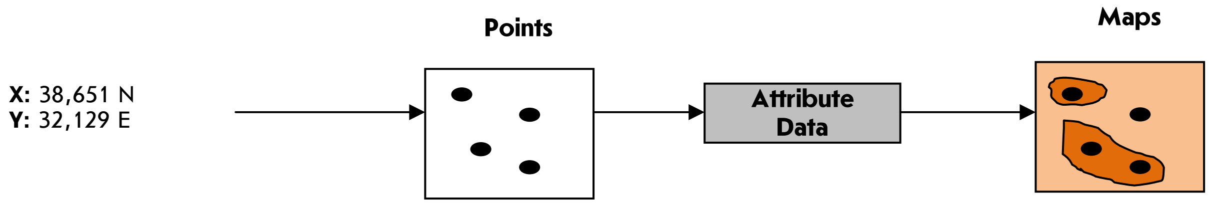

Figure 3. Visualization of coordinates

Fig 4a. Ph values

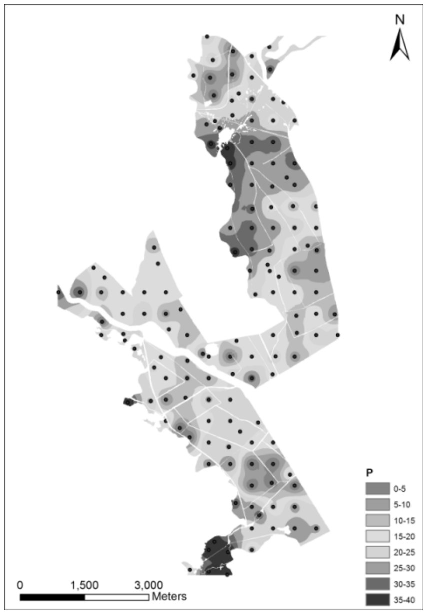

Fig 4b. P values

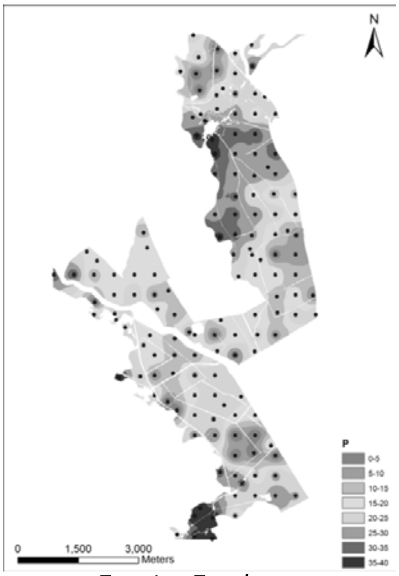

Fig 4c. F values

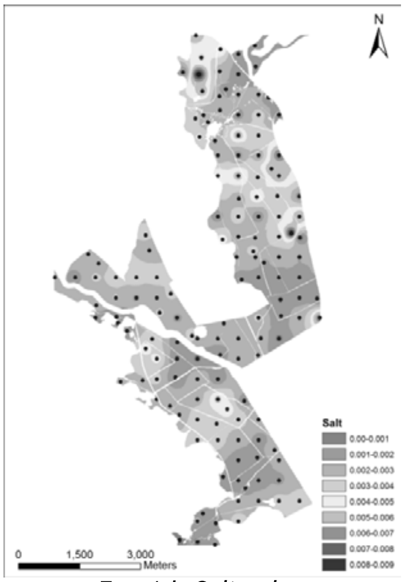

Fig 4d. Salt values

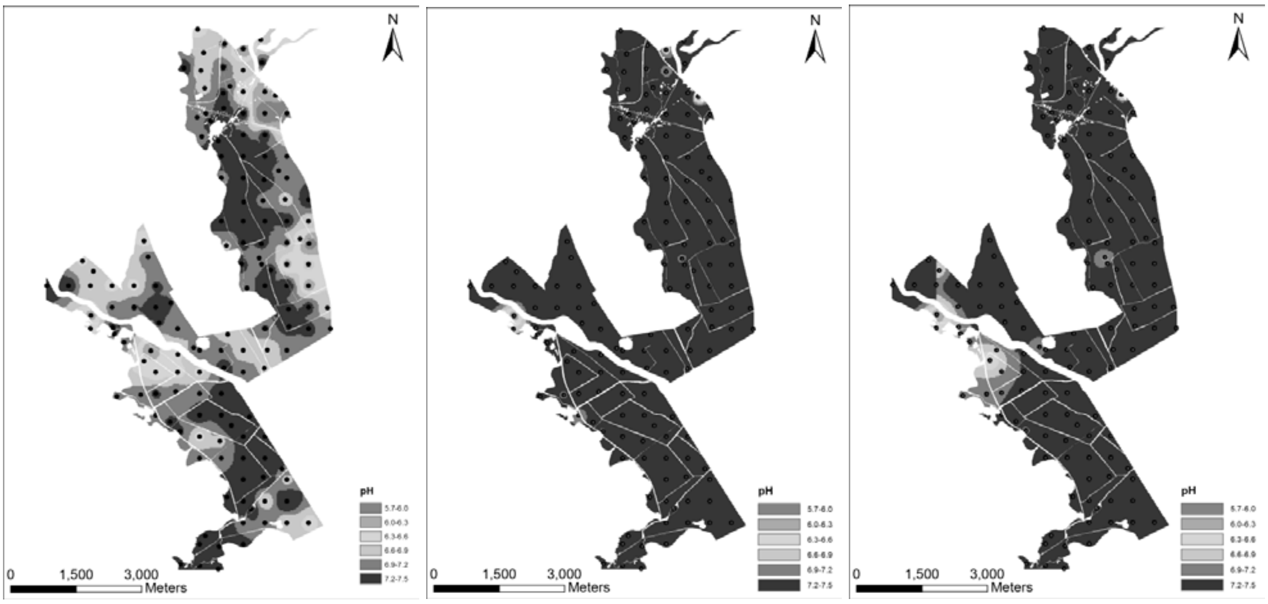

Fig 5a. 0-20 cm

Fig 5b. 20-40 cm

Fig 5c. 40-90 cm

Figure 5. Visualizing of PH values in different deeps

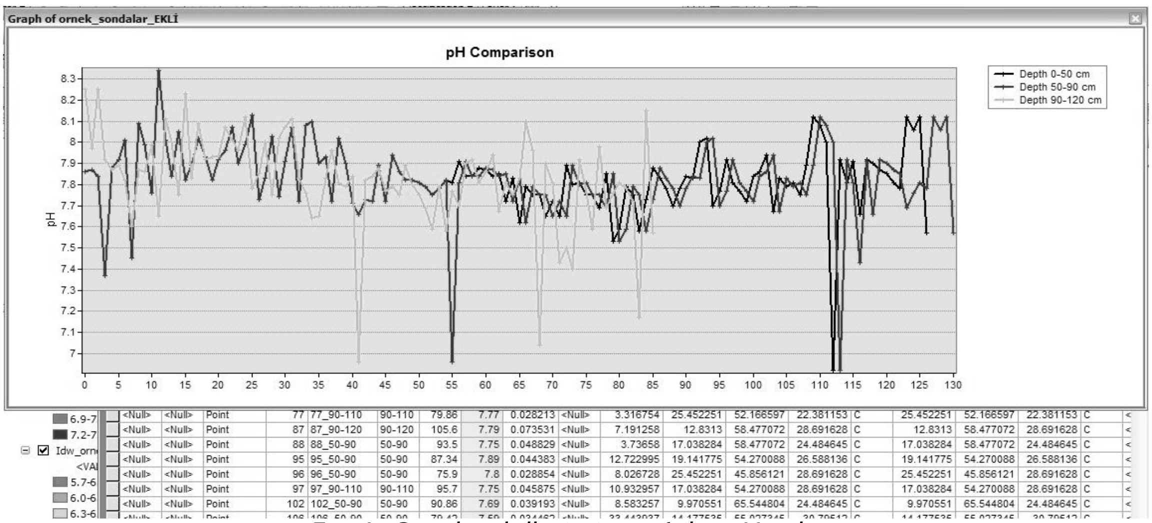

Fig 6. Graphical illustration of the pH values

Geographical Information Systems are also providing graphical illustrations with attribute data. Graphics can be used to compare different values or same values with different time or depth. In Figure 6, graphical information illustration of pH values are compared according to the different depth values. The graphic is an illustration of Figure 5a, 5b and 5c.

CONCLUSIONS

Soil as a natural system mediates the energy and material fluxes at the earths' surface. It is characterized by uncertainties, inexactness and ambiguity (Webster, 2000). Nevertheless, information about spatial distribution of soil attributes in a given area is an essential part of land surface requirements for environmental purposes, agriculture and other land uses (Chukwu 2007). Geographical Information Systems are providing an integration platform for sustainable agricultural management in land consolidation. Irrigation planning can be done with GIS based systems according to the needing and land properties. Also fertilization planning can be examined with this system considering soil survey results with desired crop. Efficient use of this system should be opened to the users to query or view the results for crop planning. This can be succeed with web based GIS systems. Web based GIS systems are providing web interfaces to access and view spatial data via internet. Queries and results can be seen with web interfaces. Thus, the results are being shared with third party user. Web based GIS systems are being a share platform between planners, users and other authorities to realize agricultural monitoring and sustainable land planning.

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ПЕРЕПЛАНИРОВКА СЕЛЬСКОХОЗЯЙСТВЕННЫХ УГОДИЙ ПОСРЕДСТВОМ ПРОЕКТОВ ПО УКРУПНЕНИЮ ЗЕМЕЛЬНЫХ УЧАСТКОВ (НА ПРИМЕРЕ РАЙОНА КИСЕЦИК)

REARRANGEMENT OF THE AGRICULTURAL LANDS VIA LAND CONSOLIDATION PROJECTS; A CASE STUDY KISECIK

Ключевые слова: *земельные ресурсы, развитие сельской местности, сельскохозяйственные угодья, укрупнение земельных участков.*

Keywords: *land resource, rural development, agricultural land, land consolidation.*