# A Spatial Decision Support System Design for Land Consolidation Projects

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Key words: Land consolidation, SDSS, system design, reallocation

### SUMMARY

Land consolidation (LC) has been defined broader social and economic reforms from the time of its earliest applications in Western Europe. The first consolidation initiatives of Denmark in the 1750s were part of a profound social reform to free people from obligations to noble landlords by establishing privately-owned family farms. The consolidation of fragmented holdings did result in improved agricultural productivity but this was not the only objective of these reforms. This chapter illustrates the wide range of rural development objectives, ranging from agricultural improvement to village renewal and landscape development and protection, which can be addressed through land consolidation projects. It describes various land consolidation approaches and concludes with an overview of conditions that should be put in place before land consolidation projects can be undertaken.

Increasing of the agricultural manufacturing and development of agricultural sector is defined as splitting of agricultural lands and combining seperately splitted agricultural areas according to the modern administrating services, styling and land arranging.

Land consolidation projects are a multiple criteria problem including location of parcels, redistribution, appointment steps. There is not a unique solution to solve this problems. For reallocation processes, generally computer calculations are not much considered. Because for the required criterias and limitations in the splitting step a computer calculation is unable to give all necessary answers at all. For a fast and efficient progress of the project studies, usage of the computer technology has been an essentiality.

Spatial Decision Support Systems (SDSS) consist of multiple chose criterias and a managing system that produces the most efficient solution for managing these criterias. In this study design step of SDSS is dealed for helping planning and decision making in land consolidation studies. It will be able to help an easier decision making by analysing datas required by database which is created in Geographic Information System (GIS) style. Also the best visual design is aimed to be served to the user with an efficient interface.

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### 1. INTRODUCTION

Agriculture has been accepted as the basic of nations' political and social stability since ancient times. Agriculture sector plays an important role in large scaled employing of people. In most countries of the world, agriculture is still the most responsible sector for employment and maintaining a large percentage of society.

Land degradation is the biggest obscure for the sustainable agriculture. Primary way of preventing this negativity is making legal arrangements for preventing more breaking up and healing the breakages, disorders already existing. These studies which aim rearranging of the agricultural areas are called as land consolidation.

Land consolidation can be described as rearranging and taking all precautions for a more fruitful working of land areas according to the developing agriculture technology of today (Çay, 2001).

In the study of land consolidation, reallocation step is accepted as core of consolidation. This is a tool which rearranges proprietary rights. The pleasure of consolidation is accepted as "pass grade" of land consolidation in a way. Because problems in the step of reallocation are the main reasons of rejections in the end of the project. In the basis, wishes of the landholdings for the reallocation are asked and assessed in the beginning. In this step, wishes of the landholdings should be considered carefully and necessary studies should be done for convincing them.

In this study we proposed a methodology about the land reallocation of the farm areas' parcels, along with a software which we have created. This system which is called as SDSS is a computer based system for the spatial reallocation decision problems, and gives great achievement in solving them. Experts of the matter thinks that this software will ease and fasten the land consolidation studies. This system which we have created in GIS style will be able to analyse the data which we required from database and will help to fasten the process and fastening the decision making. Also best visual design is aimed with an efficient interface. The created system data includes input, stocking, handling, analysing, calculating, reporting and geographically referenced datas visualition processes.

And data for the project area and coordinates can not be shared within the commercial softwares for the land consolidation. So, when we transfer the datas which we use for a commercial software to another software, there is a lot of loss of data. This process does not supply us so much choices. In the created software, these datas are kept in a database which enable us to use it in a lot of softwares.

Armstrong and Densham (1990) offered 5 key modules which is necessary for a SDSS :

- 1. Database management system
- 2. Analysis processes in a model based data management system.
- 3. A graphic producer
- 4. A report producer
- 5. User interface

We will explain our study on these five main modules.

# 2. A DATABASE MANAGEMENT SYSTEM DESIGN FOR LAND CONSOLIDATION

Cartographic views of a database for spatial decision support system, can support spatial questionings and analitical models. We have used MS Access for creating database in our study.

For using in land consolidation studies, cadastral parcels, block records, land degrees, application limitations, farmer choices, an easy to use database is designed (Figure1). Spatial datas are generally information related spatially. In general meaning spatial data has three types: point, line and polygon (Yomralioglu, 2000). In our study spatial datas are classified according to the specification of the data.

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Figure 1. Database created by MS Access

Most effective method of the spatial data management is to use layer. For this aim we have used a "layer table" in our study (Figure2). KADASTRO\_PARSEL (cadastral parcel), KADASTRO\_ADA (cadastral blocks), BLOK\_PARSEL (new parcels), BLOK\_ADA (new blocks), TOPRAK\_DERECESI (soil degrees) and GENEL\_SINIR (project border) that shows limits of the study area are the basic layers that we use. In the questionings about the figures SQL, which is a sublanguage used in database questionings, preferred instead of MS Access.

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Figure 2. Created layer table.

# 3. ANALYSIS AND NUMERICAL CALCULATIONS IN A MODEL BASED DATA MANAGEMENT SYSTEM

We have used automotic data input in SDSS as manual data input process will take a long time. In order to be able to start land consolidation studies, cadastral records of the study area should be recorded in system.

Data collection for the spatial studies comprises nearly 2/3 of the total business cost. For this reason, creation of the data by the first hand and by the related institute, it is more advantegous to have related data from other sources related with the area. A software is prepared for the standardization of the datas. In the system, graphical values of the cadastral datas about the related area, is required by a commercial CAD software called as NETCAD (Figure3). But we will use our own software in our study, coordinate values of all datas are converted into required system with \*.cks extended report files and transferred into MS Access database (Figure4).

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Figure 3. Coordinate report file presented by Netcad software.

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Figure 4. Transfer of converted coordinate values to the database.

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All geographical data objects have geometrical structure like point, polygon or line (Tsou, Buttenfield, 1996). By starting from this point, after the coordinates and parcels are transferred into database, parcels are drawn in vector data format as polygons (Figure 5).

As non-spatial datas was provided from the cadastre foundation, process of transfering datas to the system is shown in Figure 6. Also in the same figure, index calculations of each parcel to be able to make the studies and overlay calculations, are required from degree areas and intersections of the parcel areas. At the end of this process, values of each parcel in the same degree values;

Parcel Unit Value (PBD) = Share × Index .....(1)

calculated by system by using the above formula.

After that, by keeping the same degree value;

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Deduction = \frac{\sum \text{ cadastral parcel area} - \sum \text{ blockarea}}{\sum \text{ cadastral parcel area}} (2)
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With this formula exact values are calculated which will be recorded with deduction values. After obtaining the necessary values, we can progress to the reallocation process which is accepted as the most important step for the land consolidation projects.



Figure 5. Drawing of the cadastral datas and parcels in vector data format which are added to database.

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Figure 6. Transfer of non-spatial datas to the system.

A land consolidation project consists of various steps. Among these steps, reallocation of the parcels is a process which requires various criterias and considering a lot of limitations (Semlali, 2001).

In the devoloped software, most important criteria for the reallocation is the wishes of the landholdings. In this aim three choices are asked to all landholdings and recorded in system. Figure 7 shows the system that we created for reallocation process. There is two options are given for the reallocation.

First technique is to make reallocation process manually (Figure8). In this situation, authorised person finished the process by following the wish of each landholding on the screen and graphical situation of the blocks.

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İşletme No	Parsel No	Hakediş	Kalan	~	Π	Blok No	BDS	Kalan	Parsel Sayisi
1	863	147,32	147,32		Þ	149	23513,55	23513,55	
2	320	3228,57	3228,57			150	14943,49	14943,49	
2	733	597,30	597,30			151	32684,80	32684,80	
2	2614	1027,92	1027,92			152	42367,74	42367,74	
2	2649	3925,31	3925,31			153	56473,98	56473,98	
2	2796	1099,40	1099,40		Π	154	90503,97	90503,97	
2	2833	1441,74	1441,74			155	111208,77	111208,77	
3	299	4760,79	4760,79			156	82762,49	82762,49	
3	304	864,54	864,54			157	104011,53	104011,53	
3	855	1172,24	1172,24			158	127619,25	127619,25	
4	612	970,83	970,83			159	56990,04	56990,04	
4	640	549,92	549,92			160	45903,38	45903,38	
4	2772	1295,54	1295,54			161	60071,42	60071,42	
4	2809	2555,28	2555,28			162	43221,06	43221,06	
5	2733	2382,07	2382,07			163	64737,68	64737,68	
6	608	739,80	739,80			164	100733,84	100733,84	
6	1096	681,39	681,39			165	57297,05	57297,05	

Figure 7. Created table for reallocation.



Figure 8. Manually reallocation.

Second technique is the main subject to be insisted. System makes the reallocation process automatically (Figure9). Here, some criterias are considered as the appointment process is done automatically. These criteria;

- Allocation process first starts with the landholding who has a statical facility on the land. Aim of this, is giving priority to the facility owners as stated in the laws.

- Secondly, allocation process of the farmers who haev more than three facilities will be completed. Reason of this, preventing splitting the land of the farmers who already have small pieces.
- And lastly, the farmers who are out of this conditions are set into their new blocks and finished.

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İşletme No	Parsel No	Hakediş	Kalan	~	Blok No	BDS	Kalan	Parsel Sayisi	
1	863	147,32	147,32		149	23513,55	23513,55		
2	320	3228,57	3228,57		150	14943,49	14943,49		
2	733	597,30	597,30		151	32684,80	32684,80		
2	2614	1027,92	1027,92	10	152	42367,74	42367,74		
2	2649	3925,31	3925,31		153	56473,98	56473,98	1	
2	2796	1099,40	1099,40		154	90503,97	90503,97		
2	2833	1441,74	1441,74		155	111208,77	111208,77		
3	299	4760,79	4760,79	20	156	82762,49	82762,49		
3	304	864,54	864,54		157	104011,53	104011,53	1	
3	855	1172,24	1172,24		158	127619,25	127619,25		
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5		700.00	700.00			100700.01	100700.01		
6	608	739,80	739,80	_	164	100733,84	100733,84		
6	1096	681,39	681,39	~	165	57297,05	57297,05		

Figure 9. Process of automatic reallocation.

# 4. A GRAPHIC PRODUCER

The system that we created, is a information system that give us the opportunity of analysing graphical information like the cadastral, block, road, static facilitiy and ungraphical information about these values (like landholdings, areas) and assignment for each parcel and block. By representing the results with a software that we created, there is no need for a commercial software. System also includes most questionings done by commercial softwares (Figure10).

With the system we created, all reports and statistical results asked by the institute, which makes land consolidation, can be required as a print out by the system.

## **5. A USER INTERFACE**

Components of the decision support systems (DSS); DSS database, DSS software system and user interface. Analysis qualification of these methods is depended on comprising it with a user interface which will ease the use of model (Çetinyokuş, Gökçen, 2002).

We have used an easy designed and extremely effective user interface in our study (Figure 11).



Figure10. Questioning the cadastral parcels of number 2 landholding.

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Figure 11. General view of the user interface.

### 6. CONCLUSION

This study is proposed a methodology about the land reallocation of the farm areas' parcels, along with a software which we have created. This system which is called as SDSS is a computer based system for the spatial reallocation decision problems, and gives great achievement in solving them. Experts of the matter thinks that this software will ease and fasten the land consolidation studies. As this is a thesis study and parcelation is not completed yet, we did not do application study and result investigation. But distribution step of the parcels is completed and distribution results are studied by experts and positive opinions are obtained.

SDSS software which we prepared with C++ programming language and includes a simple and easy interface with GIS functions, it will be a more economical solution for the usage instead of professional and commercial software packages.

In our study, we have planned to make a different study without necessity of any commercial software and with a design only for our study. Here, the aim is to automatisation of the distrubition studies and having an efficient and economical solution in the land regulation by obviating dependency for expensive systems like CAD and GIS.

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