The Computerised Land Re-Allotment Process in Turkey and the Netherlands in Multi-Purpose Land Consolidation Projects

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Key words: land re-allotment, land consolidation, cadastre, implementation of plans, security of tenure.

SUMMARY

A main objective of the Turkish Government is a decrease in socio-economic differences in specific areas in the country. Land consolidation is considered to be an effective instrument to offer better opportunities for higher agricultural production, improved income for farmers and family, better infrastructure and improved livelihood in rural areas. In the coming years 5-6 million hectares of rainfed agricultural area will be consolidated and 3.5 million hectares will be irrigated. In the latter establishment of irrigation schemes will go hand in hand with the land consolidation instrument. Land consolidation will contribute to the improvement of the agrarian structure as well as including environmental issues (e.g., biodiversity conservation, landscape values and cultural heritage). In the Netherlands considerable experience in land consolidation was gained with an approach that changed over time from primarily the improvement of agrarian structure and farm enlargement to a comprehensive integrated approach including agriculture, environment and recreation. This integrated approach is what the responsible Ministries in Turkey are seeking. Although there are many similarities in the land re-allotment process, there are also major differences. In Turkey temporary rights are not considered, whereas in the Netherlands both ownership and temporary rights (e.g., leasehold) are considered because this concerns the rights of farmers with actual production in the area.
To combine land consolidation with irrigation projects, DSI and TRGM are in need of specific techniques and methods for optimising the land re-allotment process. Use of computers in this process is common, though the current software and process are being re-examined in order to improve and modernise procedures. In the Netherlands, a set of computer tools is used in a fully automated process. These tools include standard GIS and a dedicated software application TRANSFER used to optimise the land re-allotment process. This implies the calculation of the optimal balance between *claims*, expressed in alternative preferences for the location of available farmland, and *values*, available in so-called "blocks" in the project area. Especially TRANSFER has drawn the attention of the Turkish Ministries as the design of the new re-allotment plan is currently executed manually.
A combination of standard GIS functionality with TRANSFER will be most supportive to streamline the process in Turkey. This combination, comprising functionality for dynamic and value-based calculation for the location of new boundaries, will improve the process notably in terms of time and costs and the end-result of the designed re-allotment plan. The next step will be to test TRANSFER in the Turkish context.

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1. INTRODUCTION

A main objective of the Turkish Government is a decrease in socio-economic differences in specific areas in the country. Most of the farmers have insufficient agricultural land divided over a number of small plots. The population growth in rural areas is high and opportunities outside the agricultural sector are scarce. As a result people want to leave the rural areas. Under those circumstances investments in the rural areas are not easily made. Non-economic considerations may resist the transfer of land from one landowner to another. Emotional bonds to land, or farming as a profession, may play a role and so may the lack of alternative income. However, there is considerable potential and commitment in Turkey to improve the livelihoods in the rural areas and to improve agricultural production.

Land consolidation[1], defined as "*the process of assembling a series of scattered land parcels into a smaller number of units*"(Dale and McLaughlin 1999), is considered a means to offer better opportunities for higher agricultural production, improved income for farmers and family, better infrastructure and improved livelihood in rural areas. Thus, land consolidation is a tool for improving the effectiveness of land cultivation and for supporting rural development (Sklenicka 2006). In the coming years 5-6 million hectares of rainfed agricultural area will be consolidated and 3.5 million hectares will be irrigated and consolidated. In the latter, establishment of irrigation schemes will go hand in hand with the land consolidation instrument. Land consolidation will contribute to the improvement of the agrarian structure, as well as including environmental issues (e.g., biodiversity conservation, landscape values and cultural heritage) (Uhling 1989). Thus these projects will be multi-purpose oriented.

Previously in Turkey, land consolidation projects were only implemented by the General Directorate of Agricultural Reform (TRGM) of the Ministry of Agriculture and Rural Affairs (MARA). Since the new law '*On Soil Conservation and Land Use*' was implemented in 2007, the General Directorate of State Hydraulic Works (DSI) of the Ministry of Environment and Forestry also gained legal rights to implement land consolidation projects. DSI is the primary executive state agency of Turkey for overall water resources planning, managing, execution and operation. Formerly expropriation was used in the context of land development as an instrument leading to considerable resistance by stakeholders. By combining land

[1] The term 'land consolidation' is, in this paper, used for a type of agricultural structural improvement (in Dutch *ruilverkaveling*; in German *Flurbereinigung*; in French *remembrement*) in the context of integrated rural development. The latter is usually called 'land development' (*landinrichting*, *Landentwicklung, développement de l'espace rural*).

consolidation with irrigation projects, important savings could be obtained in terms of constructional and operational expenditures. Farmers will obtain resource savings in money, time and labour. Productivity in both rainfed and irrigated agriculture will increase and irrigation schemes become easier to manage.

In order to combine land consolidation with irrigation projects, both DSI and TRGM are in need of specific techniques and methods for optimising constraints in land re-allotment, i.e. the design of a new parcel allocation by either re-allotting or re-apportioning according to a plan. In Turkey, land consolidation activities have been executed since 1961, but the institutions are currently looking for a new integrated approach to multi-objective land consolidation. Use of computers in the land consolidation process is common, though the current software (NetCAD) and process should be re-examined in order to support the improvement and modernisation of procedures.

In the Netherlands considerable experience in land consolidation was gained, especially after 1945, with an approach that changed over time from primarily the improvement of agrarian structure and farm enlargement to a comprehensive integrated approach including agriculture, environment and recreation. A whole set of dedicated computer tools (GIS-based with specific routines and additional software applications) has been built over the years in order to have a fully automated process. In the Netherlands certain tasks in the land consolidation process are assigned by law. Several parties work closely together in executing land consolidation projects.

With the '*Technical Assistance with respect to computer-application and GIS-databases in relation to land re-allotment*' project, various parties were brought together for the first time in Turkey, not only TRGM and DSI but also the General Directorate of Land Registry and Cadastre (TKGM) of the Ministry of Public Works and Settlement, to face the challenge to share knowledge and experiences from Turkey and the Netherlands where water conditions greatly differ: in the Netherlands excess water has to be drained, in Turkey water has to be brought to the farms. The project provided exciting opportunities to bring the Turkish and Dutch experiences and experts together, and thereby to learn from each other.

Cross-national exchanges can be useful for various reasons. They are foremost interesting as an eye-opener: (1) placing one's own system in a broader context can be very clarifying; and (2) it may highlight aspects that have always been taken for granted. Studying land consolidation projects abroad may trigger adaptations or improvements (Van Dijk 2002).

Recent developments in Geo-Information and Communication Technology (ICT) have a serious impact on the development of a Land Consolidation System. Both theoretical and practical ICT developments such as the ubiquitous communication (Internet), database management systems (DBMS), information system modelling standard Unified Modelling Language (UML), and positioning systems will improve the quality, cost effectiveness, performance and maintenance of a land consolidation system for Turkey compared to the existing system NetCAD. All this can include the re-use of existing functionality from

NetCAD. This means re-programming on another platform. The existing platform (MSDOS, CAD based and Paradox database) is outdated and an alternative should be sought for future enhancements and developments.

Moreover, users and industry have accepted standardisation efforts in the spatial area by the Open Geo-Spatial Consortium (www.opengeospatial.org) and the International Organisation for Standardisation (www.iso.org; e.g., ISO T211 Geographic Information/Geomatics). This has resulted in the introduction of new (versions of) general ICT tools with spatial capabilities (e.g., eXtensible Mark-up Language/Geography Mark-up Language (XML/GML), Java (with geo-libraries), object/relational Geo-DBMS including support of simple geographic features) based on ISO standards and *de facto* standards from OGC.

The purpose of this paper is to highlight some specific differences between Turkey and the Netherlands in the computerised land re-allotment process with the knowledge that in Turkey there is an urgent need to revise the current system. Land re-allotment is part of the land consolidation process of which the legal framework, institutional setting and required input data is briefly described for the two countries. This is followed by a discussion of functional and technical requirements of a number of subsystems vital to a future Land Consolidation System. Other necessary subsystems have been addressed in the project but will not be discussed here. The selected subsystems play a key role in the land re-allotment process.

2. THE LAND CONSOLIDATION PROCESS

The project concentrated on the instruments required to execute a computerised land re-allotment approach. Land reallocation is considered the 'unique core' of land consolidation as it is the only tool available to rearrange rights of ownership and use and withdraw land from individual owners and users to public use (Van den Brink 2004). However, the land consolidation process relates to the broader context of computerised land re-allotment and needs to be briefly explained to show the context in which land re-allotment is executed in Turkey and the Netherlands.

2.1 The legal framework and institutional arrangement in the Netherlands

In the Netherlands, according to the Land Development Law of 1985, the Government Service for Land and Water Management (DLG) of the Ministry of Agriculture, Nature Conservation and Food Quality is responsible for the project management of 'land consolidation by law' projects, whereas Kadaster is responsible under this law (and a more recent law, the Rural Land Development Law of 2007) for the legal certainness of the right holders of the immovable property and executes a specific set of activities such as making an inventory of the existing situation (e.g., rights and values of property), establishing re-allotment plans and preparing the final invoice for each individual right holder. Kadaster is involved throughout the life span of a land consolidation project.

The *Land Bank* is an instrument that is particularly suited for solving problems that may arise during a land consolidation project (Van Dijk and Kopeva 2006). It is useful in case of fragmentation problems and it provides land with which the achievement of a balance between allocated values and allocation claims can be facilitated, as well as achieving non-agricultural goals in an area. The Foundation for Agricultural Land Management administers these land reserves. It is a state agency that buys land on a strictly voluntary basis.

In the land consolidation process the input data comes from the national key baseline datasets, such as the digital data from the cadastral real estate system (registry and maps) and digital topographic data provided by Kadaster, whereas the output (i.e. updated re-allotment plan and deed of re-allotment) will be fed into these databases towards the end of the process. So for a considerable part of the process input data for the land consolidation project area is uploaded from the main cadastral systems and kept in parallel to these systems. Only at some distinct moments in the land consolidation process an update of the actual cadastral data is made. This choice is based on pragmatism and allows the development of a re-allotment plan without continuous updating.

2.2 The legal framework and institutional arrangement in Turkey

In Turkey, over time the laws applicable to land consolidation changed and with it the institutional setting. Currently the main set of laws that apply are:

- Law 3083 *Agrarian Reform Law due to Land Re-allotment in Irrigation Fields*: this is the law under which TRGM executes land consolidation in the whole of Turkey.
- Law 5403 *Soil protection and Land-Use Law*: MARA prepared this law which became operational in 2008. Under this law all governmental institutions and private sector can apply for a land consolidation project. However, it is required that any aspirant institution applies for a project to MARA. The latter has the decision power whether a proposed project of an aspirant institution can be executed.
- Law 5578 *Permission to Private Land Consolidation*: Land Consolidation Regulation and Guide (not in force yet). This law changed the 17th paragraph of Law 5403 and gives DSI and other governmental institutions the right to execute land consolidation projects when approval of MARA is obtained.

Thus, in Turkey different governmental institutions can execute land consolidation projects. Not only TRGM and DSI can execute land consolidation projects but also Municipalities and Province Private Administrations. The new laws transfer the land consolidation project execution rights also to other state institutions, such as water boards, etc., in case farmers' permission is obtained.

TKGM is, unlike Kadaster in the Netherlands, not directly involved in re-allocation of land rights, but it is like Kadaster the main data supplier (registry and maps) in land consolidation projects and receiver of the data of the updated re-allotment plan. It has a key role at the very beginning and end of a land consolidation project.

Land transactions during the land consolidation projects require permission from TRGM. This implies that the land market continues during the execution of the projects. There can be, however, limitations. At a certain moment in the land consolidation process (e.g., starting when villagers are invited to express their claims and related preferences) the purchased rights on existing cadastral parcels cannot result in new claims from the buyer. The purchased right will be re-allocated (based on the claim and expressed preferences of the seller). The support of the land market is only possible if ownership rights on parcels can be re-allocated during the design phase based on the claim of the old owner and not on the claim of the new owner. Efficiency requires that this situation cannot be avoided.

2.3 Baseline data

Once the decision to execute a land consolidation project in a specific area is taken, the necessary data and information need to be collected for the new land re-allotment design. The first step is to collect available (digital) data, make data quality and consistency checks. If data are missing these need to be collected. In Turkey, this concerns for instance soil data; in Turkey and the Netherlands this concerns land valuation involving local people and the preparation of a list of right holders. For the latter an important difference exists between Turkey and the Netherlands: in Turkey temporary rights such as leasehold and tenancy are not considered; only ownership is considered. In the Netherlands temporary rights are considered because these are rights of actual land *users*. Moreover, the rights of land users take precedent over the rights of landowners. One may re-allocate ownership but this does not necessarily mean that land use is re-allocated in a manner that is beneficial to the agrarian structure or to the environment.

As a basis for the design of the re-allocation of (real) rights there will be available in Turkey and the Netherlands:

- A land development plan that basically shows what multi-objectives will be achieved in the project area (e.g., in Turkey this includes the irrigation scheme).
- cadastral map, cadastral index, parcel identifiers, parcel boundaries, parcel areas and land values, names of the owners and optionally their addresses.
- land rights and other rights (e.g., mortgages, informal rights that are not yet registered transactions, or in the Netherlands leasehold). Attention needs to be paid to rights that have been transferred informally within a family (e.g., the father is still landowner but the son is the real user of the land).
- the project area will be divided into so-called ‘blocks’ with boundaries that follow waterways or infrastructure; each block has an ID, a specific area and value. These ‘blocks’ are the units in a project and the basis for the re-allocation process; allocated values and allocation claims are related to these blocks. Attention should be paid to the following: in the Netherlands a project area is called ‘block’, whereas the Turkish term ‘block’ refers to ‘block unit’ in the Netherlands. In this paper the term ‘block’ will be used meaning ‘block unit’.

- orthophotos and/or satellite images (e.g., in Turkey the use of recent high resolution satellite images is common (e.g., Ikonos or Quickbird); they serve as the basis for the new re-allotment plan).
- soil maps (in the Netherlands digitally available for the whole territory).
- current land-use map identifying possible constraints for future allotment design (e.g., nature conservation areas and orchards will remain in the same location, greenhouses cannot easily be moved, water extraction areas prohibit certain land uses that may pollute the water, etc.).
- an inventory of farmer's preferences and alternative choices (with a maximum of three).

One should note that land consolidation projects are of a complex nature: different datasets are needed to support the re-allotment design within project areas. From the land information perspective a land consolidation project results in the renewal of legal security data in the cadastre, but also in a contribution to the creation of nationwide datasets, i.e. data relevant to the National Spatial Data Infrastructure (NSDI).

Essential to the land consolidation process and the re-allotment design are the cadastral data. In the Netherlands these data are up-to-date and digitally available. This applies to the registry (tabular data) and map data (in vector format). Public and privately owned parcels are included. In Turkey, the initial registration of rights in the land registry is nearly completed by the TAKBIS project. However, publicly-owned parcels and forests are not registered in the cadastral system.

In Turkey, TRGM receives the cadastral spatial data in raster or vector format. In case of delivery in raster format TRGM will vectorise the cadastral maps or will invite a contractor to perform this task. In this process the geometric quality of the cadastral map will not be improved. In addition, some cadastral maps, delivered by TKGM as raster files, are in a local reference system. Transformation from this system to the national reference system can be extremely complex. One should note that the existing cadastral maps have a heterogeneous quality, whereas the new maps and plans are available in the same reference system with a homogeneous quality.

Another quality check of cadastral data concerns the consistency between tabular (legal/administrative) and spatial (geometric) cadastral data. Each parcel ID listed in the tables should be on the map; this is not always the case because in some areas the cadastral map has not been kept up-to-date contrary to the registers. This situation appears for parcels that have been administratively subdivided, i.e. the ownership right is administratively divided into *shares* in the registers, but this is not displayed on the cadastral map as a subdivision.

In general, one can state that quality upgrading requires functionality and also communication on cadastral data quality (e.g., on identifiers, areas and transformations) between TRGM and TKGM. However, the quality improvement does not concern the individual coordinates of parcel boundaries.

The above means that at the start of a land consolidation project in Turkey important data issues need to be tackled, whether in the Netherlands this is not the case. One should note, however, that in the Netherlands data related to leasehold or tenancy need to be collected at the start of the project as well as land valuation.

3. THE LAND RE-ALLOTMENT PROCESS

In Turkey, the design of the new situation is executed by private companies, always in accordance what landowners have expressed and under supervision of TRGM responsible for accommodation of expressed preferences or alternative choices. In the Netherlands it is Kadaster that makes the new allotment design, this is a task assigned by law.

The design of the re-allotment plan is the most difficult and complex task within a land consolidation project. It is divided into two parts: (1) an administrative part, and (2) a spatial design part. Nowadays, the first part is executed in Turkey with the support of tabular forms. There is no mathematical algorithm at hand to calculate the balance between allocated value and allocation claims; this means that all transfers between 'blocks' have to be registered by the operator. This is a very time-consuming with risks to overlook the allocation of rights of one or more right holders.

Land is available within the boundaries of a 'block' with an allocated value. Allocation claims represent farmers' preferences and alternative choices[2]. In each block the first preferences are allocated manually. This will result in most cases in differences between allocated value and allocation claims. This cannot be the case as value and claims should be in balance. Given the alternative options, transfers are executed to reduce differences in allocated value and allocation claims. This is an extremely complex process in which reiteration takes place until balance, or nearly balance, is obtained. If this is the case, the spatial design within the blocks can start using satellite images and/or orthophotos to translate claims into land parcels and connect these with (users and) owners.

Once the re-allotment design is made the public has the possibility to inspect the design and file objection. Objections can be filed on soil quality (i.e. a change in soil type of former and new parcels), the shape and size of the new parcel, or on its location. Filed objections are assessed in Turkey by TRGM in close co-operation with the village board, and in the Netherlands by the Local Land Consolidation Committee together with an advisor of Kadaster. Assessment may result in change of the proposed re-allotment design. This is a multifaceted issue if rights are re-allocated because the already allocated rights at that location have to be re-allocated again. After such a procedure there is again a public inspection that may lead once more to objections. After agreement on the new re-allotment design the co-

[2] In both countries a systematic reduction is included, i.e. each portion that has to be redistributed is reduced by a small percentage to acquire land for the creation of provisions that are in the public interest (Sonnenberg 2002) such as infrastructure (roads or irrigation channels).

ordinates of the new boundaries are set out in the field, this may again result in objections (e.g., in case of differences between the re-allotment design and the field implementation).

If everyone agrees the new data (both spatial and administrative) are sent to TKGM. Then TKGM will inspect and survey the field situation. If TKGM concurs the new situation will be registered. This concerns cadastral renewal, a substantial quality upgrade of cadastral data as a beneficial side effect of land consolidation. In the Netherlands it is Kadaster who makes the land re-allotment design and, once it is officially accepted, imports the new data (both spatial and administrative) into its systems.

4. FUNCTIONAL REQUIREMENTS

A land consolidation system includes a database containing spatially referenced land data, a set of procedures and techniques for systematic importing, collecting, updating, improving, designing, processing and distribution of data and a uniform spatial reference system.

For the definition of the functional requirements it is of great importance to realise that in land consolidation projects existing (geometric) data will be included in the land consolidation database, but at the same time new (geometric) data will be generated. The functional requirements addressed in this paper concern:
- land valuation;
- land re-allotment design;

For the set-up of the Land Consolidation System a set of systematic working procedures are needed to assure that different people operating this system would produce the same results. This requires specification of spatial (vector and raster) and tabular data layers to be used including metadata, scale representations, data quality and consistency (e.g., between spatial and administrative data) assessments, product definitions, authorisation for the use of data, etc. For instance, three kinds of area measurements need to be supported by the system: (1) the legal area, (2) the calculated area on the basis of the spatial data and (3) the area of actual land use. Parcels are linked to owners but from these data the farm should be defined as operational unit.

Farm models for the new land allotment need to be generated for all right holders and their Total Value, or parts thereof, need to be related to blocks in a series of alternatives on a model base. Mathematical algorithms are needed to allocate the farm, or parts thereof, in a block or in different blocks. In the Netherlands, it is of prime importance to distinguish the parcel where the main farm buildings are located from parcels that have no or less important buildings. This is done for two reasons: (1) in principle the land re-allotment will concentrate the right holder's parcels where the parcel with main farm buildings is located; and (2) if such a location is not possible the distance from parcels away from the parcel with the main farm buildings should be as short as possible to minimise the time spent on transport from one parcel of the farm to another (e.g., walking distance for animals from the grazing area to the

shed, time spent on relocation of farm equipment). In addition, farm enlargement is often included to give better economic opportunities to young farmers and to buy out elder farmers.

Based upon the farmers' preferences and alternative choices, the use of mathematical algorithms can assist in locating which right should be allocated where in a similar manner for all right holders in the area. In the Netherlands a specific software application called TRANSFER has been developed to assist the Kadaster expert in optimisation of the allocated value and allocation claim for each farm. This procedure is very complex and automated support is very effective and less time-consuming than doing this manually. In Turkey the automation of the re-allocation design is considered to be a major functional requirement that will substantially speed up the process and guarantee the quality of the re-allotment design.

For the land re-allotment design it is necessary to have functionality that allows to create perpendicular lines, i.e. new boundaries, and to move these boundaries parallel to inserted boundaries to calculate the value of the online created parcel and to assess if this value corresponds to what the farmer in the old situation owned. The Total Value of the farm may vary between certain thresholds defined by law, but above or beneath these thresholds financial compensation is needed. Furthermore, newly created parcels need to be linked to the farmer. Important is also that re-allocation of mortgages is supported and sometimes this may require subdivision of a newly created parcel if the mortgage is less than the parcel value.

In the re-allocation process of rights it is crucial for legal security to have included all farmers, all right holders, all (temporary) rights. Therefore, a strong link between the spatial and administrative data is required during the whole process.

The result of the land re-allotment process is an implemented new land allotment with new subdivisions of parcels within the framework of the constraints of certain land-uses, the multi-objectives of the land development plan, the related land values, (temporary) right holders and new parcel IDs. For each individual farm the old and new situation can be displayed on maps to show that the land consolidation project has improved the situation for the farmer. These maps are useful for public inspection. The financial compensation to be paid per farm, applicable only in the Netherlands because in Turkey it is subsidised by government, can also be calculated and shown for public inspection. Farmers that consider their preferences and alternative choices not properly honoured, or do not feel that their situation improves, or that their mortgage is allocated incorrectly can file objection. Such objections need to be processed one by one and may lead to adjustments in the land re-allotment design. Such changes, in turn, need to be discussed with those involved as adjustments in the design do not only consider the claimant.

5. TECHNICAL REQUIREMENTS

There is agreement in Turkey among the institutions involved that the system concept for a Land Consolidation System (LCS) should be based on an approach where users from different organisations (TKGM, TRGM, DSI and private companies) share data in a single

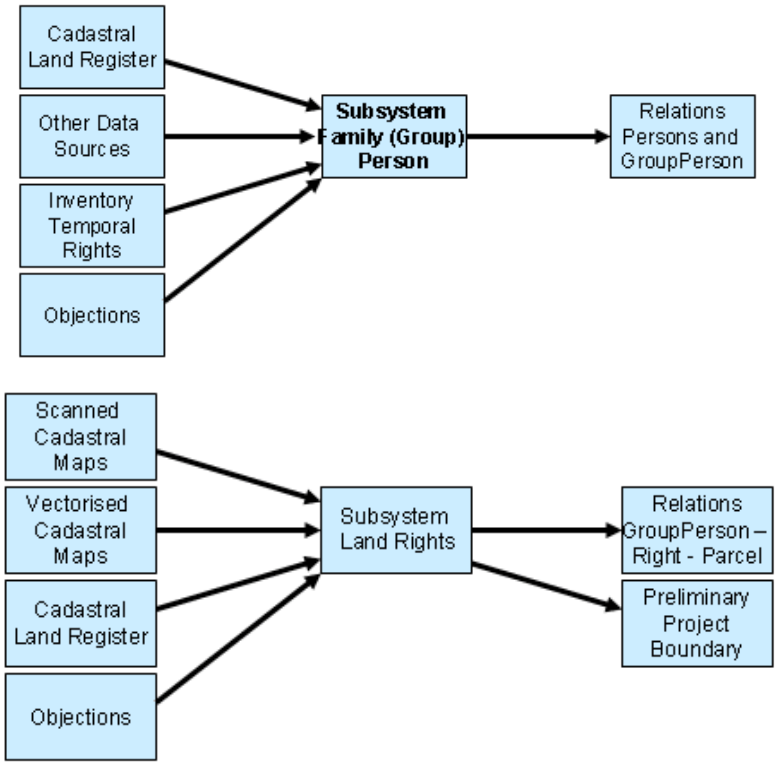
environment, i.e. the local office in the project area. Everyone can view the data, but editing will be related to authorisations. The requirements for the data model will be to be based on the principle of data sharing and not on inter-organisational workflows. Consequently, one Land Consolidation System with one database per project will be needed.

Three issues that greatly influence the data model in Turkey are discussed below.

5.1 Ownership and use rights

One major question in relation to the data model is whether land re-allotment is purely based on claims related to the re-allocation of *ownership* rights or on the claims of people who actually use the land and produce crops, i.e. the land *users*, thus including ownership and temporary land-use rights. During discussions between Turkish and Dutch experts it became clear that the landowner is decisive in this matter: in some cases the persons who lease land (the tenants) are allowed to formulate their claims, in other cases the landowner may not allow them to do so. Since 2002 tenancy is recorded in Turkey in so-called *village books* but there is no legal basis for the protection of tenancy and tenants, contrary to the Netherlands. The above implies that the data model in Turkey should support temporary land rights as a basis for claims related to re-allocation of land rights. This can be done by the inclusion of those temporary rights in a coding list for land rights, thus including an indication whether or not the land right is a *real* right.

Figure 1. Subsystems Family (Group) Person and Land Rights



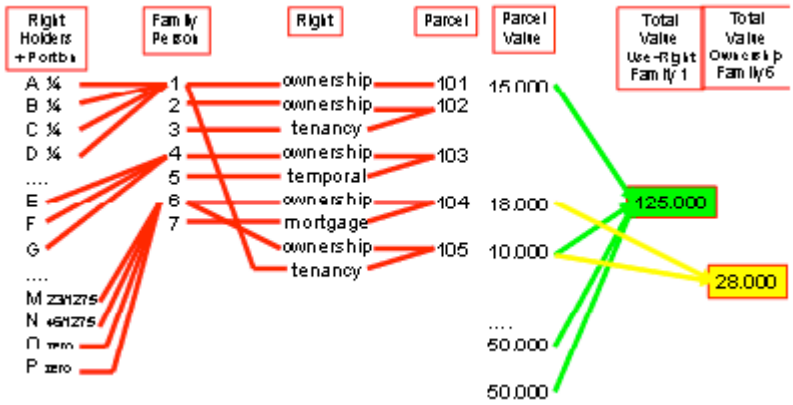
For the Land Consolidation System, a land right subsystem includes the relationship people-land via land rights (Figure 1). As people-land relationships in Turkey are very complex (as will be discussed in paragraph 5.2) a link to family relationship is necessary. With the inventory of all land rights in the project area the preliminary project boundary can be determined and requires the cadastral maps and related registers from TKGM.

5.2 Family-land relationships

In Turkey the cadastral data are not yet up-to-date. Many cases of inheritance and/or marriage have not been included in the registers, and owners are mentioned that live abroad or deceased. It is important to identify the people who are actually using the land for agricultural production as the situation can go as far back as four generations, resulting in registered ownership by persons who are deceased and with large groups of inheritors holding a portion in the original right. As a result complex trees of family relations need to be kept in the data model. Apparently there is little incentive to update the registry in order that it represents the actual situation. This could be examined for future projects as the administrative burden to sort out relationships is considerable (many owners of portions of land and only a few actual users) and should preferably be avoided in a land consolidation project. The possibility that just a single family representative is included in the administration would be worth considering. Consequently, provision for cadastral transactions should be supported as many people-land relationships are not registered.

The people (family) - land relationships are complex. There can be huge numbers of persons holding a portion in a right within one family. There is a tradition in Turkey to define a 'FamilyPerson' or 'GroupPerson' as a participant in land consolidation. Each 'GroupPerson' consists of a large number of persons holding portions in the related right. The right itself concerns basically ownership, but temporary land rights or mortgage may be included.
The complexity of the relationship Persons-GroupPersons-Rights-Parcels-NewParcels can be illustrated using an example (Figure 2). The column on the left shows the Right Holders having portions in the ownership right. Those persons do not have portions in temporary rights. The composition of 'family–persons' is a complex matter: a FamilyPerson or 'GroupPerson' can be represented by a natural person as member of the family or group, or by a person outside the family. A 'Right holder' can be alive or deceased. In case of ownership there can be one GroupPerson holding the ownership right. In case of temporary rights there is always also ownership. The latter is also valid for mortgage. In the example above the GroupPerson 1 holds an ownership right on Parcel 101 and a temporary tenancy right on Parcel 105. In case of attention to land-use rights the total value for re-allocation of GroupPerson 1 will be equal to 125.000; in case of attention to ownership only the value of 10.000 for Parcel 105 will be included in the claims for GroupPerson 6. Thus, the value of Parcel 6 can be included in the TotalValue of Group 1 or of Group 6, but not in both. Land rights can be re-allocated only once.

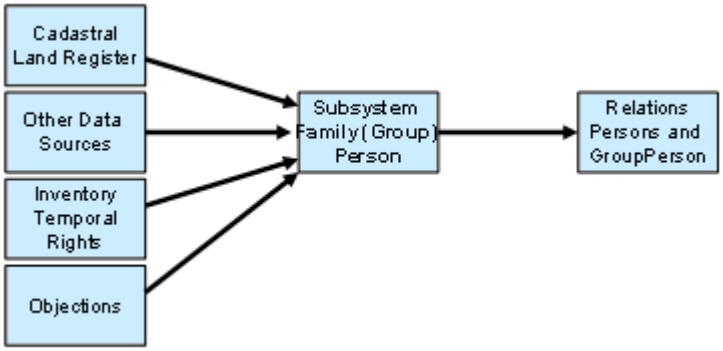
Figure 2. 'Persons-GroupPersons-Rights-newParcels' subsystem in the LCS



This subsystem supports the introduction of GroupPerson and individual members of the Group. Portions can be included for each member. Those portions are related to ownership rights, not temporary rights.

Figure 3 provides the overview and relationships in the LCS. Classes in the data model that are maintained with this subsystem are 'Person' and 'GroupPerson'.

Figure 3. Subsystem 'GroupPerson' of the LCS



5.3 Re-allocation of Total Values or parcels

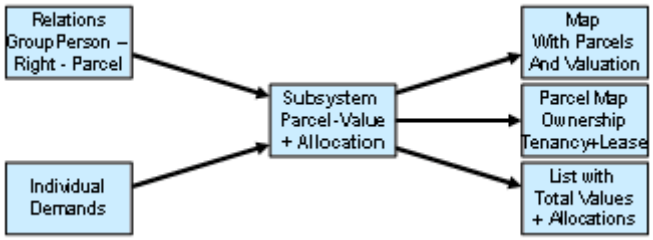
All rights or portions thereof, have to be re-allocated. The areas concerned have to be geometrically described in the new situation. The re-allocation process can be based on (parts of) Total Values per farm or on parcels, i.e. re-allocations of (rights to) existing parcels. Another possibility is that (alternative) locations are related to the values of the original parcels. In the Netherlands, Total Value per farm comprises the value of the land in ownership, minus the value of the ownership-rights that are in temporary use by another person, plus the value of the ownership-rights that are in temporary use from another person. This means that actual land use is important for re-allocation and not simply the ownership situation. For Total Values land valuation is necessary to express the parcels in terms of

(financial) value. Furthermore, re-allocation can be based on parts of the Total Value. To each part one or more locations in the so-called blocks can be given. If there are more locations this means that there are alternatives, but only one will be selected as a result of transfer of land rights.

For land valuation input from different data sources is needed. The approach can be different per project depending on available data, but should be identical within a project area. The result is a spatial dataset representing the agreed land valuation as a basis to calculate block values and Total Values per farm.

Parcel values are calculated after vectorisation and transformation to the Global Navigation Satellite Systems (GNSS) based co-ordinate system of existing cadastral maps. Existing cadastral maps are in Gauss-Kruger projection with European Datum 1950 (www.spatialreference.org/ref/epsg/2210), in a local system or purely graphical (without coordinate system). This means that parcels are described in different coordinate systems with different accuracies and different areas. The calculation of parcel values concerns a simple polygon overlay between the transformed cadastral spatial data and the valuation data. Subsequently, Total Values can be calculated automatically.

Figure 4. Subsystem TotalValue and allocation claims



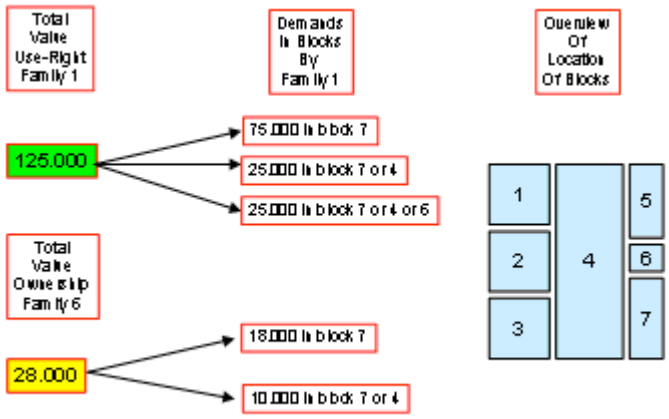
The Total Value and allocation claims (individual demands) should also be linked in the system. The Total Values per land user can be calculated when the claims per land user are known and the values of parcels. This subsystem is shown in Figure 4. The preferences and various alternatives can be inserted in this subsystem. A ranking of options can be achieved by adding weights to the expressed preference and alternatives.

For the transfer process there is no principal difference between Total Values per farm or parcels. For the data model the difference is whether or not the class 'TotalValue' is to be included. In Figure 5 this is illustrated.

Differences between allocated value and allocation claim occur. The allocated value cannot exceed the allocation claims within a block if the preferences expressed by the farmers are accommodated. Situations where differences occur (allocated value exceeds allocation claim or allocation claim exceeds allocated value) should be eliminated with the application of mathematical algorithms using the inventory of alternative choices of the farmers. If the preference of a farmer cannot be accommodated the first alternative choice will be used, then

the second alternative choice, etc., until difference are eliminated. Application of such a mathematical algorithm is only possible if there are sufficient alternatives.

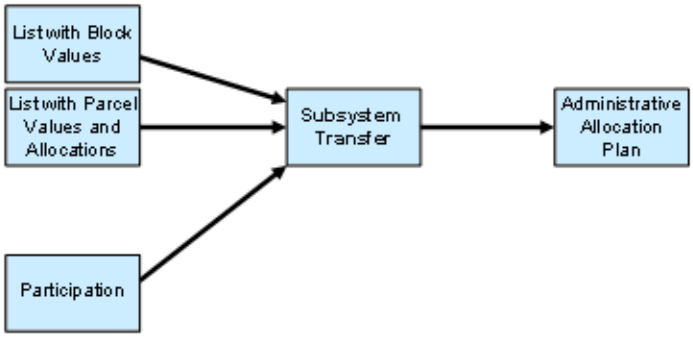
Figure 5. Re-allocation of Total Value or Parcels



In the Netherlands a dedicated software application has been developed, named TRANSFER, including various mathematical algorithms to optimise the land re-allocation process (Figure 6). It is used in every land consolidation project in the Netherlands. The basic principles behind the algorithm were developed in the 1970s. In Turkey great interest exists in applying TRANSFER in a land consolidation project to assess its capacity.

The subsystem TRANSFER will result in what preferences and alternative choices can be allocated where, so that claim and value are in balance within each block. In the next step these results need to be translated into a spatially explicit design (Figure 6) with the boundaries of the future parcels. This is a complex process requesting skilful fine-tuning of claim and value in the lay-out of parcels in each block. The design is based on the Total Values per land user (tenant, etc.) in the Netherlands; the real landowners are allocated in the next step because the rights of land users prevail over landowners. In Turkey one should consider this approach for an effective renewal of the agrarian structure and considerer farm enlargement.

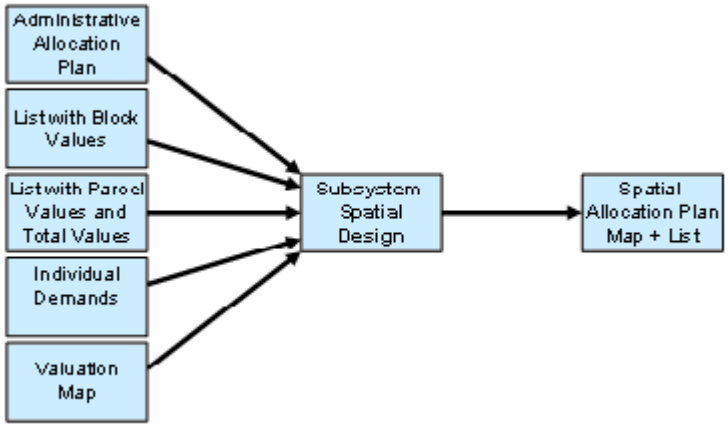
Figure 6. Subsystem TRANSFER as used in the Netherlands



The subsystem TRANSFER will result in what preferences and alternative choices can be allocated where, so that claim and value are in balance within each block. In the next step these results need to be translated into a spatially explicit design (Figure 7) with the boundaries of the future parcels. This is a complex process requesting skilful fine-tuning of claim and value in the lay-out of parcels in each block. The design is based on the Total Values per land user (tenant, etc.) in the Netherlands; the real landowners are allocated in the next step because the rights of land users prevail over landowners. In Turkey one could consider this approach for an effective renewal of the agrarian structure.

The re-allotment design should be publicly inspected and people should have the possibility to file objection. The spatial impact of such objections can be processed based on the functionality of the Subsystem Spatial Design. After agreement the allocated parcels for land users have to be divided to the real landowners. Also mortgages can lead to subdivision or to re-allocation over more then one parcel.

Figure 7. Subsystem Spatial Design

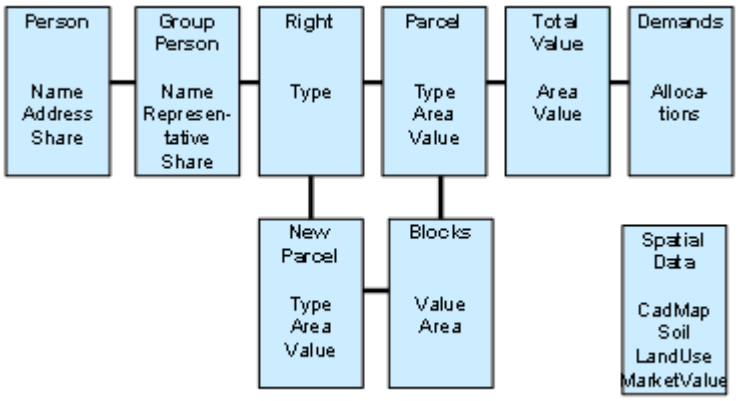


5.4 Data model

The above considerations on ownership and use rights, family-land relationships and re-allocation of Total Values or parcels, result in an outline for a data model (Figure 8). The data model can be developed in the Unified Modelling Language (UML) that allows not only 'classes' and 'attributes' but also 'methods'. The latter may be important for land value and area calculations or even coordinate transformations. Inclusion of a class 'VersionedObject' including BeginLifeSpan and EndLifeSpan attributes that will be inherited (in the sense of UML) will ensure that history can be traced back in the data.

In Turkey attention should be paid in deciding which attributes should be included. With each attribute the complexity of the system will be increased. It is, therefore, crucial to include only necessary attributes.

Figure 8. Outline for a Land Consolidation System (LCS) data model



6. DISCUSSION AND CONCLUSIONS

The social impact of land consolidation can be huge. It is therefore a key issue to communicate with people from the very beginning of the process to make them understand what land consolidation may mean for their livelihood and agricultural productivity. This may create understanding for the use of the tool of land consolidation (compared for instance with expropriation). Awareness building could be tackled at national or regional levels with the creation of a Land Consolidation Board in which also Non-Governmental organisations (NGOs) should participate. Next to this more strategic level better cooperation at technical and operational levels should be achieved.

Consolidation of millions of hectares in an efficient manner requests the implementation of standards in land consolidation design and implementation, the introduction of data sharing supported by system architecture for support in land consolidation. Standardisation, data sharing and implementation of system architecture is only possible if there is a first-rate cooperation between responsible institutions.

In Turkey, quality improvements (in coverage, scanning and vectorisation of maps, transformation of coordinate systems) of the cadastral data would greatly facilitate the execution of land consolidation projects. Improvements in data quality should not be made by other organisations than TKGM being responsible for legal certainty. Such quality improvements would have a major impact on the time currently spent in land consolidation projects to improve existing data. Better cooperation between TKGM on the one hand and TRGM and DSI on the other would create a win-win situation for all: less time needed for land consolidation projects because TRGM and DSI concentrate on programme and project management with high quality data delivered to TKGM of the new land allotment situation.

For the design of an automated system that will support land consolidation, it is crucial to make a choice whether the system will be project oriented. If this is the case, it will be easier to make organisational choices concerning the cooperation between involved institutions in

for instance (local or regional) project offices. Since the preparation and execution of land consolidation projects is becoming more and more also a geo-information management issue, one could assign a geo-information expert to one or more project offices to ensure the effective implementation and use of geo-information in the projects.

A combination of standard GIS functionality with TRANSFER will be most supportive to streamline the process of land re-allotment in Turkey. This combination, comprising functionality for dynamic and value-based calculation for the location of new boundaries, is particularly promising for improvement of the process especially in terms of time and costs and the end-result of the designed re-allotment plan. The next step will be to test TRANSFER in the Turkish context.

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REFERENCES

Dale, P.F., McLaughlin, J.D., 1999, Land administration, Oxford University Press, New York, 169pp.
Sklenicka, P, 2006, Applying evaluation criteria for the land consolidation effect to three contrasting study areas in the Czech Republic, *Land Use Policy* 23: 502-510.
Sonnenberg, J.K.B., Fundamentals of land consolidation as an instrument to abolish fragmentation of agricultural holdings, paper prepared for the FIG XXII International Congress – TS7.4 Land Consolidation: New Perspectives, Washington DC., 12pp.
Uhling, J., 1989, Land consolidation—agriculture and environmental protection, *Berichte Uber Landwirtschaft* 67, 426–456.
Van den Brink, A., 2004, Land consolidation and the emergence of metropolitan landscape, paper prepared for FIG Symposium on Modern Land Consolidation, Clermont-Ferrand, 10pp.
Van Dijk, T., 2002, Export of planning knowledge needs comparative analysis: the case of applying Western land consolidation experience in Central Europe, *European Planning Studies* 10(7): 911-922.
Van Dijk, T., Kopeva, D., 2006, Land banking and Central Europe: future relevance, current initiatives, Western European past experience, *Land Use Policy* 23: 286-301.

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