1. Introduction

- Rural Land Consolidation or « Remembrement »
  - An operation which aims to improve land cultivation by substituting the existing scattered division of the land into many parcels into new division characterized by a smaller number of parcels, larger in size, easily accessible and suitable for cultivation by machinery.
  - Needs years of studies and decision making before seeing its implementation.
  - L.C. project is based on legal, administrative and technical tasks.

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1. Introduction

- Land Reallocation
  - Most important and decisive technical step.
  - Synthesis, analyse and decision making step.
  - All the L.C. project is identified in this application.
  - Lacks of good approach to process large volume of data.

1. Introduction

- Technical operations:
  - Land surveying tasks.
  - Social and economic inquiries.
  - Soil studies.
  - Network studies (water management and network access to fields).
  - Land Reallocation process.
  - Implementation.

1. Introduction

- Manipulation of different documents (land surveying plans, soils classes plans, network plans, etc).
- Data treatment.
- The preferences (wishes) of farmers for particular spatial location.
  - Qualitative data.
  - Quantitative data.
1. Introduction

- **Objective**
  - Development of new methodology approach integrating steps of L.C. in a GIS framework in general, and the step of Land Reallocation in particular, accounting for Moroccan realities

- **Methodology**
  - Design of Conceptual Data Model for all steps of L.C. project
  - Establishment of landowners list to be reallocated inside a block "Temporary Land Reallocation"
  - Development of a specific GIS prototype for L.C. project

2. Land Reallocation Process

- **Conceptual Data Model was developed for L.C. project in irrigated areas with “Merise”**

- **Four main operations are needed for L.R.**
  - Preliminary calculations
  - Temporary Land Reallocation
  - Definitive Land Reallocation
  - Implementation

2. Land Reallocation Process

- **Preliminary calculations**
  - Calculation of the parcel areas and their values before L.C. (digitising parcel limits and their soil classes)
  - Calculation of the block areas and their values (digitising block limits and their soil classes)
  - Calculation of the required public use land value (roads, hydrographic network, etc.)

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**Calculation steps of L.R.**

- **Temporary Land Reallocation**
  -Performed by conventional methods
  - Determine approximate localization of owners inside the irrigation network frame (block), and the landowners list in each block
  - Factors taken in account:
    - Existing “plus value”, e.g. house, well, rock mass, etc.
    - Existing parcel within the block
    - Landowners requirements and wishes
    - Existing of a dominant class of soil inside a block
    - Existing of a parcel whose value is higher than the mean of all parcels of a specific area
2. Land Reallocation Process

- **Definitive Land Reallocation**
  - Determine the exact position and the “definitive” localization of each landowner's parcel in a concerned block
  - More than a geometric problem (several constraints)
    - The value of the block
    - The value of the new parcel
    - The soil classes
    - The "plus value"
    - The types of irrigation network ("trames" in French)

3. New approach for Land Reallocation

- The main problem with L.C. in general, and L.R. in particular, is the manipulation and combination of qualitative and quantitative data
- To overcome this challenge, a new approach has been developed for “Temporary Land Reallocation”
- Question survey was established and sent to different persons involved in L.C. projects (private companies, administrations, state departments, etc.)

3. New approach for Land Reallocation

- Results of the question survey
  - Model was developed by assigning weights for each criterion and constraint for a specific block
  - The grant of these weights is based on the synthesis of survey results
  - Two methods
    - Closed method or by default (weights are fixed)
    - Open method or by choice of the user (to work according to the specificity of every region)

3. New approach for Land Reallocation

- To put in a conspicuous position the importance of the "plus value", a highest weight was affected to this criterion
- With this condition it's sure that the landowner who has a "plus value" will be selected and reallocated in the concerning block

### 1st Method

<table>
<thead>
<tr>
<th>Criteria and constraints</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>« Plus values »</td>
<td>50</td>
</tr>
<tr>
<td>Possession a parcel inside a block</td>
<td>20</td>
</tr>
<tr>
<td>Landowner wishes</td>
<td>15</td>
</tr>
<tr>
<td>Dominant soil class</td>
<td>10</td>
</tr>
<tr>
<td>Existence of a parcel which its value is higher than the mean of all parcels of a specific area</td>
<td>7</td>
</tr>
<tr>
<td>Existence of a parcel which its value is lower than the mean of all parcels of a specific area</td>
<td>4</td>
</tr>
<tr>
<td>Closer to the villages</td>
<td>3</td>
</tr>
</tbody>
</table>

### 2nd Method

<table>
<thead>
<tr>
<th>Criteria and constraints</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>« Plus value »</td>
<td>?</td>
</tr>
<tr>
<td>Possession a parcel inside a block</td>
<td>?</td>
</tr>
<tr>
<td>Landowner wishes</td>
<td>?</td>
</tr>
<tr>
<td>Dominant soil class</td>
<td>?</td>
</tr>
<tr>
<td>Existence of a parcel which its value is higher than the mean of all parcels of a specific area</td>
<td>?</td>
</tr>
<tr>
<td>Existence of a parcel which its value is lower than the mean of all parcels of a specific area</td>
<td>?</td>
</tr>
<tr>
<td>Closer to the villages</td>
<td>?</td>
</tr>
</tbody>
</table>
3. New approach for Land Reallocation

- Post-destination algorithm for landowners
  - Calculate the numerical value for each landowner, in basis of
criterion priorities inside of each block
  - Calculate the sum of numerical values of the landowners in each
  block
  - Classify blocks in ascendant order according to the sum of
numerical values
  - Determine the landowners to reallocate, starting by the block
which has the maximum points of landowners

- Reallocate the landowners possessing the “plus value” in the
specified block
  - Determine the landowner lists to be reallocated by priority
order, and by comparing the sum of reduced value landowners
with the value of the block
  - Proceed on the same way for other blocks, by eliminating each
time the reallocated landowner.

1. The landowners possessing the maximum of points will be the
first selected inside a specific block
2. The operation is repeated by iteration until the L.C. operator is
satisfied
3. The adjustment of the block value with the total value of
landowners will be achieved interactively, if it seems necessary
4. The tolerance shouldn’t exceed 1% between the block value
and the landowners reduced value
4. Development of the prototype

- A prototype was developed within PC ArcInfo GIS software to deal with complex tasks in the:
  - Acquisition
  - Processing
  - Querying
  - Analysing
  - Displaying
  - Archiving
4. Development of the prototype

- Test was carried out with a real project with this application.
- The accomplishment of this task passed from weeks to a few days only.
Superposition of irrigation network and parcels before L.C.

Superposition of parcels and soil classes

Superposition irrigation network and soil classes

Parcels of landowner № 50
5. Conclusion

- Land Consolidation has several positive impacts on rural land development, which is the most discussed subject by different institutions (government agencies, Moroccan companies, and scientific researchers).

- The new method developed for “Temporary Land Reallocation” step will help planners and decision makers during the L.C. procedures.

- The use of GIS is very essential for such projects, especially where we deal with multi-criteria data analysis.