

Generic Tooling for Land Consolidation – The Concept Explained

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SUMMARY

As an instrument for rural development, land consolidation is applied in various countries. The process of exchanging land rights is quite complex, depending on the number of participating stakeholders, the quality of the land administration, parcelling, and natural characteristics of the landscape (among many other features that influence the use and allocation of land). A digital system that captures administrative information (both geographical and non-geographical) is much needed to conduct the tasks throughout the land consolidation process. Such a system will also be of great value to guarantee legal certainty for those right holders involved, as well as to foster an efficient and transparent land consolidation process. Since there is currently no standard system in the market, most countries employing land consolidation have developed a customized digital system to manage the geographical administration throughout a project. As the main principles of land consolidation across various practices are similar, this paper investigates whether it is possible to develop a generic tool that can be employed in different countries, with different legal frameworks, different traditions regarding land consolidation, and different aims. This will both benefit countries that have already adopted land consolidation, as well as those who are about to adopt land consolidation but have not developed a digital system yet. In this paper, we describe the underpinning concept of such a generic tool for land consolidation, by explaining how it should work, how it can be adapted to the various use contexts, and how to adapt its functionality.

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1. INTRODUCTION

Traditionally, land consolidation is an instrument for the improvement of the structure of farms, through the consolidation of fragmented agricultural parcels (van der Molen et al., 2005). It is sometimes viewed as the simple reallocation of land plot (or parcels) to remove the effects of fragmentation. However, it can be more than a mere reallocation of land to remove fragmentations. In pre-colonial periods of present-day Nigeria, the Igbo town of *Uturu* (see Chigbu, 2013) implemented voluntary exchanges of land to specially designated classes of people (e.g. disabled people, older people or widows or widowers) to exchange their family parcels which are too far away from the villages for consolidated parcels closer to the villages. This was done to enable them not to take the risk of walking long distances to faraway farmlands, and thereby exposing themselves to the dangers of being attacked by wild animals and other sorts of environmental dangers. Hence, it is possible to say that land consolidation was done in traditional African societies for human safety and to reduce distances travelled by farmers to their farms. Ever since the first known consolidation effort was done in Denmark in the 1750s, it has always been much more than removing the effects of fragmentation (FAO, 2003). That first consolidation was “part of a profound social reform to free people from obligations to noble landlords by establishing privately-owned family farms” and it resulted in “improved agricultural productivity” (FAO, 2003). This situation applies to other parts of the world where land consolidation was implemented (e.g. in present-day Austria, Czech Republic, Germany, to mention a few). In Czech Republic, the initiator of land consolidation was a František Skopalík (1822–1891) who was “an esteemed farmer, mayor of the municipality and later on the deputy of the Imperial Council in Vienna” (Kaulich, 2013: p. 194). So, it was not surprising that early land consolidation in the Czech Republic was intended to create “effective and economical farming in the agricultural landscape together with its preservation and creation” (Kaulich, 2013: p. 194).

Put simply, there is a wide range of objectives for land consolidation, ranging from agricultural improvement to village renewal or revitalisation, to landscape development, environmental protection or conservation or naturalisation (Chigbu, 2012). These varying roles that land consolidation play (as a development intervention) is also the reason why it is possible to understand land consolidation from different perspectives. However, irrespective of the perspective from which anyone chooses to view it, land consolidation involves the reallocation of land parcels to allow landowners and land leasers to gain access to bigger parcels of land at one or more places in exchange of their former smaller (or fragmented) land plots, land rights and land values. As an instrument for rural development, land consolidation is applied in various countries.

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Land consolidation practices range from single-purpose to multi-purpose, from optimising land allocation for agriculture – the most widely known application - to environmental protection, water management, infrastructure and revitalisation of rural areas and to implement climate change adaptation and mitigation measures. Apart from the exchange of land parcels (which is the general commonality of all forms of land consolidation), land consolidation always involves the exchange of land rights, whether it be use rights, ownership rights, customary rights or something else. It also involves “property formation” (Gwalebe and Chigbu, 2020). So, land consolidation does not merely deal with the fragmentation of land parcels. It deals as well with the fragmentation of land rights; land uses, land interests and ownerships. Land consolidation measures are necessary for rural areas because land fragmentation has negative agricultural production and food quantity implications (Ntinhinyurwa et al., 2019).

The process of exchanging land rights can be quite complex, depending on the number of participating stakeholders involved, the quality of the land administration, parcelling, natural characteristics of the landscape and the like. Any operational approach for land consolidation should align with policy, implementation goals, monitoring and evaluation dimensions (Chigbu et al., 2019). However, coordinating these dimensions of land consolidation is a complex issue. A digital system that captures administrative information (including geographical and non-geographical information) is needed to conduct and manage the tasks throughout the land consolidation process. Such a system will also be of great value to guarantee legal certainty for those landowners and right holders involved, as well as to foster an efficient and transparent land consolidation process. A tool for sustainably operationalizing this process has become relevant.

This paper describes the underpinning concept of such a generic tool for land consolidation. It explains how such a tool should work; how it can be adapted to the various use contexts; and functionalities it should have. Apart from the introduction, the paper begins by describing the notion of generic tooling, followed by a deconstruction of the concept of generic tooling in the context of land consolidation. These are followed by a description of the input and output modules, and the functional requirements for the modules identified for generic tooling. Finally, it presents an outlook for the future of generic tooling for land consolidation.

2. INVESTIGATING GENERIC TOOLING FOR LAND CONSOLIDATION

2.1 Defining a land tool in the context of this paper

According to the Global Land Tool Network or GLTN (2014: p. 3), “a land tool is a practical way to solve a problem in land administration and land management” and “a way to put principles, policies and legislation into effect”. The term, land tool, covers a wide range of methods for improving situations that are connected to the use of land for development purposes. Examples of a land tool can include software and accompanying protocols, a concept or an idea expressed in the form of a guide or guidelines, a training manual or modules for capacity development, a checklist for conducting land management or land administration activities or a set of approaches for handling land problems. It can also be a

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way of setting up and conducting of projects (including coordination and negotiation processes). It is very simple to know a land tool whenever it is available because somebody (a user) must be able to take a land tool and apply it or adapt it to their situation to solve a land-related challenge or problem.

A land tool as conceived in this paper is a software. The paper focuses on the interpretation of a tool as a software or set of software packages that will help to run a land consolidation initiative or project digitally and electronically. The paper focuses on producing, by way of an outcome, a set of ideas (for developing such a software) capable of being generally applied in different countries to enhance the process of land consolidation. The procedure for conceptualising such an idea has been referred to as tooling in this paper. It has been considered to be generic as a way to describe the perspective of such a tool – that is, a tool that can apply to multiple geographies or jurisdiction or countries. However, before delving into the description of such a tool, it is necessary to present the generic process for establishing such a tool, then followed by an analysis of the configurable elements that determine the user needs and functional requirements of the proposed digital tool.

2.2 Setting the scope for generic tooling for land consolidation

Since there is no standard digital system for land consolidation in the market yet, most countries employing land consolidation have developed a customized digital system to manage the geographical administration throughout a project (Aslan et al., 2018; Martínez et al., 2013; Demetriou et al., 2012; Touriño et al., 2003). As the main underpinning principles of land consolidation generally apply to all practices across the world, we investigate whether it is possible to develop a generic tool that can be employed in different countries, with different legal frameworks, different traditions regarding land consolidation, and different purposes. Such a generic tool should be developed on an open-source basis by a dedicated group of experts, drawing on experiences from various countries employing land consolidation or countries wanting to employ land consolidation in the near future. This is to ensure that all functional requirements regarding the various international practices are met.

Commonalities in a land consolidation project consist of three elements: (1) a description of the current situation, (2) the reallocation of land rights and (3) a description of the new situation. The first, describes the current land rights, right holders, restrictions and parcels, as well as the relation in-between. Likewise, the third describes the new land rights, right holders, restrictions and parcels after reallocation. The second describes how land rights are redistributed upon reallocation. This may involve the rules for reallocation, determining for each right holder the rights for allocation based on the rights in the current situation etc. in case of integrated large-scale LC projects, the stakeholders and project partners' involvement and negotiation play an essential role within all three elements or stages of the LC project. This fourth element also has special tools and guides.

Apart from these basic set of commonalities, other elements may play a role in land consolidation depending on the situational context. However, the specific set of additional elements may vary from country to country, both in number and nature. For example, in many

countries, it is good practice to compensate for any differences in size and/or value of the exchanged land. Farmers that received more land or land with higher values will have to pay, and farmers that received less land or land of minor quality will get financial compensation. Many different systems for valuation do exist. Some countries determine only the value of the exchanged land after the reallocation, whereas other countries have a system for mass appraisal based on the quality of the soil for agricultural production. It can also be a compensation mechanisms for those who agree to stop agricultural activities and sell their lands to the government when compulsory land consolidation measures are applied for social purposes.

The need for a generic tool to support integrated land consolidation projects in Ukraine

Land fragmentation and the needs for land consolidation in Ukraine are different compared to other Europe. During the long-term land reform that still is ongoing, a diversity of private farming (in view of many kinds of new agriculture enterprises) evolved in rural areas. These farms differed in sizes and structure (individual farms, shareholders companies, cooperative farms, private owned enterprises and big agro-holdings). Due to this situation, there are many fragmented small-scale land properties, as well as fragmented large-scale land lease/land-use in rural areas. The reform is in its final stage. The opening up of the land market to the public could possibly happen in 2020, after approval of the new Land Turnover Law in the Parliament. This will create opportunities for many landowners to exercise their constitutional right to sell their property in the open market. This scenario could also cause a big obstacle to investments in agriculture, water, and other rural infrastructure. Delay in opening of the land market creates difficulties and delays for starting land consolidation processes. Therefore, to start land consolidation all over the country immediately after opening and during the first period of land market operation, it is important to have Land Consolidation Law and the capacities for its implementation in the country as soon as possible.

However, land lease consolidation can be another option during the period of land market development as an additional tool for land use optimization. Many international projects that show feasibility and necessity (and future options for LC in Ukraine) will have the chance to tap into opportunities created by the LC Law and advocate for a LC Strategy. Investigations in pilot areas with involvement (and in communication) with many landowners and land users, shows that there will be increasing need for LC after opening of the land market. In majority of cases, LC will become feasible and desirable from local landowners and land users and communities, especially when other RD measures are incorporated within LC projects. Such can include investments in restoration of irrigation infrastructure, reconstruction of rural roads, food processing/storage/logistics, the development of new types of business and new markets to new rural employment. The much bigger scale and multi-purpose land consolidation projects in Ukraine will require (beside technocratic approach for improving of farmers economic, as well a new focus and process-management on trust), interests and visions of local communities. It would also require the promotion of human rights, employment and improved living conditions, and environment/climate protection measures. The proposed generic tooling (presented in this paper) can provide a vital support for the creation of a transparent negotiation process between different interest groups in a project area. It can help to create trust and make it more attractive and easier for landowners and leasers to start LC via clear organization of projects management and coordination, transparent integration for all partners' interests in the different LC scenarios to reach win-win solutions.

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2.3 Grasping the purpose of generic tooling for land consolidation

Many land surveyors and other professionals are involved in land consolidation projects at both managerial and technical levels. “The matrix of objectives, procedures and tools which constitute land consolidation is under major change, as is the application in real-life situations” (van der Molen et al., 2005). Land consolidation is particularly important in rural areas everywhere, especially in the global south where they face the challenges of “land grabbing, increasing *de-agrarianization*, food insecurity, cultural loss, extreme poverty, and climate change in sensitivity, among many others” (Chigbu, 2015: p. 1068). In this regard, a generic tool will benefit countries that already have adopted land consolidation, as well as those who are about to adopt land consolidation measures as part of their development strategy. In the text box a future option for large scale integrated land consolidation projects in Ukraine and possible supportive role of a generic tool during project organisation and implementation is described.

The countries that consider applying land consolidation can use the generic tool as a basis to further develop and tailor the system to their needs and the specific context in their country or project, instead of starting from scratch. The countries that have already a system in place can reduce their maintenance costs when they use the new generic system, instead of each maintaining their own.

Apart from these direct benefits, a generic system may generate indirect benefits. In Europe (e.g. Germany) it has been possible to reinforce the economic and social independence of rural people through the development and promotion of citizenship participation, collective responsibility and self-aid among the population through land consolidation (Chigbu, 2012). Therefore, the purpose of innovating a comprehensive tool for land consolidation is to ensure that good and suitable living conditions are achieved in a rural area. This is important since life in rural areas “is characterised by decreasing opportunities to earn a decent living in both the agricultural and non-agricultural sectors” (FAO, 2003). The development of a generic tool for land consolidation would offer a renewed option for talking about rural problems that are hinged on the use of land.

3. GENERIC TOOLING APPLICATION TO LAND CONSOLIDATION: THE CONCEPT EXPLAINED

A software-based generic tool for land consolidation will play an essential role in recording mapping, tenure and socioeconomic relations because of its ability to achieve high accuracy and precision. The geometric complexity of land consolidation calculations and the large amount generated through land consolidation necessitates the development of such a tool. This means that (as already explained) the general tool must be configurable to accommodate variations in land consolidation practices. Being configurable means three different things in this context: (1) modules can be included or left out, (2) the order of the modules may be different, and (3) how a module takes shape can be different. Figure 1 exemplifies how a

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generic tool may look like (E), after the configuration of modules A - D, for two different countries (house 1 and house 2).

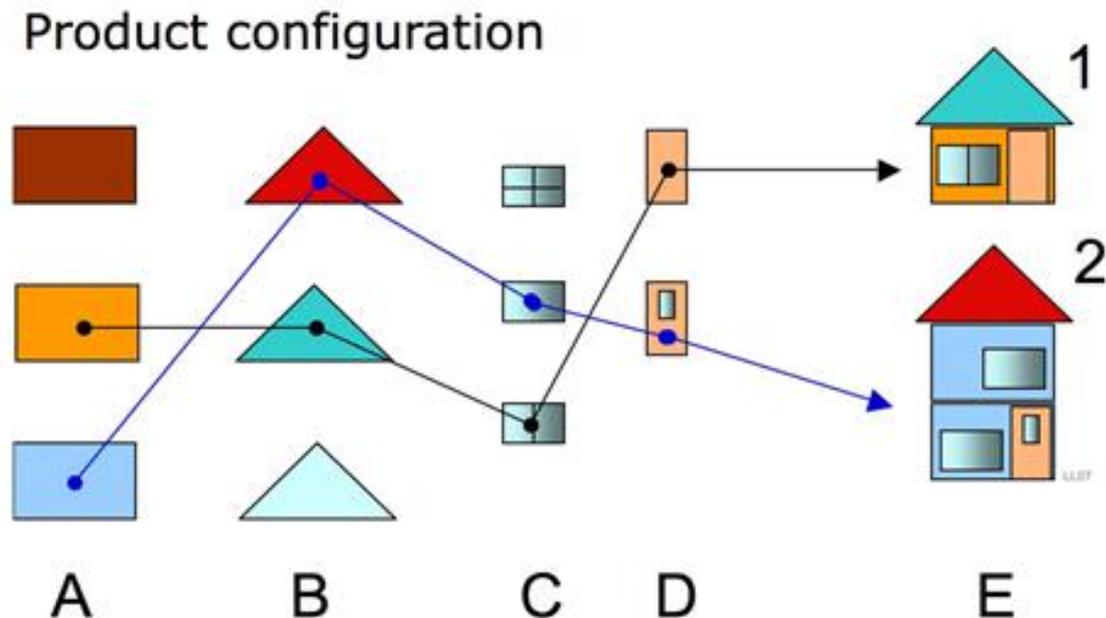


Figure 1: The principles: a modular and configurable tool

In the context of this paper, the generic tool consists of many standardised modules that together make the tool. A module, in a software-based land consolidation tool, represents separate and interchangeable components which depend on code (and data) to deliver a particular functionality. For each module, its functionality can be described based on the required input and desired output (Figure 4). Figure 3 gives an overview of all distinguished modules so far. The core of the generic system consists of blue modules. In addition to the three modules mentioned already before (description of current situation, reallocation, description of new situation) we have added the start of the project (delimitation of the project area, delimitation of the area for reallocation, aims to be realised etc.) and the financial arrangements (individual contribution/compensation, settlements between stakeholders etc.) at the end of the project.

The core modules can be complemented with the orange modules, consisting of functionality regarding the more technical parts of a land consolidation project. Currently, the following modules are distinguished: tenure system, reference date, deduction, valuation, rules for allocation, registration of new situation, rules for financial arrangements. Furthermore, we have distinguished some modules (depicted in green) related to public participation. These are wishes, grievance mechanisms and adjudication, information meetings and the like.

Some of these technical or participatory modules are linked to one moment in the process of land consolidation. For example, the wishes (including the interests and needs of the people)

will always be collected before reallocation starts, whereas other modules can be employed at more than one moment throughout the project.

Below, to exemplify practice, the scheme for management of integrated land consolidation projects in Ukraine is presented (Figure 2). The generic tool is incorporated at all stages of project organisation and implementation, including the development of interactive stakeholders' dialogue and negotiation.

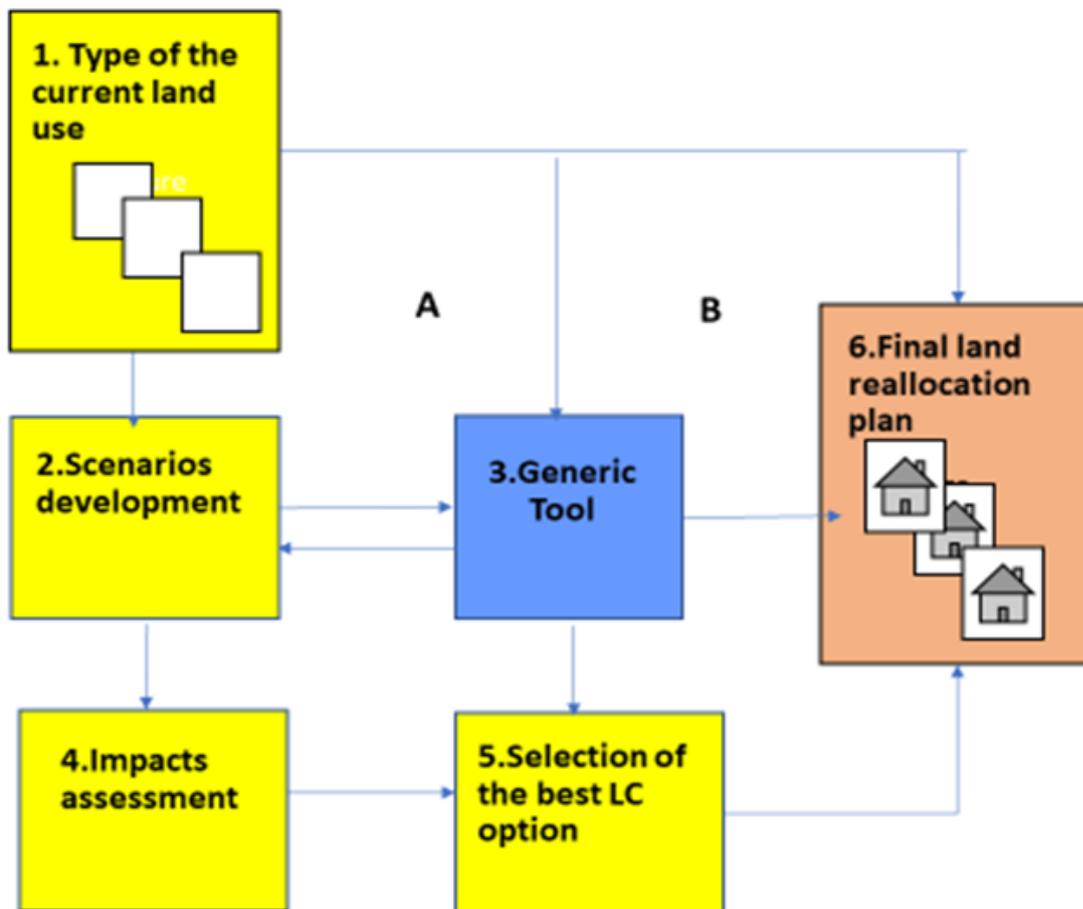
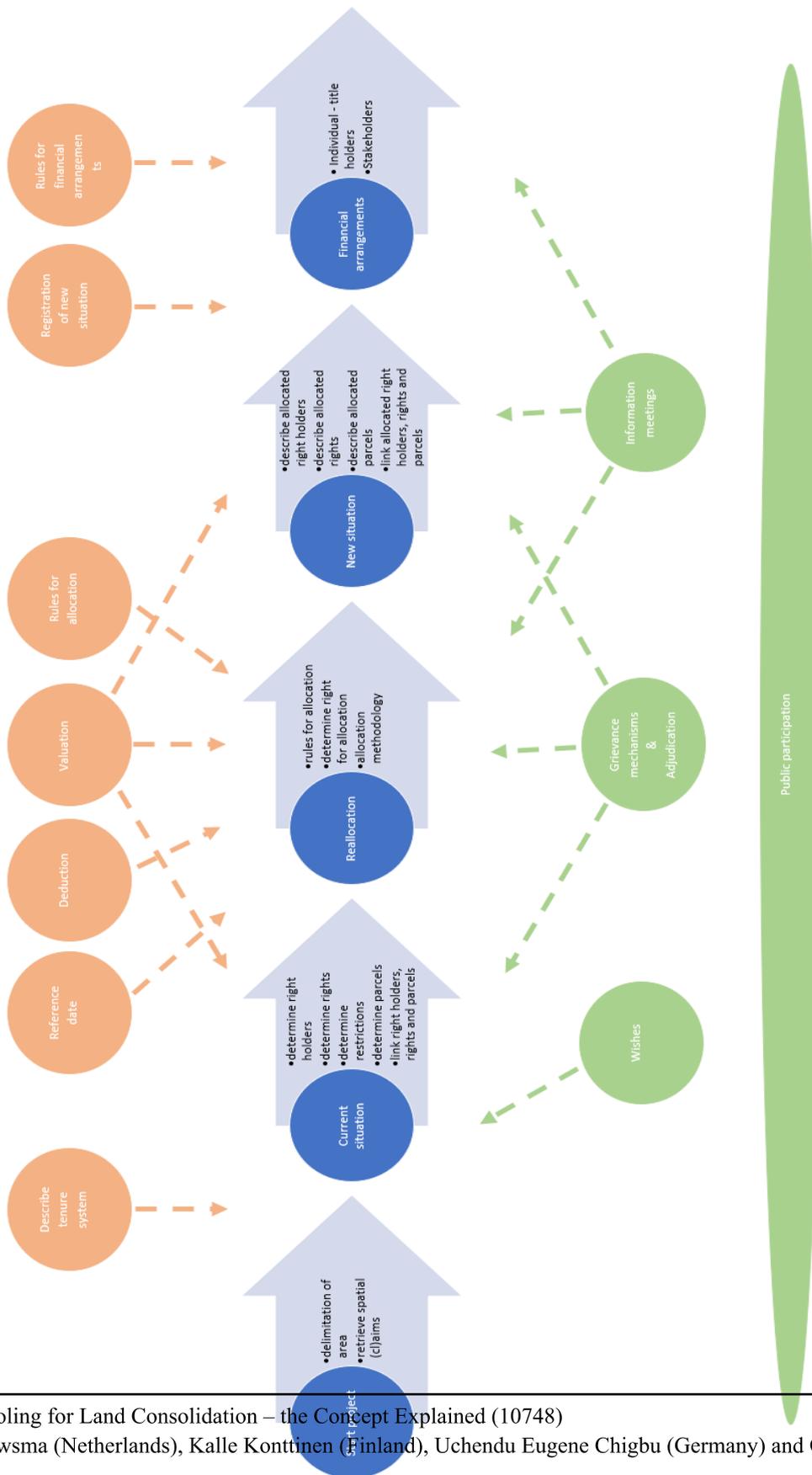


Figure 2 Proposed use case of generic tool for integrated land consolidation projects in Ukraine

For any tool to be effective, it has to accommodate various elements that would specify types of current land uses, scenarios for their development, a means for impact assessment, an element that allow for selection of best land consolidation options and a plan for final land reallocation. These situations are exemplified in the Ukrainian experience, and are necessary for integration in any generic tool.



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Figure 3 Overview of modules of the generic tool for land consolidation
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4. INPUT AND OUTPUT PER MODULE

4.1 Describing input – throughput – output

As it is work in progress, we focus in this paper on the core module of the generic tooling, namely 1) the start of the project, 2) the current situation, 3) the reallocation, 4) the new situation and 5) the financial arrangements. For each module or element, the needed input and delivered output have to be determined. The input describes the needed information to be able to describe or execute the core module. Similarly, the output of the core element describes what will be delivered. The output can either be a final product or information that is used as input for another element. An example of output as a final product is the overview of the costs that a stakeholder has to pay or the financial compensation that the stakeholder will get. The output from one module can play an essential role in successive modules. The module valuation determines how the value of parcels will be determined, and this information is relevant, for example – and depending on the context -, for determining the right for allocation of land or the financial contribution or compensation. The throughput describes the needed functionality for the module. Here, the action takes place and tasks are performed. So, the input and output provide information about the dependencies between the modules, and the throughput describes the functionality of the module based on the needed input and the delivered output.

Figure 4 provides an example that describes the tenure system element. To be able to define the tenure system of a country (or region) in the tool, one needs to have information about the type of rights that apply, including a semantically consistent description of each type of right. Similarly, an overview of the existing type of right holders and the type of restrictions that might apply is needed. By having a specific module that defines the tenure system, the generic tool can be adjusted to fit the situational context within which land consolidation will be applied.

The principle of adjusting each module to the local context applies to all core modules. It enables professionals to align the generic tool to the project situation, e.g. the existing tenure system in a country or region, the legal framework for land consolidation or re-allotment, or the followed procedure in the project.

In the next sections, the input and output for each core module will be described shortly point by point as well as some known variations in practice that might affect the required functionality at this stage in the land consolidation project. The input and output should be regarded as a first step to get an overview.

4.2 Start project

Input:

- Landowners / administrators / political decision to start investigation of the possibilities of land consolidation.
- Preliminary investigation before starting (legal) process of land consolidation is needed.

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- Policy aims and location of claims that either limit possibilities or must / should be realized.

Output:

- Delineation of the area where land consolidation takes place.
- Defined area and the stakeholders who should be involved, and to start surveying the current situation.
- Project planning, including available financial budget and expected contribution from stakeholders.

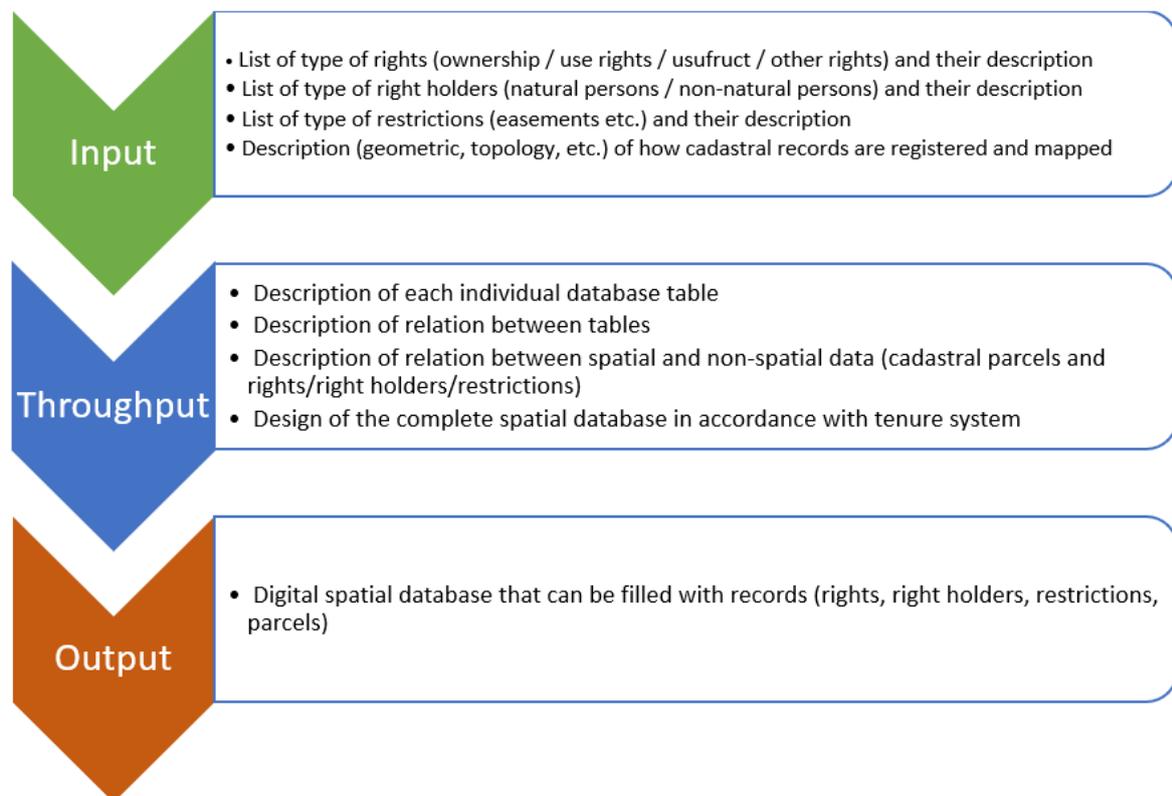


Figure 4 Input- throughput – output per element, in this example for the tenure system

Variations in practice:

- Some projects have a strict delineation of the area where land consolidation takes place, where other projects have no strict project boundary.
- In some projects, all parcels are part of the land consolidation project, whereas in other projects only part of the parcels in the area will take part.
- At the start of the project, important decisions may be taken that set the framework for the project. This may include the determination of the purposes for which land consolidation is applied, the location where these purposes have to be realized (e.g. new infrastructure), financial support, duration of the project etc.
- Defining the land consolidation area can be difficult, and different approaches can be used. The traditional way is to define one open field area and keep it as one solid block.

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This is your land consolidation area where you plan to project. Another option is to select those landowners and their land, who are interested. Perhaps neighbouring parcels have to be included as well. If required, separate parcels can also be included. Many times, holdings have parcels far away from the farmhouse or -buildings and it should be possible to include these into the project to compile an ideal reallocation plan. The generic tool should support the delineation and demarcation of the areas included for reallocation. The area can have many enclaves, but areas should be enclosed. These areas mark the area where you plan your land consolidation, perform valuation, calculate the parcel area and appraise any changes in value for the landowners.

- In some countries, first, several scenarios need to be developed for discussion and further evaluation at this stage.

4.3 Current situation

Input:

- Description of the tenure system so that the underlying database can be aligned semantically and technically (relationships, unique identifiers, and so on).
- Geographical delineation of the project area where land will be reallocated so that it is clear which parcels and right holders do take part in the project.
- A cadastral map represents the location and boundaries of the parcels within the delineated area.
- A list of rights holders within the delineated area.
- A list of tenure rights within the delineated area.
- A list of restrictions within the delineated area.
- On overview of the spatial and administrative relations between the cadastral map, the rights holders, the tenure rights, and the restrictions.

Output:

- A map of the delineated area depicting all the involved parcels.
- A map for each titleholder depicting the location of his/her parcels and tenure rights.
- An administrative list of tenure rights and right holders.
- An administrative list of tenure rights for individual right holders.

Variations in practice:

- Cadastral map or registration of titles/tenure rights may not be complete, up to date, or consistent.
- In some countries, the value of the parcels is included in the administrative overviews already at this stage in order to provide information about their right for allocation. In some countries, this is based on the value of the parcels. In other countries, it is based on the size of the parcels.
- Finland: In Land Consolidation area current situation of landowners and farmers are researched. In EU-region, usually, the current situation can be found from existing registers. If this is not the case, the situation is surveyed. To Generic Land Consolidation Tool current situation should be possible to input. One owner or one family usually is one planning unit. All cadastral units and/or owned land of this one planning unit is marked to

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it. When all land, owned by this unit, are marked, the Generic Tool should tell how much area unit has. After valuation is input to the system, it should also tell what the total value of the unit is. Area of planning unit should be possible to show on a map where all land of the unit is highlighted.

- Planning units cover all Land Consolidation area. State or municipal land has its units. If the owner has many cadastral units, all these are combined with the planning unit and planned as one.
- Ukraine: due to significant diversity of land use within rural areas in the first stage of the LC projects, the land use types should be defined, that is needed to understand what type of LC project will be selected, and what procedure of project implementation will be set-up.

4.4 Reallocation plan

Input:

- Reference date that determines what is considered to be the current situation on which the reallocation plan will be based.
- Current situation (see 4.3)
- Rules for deduction (if applicable)
- Rules to determine the right for allocation for each titleholder
- Wishes from all titleholders regarding the new allocation, based on the current situation and their right for allocation.
- Any transactions after the reference date, but before the finalisation of the reallocation plan. These transactions might be incorporated in the reallocation plan if applicable.

Output:

- Reallocation plan where new parcel structure is illustrated. New borders and owners of individual parcels are shown.
- Approved reallocation plan.

Variations in practice:

- Reallocation plan can be drawn by hand or can be drafted semi-automatically.
- Reallocation plan can be mainly based on existing parcels and topographical boundaries or can be based on a complete new percolation plan (often in combination with a new infrastructure – roads/irrigation/ditches)
- Wishes might be collected in different ways and therefore, the input for the reallocation plan can vary considerably. Wishes may encompass general directions for allocation, such as ‘I would like to have my farmland concentrated around my farm as much as possible’. It may also encompass a detailed, perhaps digital, drawing how the parcels should be reallocated. Also, the number of wishes per titleholder may vary from one to multiple wishes.
- The right for allocation may be based on the current rights of individual title holders, but a group of titleholders may also be regarded as one ‘entity’ regarding the allocation of land for the new situation. The most common example is the family farm where several family members have added their land into one holding.

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- The reallocation process of drawing and delineating new parcels and their boundaries takes shape based on the existing situation together with the planned engineering activities. While drawing, you should be able to see the existing situation and planned engineering activities to guide the development of the reallocation plan. The generic tool can help by defining how much space is available and how best to optimise the allocation. It may also be able to show the administrative (size parcels) and financial consequences (value) for individual titleholders upon finalisation of the plan. Contrary to such a more 'automated' process of allocation, drawing the reallocation plan may be based on expert judgement from the engineer, surveyor or whoever is responsible for this task.
- Some countries may work with various scenarios, i.e. various alternative reallocation plans, to allow stakeholders to discuss and choose the best possible plan.
- In some countries, the final version of the reallocation plan can only be approved after (some form of) impact assessment and/or cost-benefit analysis of scenario's, as proposed by project partners.
- Some forms of land consolidation, especially the ones based on voluntary participation, might require the consent of all involved title holders regarding the reallocation plan whereas other forms of land consolidation or some countries have legislation determining that a representative is authorised to sign on behalf of all titleholders involved. In Finland for example, before finalisation of the reallocation plan, all participants receive maps, area and value calculations so they can raise their concerns and/or influence the plan. This can be repeated several times until the final plan is established.

4.5 New situation

Input:

- Reallocation plan (see 4.4)
- Any engineering in the field (land consolidation works) that have been executed.
- Revaluation of parcels should value have changed due to executed land consolidation works.
- Any transactions after the reference date, but before the established reallocation plan.

Output:

- Cadastral map representing the boundaries of the parcels in the situation after reallocation.
- A map representing any new boundaries that need to be surveyed or recorded (if applicable).
- A list of all right holders
- A list of all parcels after reallocation.
- A list of all rights after reallocation.
- A list of all restrictions after reallocation.
- Link right holders, parcels, rights and restrictions to each other
- Individual overviews, administrative and spatially, for each titleholder/participant.
- A deed or other documentation (depending on the tenure system) to register the new situation in the land administration system.
- Initial overview of the financial contribution or compensation that each titleholder can expect to pay based on the valuation of exchanged parcels and consequently, the

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differences between current and new situation.

Variations in practice:

- The new allocation plan may entail many new parcels or boundaries that have to be surveyed due to new roads, field roads, ditches, irrigation or drainage needed to optimise the new allocation.
- The new allocation may be based on the existing percolation structure and only entails the exchange of tenure rights without touching the shape and size of the parcels.
- A relation between the old and new situation (before and after reallocation) can be described, or the new situation can be seen to ‘overrule’ any previous situation making it impossible (judicially) to retrieve historical transactions before land consolidation.
- Apart from providing overviews and information to each titleholder/participant regarding the new allocation, some countries issue new certificates as well. This depends on the specific tenure system in place.
- Sometimes the new situation is also fed into other administrative systems, e.g. those used for the Common Agriculture Policy (CAP) subsidies in the EU-region.

4.6 Financial arrangements

Input:

- Current situation (see 4.3)
- New situation (see 4.5)
- Rules to calculate financial contribution or compensation. The rules determine what is eligible for compensation or require a contribution from the participants.
- Value and/or size of all parcels that are exchanged
- Increase or decrease of parcel value due to land consolidation works
- Applied deduction (if applicable)
- Value of other aspects that are eligible for financial compensation or require contributions. What information this exactly depends on the set rules.

Output:

- A list of contributions from each participant.
- A list of compensations for each participant.
- Type of financial contribution or compensation, in-kind or in money
- Overview of all costs and expenses for the closing of the project budget

Variations in practice:

- The division of the costs over various stakeholder groups may vary. These may consist of public, private or individual contributions. For example, the public-private partnership can be established to co-finance integrated land consolidation projects that benefit local communities for their social and environmental sustainability. In some countries also, farmers do financially contribute according to their benefit (individual or holding).
- Finland: At the beginning of the project, planning is done focusing on the area (number of hectares eligible for CAP subsidies) of the farms. Valuation of the area advances while

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planning continues. Soil samples are investigated. Agricultural land purchases of the region are investigated, and the price level is determined. Farmers are involved in the valuation and facilitated meetings are held to determine essential variables and principles of the valuation. When all values of exchanged parcels are determined, the financial compensation between participants can be calculated.

5. FUNCTIONAL REQUIREMENTS PER MODULE

5.1 Describe functional requirements

The core modules get input from various complementary modules that can be plugged in the process where needed. For some, perhaps there is only one logical moment. For others, there might be various suitable moments where the complementary module is needed. In this section, we will describe for these complementary modules what functionality is required based on experiences and examples from practitioners in the field. Some specific cases from countries are described in a separate box to exemplify the context within which land consolidation is applied.

5.2 Tenure system

Land tenure defines the structure of ownership, land use and property rights. It determines the relationship people have with land. Land tenure “has always been a significant political issue, with advocates supporting either public or private land ownership” (Lee et al., 2019: 14). This situation applies to land consolidation. A primary role of land consolidation is to rearrange tenure and property rights on land. It does this by changing the position of land parcels, the rights people have on land, and the durations involved in landholding. These are crucial elements of land tenure systems. A module in the software-based tool should be capable of:

- Recording the characteristics of existing land tenure systems.
- Identify different rights and responsibilities embedded on land.
- Store relevant tenure related information for decision-making in land consolidation.

5.3 Reference date

Referencing dates are compulsory components of any software-based tool because it allows for relating recordings and programmes to specific timeframes (in terms of dates, months and year). This character of a module is essential ensuring that activities conducted using the program are citable over time. It will also allow for ensuring and determining information updates and use. Most important is that users of the software should be able to note the tool’s latest release date and update dates. This way, it is clear that an older release or update date can give a clue to users concerning whether it is a current version or and outdated versions. The module on the reference date should be able to:

- Record and display the release date of the tool.
- Record and display the update dates of the tool.
- Store and carry out commands and relate such commands to time and periods for

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reference purposes.

5.4 Valuation

Valuation is an essential part of land consolidation. At least all parcels that are exchanged or have changed due to engineering activities should be valued. Some countries work with one methodology to systematically execute valuation. Others work with experts to go into the field to appraise the exchanged parcels or any changes.

Giving a monetary value (per hectare or m²) is a regular input to describe the value of each parcel. A valuation can be maintained in a separate spreadsheet, but it is easier for the user if it is included in the tool itself. In addition to the general price level or levels of fields, there should be possible to add elements that affect the value of the parcel. For example, wild oat or acidity can be things that affect the value of the parcel. There should be a possibility to include this kind of elements that may reduce or increase the value of the parcel.

Regarding the functionality of the generic tool, it means that the valuation module:

- Should be able to import, capture and calculate the value of all parcels in a systematic way.
- Should be able to import or add the value of a parcel on an individual basis.
- Should be able to provide an overview of the total value of the property of individual titleholders or holdings.

5.5 Rules for allocation

To smooth the process of reallocation, rules and guidelines can be derived that prioritize the allocation rights of stakeholders and determine how the allocation will take place. The rules and guidelines help to perform the reallocation systematically and transparently. Depending on the context and characteristics of the area, e.g. the percolation structure, the type of agriculture present, the aims of the land consolidation, the guidelines may be shaped differently. An essential function of such guidelines is to help decide which parcel is allocated to which rights holder in order to optimize the allocation both in the interest of the individual right holder and the general public. Regarding the functionality of the generic tool, it means that the reallocation module:

- Has to provide information when the reallocation plan is not in line with the rules for allocation. This can be provided either when drafting the reallocation plan or afterwards as verification.
- Can provide an algorithm that prioritizes the allocation automatically.

To be able to deliver useful input for the core reallocation module, the ‘rules for allocation’ module should clearly describe each individual applicable rule and guideline for allocation, their status (e.g. must apply, preferably apply, optional), and the relation between the rules and guidelines (e.g. which one prevails over others).

Rules for allocation in the Netherlands – an example

The main rules for allocation are laid down in legislation (art. 4 Besluit Inrichting Landelijk Gebied). These rules arrange for a consistent way of allocating the land in line with the purpose of the land consolidation plan. The responsible authority must define guidelines for:

- The concentration of parcels
- The distance from the field parcels to the parcel of the holding
- The maximum number of parcels per type of holding
- The size of the parcels
- The shape of the parcels

These rules allow responsible authorities to tailor the guidelines to the local situation. As a legacy of the past, we see that guidelines focus on maximising the number of parcels near or next to the holding (parcel concentration), prioritize dairy farming over other types of agriculture (as cows have to have access to the milking machine on a daily basis), minimise the distance between the field parcels and the holding. Should the situation arise that a parcel can be allocated to two or more potential holdings, the establish guidelines help to prioritize the allocation of land to landowners in a transparent way.

5.6 Wishes and needs

In the context of rural development, farming is usually a dominant land-based activity in rural areas. As a result, any consolidation effort must put into consideration the needs of the farmers and other landowners (also referred to here as the wishes). As a multi-purpose process, in land consolidation, the stakes of other landowners and titleholders must also be taken into account to ensure the integrated character of the project. Also, the interests of various stakeholder groups might clash with each other, so it is crucial to handle the wishes and needs of all participants carefully. The wishes and needs of farmers and landowners (and all other stakeholders) should be prioritized, and sessions (or special occasions) should be created to enable them to express their opinions to planners and implementers in public meetings or elsewhere. Needs can come in various shapes. It can be in the form of playing a management role or specific land-use demand in the consolidation process. There are some cases where facilitated workgroups of 3 – 10 participants have risen to become land consolidation project managers in many countries. Regarding the functionality of the tool, it means that the wishes module:

- Should be able to capture the wishes of individual titleholders. Depending on the context, this can be captured on a map or as a description in a document, or a combination of both.
- Should be able to capture more than 1 wish per titleholder.
- Should be able to relate or group wishes from individual titleholders in case a holding or family consists of more than one titleholder. The allocation and consecutive steps take place based on the constellation of this group.

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5.7 Grievance mechanisms

A module that specifically deals on grievances is necessary for any software-based land consolidation tool. As land consolidation brings different stakeholders together with a common goal of creating new consolidated parcels and rights, such a meeting can serve as a powerful tool for resolving grievances people share or experience over land. Just as is the case with tenure responsive land-use planning, such a meeting creates the room for conflict or dispute resolution (Chigbu and Antonio, 2020). The meeting can become a grievance mechanism for determining who owns what and where on landholding. This can allow for negotiations over conflicting claims by farmers or landowners, as well as an opportunity for negotiations on how best to allocate rights (and privileges and share responsibilities over land. Regarding the functionality of the tool, it means that the grievance mechanisms module:

- Should be able to capture the disputes that exist on land.
- Record the parties to land disputes.
- Identify the exit grievances that motivate the dispute.

5.8 Information meetings

A software-based land consolidation tool is (in itself) an information tool for land consolidation. As a result of this, ensuring that information meetings are given a priority in the tool is a mandatory issue. Land consolidation processes can be a very complex and complicated process. It has technical, social and cultural sides to its implementation. Information meetings are therefore necessary (in fact, compulsory) to ensure that all stakeholders are informed concerning their rights and responsibilities in the entire process. It is also crucial for strong awareness creation to be part of the process. This also calls for making specialised meetings where stakeholders are briefed about conditions and changes that may be needed to make the process successful. It is challenging to promote participation in land consolidation without adequate information dissemination mechanism. This is why information meetings are crucial in any land consolidation process. It is crucial to assign a module that would deal with meetings in the land consolidation software-based tool. Any module on information meetings should be able to:

- Present the needed information and respecting the privacy of individual title holders, in case it is an open and public meeting.
- Record the identity of all stakeholders (if applicable, depending on the character of the meeting).
- Categories key meeting agreements and record protocols of meetings. This could also apply to other generic tools insofar it encompasses ordinary/general agreements or minutes of the meeting.
- It is stored over a long period for legal evidence for future needs.

6. OUTLOOK FOR THE FUTURE

This paper presents the outline of a first attempt to exemplify the concept of a generic tool for land consolidation, and as such may raise many questions after reading. The current version of the proposal emanated from a previous meeting with stakeholders where the concept has been discussed and reviewed. As such, it is by no means finalised yet. The concept and described needed functionality would have to be elaborated further. Getting input from professionals working in different environments will be very valuable to make sure that the generic tool will represent the core process of land consolidation and user needs. This common and generic core process than can be tailored to specific contexts where land consolidation will be applied. To collect such valuable input, we aim to organise several moments for feedback and review, such as the FIG Working Week 2020 in Amsterdam. Although we acknowledge that we set ourselves an ambitious goal, we would like to investigate the technical feasibility for a generic tool for land consolidation based on open-source software. As we entirely depend on volunteers contributing to the project, progress will take some time. On the other hand, it also opens up possibilities as we have close ties to practice. Perhaps, we can find a test case where we can apply some of the described principles in this paper based on already available software. However, this depends on the availability of suitable pilot projects, the willingness of involved stakeholders to participate and the available capacity and funding to support such a pilot. Whatever the final result of this project, we will disseminate the findings for a broader public within the FIG community.

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