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GOVERNANCE FRAMEWORKS FOR THE SUSTAINABLE IMPLEMENTATION OF UAVs IN RWANDA.

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Abstract

Conventional systematic survey approaches adapted from western perspectives have been found to be of limited value in supporting vulnerable communities in East Africa. At this pace, it would take centuries to deliver adequate coverage. To respond to this challenge, an alternative approach entitled 'fit-for-purpose' (FFP) approach has been developed in order to deliver more responsible data acquisition. Within this context, innovative remote sensing technologies, like unmanned aerial vehicle (UAV) are increasingly gaining importance. To understand how this technology may be sustainably implemented under a FFP approach, it requires an understanding of how these new technology and related policies potentially align with existing governance arrangements. The aim of this paper is therefore to introduce the application of a new developed framework named 'the Fit-for-purpose governance assessment framework. This framework is an attempt to develop further the FFP approach from a governance perspective. Therefore, we have aligned the seven elements that conform FFP with the governance dimensions of the Governance Assessment Tool. This new framework will assess the governance arrangement that affects the implementation of the UAV in the Rwandan context. To do so, we have conducted 37 semi-structured in-depth interviews with stakeholders from the government, private companies and non-governmental organizations (NGOs). By applying the FFP elements, we found that the Rwandan governance system is not yet flexible and upgradable, rather not inclusive and participatory, partly affordable but already attainable and reliable.

Key words: UAV, governance, fit-for-purpose, developing countries

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Introduction

Evidence from the field shows that almost two-thirds of the global population does not have access to land tenure security, which implies that several millions of land interests are not recorded nor known by governments (Bennett et al., 2017). A major proportion of this problem exists in the Sub-Saharan regions. Land tenure security is of major importance as it delivers household wellbeing, poverty reduction and creates incentives for long-term investment and innovation opportunities (Deininger and Feder, 1999; Liversage, 2010).

Conventional systematic survey and mapping approaches adapted from western perspectives, like total stations or theodolites, have been found to be of limited value in supporting vulnerable communities in East Africa. At this contemporary land tenure recording rate, it would take centuries to deliver adequate coverage (Zevenbergen et al., 2013). To a certain extent, this can be ascribed to the fact that it is time-consuming and expensive process (Enemark et al., 2015). Therefore, new approaches to land administration are being explored, such as the 'fit-for-purpose approach', aimed at delivering affordable and faster data acquisition that meets both community and societal needs (Enemark et al., 2015).

Within this context, the European funded H2020-project called 'its4land - Geospatial technology innovations for land tenure security in East Africa' aims to respond to the challenge of improving the recordation of land tenure information by leveraging affordable innovative geospatial tools including remote sensing technology, an Unmanned Aerial Vehicle (UAV). UAVs are remotely piloted fixed-wing or rotary vehicles, integrated with a positioning system onboard and imagery sensors for data collection of smaller areas of up to a few hundred hectares. In this way, it can respond to the need to update existing databases faster with reliable, high-resolution geospatial information at lower cost (Stöcker et al., 2017).

For this paper, the use of the UAV is investigated in Rwanda. UAVs technology has been pointed out by different governmental and non-governmental actors in Rwanda as the tool with the greatest

potential to answer the challenges that updating the land tenure system can face (Koeva, et al., 2018). Rwanda also presents challenges that are commonly found in developing countries and has important improvements in the last decades. For this reasons it has been considered as a model for the region. In this way, Rwanda presents a case of advanced land tenure registration since it completed a Land Tenure Regularization (LTR) in 2013, which managed to regularize all existing lands under private, leasehold, and state tenures. Therefore, customary tenures and informal arrangements would no longer carry legal recognition. The main future challenge, however, is to maintain these processes and to keep registries up to date. The UAV can support Rwanda to keep the existing land tenure information up-to-date (Koeva et al., 2018).

Although technological innovations are crucial in responding to current land tenure information challenges, adoption and sustainable use of these geospatial tools also presents challenges in terms of social innovation. Specifically, to understand how this technology may be sustainably implemented and used requires an understanding of how these new technology potentially align with current policies of practices. But perhaps more importantly, it also requires an understanding as to how this new technology might present new challenges for existing institutional governance arrangements at the country level, but also confront prevailing social structures at the individual and organizational levels. The diversity of stakeholders and corollary interests in land tenure information introduces a level of complexity in understanding how best to coordinate and manage the use of the proposed technologies to deliver maximum benefits. This suggests a need to analyse the broad country context, the types of tenure that exist and how information about these are collected, the operation of current multi-level government systems and the related institutions and policies that regulate land tenure and the related technologies. To date, limited studies have been undertaken on this specific topic in land administration and this contribution is timely given the recent emphasis on a tool-based approach to fit-for-purpose land administration. More broadly, many papers concerning this subject are often written from the technical perspective so an assessment from the governance perspective may offer some complementary insights.

The ability to fully exploit these innovative geospatial tools therefore becomes incumbent on the development of appropriate governance arrangements. This builds on a significant body of extant

that demonstrates that contemporary failures in technological innovations can be ascribed to neglecting the importance of governance aspects (Broucker and Crompvoets, 2014; Ko and Fink, 2010; Manewick and Labuschagne, 2011). For this purpose, we consider of high relevance to develop further the FFP elements, from a governance perspective. Our selected governance framework, entitled the Governance Assessment Tool (GAT), can help to identify implementation difficulties and to uncover the relationship between policies, programs and regulations from the goal perspective (Casiano, et al., 2017, 2018). There are already positive examples of the FFP approach application in Rwanda. Land tenure regularisation in Rwanda was achieved within five years with an affordable cost of 6 USD per parcel (Enemark et al., 2014). For this study, we will see how the FFP elements will fit to the governance assessment framework elements.

The aim of this paper is therefore to apply a recent developed framework which is titled the Fit-for-purpose Governance Assessment Framework (FPPGAF). This new framework will support the evaluation of the governance arrangements, focusing on a sustainable implementation of the UAV in the East African context. By evaluating the governance arrangements, we will be able to identify challenges for the implementation, organisation and use of remote sensing technologies (UAV) from a governance perspective. This paper will be divided into four sections. The first section outlines the study area including a case study description. Second, the selected methodology will be discussed. Third, the fundamental characteristics and components from the selected frameworks will be will be presented. Finally, these elements will be used to design and apply the FPPGAF to support a sustainable implementation of the UAV in the context of Rwanda.

Rwanda

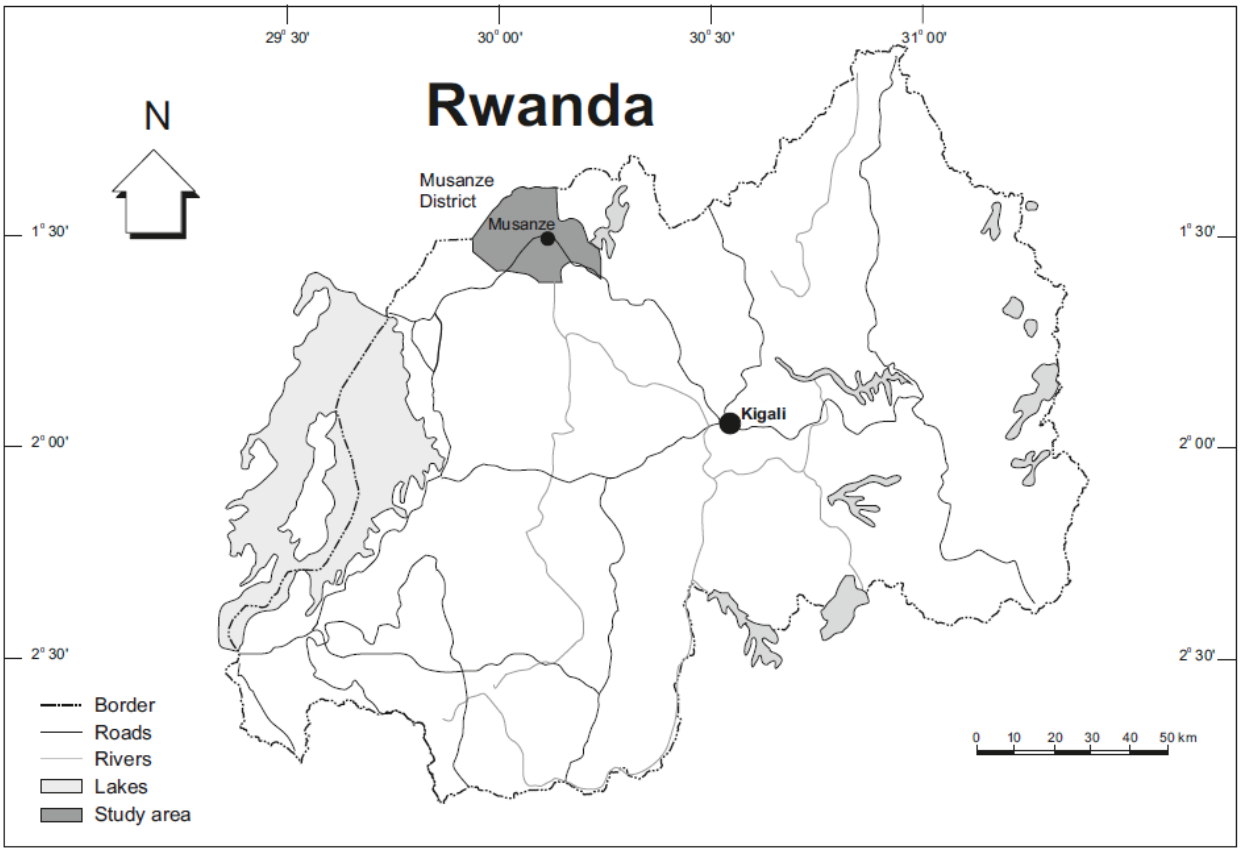

Figure 1: Overview of the selected study area Musanze, Rwanda (Ho et al., 2017)

Rwanda is a small and one of the highest populated countries in Sub-Saharan Africa (figure 1). The country is characterized by hilly landscapes, which are mainly covered by grasslands and small farms. For this reason more than 85% of the population is dependent upon agriculture as an important source of income (Ali et al., 2014). Although Rwanda has made substantial progress in rehabilitating its economy after the 1994 genocide, still 39% of the population lives below the poverty line (VLIRUOS, 2016). Rwanda's governance structure, as is shown in figure 2, is a decentralized country starting from the central government to the lowest government level or villages.

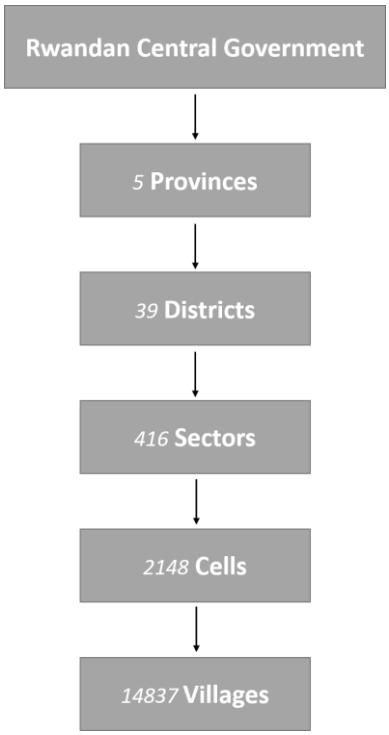

Figure 2: Rwandan governance structure

In this way, the central government is divided in 5 provinces, 39 districts, which are subdivided in 416 sectors and then to 2148 cells. Within these cells, the 14837 villages are the smallest unit (Deininger, 2010; NISR, 2014). As is stated in the Land Law of 2013, land related responsibilities are Rwanda Land Management and Use Authority (RLMUA) is as part of the national government in charge of land registration and geo-information services, land registration, issuance of land title and maintenance of land register, land management and geo-information services. The district provides technical support to the national institution in charge of the national land registry and geo-information services. Sectors are in charge of land use inspection. The responsibilities of the cell level are mainly focused on awareness raising and following up the use and management of land.

Since 2009, a legal land reform process called Land Tenure Regularization (LTR) was initiated by Rwandan government under the guise of gender recognition, overall equity, land security and

avoidance of land disputes. By 2013, This state-led process managed to register more than 10 million parcels countrywide (Biraro, 2014; Ali et al., 2014; Rurangwa, 2013). After the land tenure regulation program was completed in 2013, some regions became urbanized at a rapid pace. This has resulted in changes not reflected and recorded in the map base and there is now an urgent need for an up-to-date cadaster (Ho et al., 2017).

For this reason, the UAV are being used in Rwanda and more specifically in Musanze to update, improve and maintain the current land information system. Several rapidly urbanizing sectors are located in Musanze district in the Northern province of Rwanda. For this reason, Musanze has been selected as a case area to study the suitability to implement and use the UAV.

The Rwandan government is very progressive and eager to implement new innovations and technology. Rwanda experience in using UAVs to deliver blood to patients at remote area's through their Zipline project (Zipline, 2019). In the beginning of 2018, the Rwanda's government (steered by Rwandan's Civil Aviation Authority) has approved UAV regulations. These regulations are performance based and seek to govern the use of UAVs (The East African, 2018).

Methodology

The aim of this paper is to introduce the application of the FPPGAF. This framework is based on an existing governance framework and the elements of fit-for-purpose land administration. The selected cases are in Rwanda.

The semi-structured interviews were conducted during June and July 2018 in Rwanda by making use of a guiding topic list questionnaire, which facilitated the extensive data collection to support the development of multi-sectoral profiles (e.g. socio-economic characteristics, geospatial innovation trends, etc.) of the identified case areas pertaining to land tenure information. The questionnaire is a combination of both the alignment of FFP elements with the GAT dimensions and a compilation from an extensive literature review on governance and capacity development. It also includes information derived from an expert survey, which took place at an earlier stage of the research and through which we derived useful insights from respondents from the Netherlands,

Germany, Australia, different developing countries in Latin America, Caribbean and Southern Africa, Ethiopia, Rwanda and Kenya. The questions of the semi-structured interviews were not only structured by the specific topics, but also open enough to allow for clarifications, new insights and deepening of the subjects by new, unexpected responses during the interviews.

The participants were selected through purposive sampling in close collaboration with the Rwandan partners (INES Ruhengeri and Esri Rwanda), who can be considered as the specific country specialist. In order to get a complete overview of how the UAV needs to be used, the recommendations from 38 stakeholders that are related to land tenure were considered, situated at the governmental government (23), private companies (9), NGO's (1) and universities (5). An overview of the different conducted interviews par governmental level is presented in table 1:

Table 1: Overview of the different conducted interviews in Rwanda

Governmental level	Subdivided into…	Number of people interviewed	Name of the different governmental levels (cities, villages, etc.)
National level		11	
Northern Province	5 districts	3	
Musanze District	15 sectors	1	
Sector	sector dependent (varying between 4 to six cells)	5	Busogo, Muhoza, Kinigi, Cyuve, Musanze
Cell	Cell dependent (varying between 5 to 16 villages)	3	Gisesero, Cyabararika, Rwambogo
Private companies		9	
NGO's		1	
University		5	

Governance models

1 The Selected Governance Models

The creation of our FPPGAF is the result of aligning the FFP elements with the governance dimensions of the Governance Assessment Tool. The selection process for the governance dimensions can be described in the following steps:

First, we conducted an extensive literature review of contemporary publications on governance and capacity development models. The analysis included the revision of the top 50 cited governance related publications in the Web of Science platform.

Second, we narrowed down our selection by preselecting those models that were meeting characteristics of the UAV and responding to the governance needs. This can be translated in the following conditions:

1) The models should be adaptable to the East-African context or should have been already applied in African countries. Although, we understand the diversity of the region, we consider that narrowing this aspect, would help us to align our project better with the norms, values and governance structures of the three selected countries;
2) The models should consider topics related to land management and/or technology since the project is about land tenure recording tools;
3) The models should be applicable to analyse the organizational aspect of a variety of stakeholders. This allows us to understand both the multi-level governance aspects as the different forms of collaboration among citizens, government and private companies.

1.1 FFP land administration (FFP) and its elements

Conventional land recording depends upon tools such as theodolites, total stations, and Global Navigation Satellite System (GNSS) for position measurements and mapping purposes. These methods have proven to be very useful in developed countries as they deliver precise and accurate geospatial data. For developing countries however, they have been found to be of limited value as

area coverage is more important than accuracy (Bennett et al., 2008a; Williamson et al., 2010; Zevenbergen et al. 2013). Additionally, conventional approaches are not always able to accommodate existing contextual conditions due to the diversity of informal, social or customary land tenure types (Enemark et al., 2014). Conventional tools represent complex, time-consuming and expensive processes, which are mostly government driven. In addition, developing countries often have insufficient resources in financial and professional terms to conduct such methods of cadastral data capture. The continued use of such methods would mean taking centuries to deliver adequate coverage (Zevenbergen et al., 2013).

Around the 2000s, given the failures of several projects to deliver appropriate and adequate land recording data in developing countries, the FFP approach was introduced (Enemark et al., 2014). This sought to provide an answer to the inability of conventional methods to fully accommodate existing conditions (e.g. the diversity of informal, social or customary land tenure types), and to be sensitive to the limited resources in developing countries. FFP argues that the development of a land administration system in developing countries should be flexible and should be focused on serving the purpose of the system instead of focusing on top-end technical solutions with high accuracy (Enemark et al., 2014, p. 10). It is also participatory driven and strives towards including non-governmental actors in the process of decision making and delivering services. However, there is an acknowledgment that the role of the government remains crucial for accomplishing real change (Enemark et al., 2014).

FFP tools are designed to fulfill country specific land issues, needs and capacities (Enemark et al., 2014). These tools need to be flexible in use, accurate according to the purpose and affordable in price. This moves away from the conventional top-down approach and is more focused on a bottom-up approach aimed at better meeting the needs of users and associated policies. These tools can then be subsequently upgraded by conventional tools as soon as high precision data is a priority (UNCTAD, 2012).

There is a growing interest in using innovative geospatial tools that are more readily accessible, including examples like crowdsourcing (Goodchild & Glennon, 2010; Laarakker et al., 2015) or

mobile mapping (Enemark et al., 2014; Hay, 2016). The use of such technologies is reflected in the UAV.

Unmanned Aerial Vehicles (UAV) are remotely piloted fixed-wing or rotary vehicles, integrated with positioning system onboard and imagery sensors for data collection of smaller areas of up to a few hundred hectares (Stöcker, et al., 2017). The main advantages over conventional (manned) airborne-based mapping are threefold: i) UAVs are easily deployable; ii) UAVs are able to achieve a ground pixel size of 5 cm, which can be captured for a relatively large area in a relatively short time; iii) UAVs are easy in use - with a small training effort, state-of-the-art devices can be easily operated, even by laymen.

This can be translated in the FFP for land administration principles (Enemark et al., 2014, pp. 20–21):

1. General boundaries rather than fixed boundaries. The use of general boundaries to delineate land areas is sufficient for most land administration purposes in rural and semi-rural areas.

2. Aerial imaginaries rather than field surveys. The use of aerial imaginary is sufficient for most land administration purposes.

3. Accuracy relates to the purpose rather than technical standards. Accuracy of land information is relative and is related with the use of the information.

4. Opportunities for updating, upgrading and improvement. Building a spatial framework should consider opportunities for upgrading whenever necessary.

The three FFP basic components (Enemark et al., 2014, p. 10) are:

1. The use of affordable modern technologies. This means that the adopted technology should not be expensive for the different users.

2. The use of a participatory approach based on a spatial framework. Participation of the different stakeholders can allow the identification and recording of various legal and social rights.

3. The adoption of a legal framework with enough flexibility to implement the fit-for-purpose approach. The flexibility should allow a continuous development, according to the adoption needs.

The FFP seven elements (Enemark et al., 2014) are:

1. **Flexibility** in the spatial data capture process in order to provide information about the different uses and occupations of the land. This means that the tool aligned with the FFP approach should be able to provide information for varying uses and occupations.

2. **Inclusive** in the extension to cover all types of tenure and all types of land. This means that the tool aligned with the FFP approach should cover different types of tenure and different types of land.

3. **Participatory** in the manner to capture and use data, ensuring community support. This means that the data capture process and use of the tool aligned with the FFP approach should be supported by the community.

4. **Affordable** operation for the government and for society to use it. This means that the tool aligned with the FFP approach should be affordable for both the government and the users.

5. **Reliable** regarding the information. It should be authoritative and updated. This means that the tool aligned with the FFP approach should provide authoritative and updated information.

6. **Attainable** to create a system within a short timeframe and with the resources that are available. This means that the tool aligned with the FFP approach is capable of creating a system in a short time frame and with the available resources.

7. **Upgradable** regarding improvement over time in order to respond to social and legal needs as well as economic opportunities. This means that the tool aligned with the FFP approach can be updated over time, in order to respond to the emerging needs of social, legal and economic character.

These seven elements also have implications for the governance and capacity development models. For example: flexibility and affordability for land administration purposes are key to build a sustainable system when considering limitations in resources and capacities (Enemark et al., 2014). Flexibility as well as participatory conditions are also important in governance terms. Flexibility in the spatial data capture process also requires flexibility in regulations regarding implementation of the tools as the data (and data capture process) will be upgraded over time. A participatory process which is important to help to identify the different legal and social land tenure rights in turn requires both capacity considerations as well as an inclusive governance arrangement. Combining both flexibility and participation, we can find that "a flexible approach and the various legal and social tenure rights can be recorded in a participatory way" (Enemark et al., 2014, p. 11). Finally, there are also governance and capacity implications if captured data is to be reliable and attainable to be accepted by different stakeholders and used to respond to social needs.

1.2 The Governance Assessment Tool

The GAT sees governance as 'a context for decision-making and implementation; and it can be both supportive and restrictive for those processes'. The governance context here, assumes the existence of various actors, levels, goals, instruments and different means that can be applied (Bressers et al., 2016). The governance dimensions of the GAT have been applied to compare and to understand governance structures in developed countries such as Belgium, France, Spain, Italy, Spain, Switzerland, Finland, the Netherlands and the United States, (Bressers & Kuks, 2004; Owens & Bressers, 2013) and in developing countries such as Indonesia, Vietnam, South Africa, and Mexico (Mohlakoana 2014; Gunawan et al., 2017; Casiano Flores et al., 2017).

Five governance dimensions can be distinguished. The dimensions are multilevel, multi-actor, multifaceted nature of the problems, multi-instrumental, and multi-resources-based. These dimensions are derived from questions that respond to characteristics that feature modern governance systems: Where?, Who?, What?, How and With what? (Kuks, 2004). Adapting the dimensions of governance defined by Bressers and Kuks (2003) for this study, they result in the following:

- **Levels:** governance assumes a multi-level character of the land recording tool's adoption. This characteristic will allow us to understand the involvement and impact of the different governance levels in the tools' adoption process. The governance levels could be national, provincial and local level.
- **Actors:** governance assumes an involvement of multiple actors in the land recording tools' adoption process. This involvement will allow an understanding of the different actors and the networks involved in the adoption of the tool. They might be not only governmental actors but private companies, non-governmental organizations, universities, and citizens as well.
- **Problems:** governance assumes a multi-faceted character of the problems in the processes of adaptation and use of the land recording tools. This dimension will allow an understanding of the problems that the actors are facing when adopting the tools. The problems' analysis embrace both governmental and non-governmental actors.
- **Instruments (legal):** governance assumes the nature of multiple legal instruments that affect the adoption of the tools. This dimension will allow the identification of legal issues related with the adoption of the tool. The legal instruments are analyzed considering the legal framework composed by national, provincial and local regulations.
- **Resources:** governance assumes the existence of multiple resources to support the adoption of the tools. This dimension will allow an understanding of the different resources that are involved or that are lacking to support the adoption of the tool. This can include financial resources coming from donors or governmental agencies (Bressers & Kuks, 2003).

1.3 Fit for purpose governance framework for the implementation of UAVs in Rwanda

The GAT dimensions were selected as the main source for the governance arrangement analysis. These dimensions include characteristics of modern governance systems (Kuks, 2004). By selecting the GAT dimensions under the FFP approach, we are aiming to get a better understanding of how the UAVs can be implemented in Rwanda.

By aligning the GAT dimensions we translated the FFP elements as followed:

- **Flexibility** means that the implementation process of the UAV asks for some flexibility from the different governance levels, actors, governance instruments (including a legal framework) and the resources required.
- **Inclusive** means the involvement of the actors is required to support the adoption of the tool. This also means that all the problems that the actors face should be included when proposing solutions. The governance instruments should include the most relevant aspects that are required for the adoption of the tools and all the possibilities of resources should be considered.
- **Participatory** at the governance level means that participation should be open to all the actors that can support the tools' adoption. This includes their participation to strengthen the application of the governance instruments, solving adoption problems and to improve financial resources.
- **Affordability** from a governance perspective means that the different actors that are participating in the adoption process can afford the tool's adoption. The relevant actors will also be aware of the problems that different actors can have to afford the adoption of

the tools and they can propose changes in the instruments or resources in order to support the tools' adoption.

- **Reliability** means that the actors support the authority of the data produced by the adopted tools as well as the updating processes. The application of the governance instruments as well as resources guarantees the quality of tools' adoption as well.
- **Attainability** from a governance perspective means that actors involved support the adoption of the tool within a short time frame. There are relevant instruments as well as resources that can back up a quick adoption.
- **Upgradability** from a governance perspective means that the different actors are taking into consideration the (changing) needs, that tools have to be upgraded and improved over time. Relevant instruments, as well as the resources are being considered during the adoption process in order to support upgrading.

Given the GAT and alignment with the FFP elements, we have created the FFPGAF below (Table 2). This table allow us to assess the governance context for the implementation of the UAVs from a FFP perspective.

Table 2. Fit-for-purpose governance assessment framework

Governance Dimension	Flexibility	Inclusiveness	Participatory	Affordability	Reliability	Attainability	Upgradability
Levels	Different governance levels, according to the situation, can take a different/changing role to support the adoption of the tool	All the required governance levels should be able involved to support the tool adoption	All the required governance levels are participating in the adoption process of the tool	The adoption of the tool is affordable for the relevant governance levels involved	All relevant Governance levels support the data authority and the updating processes that could result from the adoption of the tool	The required governance levels can adopt the tool within a short time frame	The required governance levels will support the upgrading and improvement of the tool over time after its adoption
Actors (governmental and non-governmental)	Different actors, according to the situation, can take a different/changing role to support the adoption of the tool	All the relevant actors that should be able to support the tool adoption	All the required actors are participating in the adoption process of the tool	The tool is affordable for the relevant actors involved in the adoption of the tool	All relevant actors support the data authority and the updating processes that could result from the adoption of the tool	The required actors can adopt the tool within a short time frame	The required actors will support the upgrading and improvement of the tool over time after its adoption
Problems	There are opportunities to reassess the adoption process, depending on the nature of the problems	All problems' perspectives are being considered regarding the adoption of the tool	There is a participation process to solve the problems related with the adoption of the tool	Different problems regarding the affordability of the tool are taken into consideration for the	Different problems regarding the authority and updates of the data are taken into consideration for the	Different problems regarding the adoption of the tool in a short time frame are considered	Different problems regarding the upgradability and improvement of the tool are being considered

				adoption process	adoption process		during the adoption process
Instruments	It is possible to combine different type of governance instruments to adopt the tool	There are all the required governance instruments to support the adoption of the tool	There is a participation process to apply different instruments to support the adoption of the tool	The required instruments are affordable to support the adoption process	The instruments support the authority of the data and its updating processes	The available instruments provide the support to adopt the tool in a short time	Different instruments are available to support the tool's upgrade and improvement after its adoption
Resources	Different types of resources and in sizes can be used to support the adoption of the tools	There are all the required resources to support the adoption of the tool	There is a participation process to exploit different type of resources to support the adoption of the tool	The required resources are affordable to support the adoption process	The resources to support the authority of the data and its updating processes are available	The available resources provide the support to adopt the tool in a short time	Different resources are available to support the tool's upgrade and improvement after its adoption

Results

The results of the matrix are shown below in Table 3. These results will be explained after Table 3.

Table 3: Fit-for-purpose governance assessment framework applied for the use of UAVs in Rwanda

Governance Dimension	Flexibility	Inclusive	Participatory	Affordability	Reliability	Attainability	Upgradability
Governmental Levels	The national government is the mainly responsible for implementation of the UAV There is no flexibility among the governmental levels. The policy is implemented in a top-down manner	From all the different government levels, only the national government is required for the implementation of the UAV	The implementation is mainly characterized by a top-down approach There is a lack of participatory mechanisms between the different governmental levels	The national level is the only government level that can afford the implementation of the UAV	The different governmental levels support the data authority and the updating process that can result from the UAV	The national government is the only governmental level that might have the capacity to adopt the UAV within a short timeframe	Among all the governmental levels, the national government is the most capable of establishing a sustainable upgradability policy This, however, requires trained people and enough resources, which is still a big challenge
Actors (non-governmental)	Different actors have different responsibilities according to the implementation of the tool	The implementation of the tool can be used by all the different actors.	There is a lack of participation between the governmental and non-governmental actors	The affordability of the UAV is still a challenge for the different relevant actors (mainly those that are not	The non-governmental actors can adopt the UAV within a short timeframe,	All the non-governmental actors can adopt the tool within a short timeframe, this requires	Among the actors, it is the national government the most capable of establishing a sustainable

	There is no flexibility among the different actors. Each actor has an specific task assigned and they have to follow the law			specialized in UAV use)	this requires governmental support and the availability of resources	governmental support (licenses, flight permissions), resources and capacity	upgradability policy This, however, requires trained people and enough resources, which is still a major challenge
Problems	Innovations are applied step by step. There is little opportunity to assess the implementation process after it has started	Not all problems are considered, this includes maintenance problems. During previous innovations (LAIS system, DGPS, tablets) the actors were facing a lot of challenges related to maintenance	Although previous innovation programs (eg. LTR) were initiated with a participatory approach, at the end they were strongly steered by the national government Since no relevant changes have taken place in the implementation processes, we consider that this situation	Although the price to get the UAV can be afforded, extra costs such as new staff and certifications are not considered	Maintenance and long-term visions were not taken into account nor considered as an attention point	Problems are considered from a short time frame	Maintenance and long-term visions is one of the big challenges Past geospatial innovation (eg. LAIS system are often developed by someone outside the country

			will be similar when implementing the UAVs				
Instruments	The regulations to implement the UAV are in place	Except for the law, there is a lack of governance requirements to implement the UAV	There is not a participation process considered by the legal instruments, it is merely a governmental process	The legal instruments support the accuracy more than the affordability of the tool	The legal instruments support the authority of the data as long as the government is involved	The law provide the support to adopt the tool in a short time	There is a lack of instruments that support upgrading of the tools. (eg. LGAF)
Resources	Different types of resources can be used to support the adoption of the UAV	Resources is a challenge, there is a lack of resources for maintenance, upgrading etc.	There are no specific resources assigned to support a participation process Resources flow from national to local government levels	Resources to have the tool are limited Therefore the UAV cannot be very expensive	The district and lower levels of local government lacks basic infrastructure. They have scarce resources	Current resources cannot support the implementation of the tool in a short-time frame	Currently there are no resources to support the upgrading of the UAV over time

1 Flexibility

Flexibility means that the implementation process of the UAV asks for some flexibility from the different governance levels, actors, governance instruments (including a legal framework) and the resources required. The results show that the innovation process of past innovation were facing lack of flexibility as no evaluation nor adjustments nor long term vison are considered through the implementation process.

Rwanda's government and CAA announced new unmanned aircraft regulations (Part 27) on 23 Jan 2018. These are performance based and progressive. For UAVs the Rwandan Civil Aviation Authority is mainly responsible to give approval and control. For this reason, the national government needs to be strongly involved for the implementation and use of the UAV.

However, it seems difficult for the different respondents to get a flight permission if you are not working together with the only company who is currently licensed to fly UAVs in Rwanda. The monopoly of this company risks to have a lot of power and can even lead to increasing prices because of lack of competition.

R_{19} private company: "in fact, initially we would fly our own drone ourselves, which in terms of licenses were not arranged on time and […] is real monopolist and I think that they like to keep like that. So it's costly but, what you always see when companies have a monopoly, also little inspirational for innovation, so they do not use the newest of the newest equipment."

Therefore flexibility is mainly required at the actor's dimension, in order to allow the involvement of more actors.

2 Inclusiveness

Inclusive means the involvement of the actors is required to support the adoption of the tool. For Rwanda it is clear that all levels of actors are included in the implementation process however, everything is strongly steered by the national government.

In this manner, the national government is a key actor for the implementation of the tool. The other actors can play different responsibilities:

Private companies can support the government by flying and maintaining the drones and providing training.
Universities can support in training
NGOs can support in awareness raising

R_{25} national government: "The company was responsible for trainings. […] Actually they started with our staff and the staff trained other people."

3 Participatory

Participatory at the governance level means that participation should be open to all the actors that can support the tools' adoption. As is already stated before, participation in Rwanda is a possibility in theory but the national government has in reality a strong national authority.

Innovations like the LTR showed that the Rwandan government is capable applying a participatory approach. At that time, they were putting a lot of effort to ensure community support by awareness raising campaigns and to involve them in the data capturing process. However, the participatory processes are strongly steered by the national government, where most of the human and non-human capacity is concentrated.

R_{20} private company: "…national level is the final authorizing body. Without the authority, nothing on land related issues is approved, nothing…without their knowledge…"

4 Affordability

Affordability from a governance perspective means that the different actors that are participating in the adoption process can afford the tool's adoption. The implementation of the UAV can be affordable for all stakeholders but are most likely to be affordable for the national government and specialized private companies.

For the UAV data collection, the governmental or non-governmental actors can choose the most effective and least expensive sensors, fitting the needs and the data they want to collect. In this

way, The UAV data can have a relatively affordable price tag compared to the data from manned aircrafts or satellites.

The national government is the only governmental actor who is most likely possible to afford this innovation. However, before the adoption of a UAV at national level can be planned, an investment in human (staff, capacity development, pilot licenses, awareness raising) and non-human capital (UAV, certifications maintenance) is required. Training and capacity development is still a challenge.

R_{33} national government:… "Mainly the skills, and that's like… If they've finished the training, sometimes they forget. They are not practicing. Because some are lacking the tools, like software. Some of them are not existing."…

The investment of a UAV is still big for private companies who are not specialized in UAVs. In Rwanda there is only one private company specialized in UAVs. This company is nowadays already tendered for governmental, international and private projects, which makes the incentive for other actors to invest for a own UAV small.

5 Reliability

Reliability means that the actors support the authority of the data produced by the adopted tools as well as the updating processes. Rwanda is eager to innovate, and in this prone to institutionalize new technologies.

Rwanda is open to innovation and strongly supports this in several ways and is translated in the several policies they were enacting during the last decade. In 2000, they have adopted the National Information Communication Infrastructure policy (NICI) aiming to achieve full digitalization by 2020. The NICI strategy was further integrated into Vision 2020, which was also launched in 2000, aiming to transform the country into a middle-income country by 2020.

Aligned this vision, up to date and accurate land tenure data is a priority. The current data they are using is dating back from 2009. In this manner, the UAV data can help to achieve these objectives. As an interviewee commented:

R_{21} private company: "Rwanda is very open for innovation and to inspire young people into new technologies and to bring solutions. So, it is really the right country to bring up new innovation. That is the support that we also received, having a country that welcomes this innovation and promote that, that is something we really appreciate."

6 Attainability

Attainability from a governance perspective means that actors involved support the adoption of the tool within a short time frame. Analysis of past innovations show that short time adoption is possible, long term use is a challenge.

The Rwandan government showed through previous innovations that they are capable of implementing new innovations in a short time frame. One of the example of the Land Tenure Registration, through which Rwanda managed to register more than 10 million parcels countrywide in 4 years' time. The main future challenge, however, is to maintain these processes and to keep registries up to date.

With the UAV law in place, short time adoption of a UAV can take place. However, the law is very practical and open for interpretation and a long term vision is still a challenge.

R_{16} private company: "The regulations are new now. They are not very specific but they also leave a lot of freedom for interpretation but that could also be problem."

7 Upgradability

Upgradability from a governance perspective means that the different actors are taking into consideration the (changing) needs, that tools have to be upgraded and improved over time. For the upgradability of the UAV, shortage of both human and non-human capacity which is a challenge.

As is stated before, maintenance is a big issue because of shortage of trained people, shortage of trainings, maintenance and repair skills. Since Rwanda does not have a long history of land tenure registration and human capacity is still a challenge.

For example, the Rwandan Land Administration Information System (LAIS) is mostly developed via tendering experts outside the country without any capacity transfer to the government. This makes it difficult for the Rwandan government to make adjustments to the system. Moreover, the national government is facing difficulties to fill in the different vacancy positions and there is a high turnover rate of employment which makes a sustainable implementation difficult.

R_{37} private company: …"In the end you have a stack of software stuff making everything slow. They had several consultants who said it's old enough, you have to rebuild it and you have to do a clear start again. But he struggled because there was no documentation, how are u supposed to know what it was supposed to do by just looking at it. And if you are serious about IT, the buying part is the easiest and having the first training delivered…"

Conclusion

The aim of this paper has been to introduce the application of a new developed framework named 'fit-for-purpose governance assessment framework'. This framework has allowed a systematic contextual analysis of the possible challenges that the implementation of a UAV can face in Rwanda from a FFPLA governance perspective. The results show that not all the fit-for-purpose elements are in place yet. The main challenges are a lack of flexibility and upgradability. There is a lack of flexibility of the implementation process as soon as the implementation has started, there is not much room for evaluation or adjustments. Therefore, we consider that instruments that monitor and evaluate constantly the implementation should be introduced. From past innovations, we can conclude that a lot of innovations are project based and long term visions or maintenance is not enough considered. Therefore the inclusion of fix costs related with long-term maintenance and upgradability should be considered since the beginning of the implementation process. Even when the implementation process tries to be inclusive and participatory; there is a very strong national government that is steering the process in a top-down manner. Therefore mechanisms that support participation such as commissions or committees where all the stakeholders can participate should be encouraged. The affordability of the implementation process is also a challenge since not all different actors are capable of making the investments to buy and maintain the UAV with

the related costs. Only the national government and specialized private companies are likely able to make this investments. The implementation process of the UAV can be attainable and reliable. Past implementation processes have shown that Rwanda is capable of implementing innovations within a short timeframe. Since the Rwandan government is very eager to innovate and to promote a digital transition, the UAV can be implemented in a short time frame as soon as the national government is convinced that it can deliver public services on a more responsible and accurate manner. Therefore, we recommend that if UAVs tools want to be implemented in a sustainable way, it is important for policy makers, technology developers and implementers take into consideration the governance challenges mentioned before, in order to create a more supportive governance system.

References

Ali, D. A., Deininger, K., and Goldstein, M. (2014). Environmental and gender impacts of land tenure regularization in Africa: pilot evidence from Rwanda. Journal of Development Economics, 110, 262-275.

Bennett, R., Wallace, J., & Williamson, I. (2008). Organising land information for sustainable land administration. Land Use Policy, 25(1), 126–138.

Bennett, RM, , Gerke, M, Crompvoets, J, Ho, S, Schwering, A, Chipofya, M, Schultz, C, Zein, T, Biraro, M, Alemie, B, Wayumba, R, Kundert, K, Crommelinck, S, Stöcker, C (2017), 'Towards innovative geospatial tools for fit-for-purpose land rights mapping', Worldbank Land and Poverty Conference 2017, Washington DC, USA.

Biraro, M. (2014). Land information updating: Assessment and options for Rwanda. [master's thesis, University of Twente, The Netherlands]

Bressers, H., & Kuks, S. (2004). Integrated Governance and Water Basin Management: Conditions for regime change towards sustainability. London: Kluwer Academic Publishers.

Bressers, H., Bressers, N., Kuks, S., & Larrue, C. (2016). The Governance Assessment Tool and its Use. In H. Bressers, N. Bressers, & C. Larrue (Eds.), Governance for Drought Resilience. Springer International Publishing.

Casiano Flores, C., Özerol, G., & Bressers, H. (2017). "Governance restricts": A contextual assessment of the wastewater treatment policy in the Guadalupe River Basin, Mexico. Utilities Policy.

Casiano Flores, C., Buntinx, I., & Crompvoets, J. (2018). Deliverable 7.2 Review of governance and capacity development models. Leuven.

Deininger, K., & Feder, G. (1999). Land policy in developing countries. Rural Development Note, (3).

Deininger, K., Augustinus, C., Enemark, S., and Munro-Faure, P. (Eds.) (2010). Innovations in land rights recognition, administration, and governance. World Bank Publications.

Enemark, S., Bell, K. C., Lemmen, C., & McLaren, R. (2015). Fit-For-Purpose Land Administration. International Federation of Surveyors (FIG). Copenhagen: International Federation of Surveyors (FIG).

Enemark, S, McLaren, R, Lemmen, C (2015), 'Fit-For-Purpose Land Administration–Guiding Principles', UN HABITAT/GLTN, Nairobi, Kenya.

Gunawan, H., Bressers, H., Mohlakoana, N., & Hoppe, T. (2017). Incorporating Air Quality Improvement at a Local Level into Climate Policy in the Transport Sector: A Case Study in Bandung City, Indonesia. Environments, 4(3), 45.

Goodchild, M. F., & Glennon, J. A. (2010). Crowdsourcing geographic information for disaster response: a research frontier. International Journal of Digital Earth, 3(3), 231–241.

Hay, G. (2016). Cloud, Mobile and Big Data Technologies in Responsible Land Administration. In 2016 World Bank Conference on Land and Poverty. Trimble Navigation.

Ho, S., Crompvoets, J., Broucker, B., Bennett, R., Alemie, B., Lengoiboni, M., Wayumba, G., Biraro, M., Kundert, K. (2017). D2.2 Stakeholder audit and classification, its4land, KULeuven, Belgium

Koeva, M. N., Crommelinck, S., Stöcker, C., & Crompvoets, J. (2018, May). Its4land-Challenges and Opportunities in Developing Innovative Geospatial Tools for Fit-For-Purpose Land Rights Mapping. In FIG Congress 2018. International Federation of Surveyors (FIG).

Laarakker, P, Zevenbergen, J, Georgiadou, Y (2016), 'Land Administration Crowds, Clouds, and the State', in: Advances in Responsible Land Administration, eds. Zevenbergen, J, de Varies, W, Bennett, RM, CRC Press, pp. 91-114.

Liversage, H. (2010). Responding to" land grabbing" and promoting responsible investment in agriculture. Rome: IFAD.

Mohlakoana, N. (2014). Implementing the South African free basic alternative energy policy: a dynamic actor interaction. CSTM. University of Twente, Enschede.

National Institute of Statistics Rwanda (NISR) (2014). Fourth Population and Housing Census, 2012 Census Atlas, Rwanda.

Owens, K., & Bressers, H. (2013). A Comparative Analysis of How Actors Implement: Testing the Contextual Interaction Theory in 48 Cases of Wetland Restoration. Journal of Comparative Policy Analysis: Research and Practice, 15(3), 203–219.

Rurangwa, E. (2013). Land tenure reform. The case study of Rwanda. In Conference on 'Land Divided: Land and South African Society.

Stöcker, C., Bennett, R., Nex, F., Gerke, M., & Zevenbergen, J. (2017). Review of the Current State of UAV Regulations. Remote Sensing, 9(5), 459.

The East African (2018). Rwanda skies now open for commercial drone flyers. Available at: https://www.theeastafrican.co.ke/rwanda/Business/Rwanda-skies-now-open-for-commercial-drone-flyers/1433224-4321518-6tgoybz/index.html

UNCTAD. (2012). Geospatial Science and Technology for Development With a focus on urban development, land administration and disaster risk management. New York.

VLIRUOS (2016). Country fact sheet – Rwanda.

Williamson, I., Enemark, S., Wallace, J., & Rajabifard, A. (2010). Land Administration for Sustainable Development. Sustainable Development. Redlands: ESR I Press Academic.

Zevenbergen, J, Augustinus, C, Antonio, D, Bennett, R (2013), 'Pro-poor land administration: principles for recording the land rights of the underrepresented', Land use policy, Vol. 31, pp. 595-604.

Zipline (2019). In 2014, we created Zipline to deliver medicine to those who need it most. Available at: https://flyzipline.com/about/