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A capacity assessment framework for the fit-for-purpose land administration systems: The use of unmanned aerial vehicle (UAV) in Rwanda and Kenya

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ABSTRACT

This article presents a novel capacity assessment framework, coined as Fit-For-Purpose capacity assessment framework (FCAF), to measure the capacity of the land administration system compliant with the Fit-For-Purpose approach. The framework incorporates legal, political, operational, social, technical, and technological capacity conditions and provides a holistic view of the capacity development pathways. The FCAF is designed by merging six capacity dimensions, namely regulations, political system, operational unit, social norms, land recording techniques, and software. FCAF systematically identifies context-specific, enabling and impeding capacity components and thus provides a basis to develop the necessary capacity development strategies and interventions. Specifically, FCAF can serve as a useful heuristic for the development of the capacity development strategies for the adaptation and sustainability of the geospatial technologies in land administration systems. In the article, by assessing the capacity needs for the adaptation of unmanned aerial vehicle (UAV) technology in Rwandese and Kenyan land administration systems, the efficacy of the FCAF is tested. The findings suggest that in Rwanda, capacity conditions are more supportive of an easier uptake of UAV. Nonetheless, weak market conditions and strict regulations concerning UAV call for attention. In Kenya, existing institutional and political challenges in the land administration system raise concerns about the reliability and attainability of UAV under the current framework conditions. Despite that, there are more supportive market conditions in Kenya in comparison to Rwanda and multiple non-governmental and private actors that can bolster the adaptation process into a more sustainable and scalable land administration system.

1. Introduction

The Fit-For-Purpose (FFP) approach in land administration aims to address the challenges of land administration systems in developing countries. For a rapid transition, the FFP approach advocates the use of aerial or satellite imagery and geospatial technologies in the field to identify, delineate, and adjudicate the visible land parcel/spatial unit boundaries. However, the implementation of these new technologies in land administration might bring further capacity challenges to a land administration system (LAS). Therefore, it is critical to assess the capacity development conditions for a successful transition of the LAS.

In the land administration literature, such a systematic capacity assessment framework is currently missing. The existing capacity assessment frameworks are either too broad in scope and fail to provide concrete steps in capacity development- e.g. UNDG capacity assessment framework (UNDP, 2008)- or focus only on the self-assessment of the actors in land administration and do not provide a holistic view in capacity development- e.g. Capacity Assessment in Land Administration (Enemark and Van der Molen, 2008). Furthermore, certain aspects of the current FFP guidelines are criticized as overly prescriptive in capacity building activities and some recommended strategic options are contradicting with the underlying philosophy of the FFP approach (Barry, 2018).

In this article, we present a novel capacity assessment framework, coined as the Fit-For-Purpose Capacity Assessment Framework (FCAF), to assess the capacity of a LAS for the successful uptake of geospatial technologies in compliance with the FFP principles. FCAF is based on the semi-normative conditions set by the 'Fit-For-Purpose Land

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Administration' (FFPLA) (Enemark et al., 2016) and incorporates regulative, political, operational, social, technical, and technological dimensions in the capacity assessment. The main objective of this article is to introduce FCAF as a tool to structure systematic analysis of land administration systems. We illustrate its potential as a policymaking instrument for capacity development strategies in land administration. In that sense, the FCAF complements the Fit-for-purpose governance assessment framework (Casiano Flores et al., 2020) in expanding applied research on FFP land administration.

In this article, we demonstrate the applicability of the FCAF via the case of unmanned aerial vehicles (UAV), which is a key geospatial technology in land administration. UAV are remotely piloted fixed-wing or rotary vehicles, integrated with a positioning system onboard and imagery sensors for data collection of small to medium scale areas (Stöcker et al., 2019). Previous research shows that UAV can respond to the need to update existing databases faster with reliable, high-resolution geospatial information at low cost (Koeva et al., 2017; Stöcker et al., 2019). Yet, only very few studies have focused on the associated capacity challenges that the adaptation of UAV in LAS requires (Bennett and Alemie, 2016). Available research has indeed shown the relevance of considering some of the FFP elements (e.g. participatory, attainable, reliable, and affordable) to evaluate UAV for cadastral data acquisition (see Ramadhani et al., 2018).

Two areas in two countries in East Africa, Rwanda (Musanze district) and Kenya (Kaijado county) are selected as case studies. We selected these cases, because both countries recently undertook significant policy and legal reforms concerning land administration and promote ICT-based transformation of their public sector, and as such makes them comparable cases. Our findings show that dissimilar capacity development strategies are needed in Rwanda and Kenya for a sustainable implementation of UAV in the LAS.

The remaining part of the article is structured into six sections. The second section presents the Fit-For-Purpose land administration (FFPLA). The third section introduces Fit-For-Purpose Capacity Assessment Framework (FCAF) and discusses some caveats to consider when applying the Framework. The fourth section presents the country cases. The fifth section is about methodological choices in data collection and analysis. The sixth section is about the analysis of the capacity conditions in both cases by the application of FCAF. The final section presents the concluding remarks, contrasts the capacity development conditions in Rwanda and Kenya, and shares recommendations for policy practitioners and researchers.

2. Fit-for-Purpose land administration

LAS is the actors, processes, and technologies that record and maintain information about people, land, and tenure rights (Dale and McLaughlin, 1999). LAS is recognized as crucial for delivering sustainable economies, environments, and social cohesion (Williamson et al., 2010). However, a large majority of developing countries do not maintain a complete and functional LAS and do not have access to formal land tenure security (McLaren, 2011). It is estimated that approximately 4 billion people's land interests are not recorded or known by governments (Zevenbergen et al., 2013). Many of these are found in sub-Saharan Africa, where LAS is in various states of development or decay. Using current approaches and at current rates, it will take decades, if not centuries to deliver adequate coverage (Zevenbergen et al., 2013). Therefore, there is a need to develop new land administration approaches that are faster, cheaper, and easily accessible for the usage of the public sector, private sector, and citizen end-users – and that also take into account diverse tenure contexts in developing countries (e.g. communal and customary lands rights).

The Fit-For-Purpose (FFP) approach in land administration has been particularly developed to address this challenge in developing countries. FFP land administration (FFPLA) assumes that when considering the resources and capacities required for building complete and up-to-date systems, the focus should be on meeting the needs of the society today that can be incrementally improved over time (Enemark et al., 2014).

The FFP approach has been introduced in developing countries after the failures of several projects to install appropriate and adequate land tenure recording systems (Enemark et al., 2014). The strengths of FFP are that it provides an answer to the inability of conventional methods to fully accommodate existing tenures (e.g. the diversity of formal, informal, social, or customary land tenure types) and that it is sensitive to the limited resources in developing countries. According to the FFP literature, there are seven elements the LAS should incorporate (Enemark et al., 2016):

1 *Flexible* in the spatial data capture process to provide information about the different uses and occupations of the land;
2 *Inclusive* in the extension to cover all types of tenure and all types of land
3 *Participatory* in the manner to capture and use data, ensuring community support
4 *Affordable* operation for the government and society to use it
5 *Reliable* regarding the information, it should be authoritative and updated
6 *Attainable* to create a system within a short timeframe and with the available resources
7 *Upgradable* regarding improvement over time to respond to social and legal needs as well as economic opportunities.

To date, the FFP approach has been implemented in several developing countries (e.g. Rwanda, Ethiopia, Kyrgyzstan) and the implementation results show significant improvements in the rate of land coverage by the LAS (Enemark et al., 2016). Enemark et al. (2016) identify three key challenges for the countries seeking to implement the FFPLA: (1) an effective change management strategy driven by strong leadership; (2) the overhaul of the legal framework to provide the required flexibility to accommodate the FFP approach; and (3) the need of capacity development to build scale quickly. All three factors are interdependent to understand where there is a need for change and what type of change is necessary. This may require the overhaul of the institutions, organizations, and practices in land administration.

The FFP approach uses aerial or satellite imagery in the field to identify, delineate, and adjudicate the visible land parcel/spatial unit boundaries, and the rights are determined and entered directly into a register (Enemark et al., 2016). Therefore, the effective implementation of geospatial technologies is indispensable in the FFPLA. But, the FFP approach suggests associated technologies should be selected and applied to match the capacity and cost constraints of the LAS (Enemark et al., 2014). Resources, skills, and framework conditions must be assessed upfront to understand the capacity needs for sustainable implementation. The implementation of new technologies in land administration might bring further capacity challenges to the LAS. Therefore, it is important to assess the capacity development framework alongside legal, regulatory, institutional, and spatial frameworks (McLaren et al., 2018). Moreover, the diversity of stakeholders and their corollary interests in land tenure information introduce a level of complexity in understanding how best to coordinate and manage the use of new technologies if maximum benefits are to be achieved. The FCAF particularly provides answers to these questions.

3. Fit-for-Purpose capacity assessment framework

Academics, practitioners, and policy analysts attribute different meanings to capacity, and the scope of capacity assessment varies depending on the macro- or micro-visions on the concept (Morgan, 2006). The literature describes capacity as a process and an outcome (see Sowa et al., 2004); as the ends and the means to the ends (see Honadle, 1981); as dynamic and multidimensional (see Ingraham and Kneedler, 2000); it is given both tangible and intangible, or quantitative

and qualitative dimensions (see Kaplan, 2000; Christensen and Gazley, 2008). This elusiveness complicates defining the concept, and thus, various definitions exist in the literature. However, in almost every definition, capacity is associated with an *ability to perform* (Tan, 2019). In our study, we use capacity as the cumulative abilities of the LAS to implement the expected tasks.

In the construction of the FCAF, we selected the expectations from the LAS according to the seven semi-normative elements (i.e. flexible, inclusive, participatory, affordable, reliable, attainable, upgradable) associated with the FFPLA. These seven elements are selected as evaluative qualities in assessing the capacity dimensions of the LAS (Casiano Flores et al., 2019). The selection of the capacity dimensions has proceeded via two subsequent stages (see Table 1).

At the first stage, we followed a grounded theory approach. Grounded theory is a useful and proven method in the conceptualization and conceptual ordering of research data (Glaser, 1978). More, in particular, to identify and prioritize the problems and solutions for making the land administration ready for the sustainable implementation of UAVs, we relied on the nominal group technique (Harvey and Holmes, 2012; Ho et al., 2017). We organized a series of group interviews and workshops with groups of local stakeholders in the case countries from November 2016 to June 2017[1] . Later, we expanded our data collection via purposive samples of community groups and semi-structured interviews to better understand the needs of stakeholders and local communities that were not able to attend the workshops.

At the second stage, we conducted a literature review and held expert interviews to identify the coarse dimensions in capacity assessment for the implementation of geospatial technologies in land administration[2] .

The combination of experts' responses, the literature review, and the type of needs identified throughout the fieldwork resulted in the selection of six core capacity dimensions: regulations, political system, operational unit, social norms, land recording techniques, and software, which we conceived as following:

1 *Regulations:* The laws and policies that regulate the land administration system;
2 *Political system*: The political environment concerning the land administration system;
3 *Operational units:* The managerial and organizational capacities of the governmental and non-governmental organizations that take part in the land administration system;
4 *Social norms:* The social norms[3] and social capital in the society concerning the land administration system;
5 *Land recording techniques:* The technical features, scale, and scope of the land recording tool;
6 *Software:* The security, cost, and functions of the software used in recording land information.

As a final modality to the capacity assessment framework, we developed a three-level capacity rating scale (low-moderate-high). This served as the basis to systematically assess the different dimensions. **Low capacity** implies that there are significant challenges concerning the assessed FFP element and that the LAS would need structural changes for capacity development. Structural changes are the kind of changes that require institutional reforms that affect existing rules and norms in the LAS. **Moderate capacity** means that there are certain challenges concerning the assessed FFP element and the LAS would need processual changes for capacity development. With the processual change, we refer to the changes in the operational rules and policies that do not require normative or institutional changes in the LAS. **High capacity** infers that the LAS is largely supportive and there is in principle no need for substantial changes for capacity development.

Table 1 presents the FCAF and the operationalization of each capacity dimension for the seven FFP elements. The FCAF is a useful heuristic to assess either the capacity of the LAS as a whole and/or it can assess the capacities associated with particular geospatial technologies in the LAS.

FCAF is designed to identify the strengths and weaknesses of the LAS in a specific context and if aimed, it also allows comparative studies of the land administration systems from the FFP perspective. The FFP approach infers that a functional capacity assessment tool should avoid relying on rigorous indicators in its assessment of FFP elements, as that would innately disregard the role of contextual factors in assessing capacity dimensions. Relying on a qualitative, inductive approach, the FCAF allows incorporating country idiosyncrasies in its assessment while overseeing the cross-case compatibility of the LAS to the FFPLA.

There are some caveats, however, to draw attention to when using FCAF for capacity assessment. First of all, one ontological limitation of the FCAF is that it presumes that FFP land administration is the desired state for a well-functioning LAS and the framework treats all FFP principles with an equal weight of importance for the successful implementation of the geospatial tools. Depending on the political priorities and policy goals, some principles of the framework can be taken as secondary in importance in capacity development.

Secondly, FCAF is not built on quantifiable indicators. The capacity assessment strongly relies on the interpretations of the experts and stakeholder opinions. In that sense, selecting the relevant information for the capacity dimensions requires due diligence in research and context-specific knowledge. The selection of stakeholders and experts should proceed with the utmost care and should ensure that a comprehensive and robust perspective can be obtained. The framework allows the inclusion of both nation-wide but also regional and local specificities for the capacity assessment. Therefore, depending on the scale of the study and the area of application, it is possible to have varying results from the same country case. The framework is flexible as the capacity assessment process can be adapted to the objectives of the researchers. In the same vein, we would like to draw special attention to the interpretation of the impact of social norms. After all, the relevance and salience of social norms can vary depending on the area of application, from region to region, and across specific technologies/tools for land recording. To account for a reliable interpretation of which social norms are salient in a particular area and how they can affect the land recording processes, it is imperative to integrate local expertise and knowledge. Also, considering both the positive and negative implications of social norms for the adoptability of land recording tools and methods would logically strengthen the quality of the analysis.

The same caveat applies to the generalizability of the findings. By nature, the policy inferences drawn from the interpretation of the FCAF results are context-dependent and do not lend themselves to direct replicability and generalizability to other cases. Self-evidently, users who apply this framework should be careful and reflective of the biases that may come with qualitative approaches. Rigorous attention needs to be given towards issues as sampling, coverage, nonresponse, and measurement in the data collection and analysis. The selection needs to consider those stakeholders, experts, and researchers who are relevant

[1] All interviews with local communities (and at times, local governments) were conducted in the local language by the local partner, or by a translator. In total, 20 organizations, and groups participated in data collection activities in Kenya, spread across government, private sector, third sector, academia, and local communities (Ho et al., 2017). In Rwanda, we reached 22 such groups and organizations.

[2] We reached 14 experts, coming from different areas of expertise in land administration, including policymaking, training, and research in land administration, cadastral systems, land administration system development, land surveying, GIS management, and land information management. The respondents represented both country settings with well-developed LAS (e.g. the Netherlands, Australia, Germany) and developing countries (e.g. countries from Latin America, Caribbean, Southern and Eastern Africa).

[3] We conceptualize social norms as 'collective representations of acceptable group conduct as well as individual perceptions of particular group conduct' (Lapinski and Rimal, 2005)

Table 1
FFP Capacity Assessment Framework.

Capacity Dimensions	Flexible	Inclusive	Participatory	Affordable	Reliable	Attainable	Upgradable
Regulations	*High:* The regulations are descriptive of the type of capacities required by the operators.	*High:* There are no regulative obstacles to record a particular tenure or land type.	*High:* The regulations promote participatory practices in land recording.	*High:* The administrative costs and user fees are affordable to the stakeholders.	*High:* The rules are prescriptive and enforceable.	*High:* The regulative framework is complete to run the operations.	*High:* The regulative framework is complete to upgrade and scale up the operations.
	Moderate: The regulations are prescriptive on the type of capacities required by the operators.	*Moderate:* There are bureaucratic obstacles to record a particular tenure or land type.	*Moderate:* There are bureaucratic obstacles to include local stakeholders in the land recording.	*Moderate:* The administrative costs and user fees are affordable to certain stakeholders.	*Moderate:* The rules are prescriptive but not always enforceable.	*Moderate:* The regulative framework is not complete but it is possible to run the operations.	*Moderate:* The regulative framework is not complete but it is possible to upgrade the operations.
	Low: The regulations are restrictive on the type of capacities required by the operators.	*Low:* There are legal obstacles to record a particular tenure or land type.	*Low:* The regulations do not describe participatory processes in the land recording.	*Low:* The administrative costs and user fees are not affordable for the majority of the stakeholders.	*Low:* The rules are not prescriptive and open for interpretations.	*Low:* The regulative framework is not complete and it is not possible to run the operations.	*Low:* The regulative framework is not complete and it is not possible to upgrade the operations.
Political system	*High:* There are no particular political risks that can affect the operations.	*High:* All types of tenures are recognized and land rights are justly treated.	*High:* Participatory practices are widespread in the land recording processes.	*High:* There is no political cost of the operations.	*High:* The political actors are trusted by citizens and stakeholders	*High:* The political system can endorse the operations at a national scale.	*High:* The political actors are strong enough to implement changes if there is a need.
	Moderate: There is some political risk that can affect operations.	*Moderate:* The informal and social tenures are recognized but they are either in secondary importance or disregarded.	*Moderate:* In some political areas, participatory practices are not implemented in the land recording.	*Moderate:* There is a political cost of the operations at the local/regional scale.	*Moderate:* Some political actors are trusted by citizens and stakeholders	*Moderate:* The political system can endorse the operations at a regional/local scale.	*Moderate:* The political actors need the support of other actors to implement changes if there is a need.
	Low: There are widespread political risks that can affect operations.	*Low:* Certain tenure types and the rights of groups are not recognized by the political system.	*Low:* Particular political minorities are excluded systematically from land recording processes.	*Low:* There is a political cost of operations for the national government.	*Low:* Political actors are largely not trusted by citizens and stakeholders.	*Low:* The political system lacks resources to endorse the operations.	*Low:* The political actors have little legitimacy to implement changes if there is a need.
Operational Units (OU)	*High:* There are multiple OU and ways for land recording	*High:* The majority of OU has the necessary skills to operate the land recording tool in different terrains.	*High:* The majority of OU has the necessary skills and knowledge to collaborate with local stakeholders in the land recording.	*High:* The majority of OU can afford the cost of operations at any scale.	*High:* The majority of OU has the operational capacity to provide authoritative and up-to-date data.	*High:* The majority of OU can run the operations without the need for additional training.	*High:* There are OU with specialized skills and knowledge to upgrade the operations.
	Moderate: There are multiple OU but a single way for land recording.	*Moderate:* The majority of OU lacks particular skills to operate the land recording tool in different terrains.	*Moderate:* Only some OU has the necessary skills and knowledge to collaborate with local stakeholders in the land recording.	*Moderate:* Only some operators can afford the cost of operations at any scale.	*Moderate:* Only some operators have the operational capacity to provide authoritative and up-to-date data	*Moderate:* Only some operators can run the operations without the need for additional training.	*Moderate:* There are OU with relevant skills and knowledge to upgrade the operations to a limited degree.
	Low: There is one type of OU and a single way for land recording.	*Low:* The majority of OU lacks the necessary skills to operate the land recording tool in different terrains.	*Low:* The majority of OU lacks the necessary skills and knowledge to collaborate with local stakeholders in land recording	*Low:* The majority of OU cannot afford the cost of operations or only on a small scale.	*Low:* The majority of OU does not have the operational capacity to provide authoritative and up-to-date data	*Low:* The majority of OU needs the training to run the operations.	*Low:* The OU do not have the skills and knowledge to upgrade the operations.
Social norms	*High:* Social norms allow usage of alternative ways for land recording.	*High:* There is no compliance problem between social norms and legal land rights.	*High:* Social norms encourage the participation of local stakeholders in the land recording.	*High:* Social capital is useful to reduce the cost of operation.	*High:* Social norms do not undermine the authoritativeness of land records.	*High:* Social norms do not impede the adaptability of the operations.	*High:* Social norms support innovation.
	Moderate: Social norms can allow the usage of alternative ways for land recording if there is a proactive policy.	*Moderate:* There are minor compliance problems between social norms and the legal land rights of minorities or communities.	*Moderate:* Social norms can encourage the participation of local stakeholders if there is a proactive policy.	*Moderate:* Social capital can reduce the cost of operation if there is a proactive policy.	*Moderate:* Some social norms can undermine the authoritativeness of land records.	*Moderate:* Some social norms can impede the adaptability of the operations.	*Moderate:* Social norms suggest a specific type/way of innovation.

(*continued on next page*)

Table 1 (*continued*)

Capacity Dimensions	Flexible	Inclusive	Participatory	Affordable	Reliable	Attainable	Upgradable
Land recording techniques (LRT)	*Low:* Social norms prevent applying certain methods in land recording.	*Low:* There are widespread compliance problems between social norms and the legal land rights of minorities and communities.	*Low:* Social norms discourage the participation of local stakeholders (e.g. women, youth, ethnic minorities) in the land recording.	*Low:* There is low social capital to reduce the cost of operation.	*Low:* There are social norms that undermine the authoritativeness of land records.	*Low:* There are social norms that impede the attainability of the operations.	*Low:* Social norms are impeding innovation.
	High: LRT capture different land information for multi-purpose use.	*High:* LRT can capture land data in any scope.	*High:* Local stakeholders are part of the land recording process.	*High:* LRT are affordable at any scale.	*High:* LRT can provide up-to-date and authoritative data on any scale.	*High:* LRT are attainable on a large scale.	*High:* It is possible to modify the modular design of LRT in any scope.
	Moderate: LRT capture different land information for single-purpose use.	*Moderate:* LRT can capture land data in a specific scope.	*Moderate:* Local stakeholders are informed about the land recording process.	*Moderate:* LRT are affordable only on a medium scale.	*Moderate:* LRT can provide up-to-date and authoritative data on a medium scale.	*Moderate:* LRT are attainable only on a medium scale.	*Moderate:* It is possible to modify the modular design of LRT in a specific scope.
	Low: LRT capture specific land information for single-purpose use.	*Low:* LRT cannot capture a certain type of land data.	*Low:* Local stakeholders are not part of the land recording process.	*Low:* LRT are affordable only on a small scale.	*Low:* LRT can provide up-to-date and authoritative data on a small scale.	*Low:* LRT are attainable only on a small scale.	*Low:* It is not possible to modify the modular design of LRT
Software	*High:* There are alternative software solutions that allow adjustments in the land recording.	*High:* The software can process any type of land information.	*High:* The software allows local stakeholders to input or edit land recording data.	*High:* The software is affordable for the operators.	*High:* The software is secure and reliable.	*High:* The software is attainable for the operators.	*High:* The software is open-source and allows changes in any scope.
	Moderate: There is alternative software but with limited modular functions in the land recording.	*Moderate:* The current version of the software cannot process some type of land information.	*Moderate:* The software only allows local stakeholders to access land recording data.	*Moderate:* The software is affordable only for some operators.	*Moderate:* The software has some weaknesses with reliability.	*Moderate:* The software is attainable only for some operators.	*Moderate:* The software is protected but allows modifications in specific cases.
	Low: There is only proprietary software with limited modular functions in the land recording.	*Low:* The software cannot process the land information about a specific land or tenure type.	*Low:* The software does not allow local stakeholders to access land recording data.	*Low:* The software is not affordable for the majority of the operators.	*Low:* The software risks data breach and has weaknesses with reliability.	*Low:* The software is not attainable for the majority of the operators.	*Low:* The software is protected and does not allow changes in coding.

for the implementation and the assessment of the policy. Different experts might come to different conclusions if they hold different political-economic beliefs or are from different cultural and scientific backgrounds. The inclusion of a variety of experts and stakeholders in the evaluation process is critical to improving the quality of the assessment process and deliberative discussions and iterative processes may require until a common conclusion is reached. Similarly, policy practitioners have to be careful about how to interpret the results of the analysis to improve land administration systems and should cautiously consider appropriate responses. Solutions to capacity problems should be derived from local contexts and not necessarily by mimicking the systems in Western countries. Land tenure administration interventions can create social change and may have different impacts in time on local politics and social norms (Barry, 2018). Changes in a particular capacity dimension can cause changes in other capacity dimensions which may not have been initially expected nor accounted for.

In the remaining part of the article, we illustrate the usage of the FCAF by analyzing the capacity development framework of UAV technology in the land administration systems of Rwanda and Kenya. First, we introduce the land administration contexts in both cases. Subsequently, we explain the data collection and analysis methods and present the findings in each country's case.

4. Land administration context in Rwanda and Kenya

4.1. Rwanda

Rwanda, with an area of over 26,000 km^2 and a population of almost 12 million people, is the most densely populated country in Africa (World Bank., 2016). Despite that, the population of Rwanda is still largely rural, with 83 % living in rural areas (National Institute of Statistics Rwanda (NISR, 2014). Rwanda has a deconcentrated government from the central government to Provinces (5), Districts (39), Sectors (419), Cells (2148), and Villages (14,837).

Around half of the urban population in Rwanda is located in Kigali City, which has a population of about 1 million. The government recognizes uneven urbanization as an area that must be addressed to transform the economy. It has been a priority area in the recent national 'economic development and poverty reduction strategy' (EDPRS) (2013–2018), and six cities have been identified as targets to balance urban-regional growth. To achieve this, land use planning and relevant spatial development are key, but major challenges persist including limited capacity at lower levels of government, ineffective implementation of the land use Master Plan, weak national coordination of the urban system, and lack of coherent planning for housing and infrastructure of grouped settlement sites (Republic of Rwanda, 2012; Ministry of Finance and Economic Planning (MINECOFIN, 2013). In rural areas, the EDPRS aims to reconcile the various demands on limited land resources through land-use allocation and management and producing

village/cell layout plans through a community-led process.

Recently, a countrywide land tenure regularization program was completed where more than 11 million parcels were demarcated and titled (Government of Rwanda, 2018). Geo-information derived from this exercise has also enabled the development of a national cadastral map (or land information system), which now underpins a range of purposes.

The case area in Rwanda, the Musanze District, is situated in the Northern Province and home to Musanze City. The district is divided into 15 sectors, 68 cells, and 432 villages and has a population of more than 360,000. The district exhibits one of the highest population densities in the country. Housing in Musanze presents several challenges. Firstly, like many rural areas, Musanze has dispersed settlement patterns that inhibit sustainable development and management. Given the rising population in the district, it is no surprise that affordable housing is limited (Republic of Rwanda Northern Province, 2013). Although a national policy response is now encouraging *imidugudu* development, this has not been particularly successful in the district, with settlement levels only reaching two-thirds of the national average (26 % vs. 38 %) (National Institute of Statistics Rwanda (NISR, 2012). This is compounded by rural poverty rates that in general, inhibit community participation in these initiatives (Republic of Rwanda Northern Province, 2013). Land consolidation has been adopted as a policy response to facilitate standard-sized parcelization of land to accommodate model houses. Private transactions to acquire land are also unusually high in Musanze District (approx. 36 %) (Rwanda Natural Resources Authority, 2015). Furthermore, decentralization has fostered capacity problems such as limited skills at the village, cell and sector levels to manage and mitigate planning and development to support sustainable urbanization, as well as a lack of administrative capacity to engage with the community (Nyenyezi Bisoka et al., 2019). Considering these challenges, we consider Musanze as a 'critical' case to investigate the capacity elements that need to be in place for a sustainable implementation of UAV in land administration.

4.2. Kenya

Situated in East Africa, Kenya is administered via a two-tier system of government comprising the national government and the 47 county governments. Around 80 % of Kenya's land is categorized as arid or semi-arid, with only 15 % of this suitable – and fully used – for agricultural production (McLaren, 2009). 67 % of land in Kenya is held under communal tenure (i.e. untitled) and supports about 10 million people and 70 % of the livestock population (Njagi, 2016).

Kenya's land sector is fraught with complexities and has a troubled, violent past. Colonial occupation and imported European practices have left a legacy of ineffective administrative and institutional practices. The use (or abuse) of state power to redistribute land in Kenya has been the cause of major land disputes (Willy, 2018). It has resulted in uneven distribution of wealth, corruption, and the dominance of the elite, which perpetuates the cycle as seen in the spate of informal and illegal allocation of land in the 1980 s–1990 s. Customary lands, particularly those associated with the Maasai tribe, have consistently been subservient to western forms of property rights with an appropriation of traditional lands occurring under both colonial and independent Kenyan governments' rule. Tribal land issues that started in colonial times have also been compounded post-independence, particularly in how territory was divided, fostering power imbalances and a sense of cultural deprivation.

In 2010, Kenya enacted a new constitution, which guaranteed equal access to land, promulgated the use of land for the benefits of local communities, and devolved the land administration to county governments. A series of legislative, regulatory, and policy reforms followed afterward including National Land Policy of 2009, the Land Act 2012, the Land Registration Act 2012, the National Land Commission Act 2012, the Land Bill 2015, the Community Land Act 2016 and the National Urban Development Policy of 2016. These constitute regulatory and institutional reform aimed at improving land governance by providing recognition and protection of different land tenure types and aligning land use policy to the Constitution. In particular, the new Community Land Act introduced community titles in Kenya to address the issues experienced in customary land, where lack of legal title has led to many communities being displaced through fraudulent land sales.

Despite these efforts, bureaucratic hurdles and persistent corruption has manifested in informal markets, assuring their status as a de facto avenue for accessing land (World Bank., 2016). Besides, information gaps stemming from outdated information in the land registry and registry maps, absence of complete information on titles (e.g. encumbrances and easements) and lack of coordination between different levels of government contribute to ongoing fraudulent sales of land (Mwathane, 2017). Legislative reforms have also unintentionally created ambiguity over the legal jurisdiction of the National Land Commission (NLC) (established under the National Land Commission Act 2012) and the Ministry of Lands, Housing and Urban Development (MLHUD) in areas like land registration impeding the land sector reformation efforts.

Like many developing countries, Kenya is experiencing rapid rates of urbanization, which is expected to rise to 50 % by 2050 (World Bank., 2016). Lack of affordable housing is a chronic issue: between now and 2050, Kenya's urban housing supply will need to increase almost four-fold; yet the current supply is less than a fifth of what is needed, resulting in informal housing becoming the only choice for the majority of urban Kenyans (World Bank., 2016). Yet paradoxically, Kenya is considered to be under-urbanized, i.e. it is not enjoying the full economic benefits of urbanization (World Bank., 2016). Much of this is a consequence of imbalanced growth due to *ad hoc* identification of urban areas leading to skewed distribution and inequality in development (Wanzala, 2016). Lack of clarity over ownership of land, as well as questions over the legal provenance of ownership, have also been shown to translate to real impingement on investment and economic development (Were, 2015).

All the issues outlined above are most keenly felt in Kenya's urban border towns, a well-recognized consequence of urbanization. Besides, these border towns are also contending with the tension between development and culture, where conflict of interests is evident in land issues confronting the Maasai. An archetypal case is the Kajiado County, which borders Nairobi and Tanzania and is predominantly occupied by the Maasai.

5. Methodology

To assess the capacities of the land administration systems in Rwanda and Kenya, we adopted qualitative research methods in data collection and an inductive approach in the data analysis. In particular, we used semi-structured interviews and complemented these with information collected via secondary sources. These included news articles, official records, national strategy documents, international reports, and technical reports on the implementation of UAV technology (e.g. Ho et al., 2017; Stöcker et al., 2018). The interviews were structured along with a guided topic list, which systematically corresponded to the capacity dimensions of the FCAF. The analysis of the cases and the interpretation of the situation were later validated by the local and technical

experts on UAV technology.

The fieldwork in Rwanda took place in June-July 2018 with a total of 38 interviews conducted in Musanze and Kigali. The participants were selected through purposive sampling, and in mutual consultation with the local country specialists. In Rwanda, 23 interviewees were from central and local government, 9 from the private sector, 9 from non-governmental organizations, and 5 were from academia.

In Kenya, fieldwork took place in September-October 2018 in Kaijado and Nairobi with a total of 16 individual interviews (3 from the national level, 8 from the county level, 3 private companies, 1 NGO, and 1 university). We complemented these with three one-day workshops[4] with local stakeholders. The workshops consisted of highly interactive sessions, where the participants could give feedback on the sustainable implementation of UAV technology. The outcomes of discussions were summarized in areas of strength and weaknesses concerning the capacity of the LAS in terms of the adaptation of UAV.

The eventual analysis of the collected data proceeded iteratively by contrasting the different answers and triangulating the field data with data from secondary sources. The results were considered reliable when the majority of the stakeholders consistently reported in similar ways and if the findings were supported by the secondary sources. By following the FCAF, we filled in the capacity assessment matrix for each case. The results were also corroborated by technology and country specialists.

6. Findings

In what follows, we briefly present the results of our capacity assessment[5] . The capacity scorecards for both country cases are presented respectively in Table 2 and Table 3. The capacity scorecards are created by following the evaluative classifications as identified in Table 1 and through the methodological steps described in the previous section. The section highlights the areas where we identified higher capacities and most significant capacity challenges, i.e. the challenges that require structural changes in the LAS when applying UAV for demarcating the land parcels. The assessment matrices that are provided as supplementary material include a more extensive assessment of all capacity dimensions.

6.1. Rwanda

6.1.1. Regulations

The legislative framework of the UAV presents the most pressing capacity challenges. In Rwanda, UAV licensing and rules of the operation comply with the 2016 Ministerial regulation N°01/MOS/Trans/016 and 2018 law on governing civil aviation. The UAV legislative framework requires high quality and compliance standards from private/commercial operators and the same rules apply for both commercial and private flights. The legislative rules oblige commercial operators to have an internationally recognized pilot license that can be only obtained outside of the country. The Rwandan officials justify the need for high-quality standards in UAV operators as the reassurance of public safety, but only a few operators have the financial and technical means to go through the rigid licensing procedure. At the time of writing, there is only one commercial UAV operator (i.e. CharisUAS) in Rwanda, which has completed the licensing procedure. Furthermore, the pilot study in Rwanda showed that this procedure is lengthy, time-consuming, and expensive. Although the cost of the UAV registration is about US$150 (110.000 RWF), the regulation[6] obliges each person to conduct UAV operations to subscribe to liability insurance, which is no less than US$ 1 million. Additionally, Rwanda does not produce UAV and thus the administrative cost of UAV import and certification process can add up to 20 % of the initial purchase price. Overall, these regulations restrict the affordability and flexibility of UAV operations. The flight restrictions as part of the civil aviation safety rules are also restrictive for the use of UAV in some urban and peri-urban areas.

6.1.2. Political system

Rwanda has a strong presidential system and hierarchical political traditions, with the central government being situated at the core of the LAS. The current government supports fiscal and administrative decentralization in land administration toward the district level without relinquishing its political control. The political system is also inclusive in recognizing different tenure rights as long as there is evidence to support the ownership claim. The political system is perceived as having high legitimacy and the stakeholders we interviewed in principle trust the capacity of the national government to implement the UAV technology. Therefore, as to the political capacity of the LAS, we do not expect any significant challenges.

6.1.3. Operational unit

The operational capacity of the land administration units shows overall moderate compatibility for the adaptation of UAV. Here the most significant challenges are related to the attainability dimension. For the UAV, the private surveyors and the government operators would need to follow additional training and resources to operate UAV in land surveying. Furthermore, at the moment only a limited number of pilots have UAV flight licenses. As to financial resources, the central government and partially the district level government have sufficient capacity to implement UAV. However, this is not the case for private operators, of which only a few private operators have sufficient financial resources to implement UAV without the support of state resources.

6.1.4. Social norms

The analysis does not reveal particular social norms, which could challenge the compatibility of the UAV with the LAS. On the contrary, the Rwandese government embraces a strategy called 'Home Grown Solutions' to combine traditional practices with SDG. One of them is the *Imihigo*, where government officials and/or individuals commit to deliver certain service activities within a specific period. It is possible to use these social practices to facilitate the adaptation process.

6.1.5. Land recording techniques

The analysis suggests that there is a moderate to high compatibility in this capacity dimension. The commercial surveyors and some local government operators would need additional training on how to use UAV to provide base data for land recording processes. Also, there is a need for more guidelines and policy documents on how to integrate UAV-based orthoimages in the recording of cadastral and non-cadastral information.

6.1.6. Software

Knowledge of new software solutions is important for the land recording performance of UAV operations. For the commercial software

[4] The workshops titled 'innovative geospatial technologies to enhance land tenure security in Kenya' were organized for three days for three different target groups with a total of 51 participants. The first workshop took place in Kajiado for local government officers on 28 September 2018. The second and third workshops took place in Nairobi on 1st and 2nd October 2018. The first day with participants from the private sector and NGOs, and the second day with participants from the National Government. For more details of the workshop, we refer to the March 2019 workshop report accessible at www.its4land.com.

[5] The assessment matrices for the country cases and the corresponding sources used for the analysis are provided as supplementary material in the online version. The retracted version of the interviews that are used in the analysis can be accessed via the following link: https://doi.org/10.17026/dans-zzz-rwa7

[6] Reg. 26 of N°01/MOS/Trans/016

Table 2
Capacity Scorecard-Rwanda.

	Flexible	*Inclusive*	*Participatory*	*Affordable*	*Reliable*	*Attainable*	*Upgradable*
Regulations	LOW	LOW	HIGH	LOW	MOD.	HIGH	MOD.
Political System	HIGH	HIGH	HIGH	HIGH	MOD.	HIGH	HIGH
Operational Unit	HIGH	MOD.	MOD.	MOD.	HIGH	LOW	MOD.
Social Norms	HIGH	MOD.	MOD.	MOD.	HIGH	HIGH	HIGH
Land Recording Techniques	HIGH	MOD.	HIGH	MOD.	HIGH	MOD.	HIGH
Software	HIGH	MOD.	HIGH	HIGH	MOD.	MOD.	MOD.

Note: Red = Low capacity, Yellow = Moderate capacity, Green=High capacity.

Table 3
Capacity Scorecard- Kenya.

	Flexible	*Inclusive*	*Participatory*	*Affordable*	*Reliable*	*Attainable*	*Upgradable*
Regulations	MOD.	MOD.	MOD.	MOD.	LOW	MOD.	LOW
Political System	MOD.	MOD.	MOD.	HIGH	MOD.	MOD.	HIGH
Operational Unit	HIGH	MOD.	LOW	MOD.	MOD.	MOD.	LOW
Social Norms	HIGH	MOD.	LOW	MOD.	MOD.	MOD.	MOD.
Land Recording Techniques	MOD.	MOD.	HIGH	MOD.	MOD.	LOW	LOW
Software	HIGH	MOD.	HIGH	MOD.	MOD.	MOD.	MOD.

Note: Red = Low capacity, Yellow = Moderate capacity, Green=High capacity.

solutions, the update of the software is automatic and it does not require capacity development at the local level. For sustainability, the usage of open source solutions is generally favored. In that sense, there is a need for capacity development on using open-source software. The local expertise on UAV technologies is currently limited, but there are new initiatives (e.g. collaboration of CharisUAS with University of Rwanda) to build up local capacity through specialized training and programs.

Table 2 presents the capacity challenges associated with LAS in Rwanda. The table suggests that an effective capacity development strategy should focus on reforming UAV regulations. The flexibility, inclusiveness, and affordability of the UAV operations in the LAS are the particular issues to be dealt with. Furthermore, few private operators have UAV licenses and operators need further training to implement UAV in land recording processes. This suggests that the attainability of the UAV operations is limited, and further initiatives are needed to increase the base of capable UAV operators.

6.2. Kenya

6.2.1. Regulations

The legislative framework in Kenya shows rather limited compatibility for the adaptation of UAV. The initial law on UAV has been withdrawn in 2017 following political pressures on the government. The former legislative process had been conducted without participatory mechanisms and the current legislative process is still in progress. In the current interim period, informal channels have become common for the licensing of UAV. Although this brings a certain level of flexibility, it does not suggest a reliable regulative framework. Furthermore, the present land regulations are not prescriptive on the capture and use of aerial imagery. There is a lack of enforcement of laws and regulations and conflicting state records due to the duplication of mandates for the management of the public lands. All these factors reduce the reliability of the regulative framework.

Another challenging dimension about regulations is the upgradability of the LAS. It is hard to anticipate to what extent the final act will allow improvements in surveying techniques with UAV. However, the current draft law on UAV contains restrictive provisions on the upgradability of UAV. For example, the rules on import and export of unmanned aviation systems (UAS) states: "A person shall not import a UAS or a component thereof without a permit issued by the Authority." Similarly, the rules on manufacture, assembly and testing of UAS mention that: "Any person intending to manufacture, assemble, test or sell a UAS or a component thereof shall apply for authorization from the Authority." Both of these clauses suggest a rather restrictive framework for the upgradability of the system.

6.2.2. Political system

The political capacity of the LAS in Kenya is somewhat limited particularly when it comes to boundary disputes and securing the rights of specific groups and actors, despite the participatory clauses in the Land Act 2012. The provisions of the Land Act 2012 on guiding principles state that public officials should encourage communities to settle land disputes through recognized local community initiatives. However, actual practices suggest that the system has been less participatory than the regulative framework is indicating. For example, existing processes around the subdivision of group ranches have by no means been participatory or transparent and have led to members within a group, particularly women, being dispossessed of their land. Devolution has increased a sense of ethnic-based land ownership, but the land is currently already in the hands of external owners, therefore, local ethnic communities are not easily included. For example, in Kajiado, which is a Maasai majority county, much land is owned by non-Maasai, leading to tensions between the communities. Furthermore, 'winner takes all' policies at the county level have led ethnic majorities in power to exclude minorities from accessing the state resources.

The political system has also some challenges due to the lack of trust vested in land administration institutions. The Njonjo Land Commission report (Republic of Kenya, 2002) suggests that citizens have low trust in the land dispute settlement mechanisms and institutions due to delays, incompetence, corruption, nepotism, and political interference. The overlap of roles and functions leads to conflict, confusion and unnecessary bureaucracy, which are exacerbated by the low participation of the local people in land dispute resolution mechanisms. The current situation is relatively improved following the enactment of the National Land Policy in 2009 and recognition of the alternative dispute mechanisms. Yet, cases of corruption concerning the land administration institutions suggest that lack of trust is still an issue of concern. Recent findings of corruption (Chase-Lubitz, 2018) regarding National Land Commissioners have threatened the legitimacy of the organization in the management of spatial data concerning public lands. These political challenges do not necessarily suggest a need for structural change, but there may be limitations in building trust in the system if public institutions are put in charge of the UAV operations.

6.2.3. Operational unit

The lack of participatory practices during UAV operations infers low capacities for the LAS. The field offices of the Ministry and county governments do not share their land data, which is an impediment. Moreover, collaboration with non-governmental actors takes place on an *ad-hoc* basis, and there are no well-established participatory mechanisms at the local level. One interviewee from the National Land Commission (NLC) suggested that there is a need for capacity building and additional resources to support participatory processes; "*If I may tell you the truth and the bitter truth, there is no capacity building [at least from the commission's point of view] so that the field has completely been overlooked or has been neglected by one reason or another. Because for example, we need to train the group ranch officials on how to manage land. We need to talk to women, whose rights have been violated by men. Their disputes come to us. OK, we have issues of capacity building where you have to enlighten people on their rights about their land, land information. It is not there. So, all this is a result of a lack of resources. Even despite we like to propose, who is going to fund? There is a clear gap in the capacity; both for the staff as the capacity for people and other stakeholders too*. [original quote]" There are certain limitations concerning the upgradability of the UAV in the system as well. Findings suggest that operational units lack the specialized knowledge and technical expertise to improve the operation of UAV. Therefore, specialized training and capacity building programs are needed for the sustainable deployment of UAV operations.

6.2.4. Social norms

The analysis of social norms does not suggest major limitations for the adaptation of UAV. Nevertheless, following the devolution of the LAS, ethnic diversities at the county level have become a source of violence and resulted in the exclusion of ethnic minorities. There have been reports on the displacement of certain ethnic and social groups (e.g. pastoralist or farmers), in rural and community-owned areas. In the absence of mitigating political and judicial actions, these exclusionary practices toward non-ethnic communities may affect the sustainability of the technologies and as such also impact the effective use of UAV.

6.2.5. Land recording techniques

Capacity conditions concerning land recording techniques suggest a variety of challenges for the adaptation of UAV. Especially, attainability stands out as the most challenging issue. The financial and HR capacities of private and state operators (i.e. county government and field offices of the Ministry) vary significantly, which limits the attainability of UAV operations at a small scale in the LAS. The lack of technological capacities in land recording processes is also an impeding factor for the upgradability of the UAV. While it is possible to improve the performance of the UAV due to the modular design, it is currently difficult to automate the data collection with UAV given the lack of technological skills and infrastructure in most of the local offices.

6.2.6. Software

The capacity conditions concerning software are mostly compatible with the local framework in Kenya. However, many county governments and field offices lack digital infrastructure and adequate HR capacities in terms of computer literacy. Therefore, for these organizations, there could be difficulties in installing and using the software. Moreover, open-source solutions are not prevalent in Kenya, which may exacerbate the skill gap in human resources capacities. Similar to the case of Rwanda, proprietary GIS systems (e.g. ArcGIS) are used in Kenya, and the usage of open-source-based solutions would require technical and policy support as well as further training.

Table 3 gives an overview of the capacity challenges associated with the LAS in Kenya. The analysis suggests multiple pathways in capacity development to address the weaknesses of the system. First, exclusionary practices at the operational and societal levels suggest that capacity-building practices supported by international and national non-governmental actors can improve the participatory feature of the LAS. Second, cooperation with universities and private actors can substitute the lack of technical skills and infrastructure at land recording processes. Third, completion of the legislative framework with prescriptive rules for licensing and modification is important.

7. Conclusion

This paper introduced the 'Fit-For-Purpose capacity assessment framework (FCAF)', a novel framework to assess the capacity of the land administration system. The paper has illustrated its application through the case of UAV technology in Rwanda and Kenya. By applying FCAF we systematically identified country-specific, enabling and impeding capacity components for the successful adaptation of the UAV in the LAS land administration systems of two case countries. Our findings provide a basis to develop the necessary capacity development strategies and policy interventions.

In general, different framework conditions exist in Rwanda and Kenya for the sustainable implementation of UAV technology in the land administration system.

Interestingly, while Rwanda is seen as an exemplary case for the successful implementation of the FFP approach (Enemark et al., 2016), our analysis provides some nuances. In Rwanda, capacity conditions are indeed more supportive of an easier uptake of UAV. Nonetheless, weak market conditions regarding the availability of UAV call for attention and strict regulations concerning UAV operations contradict FFP land administration (see Enemark et al., 2016). We see two possible policy actions for capacity development. First, the government can ease the procedures for UAV flights to enhance market diffusion. Second,

unfavorable market conditions imply that a concerted effort is needed from the government towards commercial operators, instead of merely relying on market mechanisms. Here, collaboration with international donor organizations and local stakeholders could help to enhance the capacities of private and local UAV operators.

Kenya, on the other hand, portrays a more complicated picture. Existing institutional and political challenges in the land administration system raise concerns about the reliability and attainability of the UAV under the current framework conditions. Despite that, unlike in Rwanda, there are supportive market conditions and capable non-governmental and private actors that can bolster the adaptation processes into a more sustainable and scalable land administration system. Therefore, market-led policies, co-production, and outsourcing can yield more successful outcomes, should there be interest in the full integration of UAV in the Kenyan land administration system. For that, we draw attention to the targeted development of communication and technical capacities at local public offices to successfully manage engagement with non-state actors.

FCAF can serve as a useful heuristic for the development of the capacity development strategies to overcome the challenges with adaptation and sustainability of the geospatial technologies in land administration systems. The framework in principle holds relevance also for the adaptation of other technologies that were not part of our research. One advantage of FCAF is that it provides a tool to systematically identify context-specific, enabling and impeding capacity components and thus possibly to develop the necessary capacity development strategies and policy interventions. FCAF also provides a comparable normative basis for the land administration systems. By applying this framework, users can assess to what extent different land administration systems comply with FFP principles.

Nonetheless, while FCAF is a valuable tool to give a snapshot view on the present capacity conditions in a particular setting, the findings cannot be directly translated into policy intervention strategies, which can mitigate any possible deficiency. Earlier we contemplated the ontological limitations of the FFP approach in general and the FCAF in particular. We recommend policy designers who are willing to use this framework to be reflexive about these limitations and the principles of the FFP land administration and adjust their policy strategies according to their policy priorities. FCAF is designed as a tool for policy practitioners to develop the appropriate policy intervention strategies from the local context and for the local context, therefore, policy developers need to be refrained from simply replicating the solutions developed for other country cases. That being said, further case studies and practices with FCAF can lead to the development of best practices in tackling particular capacity challenges that are common in developing countries, thereby expanding the accumulative knowledge on developing more effective land administration systems.

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Evrim Tan: Conceptualization, Methodology, Data curation, Writing - original draft. **Valérie Pattyn:** Conceptualization, Writing - review & editing. **César Casiano Flores:** Writing - review & editing. **Joep Crompvoets:** Writing - review & editing, Supervision.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2020.105244.

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