Application of Unmanned Aerial Vehicles in Strengthening Land Rights for the Youth in Kenya

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Abstract

This paper explains why and by what means Unmanned Aerial Vehicles (UAVs) can be used to strengthen land rights for the youth in Kenya. In agriculturally viable rural areas of Kenya, land rights are important to the youths since it is the main source of their livelihood, household food security, employment creation and income. The youths normally acquire land through inheritance from their parents. In most cases, the land is subdivided informally hence undocumented. In addition, the process of transfer is bureaucratic and complicated making it difficult to formalize rights to land. Due to the informal transfers, the youth normally lack formal rights to land that are recognized in a register. The lack of formal title deeds also makes it difficult for the youth to acquire credit from financial institutions. In Kenya, like most Sub-Sahara African countries, only about thirty percent of the land is registered. Considering that majority of the population in Kenya are youth, it means that most of them live in the unregistered land. Therefore, there is a need to devise a quick means of documenting property boundaries either through first registration, or updating of changes that have occurred due to the inheritance of land. UAV technology provides a photogrammetric platform that has opened a new means of mapping property boundaries as a step towards land registration. The UAV data is usually acquired real-time, is cost-effective, is of high resolution and can be cloud free. Thus, UAV derived maps can provide a quick means of registration that will enhance land rights for the youth. This paper applies case study methodology to explain why and how UAVs can be used for land registration in Kenya. The results provide an appraisal of the extent of registration in Kenya and how UAVs can be used to produce maps that may be used for registration. The hope is that this paper will contribute towards not only enhancing land rights for the youth in Kenya but also in other African countries.

Key Words: Youth, Land Rights, Unmanned Aerial Vehicles

1. INTRODUCTION

This paper explains why and by what means Unmanned Aerial Vehicles (UAVs) can be used to strengthen land rights for the youth. Secure land rights provide a foundation for economic growth and development. In most developing countries, secure land rights are a key foundation for generating livelihoods, investing and a means of transferring wealth from one generation to

another (Deininger, 2003). In view of high rates of unemployment, access to land provides an alternative means of income for the majority of people in rural areas of developing countries. Hence, there is a need to secure the rights to land that are held by the youth in developing countries.

In general, the extent of formal land registration in developing countries is very low. According to a World Bank report that was produced in the year 2003, only about ten percent of land in Sub-Sahara Africa has been formally registered (Deininger, 2003). In the recent past, a more optimistic figure has been given, in which only about thirty percent of land in developing countries has been registered (Zevenbergen et al., 2013). The latter figure seems to conform to Kenya in which figures show that only between twenty-five to thirty percent of the land has been registered (Siriba, 2011). Therefore, a majority of the people, including youth, in developing countries are unable to gain from the potential benefits of land registration.

In addition to the unregistered areas, the land rights of the youth are also usually insecure in the places where formal registration has been introduced. The youth normally acquire land through inheritance from their parents. However, the youth usually secure the land through custom or informal means as opposed to the land register. In regard to custom, the youth usually ensure that they participate in customary rituals when they are occupying the land, as a means of developing some legitimacy as landholders (Goodwin, 2013). In the informal means, the youth can acquire informal documents, for example, land transaction agreements that are witnessed by chiefs, as a means of securing their holding, as opposed to acquiring formal title to land (Chauveau, 2007). Thus, the customary or informal rights to land that are held by the youth may be insecure because they are not backed by state-sanctioned formal land registers.

Unmanned Aerial Vehicles (UAVs), also known as drones, can contribute towards strengthening the land rights held by the youth. In most cases, the land held by the youth is usually fenced using hedges which can be mapped from the air. In Kenya, the colonial and post-independence governments used aerial photogrammetry as means of quickly mapping and developing maps that were used for land registration (Wayumba, 2015). During that time, aerial photographs were flown at a scale of 1:12,500 or 1: 25,000. Subsequently, the photographs were mosaicked and enlarged to a scale of 1:5,000 or 1: 2,500. The boundaries on the mosaicked photographs were then traced to produce Registry Index Maps (RIMs) and Preliminary Index Diagrams (PIDs) that were used as a basis for land registration (Siriba et al., 2011). Similarly, UAVs can be used to quickly capture the unmapped boundaries and use the developed maps to enable land registration for the youth.

There are various reasons why UAVs can be used to enhance land rights for the youth in developing countries such as Kenya. In essence, a UAV, also known as a drone can be described as an aircraft that does not have a person onboard. It is an unmanned aircraft. The first advantage of using a UAV for mapping is that it is quick as compared to ground methods. The second

reason is that the data can be acquired in real-time, hence enabling quick generation of maps. The third is that because the craft can fly below clouds, it can be used to acquire cloud-free data. UAV also provide high-resolution photographs, which is the ideal of land registration. Finally, the UAV data can be automatically linked to a specific coordinate reference system, hence enhancing the quality of maps for land registration. The next section describes the methodology that was used in this paper.

2. METHODOLOGY

In order to explain how UAVs can be used to strengthen land rights for the youth in Kenya, case study methodology was selected as the main form of inquiry. In general, case study approach is a social science research approach that allows examining and analysis of certain phenomena (Eisenhardt & Graebner, 2007). Additionally, the approach allows for the usage of different sources of data such as books, journal articles, newspaper articles, interviews and observation (Yin, 2013). Case study methodology is also ideal for developing theories about a phenomenon under investigation (Eisenhardt & Graebner, 2007).

Case study methodology was used to explain how UAVs can be used to map hedges as a means of enhancing land registration. In this regard, exploration was made of existing literature on the use of UAVs for mapping and general aspects of land registration. Based on the methodology, key categories and themes were derived from the use of UAVs. The key emerging categories that emerged and used for writing are (i) types of UAVs, (ii) Spatially data acquisition process and (iii) possible registration maps from UAVs. Each of these categories is explained in the subsequent sections of this paper.

3. APPLICATION OF UAV IN LAND REGISTRATION

i. Types of UAVs

There are many different types of UAVs that can be used for mapping. The different types can be classified as multi-rotor, fixed wing, and a hybrid of fixed wing and multi-rotor (Wayumba et al., 2017). These varied types of drones have different capabilities for mapping. Fixed-wing UAV is designed much like conventional aircraft thus require the forward trust to fly and large space to take off and land. The fixed-wing UAVs are generally more productive in mapping larger areas due to longer endurance time and high speed.

On the other hand, Multi-rotor drones are easy to manoeuvre, hover over a point and require less space for take-off. They are therefore preferably suitable for mapping of smaller, tight areas with obstacles. The use of fixed wing or multi-rotor drones can benefit land registration projects, but deployment depends on the scope and coverage of mapping. Examples of fixed wing and multi-rotor UAV is as shown in the below figures.

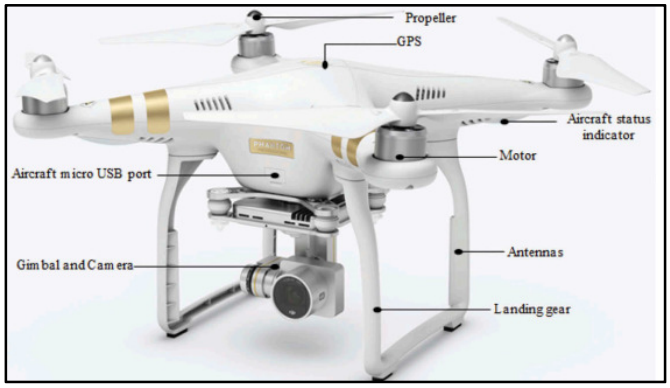

Figure 1: Shows a DJI Phantom Multi-rotar Drone/ UAV

Figure 2: Shows a DT-18 Fixed Wing UAV from Delair-Tech

ii. Spatial acquisition of data

a. Reconnaissance

Like any other field data acquisition, UAV data acquisition always begins with field reconnaissance to enable the user to familiarize with the area of interest. Field reconnaissance helps in the determination of safe zone for placing the GCPs for geo-referencing the image and for smooth safe flight mission. Additionally, preflight checks are carried out to test all functionality of the electronic components such as the camera, the battery, and the wings to avoid any eventuality during flight (Ajayi et al., 2017).

b. Mission planning

The process for image acquisition is designed in the office by use of laptop equipped with appropriate software and a high-resolution image, such as those in Google Earth. During mission planning, the user needs to consider the desired ground resolution, flying height, desirable percentage forward and side overlap and endurance time. With the aid of the software, the user can delineate the area to be mapped and automatically generate the flight path. The flight path can then be modified to suit the desired requirements.

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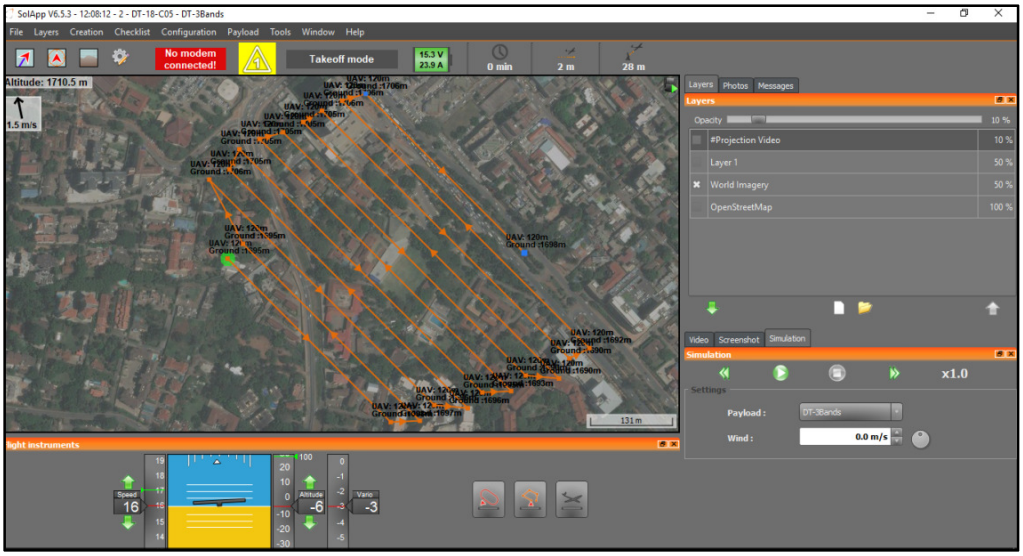

Figure 3: Shows Flight Path in SOLAP Software

c. Image capturing

In image capturing, the user conducts the flights. The user takes the UAV equipment to the area where mapping needs to be done. Since the critical parts of flying the UAV is landing and takeoff, an open area-free from obstacles is chosen. The user is required to follow the manufacturer manual in establishing a connection between the UAV, laptop and the antenna. Once the connection is confirmed, the UAV functionality is tested and a position is obtained with an adequate number of Global Navigation Satellite System (GNSS). At this point, the mission planning design can be loaded in the UAV. The User then launches the UAV and allowed to fly and capture images automatically following the predefined flight paths (Delair-Tech, 2016).

d. Image processing

The images obtained are processed to generate a mosaicked, ortho-photo to allow tracing of boundaries. Usually, the captured images have a forward and side overlap of 65% and 30% respectively. Since the cameras used are non-metric and geometrically unstable, both classic photogrammetry and computer visioning techniques are used in processing the photographs. During processing, image orientation and camera calibration are determined. The extraction of tie points and bundle adjustment is performed. Different commercial software's for processing UAV images such as photscan, photomod, PIX4D mapper, Drone2Map etc. exists in the market.

iii. Possible Maps from UAVs for land registration

The final product from the UAVs should be maps that can be used for registering land rights held by the youth in Kenya. There are different types of maps that are formally recognized for land registration in Kenya. The maps include deed plans, which are derived from a process of accurate ground surveying-Registry Index Maps (RIMS) and Preliminary Index Diagrams (PIDs) are obtained from aerial photography.

Registry Index Maps are prepared for the first registration of land. RIM is usually prepared using ground survey or aerial photography methods for every registration district or registration sections identified by distinct names. The information contained in the RIM includes the location, sheet and index number, edition of the sheet, sheet history (amendments), plot numbers and scale. Preliminary index diagrams, on the other hand, are provisional maps used for land adjudication in a larger area of rural Kenya. These maps are produced by taking aerial photography at a scale of 1:12,500. The non-rectified, mosaicked photographs are then enlarged to a scale of 1:2,500 or 1:5,000 to enable easy identification of the boundaries. Once the parcel boundaries have been identified and marked on the photographs with the help of photo interpreters, the parcels boundaries are traced to produce a temporary map for registration (Ondulo, 2010).

A new type of map should be developed from UAV imagery and legally accepted for land registration. The maps can be possibly called "UAV based RIMS" or 'UAV-RIMs' considering that Kenya already has many types of RIMS. The PIDs for registration lacks spatial reference and are less accurate. UAV platform is suitable for documentation of parcel boundaries. The geometrical accuracies obtained from the high-resolution UAV images are no less than accurate as conventional terrestrial surveying methods (Volkman & Barnes, 2014). Therefore, UAV platform can provide alternative geospatial data acquisition hence economic viability in land registration in Kenya.

4. CONCLUSION

This paper has explained why and how UAVs can be used to strengthen land rights for the youth. UAV technology has provided an opportunity that can benefit land registration in Kenya. Proven benefits, the technology is the equipment of choice in cadastral (particularly) adjudication surveys to increase and update the extent of land registration. Elaborately, this paper has covered the technical aspects by giving how UAV mapping for land registration can be done. The hope is that this paper will contribute towards the use of UAV not only in Kenya but also in other developing countries.

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