



Ultra-light commercial drones record aerial imagery that can be quickly processed into accurate, cost-effective maps

# Using Geo-spatial Data to Secure Property Rights

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## SUMMARY

Property rights are critical to economic growth and social stability, yet almost 75 percent of the world's population lacks access to formal systems to register their land rights. In a new approach to recording property rights quickly and cheaply, this project used Unmanned Aerial Vehicles (UAVs), commonly known as drones. These record imagery which is processed into high-resolution orthophotographs (aerial photographs corrected to have the same lack of distortion as a map). The process generates accurate, cost-effective and up-to-date maps and 3D computer-generated landscape models in a fraction of the time of conventional aerial surveys. In Kosovo, the team used a UAV to map villages where the men were killed in the Balkan conflicts and the women lack formal property title. They are now using the new maps to help the women define their property boundaries and officially register their rights. They also deployed the UAV successfully in the fast-growing city of Ferizaj, to support a government program for unregistered land owners to legalize their property rights. The initiative can be scaled up globally, especially to secure land rights in developing countries.

## CHALLENGE

Almost three-quarters of the world's population lack affordable access to formal systems to register and secure their land rights. Poor people, including indigenous and vulnerable groups, are disproportionately affected. Even where affordable formal systems exist, data quality often remains low, yet property rights are critical to economic growth and social stability. Without secure rights, land remains underdeveloped and underutilized. Access to secure land rights eliminates threat of eviction, increases investment and improves agricultural productivity. Women's property rights have been shown to improve children's health and education, foster inclusive family decision-making and reduce domestic violence.

There is urgent need to develop ways to identify and record land rights information far more quickly and cheaply than conventional methods. New technology is enabling the local capture of high-resolution geo-spatial data and processing into accurate maps. Combined with open-source software programs, this provides huge potential for a more cost-effective and inclusive approach to securing property rights. The project therefore aimed to produce faster, cheaper spatial data using processed imagery from Unmanned Aerial Vehicles (UAVs) to help the majority of the world's population who lack secure property rights.

This mapping approach could be used to complete or update cadastral maps. By facilitating the registration of land rights, it would allow poor people to acquire a tangible asset, which they could use directly or as collateral to invest in other assets. Vital for economic and social inclusion, this security of tenure would help people escape the vicious cycle of poverty.

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*The approach significantly reduces the cost and timescale of high-quality cadastral mapping, and empowers local communities to participate*

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## INNOVATION

UAVs offer a new approach to producing accurate, cost-effective and up-to-date maps and 3D computer-generated landscape models. More commonly known as drones, commercial UAVs are small and ultra-light, facilitating an affordable mapping service through a process that takes days or weeks from planning to product, rather than months or years. These maps can easily be disseminated and used by citizens, local government, utility companies and businesses, among others.

To refine the identification of land plots by UAV, the team built on a 2014 World Bank project which successfully used UAVs for mapping and citizen engagement in defining property rights in Albania. They used drones to collect aerial imagery and produce high-resolution orthophotographs – aerial photographs geometrically corrected for topographic relief, lens distortion and camera tilt ('orthorectified'), so that their scale is uniform and there are no distortions. Unlike an uncorrected aerial photograph, an orthophotograph can be used to accurately measure distances. The team is now combining the orthophotos with open-source, customizable registration software to record property rights information from citizens. Together, UAVs and the new software offer an innovative and cost-effective property mapping and registration toolkit.

The process results in geo-referenced maps with boundaries and information on ownership and use for each property. These can be distributed to each owner and the local community, allowing land owners to easily identify and verify the boundaries of their properties. Although the maps do not constitute formal registration, the team also works with government agencies on how the field information can be integrated into the official cadaster or registration database.

### ***Securing women's property rights***

To scale the Albania pilot up to operational levels, the team turned to Kosovo, where the World Bank is helping the government produce a national cadaster system. Working with the Kosovo Cadastral Agency, the team began to integrate UAVs into the national mapping program. This would significantly reduce the cost and duration of cadaster development, and facilitate informed planning. The process would also empower local communities to participate.

For their first UAV deployment, the team worked to support the property rights of women in Krushe e Madhe, where most of the men and boys were killed in 1999 in the Balkan conflicts. The women have slowly rebuilt their lives and have organized several agricultural cooperatives. However, official data from the Kosovo Cadastral Agency shows less than 10 percent of properties in Krushe e Madhe are registered in a female name. This prevents women from using their land as an effective economic asset – in particular, as collateral for credit. The time, cost and complexity of conventional cadastral registration, along with poor knowledge about their rights, often exclude the women from the benefits of registration.

To map Krushe e Madhe's property boundaries, the team used a Sensefly eBee fixed-wing UAV, owned by the World Bank's Innovation Labs. The drone carries an 18 megapixel camera and flies within remote control contact at an altitude of around 100 meters. It covers a predefined area, prepared by setting survey 'ground control points' (marked with spray paint) that ensure the highest accuracy of the maps. In a week, the team completed 25 flights covering 12 square kilometers and processed the images locally, with the help of the Kosovo Cadastral Agency, into high-resolution maps of around three centimeters per pixel.

### ***Mapping cityscapes***

The UAV was also deployed successfully in a fast-changing urban context. In the past two decades many cities in Kosovo have experienced rapid, unplanned expansion resulting in informal settlements, illegal constructions and chaotic development.

In response, the government recently introduced a program for land owners to legalize their property rights. To facilitate property registration in the city of Ferizaj, the team spent a day carrying out six flights, covering three square kilometers in a total of three hours' flying time. The data were processed in 24 hours using two local high-end desktop computers, resulting in orthophoto maps with 1.9cm resolution from which land owners can easily identify their property.

## **RESULTS**

The project showed that UAV technology supported by customized open-source software can produce accurate, cost-effective and up-to-date maps and ownership information for the registration of property rights. This approach significantly reduces the cost and timescale of high-quality cadastral mapping activities, and empowers local communities to participate by identifying and verifying boundaries on the maps. In Krushe e Madhe, the team is using the new maps to help the women define their property boundaries, and working with officials to develop a system for completing official registration using the maps and community information on property ownership. The maps and digital elevation model produced in Ferizaj will be made available free of charge to citizens who are participating in the legalization program, as well as to the municipality and other authorities via the national Geoportal (which offers web access to maps and other geospatial information).

The project also proved the versatility of the UAV approach. While flying near the construction site for a new national highway, the team responded to a spontaneous request for assistance from a local official. The road crew had recently found an archaeological site, but existing aerial imagery and maps provided no evidence of it. Using the UAV, the team was able to plan, fly and process a high-resolution 3D map of the area in less than 24 hours. This provided accurate information for rerouting the road and preserving the cultural heritage site.

Other examples of UAVs' potential include utility inventories, supervision of major infrastructure contracts, post-conflict or disaster response assessment, recording the rights of indigenous and vulnerable communities, and road engineering. The initiative can be scaled up globally, especially to secure land rights in developing countries. The results will also inform the global discussion on how to help people currently unable to register their land rights and how to build sustainable systems to identify the way land is used.



The orthophoto produced from the drone and the software on the tablet are used to gather property information from local residents in Kosovo. The property boundary information is then updated on the orthophoto

## LESSONS LEARNED

The project confirmed the potential of UAVs for collecting geospatial information. Paradoxically, the use of big data and powerful technology can empower people at community levels.

- ***Use drones for a wide range of aerial imaging requirements***

UAVs are becoming a more commonly accepted tool for producing high-resolution mapping products for targeted areas. They support 'fit-for-purpose' mapping principles, which hold that land administration should be designed to meet the needs of people and their relationship to land, support security of tenure for all, and sustainably manage land use and natural resources.

- ***Empower local communities through new technology and big data tools***

Although a certain level of resources and capabilities is needed to process and manage big data such as the high-resolution geospatial information produced by UAVs, the project demonstrates how this new technology allows a more decentralized approach to traditional mapping. The potential to empower communities and local government to visualize their environment and make informed decisions can be significantly increased by using these new tools and technology.