



**Integrating Land Governance into the Post-2015 Agenda  
Harnessing Synergies for Implementation and Monitoring Impact**

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# Drones for Peace: Part II Fast and Inexpensive Spatial Data Capture for Multi-Purpose Use

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## **Abstract**

A World Bank Europe and Central Asia (ECA) Region innovation grant was awarded to test the use of unmanned aerial systems (UAS) as a way to accelerate the production of fit-for-purpose spatial data, thereby allowing local and national government and the private sector to use the up-to-date and accurate data for multiple purposes. The pilot was conducted in several locations in Albania in December, 2013 and the analysis is presented as a two part series to document the findings and potential applications of this new technology.

The emergence of small, affordable UAS technology and recent advances in highly automated mapping techniques promises a widespread enablement of small entrepreneurs and development agencies to enter the field of mapping. Because of its rapid and easy deployment characteristics, UAS technology is most appropriate for short notice acquisition of high resolution digital aerial images over small areas. The combination of highly automated and precise UAV navigation with recent advances in automated image processing and mapping techniques and the ever continuing effects of Moore's law on personal computing performance is rapidly reducing the entry barriers to mapping tasks that have to date been exclusively performed by centralized resource centers such as international mapping companies and national mapping agencies.

The pilot study in Albania was designed to test the performance and relevance of UAS technology and modern modeling techniques in an environment where there is a dire need for new spatial data and for improvement of the quality of existing spatial data. We found that the enabling advantages of UAS aerial image acquisition combined with the automated Multi-View Stereopsis (MVS) technique for general and specific mapping and modeling tasks will find many appropriate applications in support of informed development design and management at local and national level. In particular we are confident that the basic methodology applied in our study will result in improved supply of high quality spatial information to all stakeholders in the fields of infrastructural design, urban and rural planning, resettlement action plans (RAP), civil contract management, cadastral surveying and property registration, environmental impact assessments, natural resource monitoring and disaster risk mitigation. We also conclude that with additional funding we will be able to establish a feasible and cost-effective approach to introduce UAS and the associated image processing techniques to establish sustainable, decentralized, individualized mapping capacities across countries such as Albania.

**Key Words:** UAV, UAS; National Spatial Data Infrastructure; SDI, orthophoto, 3D models

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## **I. Introduction**

A World Bank Europe and Central Asia (ECA) Region FY14 Innovation Grant was awarded to test the use of an unmanned aerial system (UAS) as a way to produce faster, fit-for-purpose spatial data (aerial photographs, digital orthophotos, maps and 3-D models) allowing local and national government and the private sector to use the up-to-date and accurate spatial data for multiple purposes. The use of UAS technology can revolutionize the way governments acquire and manage spatial data as well as the manner in which the World Bank and other development partners design, implement, and monitor their projects by making these processes more timely, inclusive, transparent, accurate and cost effective. An UAS is a new tool for improved project design and implementation in which spatial data can be applied to various fields such as securing property rights, improved infrastructure and related services, better urban planning and integrated development, and disaster risk management that are at the heart of the World Bank's poverty reduction and shared prosperity agenda.

This paper is Part Two of a two part series that presents the results of testing UASs to produce spatial data for multi-purpose use in Albania in December 2013.<sup>1</sup> Part One presents technical aspects and the application for cadastral mapping, while this paper explores the use of UAS for other applications and non-technical considerations such as legal issues and project management considerations for using UAS in a development project context.

As described in more detail in Part 1 of this series, the use of UAS was piloted in three areas in Albania in December 2013 in order to explore development of a more efficient, accurate and timely spatial data capture process. A fourth area, live footage along a river after a flood, provides a brief look at applications in a disaster scenario.

### **Why in Albania?**

In Albania a new computerized system for land administration was developed in 2012 with national roll-out ongoing. The new system is the first in Europe based on the 'Land Administration Domain Model' (LADM), which was approved as an official International ISO Standard on 1 November 2012. The Albanian system has been populated with a good quality data from the systematic first registration process under the World Bank financed Land Administration and Management Project (LAMP), which covers approximately 20% of properties in the country. However, for almost 80% of cadastral zones the existing maps are maintained in paper form and are of poor quality and therefore cannot serve as base

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<sup>1</sup> A multi-disciplinary team included the team leader/land lawyer from the World Bank, a UNFAO Information Technology expert, international surveyors with UAS experience, local surveyors, and international and local university professors in the fields of GIS and photogrammetry. The team was assisted by the Chief Land Registration of the Albanian Immovable property Registration Office and the mayor of the *Komuna Farke*, both of whom facilitated the field work and access to other information and data sets for the pilot.

maps to build the Albanian National Spatial Data Infrastructure (SDI). The latest available orthophoto maps were produced in 2007 (i.e. some seven years ago) and, with the rapid urbanization, are now out of date. Therefore, the benefit from the investments made to introduce the new IT system in Albania cannot be fully realized until a data quality improvement process is developed.

## **Background**

The costs of producing conventional aerial photographs and digital orthophotos and the performance of terrestrial surveys can amount to several thousand or even millions of dollars and can use up a significant amount of a project budget. The time line of a typical procurement of conventional map products such as a regional or national topographic map series or of wide area coverage of orthophotos from inception to delivery often consumes a disproportionate amount of time of a development project life cycle. Conventional mapping projects are highly sensitive to economy of scale. Hence mapping contracts have tended to be large and most often are allocated to international companies or institutions. Delivery typically is partitioned into large chunks of information that often arrives too late to be consumed and analyzed before the information has become outdated. The work done under the Innovation Grant included testing the introduction of UAS at the local level, as an additional tool for small survey and mapping companies or local private surveyors, to produce spatial data with high accuracy in a matter of a few days, AS and WHEN needed. Placing mapping capacities at the local level opens opportunities to significantly shorten supply lines and to respond much more dynamically to immediate demands for spatial data.

## **Operational Characteristics of UAS**

UAS now come in small, portable versions, yet can produce accuracy results equivalent to or better than conventional surveying and mapping methods. UAS add new dimensions to baseline data gathering for concept development, alternatives assessments (e.g., site and route selection), and environmental and social impact assessments. Typical data sets that can be acquired include aerial imagery from which topographic data can be produced and multispectral data through Lidar (laser scanning). Major advantages are the resolution of the data acquired, speed of capture and delivery, ability to target discrete areas and repeatability to monitor change.

One of the most valuable by-products of a UAS navigation system is that with little extra effort all sensor products, be they in the form of air quality measurements, RGB or infrared imagery or gravity measurements, can be accurately time-stamped and positioned (geo referenced). Because they are small (2x2cm) and light (30g) most UAS use stand-alone GPS receivers for navigation. In those areas where satellite augmentation services such as WAAS for North America and EGNOS for Europe are available

the positioning accuracy of these devices is in the 3 to 5m range – adequate for any mapping tasks at scales of national topographic mapping series.

GPS yields positions on the WGS datum. Where existing maps are on a national or local datum, the WGS coordinates have to be converted to the national or local coordinate system with the use of local transformation parameters. Most countries have or are in the process of establishing national spatial reference frames based on one of the International Terrestrial Reference Frame (ITRF) versions. The relationship between WGS84 and ITRF is very well established and coordinate conversion tools to convert between WGS84, ITRF and most national and sub-national coordinates systems are readily available on the internet or embedded in mapping and GIS packages. Thus, UAS-derived geo-spatial observations and raw imagery can in many instances be plotted on national topographic maps.

### **UAS to Augment Satellite Imagery**

The most advantageous consequence of having UAS derived spatial data geo-referenced is that the data can so easily be rendered in global satellite image servers such as Google Earth, which is an underutilized tool in the development aid industry. Google Earth is an immensely valuable, free resource and, within the context of development work, was used as the basic platform for the planning of the pilot study in Albania. Although Google Earth has some shortcomings (relatively poor spatial resolution at 50 cm, local distortions, internet access required), the appropriate application of UAS very efficiently overcome these issues.

Google Earth thus presents a powerful link between non-spatial and spatial data. When starting new projects the combined use of Google Earth and UAS can, for most purposes, accelerate geo-spatial tasks. Google Earth provides a rough inventory and subsequent UAS applications immediately start delivering high accuracy geo-spatial products to satisfy immediate demand. Hence UAS technology integrates production of geo-spatial base products into the development workflow and there is no need to wait for blanket mapping coverage.

Because acquisition costs are low, the units are physically small and their operation requires low skill levels, UAS technology can be easily disseminated (geographically as well as demographically) to efficiently establish A to Z mapping capacities in countries that don't have such capacities and are thus in dire need of improved spatial data.

Since UAS can take off and land in the presence of local stake holders and the spatial products can be delivered in a matter of days, they will most convincingly bring credibility of maps to citizens. Increased

interest in environment and planning issues will very likely result from increased “map awareness”, “map acceptance” and increased citizen engagement.

## **II. Improvement of Operational Effectiveness: Albania Case Study**

This section will build on the findings of Part I of the two part series which focused on the operational aspects of UAS and cadastral mapping applications. The focus will now turn to aspects related to the use of this new technology for better project design, implementation and monitoring.

### **Infrastructure Development Scenarios**

UAS can have a significant positive impact on all stages of infrastructure development from feasibility and design to safeguard compliance and monitoring and evaluation (M&E). At the initial design stage of a project UAV derived imagery and post processing products such as Digital Elevation Models and 3D visualization allow engineers to plan and design the most cost effective and logical routes. The spatial data also provide a snapshot of the assets and social impact that a proposed project will have and allows for a clear point of reference for Resettlement Action Plans, cut-off dates and compensation calculations. Periodic follow up flights allow for monitoring of contractor performance and assessments of any environmental or other impacts that occur. During the post-construction phase of infrastructure projects UAS can play a significant role in inspections to trigger preventive maintenance actions.

In Albania, the team chose two sites to demonstrate how UAVs can provide critical information for infrastructure. The first site demonstrates the power of UAV imagery and derived products along a new highway corridor that also included high tension power lines. The second location covers an area that is part of a new urban water supply project where land will be acquired but the official property registration maps and ownership information are out of date or incorrect. The photos and descriptions below provide concrete examples of how UAS can improve infrastructure development and management.

## Energy



### **Energy: Power Lines and Towers**

- Create inventory of assets
- Conduct detailed inspections
- Document current occupation and condition of equipment
- Assess need for vegetation clearance
- Identify illegal easement encroachments
- Use infra-red survey to detect insulation problems
- Assess conditions after storm damage and stability

*Geo-referenced imagery allows easy inventory, inspection and monitoring of infrastructure assets (Elbasan Highway corridor, Albania)*

## Transport

In topographic surveying for engineering design purposes, small UAS can be employed to significantly reduce the field data collection time. The Albania team acquired sufficient aerial imagery in only 30 minutes to create a very realistic model of an 800m stretch of highway under construction. The model can be used to create a three dimensional virtual world within which traditional survey work can be performed “virtually”. Traditionally, topographic surveys are performed either by expensive (economy of scale dependent) lidar methods or by covering the ground with “spot shots” using either total stations or GNSS RTK. The team estimates that a seasoned survey crew equipped with total station or GNSS RTK would need at least two weeks to collect all the data contained in the UAS derived model. Virtually surveying the terrain entails capturing the details of interest one mouse click at a time, whereas in conventional surveying each point of interest has to be physically occupied. Considering that an appropriately configured UAS can be supplied at a cost below that of either GNSS rover or total station and that relevant image processing software can be purchased for less than US\$5000, the gains in efficiency and economy make a compelling case for including a UAS as an additional tool for general surveying and mapping purposes.



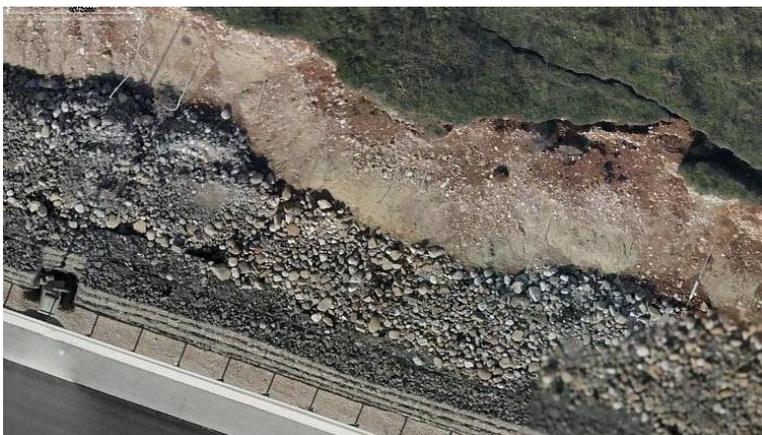
**Transport, Pipe Line, Rural Electrification and Road Construction:**

- Conduct feasibility studies and route planning
- Use Digital Elevation Models for engineering
- Profile routes
- Monitor contractor performance and progress
- Facilitate land acquisition and resettlement requirements

*The clear imagery allows monitoring of progress and impacts from construction works (Elbasan Highway Corridor, Albania)*



*3D and Digital Elevation Models facilitate engineering and design (Elbasan Highway Corridor, Albania)*



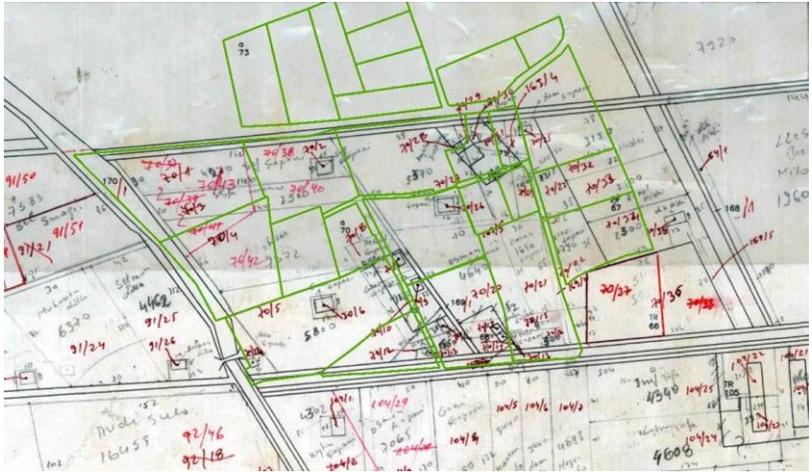
The aerial imagery from the test site clearly shows the pending failure of the embankment.

**Water Structures:** Although large water structures such as dams, canals, levees, and weirs were not included as the first phase testing in Albania, UAV imagery can establish a geo-referenced inventory of water structures and it can also inspect water quality by using multispectral sensors during the flights, detect leakage and waste, and identify cracks in water structures. One related application did demonstrate the applicability of UAV technology in a proposed urban water supply project, where engineering works and land acquisition is planned.

In the case of the 20 ha agricultural area that will be used for the new urban water supply project, the UAV reduced 3-4 weeks of field surveying to 3 hours (one hour to survey 10 ground control points, one hour reconnaissance and flight planning, one hour to do four flights). The resulting digital orthophoto with 18mm GSD and sub-decimeter accuracy was produced locally within 48 hours. The up-to-date and very accurate maps were combined with several other data sets to demonstrate various applications.



Less than one week after capturing the aerial imagery the orthophoto was used in the field to demonstrate how effective it can be in participatory mapping and identification of property boundaries and land rights with the involvement of the local land owners.



The accurate and current UAV derived maps were overlaid onto a scanned image of the existing registration index maps from the Immovable Property Registration Office and clear inaccuracies could be identified which impact the security and tradability of property rights, and could impact the project's Resettlement Action Plan.

The related 3D model was combined with the 2007 orthophoto that was used for the original pipeline design and the team could clearly show the changes that have taken place in the last 7 years, including two new houses that had been built and would be affected by the original pipeline design. Using better spatial data could avoid costly delays and mistakes in such designs and better support the World Bank's safeguard policies.



*The proposed pipeline running through 2 houses that were not on the 2007 orthophoto (Fushe Milot, Albania)*

**Urban Planning, Taxation, Upgrading of Informal settlements**

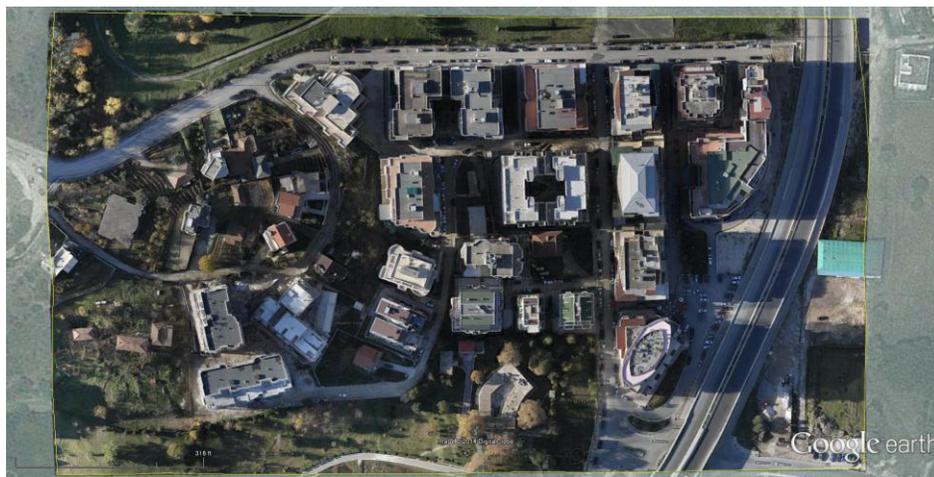
Another example is the dense urban setting where the team produced spatial data for approximately 60 ha of former olive groves and agricultural land that is now an extension of the urbanized capital city. The local government is desperate for accurate maps and other data to help it provide appropriate services to its citizens and bring some order to the unplanned and chaotic development that occurred over the past 15

years. The new maps produced by the team highlight the inaccuracies and poor quality of the existing registration index maps which supports the claim of the local government officials that the existing maps and data actually create conflict amongst citizens and between citizens and their local government. In addition to providing better land tenure information, the 3D models will help the local government and citizens visualize their environment for improved planning and infrastructure upgrading.

One important observation is that 3D modelling, especially of dense urban areas, requires more intensive processing power and time. It will also require that oblique shots are included in the initial data capture and manual linkages and corrections need to be factored into the time and cost estimates.



*Google Earth Image dated 16 June 2002 (Komuna Farke, Albania)*



*UAS-derived Ortho Photo (GSD 2cm) dated December 8, 2013.*



*Visualization of UAS-derived 3D-models of same buildings shown above*

As the photos above demonstrate, the use of UAS technology allows the production of very accurate orthophotos and additional visualization tools such as 3D models. By using Google Earth as the platform, the Albania team took advantage of this free resource that allows almost anyone to open and use the files (no expensive licenses needed). In addition, the use of Google Earth allows the tracking and change detection of an area over time. For example, there are more than 8 Google Earth images for the pilot location in Albania between 2002-2013. This very accurate and easy to understand information can be used by local governments for many purposes: urban planning, infrastructure upgrading, selecting locations for schools and hospitals, as well as providing better communications with citizens about their environment and encouraging their participation in planning and developing their community.

## **Agriculture**

UAS are already used in many countries to support the agricultural industry. Farmers in Japan, Brazil and Australia use the technology to help increase productivity by providing more accurate information about their land and production aspects. UASs can be used to survey crops, monitor for disease, and determine irrigation needs and precision-spray pesticides or fertilizers. The use of such timely and accurate data will allow better use of resources and help prevent unnecessary run-off and other damage to the environment. Adding a camera with a multispectral imager expands the potential use to assess plant stress, productivity, biomass, and to predict crop yield. UAS can also be used to monitor crops and quality control of claims for subsidies such as those under the EU's Common Agricultural Policy.

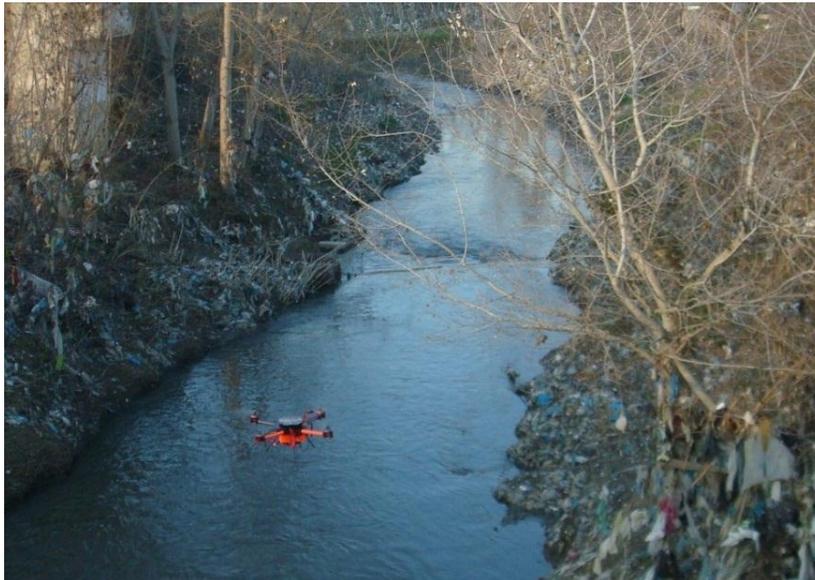
The tests in Albania demonstrated that the imagery is sufficient to define boundary lines between fields and crops, and allows for a clear view of the types of crops planted. It even allowed for counting the individual cabbages in a field.



*UAS imagery from the test site provides a clear view of the crops and trees in a field. (Fushe Milot, Albania)*

## **Disaster Risk Management and Response**

UAS have the potential to become an integral part of emergency response and disaster management planning due to their rapid deployment and portability capabilities and ability to safely navigate confined spaces and hazardous environments. Use of a UAS allows identification of critical issues, provides real time information and more efficient damage identification. The tests in Albania highlighted the benefits of live video capabilities for immediate and continuous coverage of disaster situations, such as flood or fire, without endangering the lives of the operators.



*A UAS provides real time video to inspect damage after a flood. (Fushe Preze, Albania)*

## Environment and Natural Resource Management (NRM)

Use of UAS can have an impact on environmental monitoring and NRM. As with other sectors, the rapid deployment capability and reduced production times and cost allow for incremental use to facilitate gathering baseline information and regular monitoring. For example, tests are being carried out in Kenya and Namibia to help protect threatened wildlife. The UAS is combined with other technologies such as ground-based sensors, wildlife and patrol tracking devices, custom software and a hotline that allows members of the public to text crime alerts to authorities, resulting in an integrated approach to reduce poaching. Use of UASs is also being explored for illegal fishing, especially to monitor the 12-14 mile range at the edge of international waters where illegal fishing vessels often wait until darkness before entering restricted areas. Identification and tracking of illegal activity allows for better enforcement and even provides evidentiary proof of the illegal activity.

In Albania the UAS tests identified an unauthorized waste site in a protected park and the resulting effects on the environment.



An unauthorized waste site located in the capital city park.  
(Tirana, Albania)



The UAS imagery captures the environmental damage from the illegal waste site through the visible increase in algae blooms in the adjacent lake

## **Extractive Industries**

Although not included in the Albania pilot, UAS are increasingly used in the extractive and mining industry. The ability to reach difficult locations and regularly monitor locations without placing people in a hazardous environment provides mining companies, governments and NGOs with a tool to better and more safely manage operations. The associated processing techniques for UAS imagery create realistic and geographically accurate 3D models that are essential for measuring and monitoring mine stockpiles, waste dumps, open pits and ground subsidence from underground works.

## **Cost-Benefit Analysis**

Traditionally, the high cost and long processing times associated with conventional, wide area spatial data acquisition and production were a significant drain on a project budget and could result in mistakes or delays with project design and implementation because the maps and other data were out of date by the time they were delivered.

The tests in Albania were designed to explore and demonstrate the multi-purpose potential of the technology. Bearing in mind that the pilot study was conducted in a developing country, the team was particularly mindful of the minimum level of investment needed for a sustainable establishment of a UAV based mapping unit. Hence the team avoided expensive proprietary hardware and software products.

The UAS assembled for the Albania work was a combination of parts from proven companies (for example, the airframe was designed and built in South Africa, the brushless motors were manufactured in China and the central open source flight controller hails from a company with premises in Mexico and the USA) combined with standard commercial components ordered over the internet (for example, the camera was ordered from amazon.com at a cost of US\$ 400). Other components were designed and

produced by the UAS team in a collaborative forum (for example, the mount to hold the GPS navigation receiver was designed and printed by the team using a 3D printer).

The price of the platforms used is about half of what a common GNSS rover unit would cost. For the image processing aspects the team employed the widely used professional version of Photoscan sold by the Russian firm Agisoft for a price of \$3500.

The results exceeded expectations, with the production of a rich data set in less than two weeks of field work and these data can be used for multiple applications.

Another differentiating aspect between conventional and UAV-based geo-spatial production is the height from which aerial imagery is obtained. Small UAVs generally fly much lower than manned aircraft. As a result conventional aerial imagery rarely exceeds a resolution of 8cm while UAV-derived aerial imagery with sub-centimeter resolution can easily be obtained. The significantly higher resolution of UAV-captured imagery allows for correspondingly high resolution in the derived geo-spatial products. The high resolution of UAV-derived geo-spatial products significantly reduces map reading skills and thus allows a much wider cross-section of stake holders to intelligently analyze content and thus to participate in planning and other activities. This aspect is particularly effective if UAV-derived products are rendered in 3D with the aid of powerful computer visualization tools. The increased communicability (in the sense of “a picture speaks a thousand words”) of UAV-derived geo-spatial enjoys better acceptance and credibility on the side of lay end users of the product.

### **What is next?**

The data produced and lessons learned in Albania were a successful conclusion to the initial phase of introducing UAS technology into the development project context. A second phase for using UAS technology and the resulting spatial data are planned in Albania under a joint European Union and World Bank technical assistance program which is due to continue in late spring 2014, with a focus on improving cadastre/registration information for the Immovable Property Registration office and further developing the national Spatial Data Infrastructure. The project will contribute to improve the operational effectiveness of land administration in Albania including development of a national spatial data infrastructure compliant with the EU INSPIRE Directive, develop new e-services as part of wider e-government and good governance strategies; and data quality improvement.

## **III. UAS Potential for Improving Governance**

The UNFAO Voluntary Guidelines on Governance of Tenure of Land, Fisheries and Forests state that “States should establish policies and laws to promote the sharing, as appropriate, of spatial and other

*information on tenure rights for the effective use by the State and implementing agencies, indigenous peoples and other communities, civil society, the private sector, academia and the general public. National standards should be developed for the shared use of information, taking into account regional and international standards. .*

Innovative technology applied to land records and graphics improves knowledge based decision making and expands means for data dissemination and access to land records. E-governance in spatial data management is an area of rapid innovation in developed economies, and emerging economies can leap-frog ahead in this area through exploitation of new technologies. SDI is potentially game-changing for development as it allows governments to integrate planning, taxation, disaster risk management and climate change monitoring, mitigation and adaptation in new ways with great savings in time and funds, while improving overall service and governance.

The key issue faced by most of developing countries is poor data quality and the use of UAS has a role to play in faster data quality improvement. UAS can serve as an effective tool to collect accurate and current spatial data that improve services and governance by linking spatial data through e-governance.

Countries throughout the world are taking steps to create and improve the benefits of SDI. For example, in December 2013, the US Federal Geographic Data Committee approved the National Spatial Data Infrastructure Strategic Plan 2014-2016 with core guiding principles related to ensuring data from multiple sources, shared use, open access and interoperability of information systems while respecting privacy and data protection as well as due consideration for the expected return on investments.

On the European level, the INSPIRE Directive 2007/2/EC of the European Parliament binds EU Member States to establish and provide geographic data in a standardized way. INSPIRE sets the legal framework and the technical specifications necessary to overcome existing barriers in the sharing of environmental information. Such barriers add a significant extra cost to those who need to access and use environmental information. Many countries in the ECA region have adopted INSPIRE compliant legislation, including Albania which approved its law in 2012.<sup>2</sup>

Most countries in the ECA Region are developing initiatives to widen access to and use of geospatial information, but their maturity and success vary. Land administration information is a fundamental component of SDIs. The information produced and distributed by cadastre and mapping authorities is an integral part of SDI and represents above 85 percent of the so-called reference data (base maps) without

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<sup>2</sup> Law Nr 72/2012, For organization and functioning of National Infrastructure for Geospatial Information in the Republic of Albania.

which the SDI could not be built. ECA countries have the basic automated systems to produce, maintain and share data, and there are further requests from countries to:

- 1) Develop national SDI compliant with the international standards;
- 2) Develop new e-services as part of wider e-government and good governance strategies; and
- 3) Improve data quality.

SDI is seen as part of wider e-government initiatives that reduce duplication of effort, improve quality and reduce the costs related to geographic information. It makes geographic data more accessible to the public, increases the benefits of using available data, and establishes key partnerships with states, counties, cities, academia and the private sector and supports the goals of the UNFAO *Voluntary Guidelines that state “As part of broader public information sharing, records of tenure rights should be available to state agencies and local governments to improve their services.”*

The future World Bank land agenda in ECA supports broad categories, among which are development of a more integrated approach to land management through land policies that reflect environmental and sustainable development concerns; improvement of the management of the organization and use of spatial data; support for governance and the quality and method of services provided; and encouragement of innovation and the use of SDI or spatial information underpinning new products and services.

#### **IV. Integration of UAS Technology in Projects**

Introduction and testing new technology in the development project context in Albania encountered unique challenges. With regard to the mobilization and use of UAS there are no specific World Bank institutional policies or guidelines, no laws or regulations in Albania, and generally no industry standards. As a result, the World Bank team conducted the necessary research into the developing policy and legal frameworks around the world and engaged a very knowledgeable and experienced UAS technical team who chose the appropriate equipment for the task. Safety was the priority for all aspects of project management. The very positive results and flawless operational performance can serve as a benchmark for future adoption of UAS technology in the development project context.

#### **Project and Risk Management**

The UAS market is rapidly expanding and being influenced by several factors. First, with the draw down on the wars in Iraq and Afghanistan military contractors are looking for new markets for their equipment and staff. Governments, embassies and private companies will increasingly be inundated with business development representatives trying to sell their goods and services. Second, many of the big mapping and software companies are entering the market and producing proprietary equipment and processing

programs. Finally, the availability and ease of buying UAS components over the internet allows individuals to assemble their own systems for minimal cost. Thus, decisions had to be made on which equipment to use, which experts were best qualified to join the World Bank team, and how to operate in a rapidly changing field.

The strategy of the team for Albania was to push the limits on price in order to identify low cost solutions that can be readily adopted by and for the local market. Notwithstanding cost considerations, the primary concern was operational safety and performance. A platform with a light take-off weight of 2.4kg was chosen to intrinsically limit the risk of personal injury or damage of goods.

Prior to the UAS mobilization the World Bank team held meetings with the national Albanian Immovable Property Registration Office and with the local government representatives in the test areas to provide the necessary background information and to receive approval for the work. In addition, the team was conscious of the social aspects and ensured that the local community was informed about what was going to happen. The benefits of inclusiveness and transparency were highlighted. Finally, local Albanian IT and GIS specialists as well as licensed surveyors were included on the team to provide initial capacity building and to explore the potential for imbedding UAS technology at local level.

In addition, the safety, reliability and performance of all system components were tested prior to travel to Albania and verified again in the field prior to commencement of production work. In the absence of national legislation and World Bank guidelines, the team developed and adhered to its own operational procedures for technical, safety and communications aspects.

Further use of UAS in the World Bank or other development project context would benefit from general operational guidelines. Since the legal and regulatory framework for UAS operations are very fluid at the moment and since UAS can be purchased or assembled at a very low cost, the World Bank and other development partners need to have minimum standards for safety and operations that take into account social considerations in the country context. These standards are in no way meant to be burdensome, to restrict vendors or to endorse one system over another. Rather, setting minimum standards related to equipment and operational safety, field mobilization procedures especially in the absence of a clear legal/regulatory framework in the client country, understanding the necessary privacy and data protection requirements and respecting local sensitivities about the use of UAS, will reduce the likelihood of accidents and associated liability as well as the possibility of a public relations disaster.

## **Legal Aspects for UAS Technology**

UAS technology is a rapidly advancing industry and, as with many new technologies, the legal and regulatory aspects lag behind. There are currently no international joint certification or operation

standards and the legal sphere currently lies between the traditional types of highly regulated manned aircraft under the mandate of civil aviation authorities and the less stringent rules related to hobbyists flying remote controlled aircraft.

### **National Legislation**

While many governments are attempting to address the issue in a systematic way, the body of legislation is relatively limited. In the EU, regulations that govern civilian UAS weighing 150 kg or more are planned for 2016 while UAS less than 150 kg continue to be governed by national legislation of the member countries. A few examples of EU member state national legislation:

**Switzerland:** is the most liberal country in the EU with regard to use of UAS. There are few restrictions for UAVs that weigh less than 30 kg. Aerial photographs are permitted provided that the requirements for protection of military facilities and the protection of privacy are respected, and the obligations under the Data Protection Act are met. Cantons and Municipalities may adopt additional restrictions.

**United Kingdom:** The Civil Aviation Authority issues permission for commercial use of UAS. The aircraft must weigh less than 20kg, operators cannot fly higher than 122 m and must keep the craft in "line of sight".

**Germany:** The individual states in Germany adopt the rules for use of UAS under the principles of the federal guidelines "Towards Common Principles of the federal and state governments for granting permission to unmanned aviation systems" In general, states grant authorization for two years at a time for UAVs with a take-off weight of less than 5kg.

**Romania:** in January, 2014 the Ministry of Transport issued temporary regulations that enable the operation of UAS until the time when the specific package of EU and Romanian regulations to govern both the certification and operation are issued. The rules and certification requirements are specified for UASs above 150 kg, from 1-150 kg and for hobby craft less than 1 kg. UAS less than 1 kg are not allowed to carry filming or data transmission devices.

In the USA, Congress has instructed the Federal Aviation Authority (FAA) to develop a plan for "safe integration" of UAS by September 30, 2015, although the FAA has already announced that full integration will not be possible by that deadline and the six test sites for UAS research were only selected in December, 2013. The agency is still developing regulations, policies and standards that will cover a wide variety of UAS users. It expects to publish a proposed rule for UAS under 25 kg later in 2014.

In the meantime, the issue is not well regulated and is becoming highly contentious within the legal and law enforcement community. There are no clear federal laws or regulations and in early March, 2014 an administrative judge on the National Transportation Safety Board ruled that the commercial use of small UAS is in fact legal, despite FAA statements to the contrary. The ruling effectively invalidates the FAA's 2007 ban on commercial use, although the agency may appeal the ruling.

Other developing legal issues surround air rights and who 'owns' the sky above private property. The US Supreme Court ruled on this issue in a 1946 case (*United States v. Causby*, 328 U.S. 256) stating that the navigable airspace is within the public domain. However, with the proliferation of UAS and the capability to collect better and more invasive data, the ruling may be challenged, especially in the context of Fourth Amendment search and seizure requirements. In other countries the issue of law enforcement use of UAS and spatial data collected through UAS technology, especially over privately owned land, will likely be just as contentious.

The issue of air space and the public domain is also relevant for non-law enforcement and commercial use of UAS. In the USA the issue is being tested under the Constitution's First Amendment right to freedom of speech. A January 2014 case where a journalist used a UAS at an accident scene has already led to both criminal sanctions and a retaliatory law suit alleging the violation of First Amendment rights of free speech and free press guarantees. The eventual court ruling for this case could set a specific precedent for use of UAS in the US.

Individual states are also attempting to legislate the use of UAS with a wide variation in levels of control including making the collection and holding of photographs from a UAS a crime (New York).

### **Privacy and Access to Information**

The increasing use of UAS technology by government bodies and private companies poses a unique set of problems. Privacy campaigners are raising their concerns about the proliferation of the technology and use of the data.

The introduction of SDI and e-government services enhanced with the high quality data collected by UAS technology raises a number of related legal issues, including data protection and privacy. Data protection, ensuring that the data collected and held by public institutions are safe from misuse, requires clear procedures for collection and storage as well as a process to continuously upgrade the data security of ICT systems and the knowledge and understanding of its operators. The legal framework must include the obligations and penalties, both criminal and civil, for breach of data security protocols.

A more complex issue is data privacy and its relationship to the general trend of increasing access to information. The right to privacy and the right to access information are both important human rights. Privacy relates to the protection of individual autonomy and the relationship between an individual and the government, while the right of access to information allows citizens to obtain information held by government institutions. Access to information and the new trend for Open Data are key components for transparency, accountability and governance and are increasing through new ICT systems, including those for public registers such as land administration agencies. Concurrently, privacy concerns are increasing in the same context.

Conflicts can arise when there is a demand for access to personal information held by government institutions and concerns about privacy. Privacy is especially relevant to land administration and management because so much land information is highly sensitive and UAS technology is improving the ability to collect faster and better data. Governments have been slow to adopt clear policies and legislation in order to balance the competing interests and to limit conflicts so that public institutions can provide improved services within a clear and consistent policy and legal environment. Countries vary widely in their approaches to making public registers available and several international organizations and institutions have developed models including the Organization for Economic Cooperation and Development (OECD) which updated its Guidelines on the Protection of Privacy and Trans-border Flows of Personal Data in 2013, the Council of Europe Convention 108 'For the Protection of Individuals with regard to Automatic Processing of Personal Data' (1981) and the EU Data Protection Directive (1995) with the January, 2012 data protection framework amendment. Although there is no consensus on the best model there has been some convergence in policies on the relationship between access to information and privacy laws.

As noted above, each country will need to develop its own policy and framework for balancing the important rights of access to information and privacy. The urgency becomes more apparent with the increasing use of UAS technology. While some conflict between the two rights is inevitable, the instances can be reduced to a minimum with clear and consistent policy statements and implementing laws and regulations. In the ECA region land administration field there is a trend to allow access to ownership and other data about a specific property, but only certain authorized groups (i.e. special prosecutors, tax authorities, financial crimes units) can search the property register information by name.

## **Liability**

Liability and associated insurance coverage with the use of UAS remains an uncertain market. The existing liability regimes are mainly based on aircraft weight or passengers which is not compatible with UAS. The European Commission commissioned a study on the liability and insurance requirements

generated by ‘remote piloted aircraft systems’ (RPAS), with the finding expected in March 2014. The study aims to consider the current and future risks associated with operating RPAS.

Input from some of the large insurance providers suggests that they want an industry-wide definition of what constitutes an ‘RPAS’. They note that due to the significant potential hazard, loss and third party risk, insurers recommend that proper licensing for operators and pilots is needed and that the aircraft have clear identification and tracking mechanism to the operator so that it is possible to trace the origin in the event of an accident. Another recommendation is that systems are equipped with a unique identifier/transponder unit in order to make it visible to air traffic control systems.

In the USA, insurers do not provide coverage for commercial operations related to UAS. National legislation in the EU clearly attributes liability to UAV operators and some states require a minimum of insurance coverage. For example, in Switzerland, anyone who operates a UAS must ensure liability coverage in the amount of at least 1 million Swiss francs for any damages (approx. US\$ 1.12 million). Under the recent Romanian regulation, the Ministry of Transport has clearly stated that all liability lies with the UAS operator although currently no such insurance policy options exist with Romanian insurers. Thus, there is still a significant amount of regulation and policy development to be done for insurance coverage of UAS worldwide.

## **I. CONCLUSION AND LESSONS LEARNED**

### **Lessons Learned:**

1. UAS technology is most suitable and cost effective for small areas, where digital maps and 3-D models need to be produced in a short period of time with high data quality and accuracy. For example new infrastructure investments are planned but there are no recent orthophotos and the existing digital or analogue maps are of poor quality.
2. There are no significant barriers to imbed the technology at the local level and it will revolutionize the way governments acquire and manage spatial data as well as the manner in which international organizations and development projects design, implement, and monitor activities and investments. The ease of deployability, flexibility and affordability will allow for a decentralized approach and a conduit for technology transfer to both developed and developing countries.
3. UAS technology is a rapidly advancing industry and the legal and regulatory aspects lag behind. Data protection and data privacy juxtaposed with the trend for broader public access to information and open data are some of the issues that the use of UAS is bringing to the forefront.

*UAS is a promising new tool for improved project design and implementation in which spatial data can be captured in a short time with a low cost and used in various fields and the governments, private sector, universities, the World Bank, FAO and other development partners could benefit from the experience in Albania.*

*UAS derived spatial data enhances transparent, accessible and accountable systems for land administration and natural resource management and contributes to the national Spatial Data Infrastructure (SDI) - the information produced and distributed by land cadastre/registration and mapping authorities is an integral part of SDI and represents over 85 percent of reference data (base maps).*

The team is also preparing an e-learning session for interested governments and institutions, as well as a series of short video clips for policy/decision makers and technical staff aimed to facilitate better understanding of the potential applications and present the lessons learned from the Albania experience.



*UAV team on location in Tirana, Albania. December 2013. : (Genti Qirjazi (iKub, Albania), Kathrine Kelm (World Bank, USA), Walter Volkmann (Micro Aerial Projects LLC, USA), Oliver Volkmann (Micro Aerial Projects LLC, USA), Grenville Barnes,(University of Florida, USA) ,Rumyana Tonchovska, (FAO, Italy))*

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