RNI: DELENG/2005/15153
Publication: 15th of every month
Posting: 19th/20th of every month at NDPSO

No: DL(E)-01/5079/17-19
Licensed to post without pre-payment U(E) 28/2017-19
Rs.150

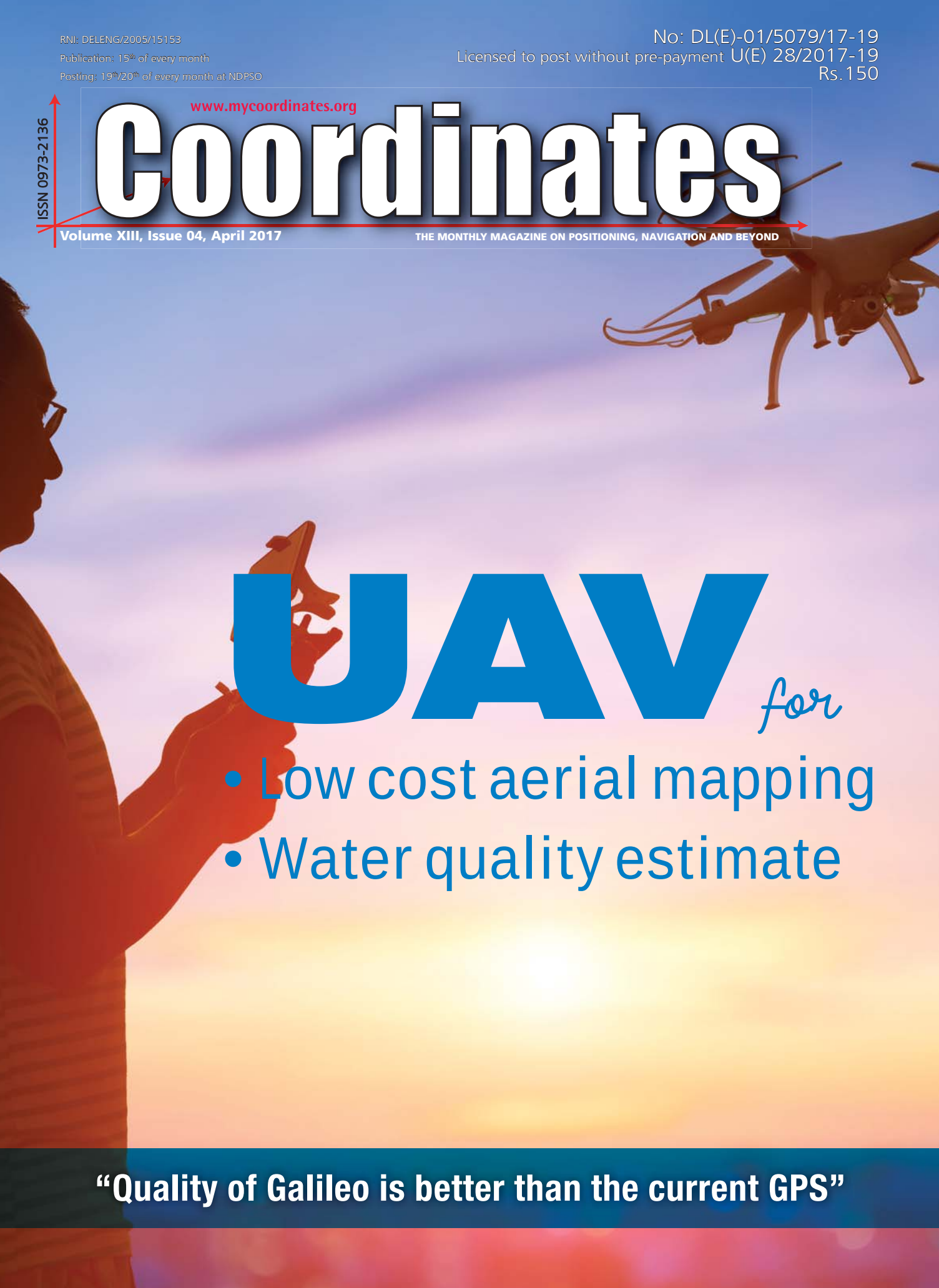
ISSN 0973-2136

www.mycoordinates.org

Coordinates

Volume XIII, Issue 04, April 2017

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND



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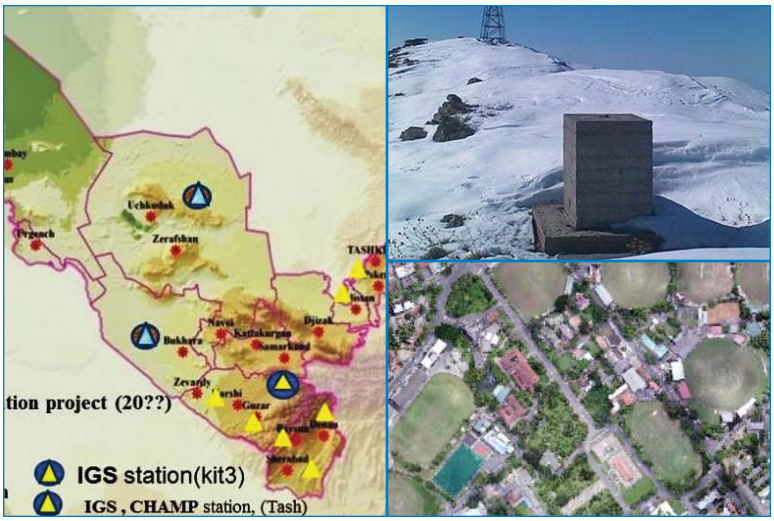

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This issue has been made possible by the support and good wishes of the following individuals and companies
Haruhiro Hidaka, L Samarakoon, Libor Tomandl, Mirmakhmudov Erkin, N Munasinghe, Noordin Ahmad, Paul Verhoef, S D P J Dampegama, S L Madawalagama, Seiji Suzuki, Sholehah Ismail, Shuntaro Otsubo Susumu Ogawa, and Vladimira Zufanova and; Effigis, Foif, IP Solutions, Javad, Labsat, Pentax, SBG System, Trace Me and many others.

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[advertising] sam@mycoordinates.org
[subscriptions] iwant@mycoordinates.org

Web www.mycoordinates.org

Annual subscription (12 issues)
[India] Rs.1,800 [Overseas] US$100

Printed and published by Sanjay Malaviya on behalf of Coordinates Media Pvt Ltd
Published at A 002 Mansara Apartments, Vasundhara Enclave, Delhi 110096, India.
Printed at Thomson Press (India) Ltd, Mathura Road, Faridabad, India

Editor Bal Krishna
Owner Coordinates Media Pvt Ltd (CMPL)
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This issue of Coordinates is of 52 pages, including cover.

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Modification of the reference frame of Uzbekistan topographic maps based on the GNSS

Development of the local geoid and establishment of national geodetic network is presented in this work. Results of geoidal heights show that WGS84 ellipsoid surface is located above of SK42 geoid

Mirmakhmudov Erkin
Associate Professor, Geology and Geography faculty, Department of geodesy and cartography, National University of Uzbekistan, Tashkent, Uzbekistan

Creating of national reference frame is not an easy task because Earth's crust continuously undergoes various deformations. Repeated geodetic determinations of the positional relationships and elevations of points on the earth's surface at certain time intervals make it possible to determine the velocity and direction of horizontal and vertical movements of the earth's crust. Due to tectonic plate motion, different parts of Central Asia move relative to each other with velocities of the order of three centimeters per year. For determination of such a magnitude of motion a GPS technique is used based on WGS84. Geodetic coordinates are always obtained in a system that has been constructed itself using real observations, a geodetic datum: a physical realization of a coordinate system used for describing point locations. The topographic variety of the territory of Uzbekistan imposes complex geodetic measurements and this variety creates a difficulty in developing a national ellipsoid. Crustal deformations and earthquakes within the lithosphere plate of Central Asia have been registered since 1990. In the area of high risk permanent GPS arrays play an increasingly important role. Geodynamic processes in Uzbekistan can also be monitored at stations equipped with GPS receivers. A multilateral cooperation between different geodetic, seismological, and geological institutions in Central Asia and the GeoForschungsZentrum (GFZ) Potsdam started in 1992. Results from repeated measurements across the 90 sites of Central Asian Tectonic Science (CATS) GPS network have provided direct evidence of current high rates of tectonic deformations. These deformations affect the change in the coordinate system of topographic maps as shown in Figure 1. To improve the quality of the topographic maps and monitoring the distortions associated with the local geodetic system, studies are being performed of the GNSS contribution for an overhaul of the State Geodetic System. Today the 'map' may be developed by a geographical information system (GIS) but the principle is exactly the same. Map coordinates of points computed from its ellipsoidal latitude and longitude by a standard formula is known as the Gauss-Krüger projection. We need to understand the reasons

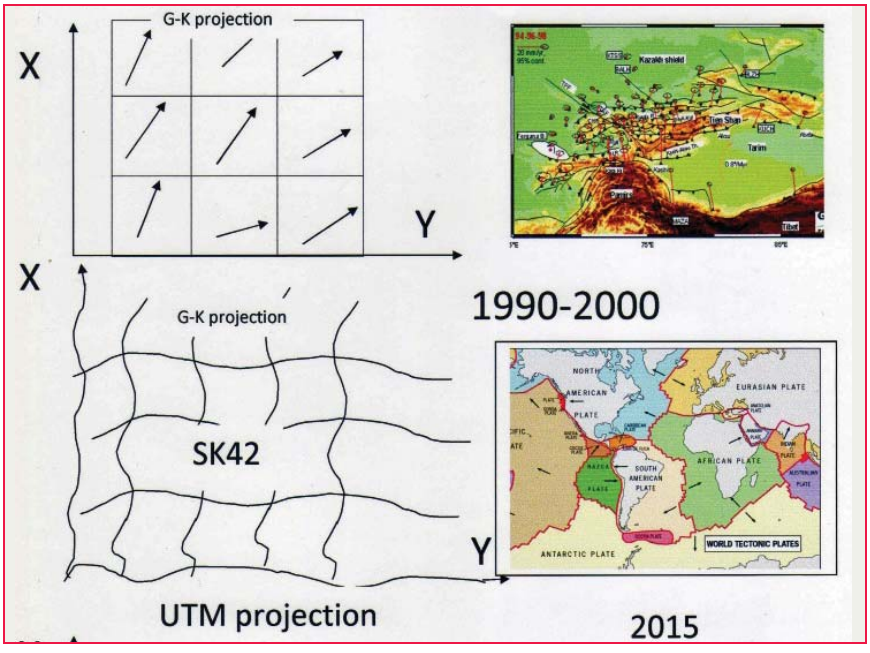

Figure 1: Grid deformations

for the differences, which might arise when comparing these coordinates with those obtained from modern coordinate systems. One of the main tasks is the derivation of representative transformation parameters for two systems. Preliminary transformation parameters between SK42 and WGS84 are determined for two GPS permanent stations and also for some points of CATS network. The coordinate differences are calculated by Molodensky and Helmert methods. The results of these transformations can be used to create a national reference frame of Uzbekistan. The first step is to use an intermediate grid between the two systems. Clear relationships between the Gauss-Krüger and UTM map projections for the Uzbekistan territory are given in this paper.

Modification of Gauss-Krüger projection (cylindrical projection)

At the beginning of the 19th century, Central Asian triangulations were performed in order to use them as a basis for geographical investigations and topographical maps. The original triangulation was carried out between 1930 and 1950 and is known as the 'Basic Triangulation'. Before 1940 all geodetic measurement were carried out in the coordinate system, CS32, based on the Bessel ellipsoid. The positions of geodetic control points are determined primarily by the method of triangulation, which is based on the trigonometric principle of measuring distances. The triangulation method consists of establishment on the terrain chains and networks of triangles consecutively interconnected by common sides. The error in measured angles of the triangles in Ist order and IInd order triangulation is usually not more than 0.7''. The altimetry was carried out with chains of precise leveling. The Uzbek geodetic network was established on the basis of angular and leveling measurements. Classical measurement methods have been mostly replaced by space-based techniques and they are only used today on a local basis or in areas where satellite techniques are not available. The former Soviet Union and Uzbekistan used the SK42 based on the Krasovsky ellipsoid and projection into the Gauss-Krüger coordinate system with six degrees meridian strips. In the towns of the Republic of Uzbekistan as well as in Central Asia the SK63 was used, and is still in use. The rectangular coordinates of the point (points) in the maps of the SK-63 are calculated in the Gauss-Krüger projection, based on the parameters of the Krasovsky ellipsoid, but only at 3° zones. Coordinates (different from the coordinates from maps made in system 1942) are obtained by moving the axial zone of the meridians and replacing the origin of coordinates. The projection is normally made into the Geographic coordinate system or into the Gauss-Krüger coordinate system with six degrees wide meridian strips. Large-scale maps were made using Local Coordinate Systems or the Gauss-Krüger coordinate system with three degrees wide meridian strips. This projection had constant scale along the central meridian and was known as the Gauss conformal projection. Topographic map based on SK42 has geographic coordinates, constant scale along the central meridian, rectangular coordinates *x,y*, in the projection and heights are usually stated to be heights above Baltic sea level (BSL). The published heights of all benchmarks, town survey marks and trigonometric beacons are orthometric heights H above BSL. The orthometric height should never be given without stating the geoid model used. The geoid model allows determine heights using GPS. Different geoid models give different heights for a point, even though the ellipsoid height might be very accurate. Height changes are mainly of interest for engineering purposes or for determination of vertical crustal movements. Vertical crustal movements are also of interest in connection with tide gauges to control sea level rise. The determination of orthometric heights using GPS is a long-term goal in surveying, in order to substitute time consuming and expensive spirit (differential) leveling. However, the SK42 and BSL have become a national standard in Uzbekistan, and are likely to remain a long time. Since 1977 all heights of topographic maps are normal heights H^{γ}, which were calculated relative to the quasigeoid (Figure 2).

Geoid height (N) is the height of the geoid above ellipsoid and it depends on latitude and longitude. Ellipsoidal height (h) is the height of the Earth's surface above the ellipsoid. The relationship between orthometric height (H) and ellipsoidal height (N) is given by H = h – N. Reduction of the normal height H^{γ} to the ellipsoidal height h is necessary to calculate the Gauss-Krüger Cartesian coordinates in the case of seven transformation parameters

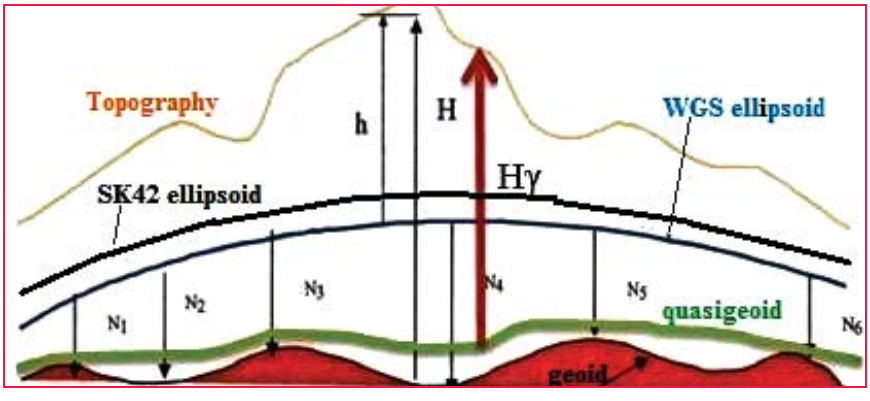

Figure 2: Fragment of Uzbekistan geoid and quasi-geoid

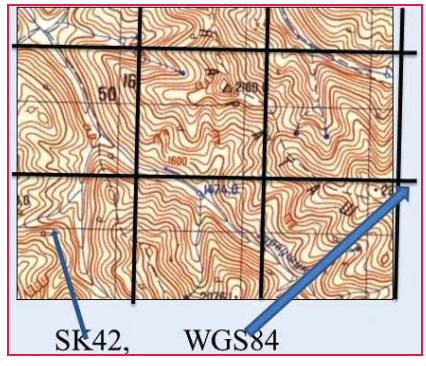

Figure 3: A fragment of topographic map with two coordinate systems

Table 1: Values of differences WGS84-SK42 of rectangular coordinates of topographic maps

Scale	$\Delta X_{wgs84-sk42}$	$\Delta Y_{wgs84-sk42}$
1:100 000	0.09mm	0.64mm
1:50 000	0.18mm	1.28mm
1:25 000	0.30mm	2.56mm
1:10 000	0.9mm	6.40mm
1:5 000	1.8mm	12.8mm

determination. Transformation parameters are determined by using these Cartesian coordinates and the WGS84 geocentric coordinates of the identical points.

At the initial stage it is planned to use an additional grid based on the WGS84. Additional reference frame based on modified Gauss – Krüger projection is more suitable for topographic maps in scales 1:100000-1:10000. A fragment of topographic map with two coordinate systems is shown below (Figure 3). The transition into the additional reference frame will help the surveyors and geodesists to use the classical and modern coordinates which are based on the two ellipsoids.

Table 1 shows the increase in values of the differences WGS84-SK42 of rectangular coordinates of topographic maps in scales from 1:100000 to 1:5000. Therefore, the surveyor can use both coordinates, depending on the task. These maps will temporarily be used because the digital maps of Uzbekistan are very expensive. In the future we need to develop a new digital map which will be more suitable for Uzbekistan.

One of the most significant developments of the past few years has been the establishment of the International GPS Service for Geodynamics. CATS project has a wider scope and covers the Central Asian region. Coverage area of GPS stations of Uzbekistan is not yet optimal. It is planned to further extend the CATS network. This starting configuration will be augmented by additional GPS stations in those areas where nothing exists, in order to obtain a more or less homogeneous data. Use of GPS will help for more correctly determination of the local geoid. In this study some data of the CATS program are used for computing of a geoid-ellipsoid separation. The geoidal heights were calculated for 15 CATS points (Table 2).

Table 2: CATS network stations

#	station	B_{wgs84}	L_{wgs84}	h,m	N, m
1	DJAN	38°20′16″.1	66°06′21″.7	790.5	-37.73
2	KITB	39°08′05″.2	66°53′07″.6	622.6	-36.71
3	OKTO	40°17′25″.7	67°40′11″.3	334.5	-40.14
4	DENA	38°14′06″.7	67°52′48″.8	477.5	-41.37
6	SANZ	39°41′37″.7	68°14′46″.1	1942.5	-36.96
9	CICR	41°34′20″.8	69°39′39″.0	771.2	-41.60
10	ALMA	40°49′42″.9	69°43′49″.0	737.9	-42.90
16	SARY	40°46′25″.2	71°42′02″.3	351.0	-50.97
40	MADA	38°41′04″.1	66°56′29″.3	2690.7	-35.64
54	ANGR	41°06′07″.7	70°04′53″.7	1307.3	-40.41
55	ADRA	40°48′01″.3	70°01′21″.6	1556.0	-42.86
56	BESH	40°21′24″.0	70°31′25″.2	421.7	-46.79
58	BAYS	38°10′31″.0	67°02′45″.6	1061.3	-37.90
59	KFIR	37°50′17″.3	67°52′05″.5	590.9	-43.85
79	BOZB	41°28′44″.6	71°47′07″.9	1758.7	-43.16

Transformation between SK42 and WGS84

The coordinates derived by GPS are referred to a global and reference frame. In order to reduce these coordinates to a local (national) coordinate frame a transformation must be performed. Converting consists of derivation of representative transformation parameters for two systems. This transformation may be performed in two steps. The first step is transformation of any kind of map projection systems to the SK42 ellipsoidal coordinates, and then from the SK42 ellipsoidal coordinates into the WGS84. There are formulas for calculating changes between geodetic datum if the point positions are expressed as latitude and longitude coordinates, without first converting the positions into Cartesian coordinates. The formulae cannot cope with a difference in orientation of the ellipsoid axes – it only deals with a translation of the origin and changes in ellipsoid size and shape**.** This transformation is one of the most widely used techniques for transforming geodetic coordinates from one system to another. It is also one of the least accurate, due to the fact that it does not account for rotation or scaling between two systems. The equation between SK42 and WGS84 is given by:

$$B_{sk42}=B_{wgs84}+\Delta B$$

$$L_{sk42}=L_{wgs84}+\Delta L \qquad (1)$$

$$H_{sk42}=H_{wgs84}+\Delta H$$

The usual mathematical form of the transformation is a linear formula which assumes that the rotation parameters are ‘small’. Rotation parameters between geodetic Cartesian systems are usually less than 5 seconds of arc, because the axes are conventionally aligned to the Greenwich Meridian and the Pole. Transforming local coordinates to WGS 84 does not improve the accuracy of the transformed coordinates. In fact, transformed geodetic coordinates will be less accurate because the errors in the transformation are added to the errors in the original local coordinate system.

In general, two three-dimensional coordinate systems in space are related to each other by the following equations:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS84} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{SK42} + \begin{bmatrix} \Delta x \\ \Delta y \\ \Delta z \end{bmatrix} + \begin{bmatrix} \mu & \omega_Z & -\omega_Y \\ -\omega_Z & \mu & \omega_X \\ \omega_Y & -\omega_X & \mu \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{SK42} \qquad (2)$$

where, Δx is translation along the X-axis, Δy is translation along the Y-axis, Δz is translation along the Z-axis, ω_x- rotation about the X-axis, ω_{y-} rotation about the Y-axis, ω_z rotation about the Z-axis, μ- scale factor.

Table3: Differences between coordinate systems the SK42 and WGS84

DATUM TRANS.	ΔX(m)	ΔY(m)	ΔZ(m)	Method	Comments
SK42-WGS84	+15	-130	-84	Molodensky	NIMA (USA)
SK42-WGS84	+43	-108	-119	Helmert	NIMA (USA)
SK42-WGS84	+28	-130	-95	Molodensky	NIMA (USA)
SK42-WGS84	+25	-141	-80	Helmert	GOST (RU)
SK42-WGS84	+22	-123	-83	Molodensky	Bazlov (RU)
SK42-WGS84	+23	-125	-87	Molodensky	Fazilova (UZB)
SK42-WGS84	+23	-124	-89	Helmert	Mirmakhmudov (UZB)

Figure 4: "MADA"CATS point

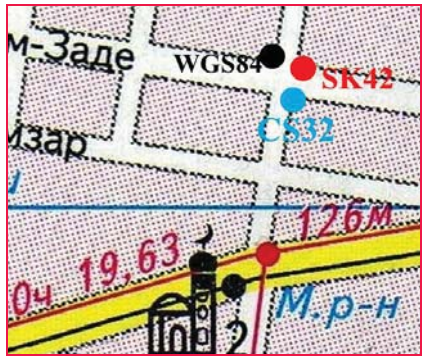

Figure 5: Three points with the same latitude and longitude in three different coordinate systems – WGS84, SK42, CS32

Results from the calculation of the differences between two coordinate systems are given in the Table 3.

The values of the transformation parameters ΔX, ΔY, ΔZ between the two systems are similar to each other, although the two methods of transformation have been used. Even if we are going to use the same transformation method, the differences are due to different geodetic networks, software and the accuracy of the coordinates of the initial geodetic points. Positioning errors can be introduced from a variety of geodetic sources, dramatically influencing the success of a drilling program. To determine the transformation parameters between WGS84 and SK42 we used some CATS network points (Figure 4.) The quality of the network geometry of the CATS network is in the order of 1-3mm for horizontal components and about 5 mm for the height. This is derived from Helmert transformation between the daily solutions and the campaign solution. The global network accuracy is in the order of 1-2cm. Difference of a coordinates between two systems ($\Delta\lambda$= 3,26″, $\Delta\varphi$=-0,17″,Δh=108,84m, ΔX=+23 m, ΔY=-124 m, ΔZ=-89 m) and velocity of Kitab station (31 mm/yr) were calculated taken into account local conditions. These results are close to the values obtained from the optic observations ($\frac{d\varphi}{dt}$= + 122;$\frac{d\lambda}{dt}$ = + 779), which were carried out by visual zenith-telescope in 1930-1978. These velocities are secular motion in latitude and longitude due to plate tectonics (AMO-2 model) in 10^{-4} ″/cy and 10^{-5} s/cy. For the best transformation model and reducing the fit errors, it is need to use data from satellite laser ranging. Transformation between SK42 and WGS84 typically is not recommended for most applications because standard transformations can introduce error that is larger relative to their difference (Figure 5). Complicating the matter, the difference between SK42 and WGS84 varies with time and location. Both systems have frequent new realizations due to more data and improved techniques.

The figure 5 shows three points which all have the same latitude and longitude but in three different coordinate systems (SK42, WGS84 and CS32) on Khakim-Zade and Bodomzor streets in the city of Tashkent . Each one of these coordinate systems is widely used in Uzbekistan and fits for its purpose, and none of them is wrong. The differences between them are just a result of the fact that any system of 'absolute coordinates' is always arbitrary.

Usually the town surveying is produced in the local coordinate system, which has definitely been referred to the state geodetic network. SK63 (Krasovsky spheroid) is used for topographic works of big cities. In the maps of the coordinate system 1963 (SK-63) rectangular coordinates of the point (points) are calculated in Gauss – Krüger projection, based on the parameters of the Krasovsky ellipsoid, but only at 3° zones. Coordinates (different from the coordinates from maps made in system 1942) are obtained by moving the axial zone of the meridians and replacing the origin of coordinates.

There is software for converting between two coordinate systems. But these computer programs were created on the

Table 4: Geographic and local coordinates for 6 GPS permanent stations

#	φ_{sk42}	λ_{sk42}	B_{wgs84}	L_{wgs84}	X_{sk63}	Y_{sk63}	Country
3	42 11 00.69	77 33 52.81	42 11 01.55	77 3350.76	4657362.11	9303965.60	Kyrgyzstan
25	42 32 20.52	76 32 17.21	42 32 21.45	76 32 15.06	4697315.65	9219612.27	Kyrgyzstan
34	42 45 22.36	78 15 05.28	42 45 23.32	78 15 03.27	4721239.27	9360153.79	Kyrgyzstan
43	42 29 26.79	78 37 25.12	42 29 27.73	78 37 23.18	4692084.85	9391007.81	Kyrgyzstan
2	39 08 05.28	6653 10.80	39 08 05.2	6653 07.06	4319695.72	5418428.14	Uzbekistan
40	3841 04.27	6656 32.47	3841 04.1	665629.30	4269778.80	5424053.53	Uzbekistan

basic approximate equations and they can be used for testing of a geographical coordinates, as well. For 6 GPS permanent stations were calculated the local geodetic coordinates at the Tashkent State Technical University (Table 4).

GNSS network of Uzbekistan

GNSS is widely used in Uzbekistan for many purposes, but more global and fundamental is mapping of a land. GNSS use in mapping can be divided into three sections: education, research and practical application. The main and important is the practical use for the construction of high-precision geodetic network and seismology. The whole territory of Uzbekistan was covered with the state geodetic network taking into account the scale, orders and a configuration. Usually, it is necessary to make a preliminary calculation of the accuracy of the network points if we are going to design a geodetic network. However, the satellite geodetic network of Uzbekistan

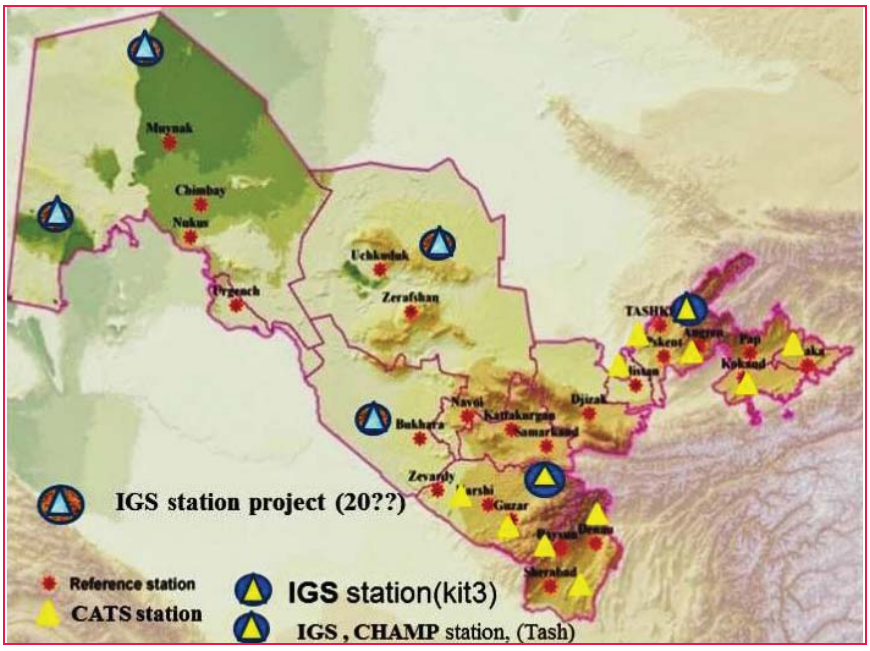

Figure 6: State satellite geodetic network plus IGS stations, plus CATS network and plus new stations

is created on the basis of a practical experience of mapping agency workers. The state geodetic network of Uzbekistan was divided into orders - I, II, III, and IV depending on accuracy and methods of surveying. The positions of geodetic control points are determined primarily by the method of triangulation, which is based on the trigonometric principle of measuring distances. Geodetic points are

located on elevated points of the terrain and are selected by reconnaissance. Each point is marked on the terrain by laying concrete block at a certain depth with a mark on it that designates the apex of the triangle and monumentation of a wooden or metal tower that serves as a stand for the angular measuring instrument and as a sighting target (geodetic target) when measuring angles. Sometimes geodetic points combined with prominent local objects, such as water towers and steeples of tall building. Geodetic networks are subdivided into orders, depending on the sequence of construction and precision of measurements. Now, some geodetic targets of the state geodetic network of Uzbekistan are lost or are out of order. In order to renovate these targets, benchmarks and geodetic points it is necessary some financial support. But the use of GPS is the most effective and accurate when mapping the territory of the Republic of Uzbekistan.

In 2002 the state satellite geodetic network was designed including Kitab and Tashkent GPS stations and 16 first order basic stations by mapping agency of Uzbekistan (Figure 6). There were produced GPS measurements with help of GNSS technologies and calculated preliminary space coordinates based on the WGS84. Due to the lack of a geodetic network computing software the adjustment is not performed. . It is planned that this network will have International Terrestrial Reference Frame (ITRF) based on the national reference system. Since the 1990s Kitab station hosted the GPS reference station (KIT3), included in International GNSS Service (IGS) and ground based beacon of DORIS satellite tracking systems, providing IERS data center with precise coordinates at sub daily frequency. Due to the dense and homogeneous global beacon network DORIS significantly contributes to the realization and maintenance of the ITRS.

The CATS network was observed during five GPS campaigns in the years 1992, 1994, 1995, 1996, and 1998. The processing software EPOS was used to derive coordinates and site velocities. The network solutions were tied to the International Terrestrial Reference Frame (ITRF97). Campaign data were processed simultaneously with data from globally distributed IGS and permanent GFZ stations in Central Asia.

The analysis of Uzbek CATS network shows that from 1992 to 1998 all station latitudes and longitudes of this network are changed with a constant rate of about 2.5 cm/yr in northeast. Over the course of a decade or so, this effect may become noticeable in large-scale mapping.

Conclusion

Development of the local geoid and establishment of national geodetic network is presented in this work. Results of geoidal heights show that WGS84 ellipsoid surface is located above of SK42 geoid. The transition to the additional reference frame will help the surveyors and geodesists to use modern coordinates, which are based on the two ellipsoids. The results of transformed coordinates will be the basis for establishment of a national geodetic network. Data of Kitab, Tashkent and Maydanak observatories will be used for investigation the kinematic parameters of reference points and for improvement of transformation parameters between the two reference systems. It will be accurately measured and modeled the geoid and its gravity field precisely to determine the position and velocity of points or objects at the surface. The combination of GNSS and classic geodetic measurements lead to geometric methods of solving this problem. Modernization of the satellite geodetic network will improve the network of Uzbekistan. For this purpose the following problems must be solved:

- Establishment of fundamental geodetic control,
- Densification of existing geodetic control,
- Analysis and improvement of existing geodetic control, and
- Contribution to geoid determination.

Acknowledgements

The author thanks Prof K Vassileva for useful advice.

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Low cost aerial mapping with consumer grade drones

This study presents an overview of using inexpensive drones for aerial mapping complementary to traditional photogrammetry as well as modern survey grade drones

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Drones are defined as flying robots in simple terms which are formally known as Unmanned Aerial Vehicles (UAV). The main distinctive characteristic of drones is the design to be operated with no onboard pilot. They are operated by remote controller or can fly autonomously through software controlled flight plans.

Drones are initially invented for military purposes but these exciting equipment are now being used for civilian application like photography, filmography, journalism, delivery systems, structural safety inspections and many more. Usage of drones in the field of geomatics is explored in recent studies and now being used as a platform for photogrammetric and LiDAR data collection. The emerging technology of drones can be used in geographic mapping alternative to high cost traditional photogrammetry and ground surveying.

Remotely sensed data obtained from drones are suited for various applications of mapping in both 2D and 3D domains. As described in literature (Nex & Remondino, 2014; Zongijan, 2008), fields as environmental surveying, forestry and agricultural mapping, archeology and cultural heritage mapping, traffic monitoring are typical fields for aerial mapping highly complies with drones. Considering these applications, commercially available survey grade drones as Sensefly eBee and Trimble UX5 are now developed.

Compared to traditional remote sensing methods, there are significant advantages of drones in applications of mapping (Dustin, 2015). Drones provide inexpensive platform for aerial data collection with no requirement of onboard personnel to carry out flight operations. They are inherently safe and can reach to places where manned flight is difficult or dangerous to access.

Drones establish a powerful alternative for traditional data capture in mapping application with high spatial and temporal resolution. They can fly in low altitudes enabling to collect data with high amount of details and can be deployed rapidly as soon as there is a requirement. The limitation of satellites and traditional aerial remote sensing of restricted maneuverability and limited availability (Zongijan, 2008) can be overcome with drones but also with certain limitations as low range and endurance.

Despite of drones designed for specific application of mapping, there are consumer grade drones which are popular among the community. Consumer grade personal drones are currently a hobbyist's item most often used for aerial photography, but there is high potential of using in applications of mapping. Today's consumer grade drones are equipped with GNSS navigation system and inertial measurement unit (IMU) which fulfill the essential requirement of automated aerial surveys as it is required to follow pre-determined flight plan. Hence accurate determination of the position of the aircraft by GNSS system and the orientation by IMU is vital for accurate aerial surveying. The payload of consumer grade drones either fixed with a digital camera or provide facilities to carry external instrument mainly an imaging device.

The recent technological advancements and availability of GNSS Systems (GPS/GLONASS), inertial measurement units (IMUs) and digital compact cameras has introduced a great potential of using

Table 1: Specification of Drones Used in the Study

GENERAL		
Vendor	DJI	SenseFly
Drone	Phantom 3 Professional	eBee
Type	Quadcopter	Fixed Wing
Weight	1280 g	690 g
Charging time (1 battery)	~1 hour	~1 hour
Camera	Sony EXMOR 4K RGB	Canon PowerShot S110 RGB
Max Speed	16 ms^{-1}	25 ms^{-1}
Price	USD 999	USD 12000
MAPPING		
Flying time on a single deployment	18 mins (Mapping) 23 mins (Manual Control)	45 mins (Mapping)
Maximum flying height	300m AGL(Mapping)	1000m AGL (Mapping)
Maximum coverage for a single deployment	~0.9 km^2	12 km^2

Figure 1: Phantom 3 Professional Drone (left) & SenseFly eBee Drone (right)

inexpensive consumer grade drones as mobile mapping systems, as a low-cost alternative to survey grade drones which further reduces costs compared to the traditional aerial mapping. This study is performed to assess the applicability and accuracy of Low cost consumer grade drones for aerial mapping.

Study area and equipment

The study area in Colombo 7, Sri Lanka was chosen as previously surveyed ground control points were available. Study area is approximately 1.28 km^2 in size, situated in the commercial capital of Sri Lanka which is a high dense urban area of. The area was aerial surveyed with Phantom 3 Professional consumer grade drone and SenseFly eBee survey grade drone. To meet the primary objective of this study, the accuracy of the results, costs and overall complexity of the two different systems is compared under the special focus of the photogrammetric performance.

Both Sensefly eBee and Phantom 3 professional drone fall to Micro UAV category (Bendea et al., 2008) according to their weight, endurance and range. Sensefly eBee is a survey grade fixed wing drone manufactured by senseFly ltd. in Switzerland. It is now being popular as professional mapping drone with in geomatics industry for various applications. The eBee drone comes with ground station and a dedicated flight planning and management software, eMotion. The camera should be separately mounted as it should be chosen to suit the purpose of the survey. The Phantom 3 Professional drone is a quad copter by Da-Jiang Innovations Science and Technology Co., Ltd. (DJI) which comes with a factory built 4K camera with 3-axis gimbal stabilizer. The controller is an easy to operate remote device which works with a smart phone. Phantom 3 Professional drone is chosen as the consumer grade drone in this study because of its affordability and popularity among the civilian community for photography.

Photogrammetric Ground Control

Ground Control Points (GCPs) are points of known coordinates in the area of interest. Their coordinates have been measured with traditional surveying methods or have been obtained by other sources (LiDAR, older maps of the area, Web Map Service). A Ground control is required to calculate scale, orientation, and absolute position information of the products with increased accuracy (Wolf & Dewitt, 2000). It is possible to obtain georeferenced products even without GCPs as the images are geocoded by the GPS device of the drone but it is highly recommended to have significant amount of GCPs to obtain reliable products. GCPs increase the absolute accuracy of a project, placing the model at the exact position on the Earth.

In modern surveying applications, kinematic GNSS Positioning is identified as the most efficient and effective way of establishing ground control as it meets the required aspects in most scenarios (Wolf & Dewitt, 2000). For this study, pre-existing survey data is used to establish the ground control, which was measured with latest CORS GNSS technology introduced very recently in Sri Lanka. A CORS or Continuous Observation Reference Station Network is a virtual RTK correction broadcasting network comprises of several permanent ground located high accuracy GNSS receivers (Snay & Soler, 2008). It has a high accuracy as 8mm+0.5ppmRMS in planimetric measurements and 15mm+0.5ppmRMS in vertical measurements. Availability of these types of network eliminates the necessity of having ground marked reference points for control surveying. Location data observed by several high accuracy GNSS receivers, commonly known as CORS are being processed at a central server. Processed data will be broadcasted to RTK Receivers via GPRS allowing users to obtain high accuracy positioning coordinates.

The GCPs are selected from the total of 79 measured points which meet general criterion to establish photogrammetric control. In general, images of acceptable photo control points must lie in favorable locations in the photographs and should

Figure 2: Sample GCPs

be sharp, well defined, and positively identified on photos. The GCPs should be placed homogeneously in the area of interest. A minimum number of 5 GCPs is recommended and 5 to 10 GCPs are usually enough, even for large projects (Agisoft, 2013). More GCPs do not contribute significantly to increasing the accuracy. In cases that the topography of the area is complex, then more GCPs will, indeed, lead to better more accurate reconstruction.

Flight planning and image acquisition

Designing and executing good image acquisition plan is the most important part of any aerial photogrammetric project as the ultimate success of any photogrammetric project depends more upon good quality photography than on any other aspect (Wolf & Dewitt, 2000). If the collected dataset is insufficient in quality, it will lead to poor results even total failure in processing. To avoid redoing field work which is expensive and time consuming, it is essential to plan the work correctly according to the requirements.

A flight plan generally consists of two items: a flight map, which shows where the photos are to be taken; and specifications: which outline how to take them, including specific requirements such as camera requirements, scale, flying height, end lap, side lap, and tilt and crab tolerances. A flight plan which gives optimum specifications for a project can be prepared only after careful consideration of all the many variables which influence aerial photography. But with today's flight planning software, flight map is generated automatically as only the vital parameters are given to the software manually. This includes area of interest, flying altitude, overlap, maximum speed etc. Flying height and image overlap are considered as the vital parameters in every flight plan. Relative accuracy capabilities in photogrammetric mapping, whether planimetric or vertical, depend upon many variables, but the most important is flying height above ground. Ground Sampling Distance varies with the flying height so it has direct influence on the achievable accuracy and amount of details in final products.

In modern photogrammetric processing, the entire process is based on automatically finding thousands

Table 2: Flight planning parameters

Drone	Phantom 3 Professional	eBee
Flying height	160m AGL	150m MSL
Forward Overlap	80%	80%
Side Overlap	80%	80%
Max Speed	15 m/s	Auto
Maximum Mapping Time	17 min	35 min

of common points between images. These points are called key points. When there is high overlap between 2 successive images, the common area captured is larger and more key points can be matched together. The more key points there are, the more accurately 3D points can be computed. The image overlap parameter should be determined with an awareness of the terrain geometry. Considering the general cases recommended overlap of 80% of side and end overlap is used.

The flight was done in full autonomous mode for both drones with continuous monitoring. Availability onboard of GNSS/INS navigation devices in both drones are make it possible for full autonomous flight (take-off, navigation, and landing) and to guide the image acquisition according to the flight plan.

Flight Planning Software

Sensefly eBee drone comes with a dedicated flight planning and management software called eMotion. . It is used to plan, simulate, monitor and control mapping flight of eBee drones and it support all eBee standard, eBee RTK and eBee Ag drones (Swinglet, 2015). The software operates in Windows environment and used for flight planning simulation, flight monitoring and in flight controlling. The software comes with features like automatic flight planning, automatic calculation of flight altitude, real time flight status monitoring, one click emergency maneuvers etc.

Unlike survey grade drones, other consumer grade drones do not comes with photogrammetric flight planning software. But there are third party flight planning application developed for some consumer grade drones. For flight planning with Phantom 3 drone, such application named Map Pilot for DJI is used. Map Pilot for DJI is a software for Flight Planning, Mission Management and the actual Mission Flight Operation for DJI drones. Currently the software operates in iOS environment for Apple iPhone and iPad devices. This app is developed by Maps Made Easy using the DJI SDK for easy data acquisition for aerial mapping with drones. The app combines advanced features like automatic flight path creation, overlap management, speed management, multi flight coordination, multi battery management, base map caching for offline operations, etc. yet preserving an easy to operate environment.

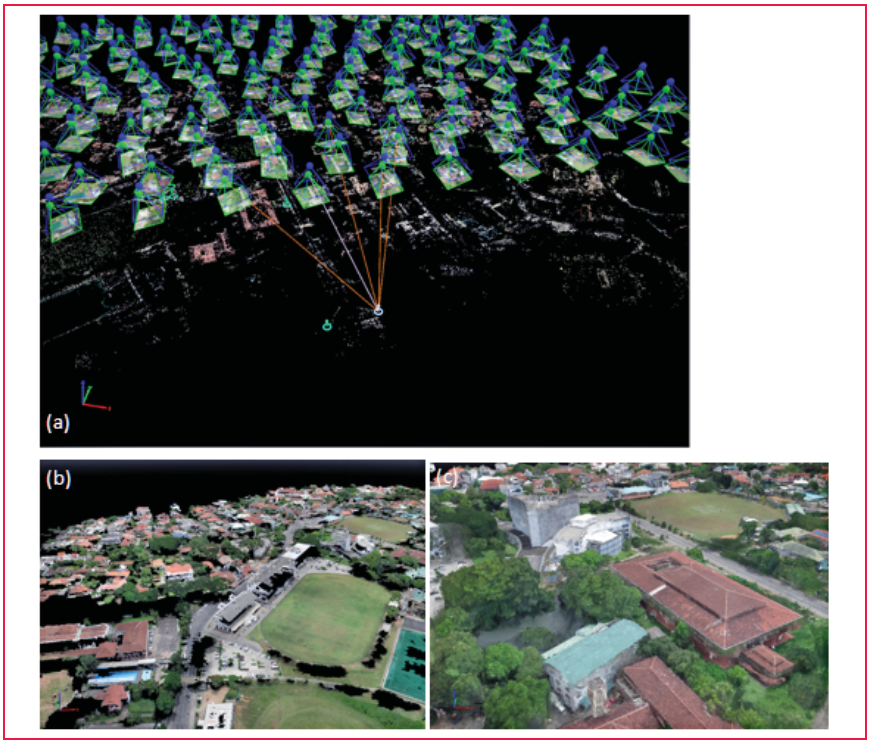

Figure 3: (a) Sparse Point Cloud and Relationship between Images, (b) Dense Point Cloud, (c) Mesh

Photogrammetric Processing and Ground Control

Point Cloud and Mesh Generation

Once a set of images has been oriented, the next steps are surface reconstruction

Figure 4: Orthoimage (left) and DSM (right) Created by Imaged from Phantom 3

Table 3: Geolocation Accuracy

	Without GCP		With GCP	
	Planimetric Accuracy (m)	Height Accuracy (m)	Planimetric Accuracy (m)	Height Accuracy (m)
Phantom 3	1.750	16.098	0.174	0.275
eBee	2.187	8.283	0.274	0.132

by generating point cloud and mesh. Starting from the known exterior orientation and camera calibration parameters, a scene can be digitally reconstructed by means of automated dense image matching techniques. A powerful image matching algorithm in the software are be able to extract dense 3D point clouds with a sufficient resolution to describe the object's surface. The generated point cloud is then triangulated to create a mesh.

DSM and Orthophoto Generation

A Digital Surface Model or DSM is digital 3D representation of an area by elevation (Uysal, Toprak, & Polat, 2015). Pix4D allows to generate and visualize a digital surface model after generating the point cloud. A DSM represents a surface model as a regular grid of height values. Each pixel of the raster image is assigned to represent the elevation of the ground location at that pixel. DEM can be generated from a dense point cloud. Most accurate results are calculated based on dense point cloud data. Additionally, contour lines can be calculated for the model.

An orthoimage is generally a photo map which is geometrically corrected so that the scale is uniform. The most common application is aerial photographic survey measurements, but it may be also useful when a detailed view of the object is required. Orthoimages can be directly used for 2D measurements for calculating distances, areas and be used in Geographic Information Systems. It is generally a photo map which is geometrically corrected so that the scale is uniform. Pix4D allows to project the orthomosaic onto desired coordinate system of the user. The processing for final orthoimages and DSM was done by using ground control points and without ground control points.

Geolocation Accuracy

The result of the 3D mapping with both drones achieved a remarkable sub meter level accuracy by processing with GCPs which fulfils most areal mapping requirements. Accuracy is computed by comparing the point locations of the products with ground truth data.

Even without using GCPs it was possible to obtain georeferenced areal maps only by using images with relevant exposure location obtained from the drone's GNSS device. The accuracy is low as expected because GNSS unit of drones does not provide high level accuracy. When examining the height accuracy of the products obtained without taking account the GCPs, calculation of mean error and slandered deviation of error shows that there is a significant systematic error. It is suspected that the well-known problem of low accuracy in height observation with GNSS system has induced a shift for measurement of heights in both drones.

Comparison of Drones

The accuracy assessment of this study shows slightly better planimetric accuracy for Phantom 3 compared to the eBee when direct geo referencing is used. But Accuracy for the height is better in eBee. It can be clearly concluded that survey grade drones as well as inexpensive consumer grade drones provide remarkable accuracies in 3D aerial mapping with aid of state of art photogrammetric processing available today.

Compared with survey grade drones, the most significant advantage of consumer grade drones is the price. The price tag of Phantom 3 drone is 12 times lower than the eBee, which is very low in price compared to other survey grade drones also.

Another drawback of Sensefly eBee is the combination of a lightweight fixed wing design and a fixed camera mount. Fixed wing designs performs fair in most of windy conditions but this ultra-light platform had a tough time taking stable pictures in wind and turbulence. For this study near vertical photographs provides best geometric conditions but some pictures taken from eBee were tilted from vertical plane due to heavy wind. We had a successful mapping mission with a Dji Phantom 3 in this wind condition due to the gimbal stabilization of the camera.

When it comes to the simplicity, Phantom 3 has better advantages. Rotary wing drones platforms like Phantom 3 can take-off and land vertically, thus no runway area is required, while fixed wing eBee requires open space to operate. Phantom 3's simple design of the flight controller with plug and play functionality enables quick and easy operations. When the flight controller

The recent technological advancements and availability of GNSS Systems, inertial measurement units and digital compact cameras has introduced a great potential of using inexpensive consumer grade drones as mobile mapping systems, as a low-cost alternative to survey grade drones which further reduces costs compared to the traditional aerial mapping

is combined with the flight management application, the data acquisition for aerial mapping becomes highly automated easy task while operation of eBee requires specific training. The UAV platform of Phantom is extremely user friendly and can be operated by an inexperienced operator in a short period of time. Prior knowledge about aerial mapping is essential for any drone operation to plan, acquire data and for successful processing.

The main advantage of eBees design is the safety. UAVs will always involve an element of risk, but the Sensefly eBee's lightweight design minimizes those risks as effectively as possible. Flight time is also a prime reason for choosing fixed wing drones over a quadcopter. In aerial mapping eBee and other fixed wing drones has better endurance compared to rotary wing drones like phantom. It was necessary to map the area in four successive flights as change of battery is required. Fixed wing mapping drones consume less power so able to cover large area in single deploy.

Conclusion

This study presents an overview of using inexpensive drones for aerial mapping complementary to traditional photogrammetry as well as modern survey grade drones. It proves that inexpensive drone can provide high accurate and high resolution products with very high level of automation which suit many geomatics applications.

Drones are now received a lot of attention for consumer application since the costs are very much affordable. The costs are drastically reduced with the availability of low cost navigation and control devices as well as the imaging sensors with development of technology. Regardless of the low cost, these consumer grade drones provide platform capable enough to apply for accurate aerial mapping which was a costly and time consuming task a decade back. Drones can be used as mapping platform for number of critical scenarios as emergency response, reconnaissance surveying, rapid mapping etc. where immediate access to 3D geo information is necessary. Although conventional airborne remote sensing has still some advantages and the tremendous improvements of very high-resolution satellite imagery are closing the gap between airborne and satellite mapping (Zongijan, 2008). As consumer grade drones have less flying time, they are not suitable for large scale mapping tasks.

The accuracy of the final products which are orthoimage and DSM is ultimately dependent upon the characteristics of the imagery which depends on several factors as camera quality (geometric and radiometric quality / photographic resolution), platform stability, successful planning and execution of flight plan and terrain type. The modern photogrammetric processing combined with state of art computer vision algorithms (Hartley & Mundy, 1993) makes it possible to obtain mapping products even with cameras with high distortion as fish eye lens cameras. For this study, both cameras used for acquiring images are consumer grade cameras with low focal length. It is a known factor that low focal length cameras introduce significant geometric distortions and effects as rolling shutter but the processing software successfully model these distortions and able to produce accuracy level down to 17 cm. With advancement of today's technology, the cameras as DSLR and Mirrorless, provide very high image quality but yet very much cheaper than traditional photogrammetric metric cameras. It is advisable use such type of camera for aerial surveying with drones for applications require higher level of accuracy.

Both flight planning and management software used for survey grade and consumer grade drones require minimum manual computations which provide the capability to user to focus only on onsite issues. The automated flight management software works without a flaw to design and execute the flight plan. As drones combines with GNSS and IMU devices, the flying operation is automated. This study shows that the desired survey area was successfully covered by both drones, covering the most of the study area with 5 or more photographs. It is great advantage in accurate processing to determine the 3D location.

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National space policy 2030: Driving the space sector in Malaysia

This paper summarizes the Malaysia National Space Policy 2030. It covers the purpose, structure and the five thrusts of the policy

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The policy will become a reference and guideline in determining the directions of space sector development, to utilize the space capabilities and align with the national priorities

In the era where the country is heading towards the 4th Industrial Revolution and the Internet of Things (IoT), the reliance on space capabilities in daily activities, modernization of the state and economic development has increased accordingly. The demand on data, images and information obtained from satellites are seen to transform the existing services and industry into new industry. The wide usage of space technology and application in all sectors especially in era of IoT and liquid data where the usage of internet applications has become double, has bring huge potential to space sector to contribute as one of the economic contributor to Malaysia. With this trend and development, Malaysia aims to have access and utilize fully the space capabilities. Towards that, Malaysian Government has approved the National Space Policy 2030 on 7 February 2017. The introduction of the National Space Policy 2030 is an important moment in the history of the country after six decades of independence and also an important milestone in carving its niche in the space sector.

National Space Policy 2030 recognizes the needs for access to space capabilities to improve the services needed by the people and national security. It will also be as a reference in determining the directions of space sector development in Malaysia to utilize the space capabilities and align the priorities and commitment in this field strategically and put the appropriate resources to gain the best results. The government recognized that space activities especially satellite communication, remote sensing and navigation applications ties directly to national economic and societal wellbeing.

The Structure of National Space Policy 2030

Malaysia's on-going social, environmental and economic wellbeing depend quite heavily on space capabilities. It increases day by day especially for the critical services. With various development, applications and activities, there is a real need to coordinate the space activities especially where space capabilities is to compliment and support other existing national policies in helping them to achieve their objectives. The National Space Policy 2030 will also help Malaysia to coordinate space issues domestically and internationally. There are a few reasons for Malaysia to have the space policy. Firstly, to harnessing the potential of space capabilities as a strategic step towards nation sovereignty, security and economy. Second, it becomes a basis to draft Malaysian Outer Space Act and ratify the international treaties. The last one is to compliment other national existing policies. There is a provision in the policy the need to ensure an adequate qualified, talented and competent workforce to develop and sustain space sector in Malaysia.

Figure 1 shows the structure of National Space Policy 2030. In general, the policy is aligned with two major policies, the National Science, Technology and Innovation Policy (DSTIN) and Malaysian Aerospace Blueprint 2030. The mission of the policy is to develop the country's potential in the space sector to support economic development and knowledge advancement for nation's prosperity. Malaysia wishes to have continuous and cost effective space capability to achieve the national goals as follows:

i. **Improved productivity**
   Space capabilities such as the usage of satellite images and precision positioning can reduce cost, improve the services efficiency and encourages innovation.
ii. **Empowering technology, infrastructure and human resources**
   The country needs to strengthen her local space technology and infrastructure and also develop talented human resources to put Malaysia at par with developed countries.
iii. **Optimizing the utilization of space capabilities**
   Space capabilities will be utilized strategically and appropriate to gain the best results. It becomes a strategic contributor to social wellbeing, economic and natural resource management, environment, disaster management and national security.
iv. **Comply the international treaties and instruments.**
   Being a responsible nation, Malaysia will comply with the international instruments related to space while strengthening the international relationship and cooperation.

From the Figure 1, the gist of the policy consisted of five thrusts which covered all the strategy needs to achieve the objectives of the policy and will deliver the nation's space capabilities.

Thrust 1: Strengthen the Governance to Optimize the Access to Space Capabilities.

Thrust 1 aims to strengthen the domestic coordination to optimize the access to the space capabilities for societal wellbeing, economic generating, natural resources and environment management and national security. Roles, activities and the existing acts and policies will be harmonized to minimize duplication among agencies and ensure there is also no duplication deed and existing policies to increase productivity and achievement of space sector development. It is also to ensure that the space sector is administered properly and adjusted to optimize the use of national resources.

Effective legal and administrative framework is very important in ensuring a sustainable space development and to make sure the peaceful exploration and use of outer space.

In order to improve the domestic coordination, a National Space Committee (JANGKA) is set up (Figure 2) that will involve all space-related stakeholders to streamline the strategic direction of space sector development. Since space technology is a dual-purpose technology, JANGKA will get an advisory and information sharing from National Security Council (NSC) for the security aspect, and the Malaysian Aerospace Council (MAC) for the commercial aspect. Under JANGKA, it will has a Space Coordination Committee chaired by the Malaysian Space Agency (ANGKASA), an agency under Ministry of Science, Technology and Innovation (MOSTI) to coordinate space activities with states, industries and research institution.

As a space participant, Malaysia is seriously looking forward to its national space legislation and putting the law into practice. The need for a national space legislation is in fact responding to numerous factors including requirements imposed by international law that states should be held responsible as well as internationally liable for their national space activities (Saari, 2014). So, the Malaysian Outer Space Act will be formulated to create clear regulations and guidelines in administer, coordinate and to control space activities at all level of users either government agencies, industries or individual. With this act, the Malaysian Government will be able to monitor and supervise its national space activities effectively in accordance with international law. Moreover, Malaysia will be able to deal with the international responsibility and liability of its nationals appropriately at the national level and ratify the International Outer Space Treaties.

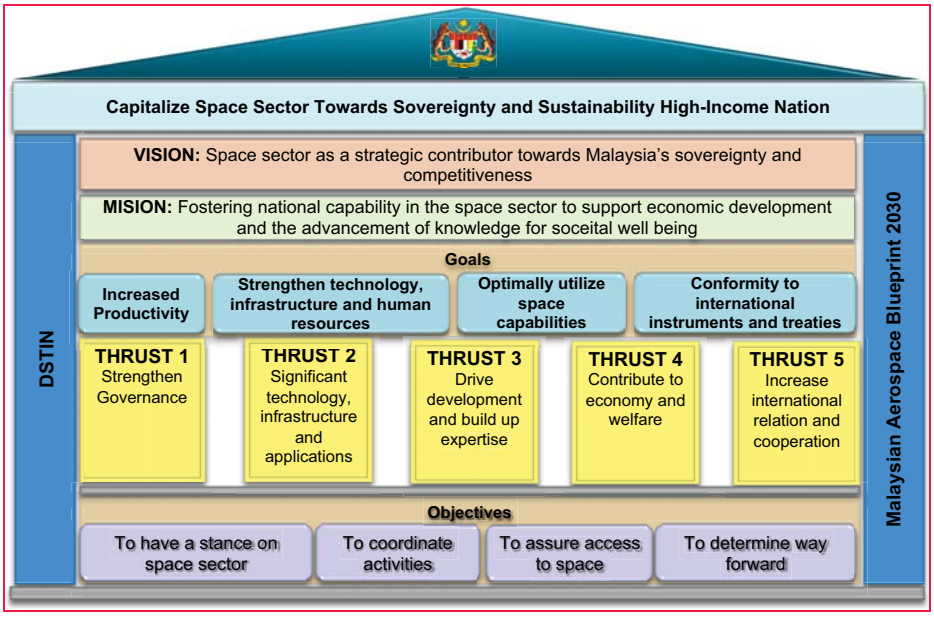

Figure 1: Structure of National Space Policy 2030

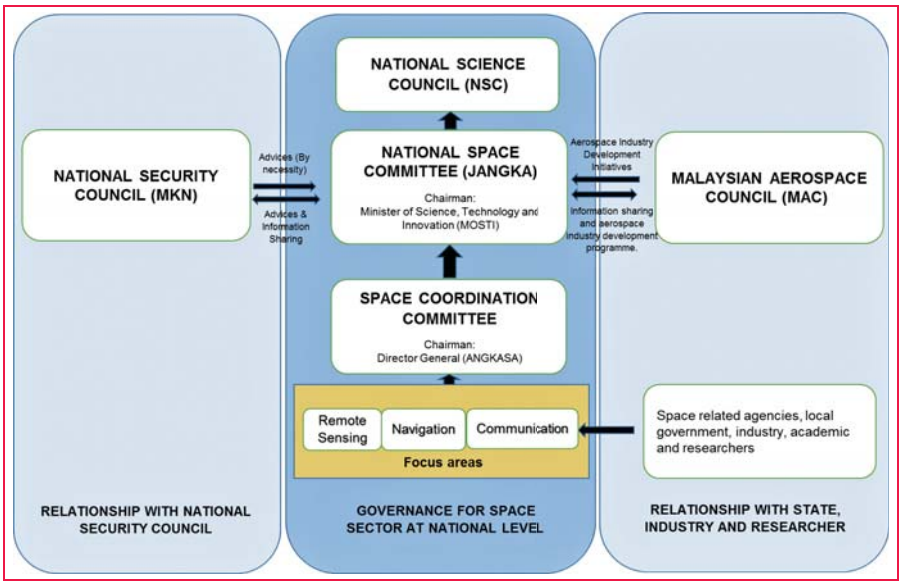

Figure 2: A Framework of National Space Committee (JANGKA)

Thrust 2: Focus on Space Technology, Infrastructure and Applications Significant to the Country

The Malaysian government's efforts will be more focused on the development of space technology, infrastructure and applications that have an impact on safety, economic and social, especially in the three focus areas of the space sector; remote sensing, communications and navigation. The Government recognizes the combination these three focus areas can help and contribute to ability and critical needs such as planning and management of natural resources and environment, weather and climate prediction, the search and rescue (SAR), disaster management, infrastructure monitoring, mapping, navigation and safety.

Malaysia encourages access to programs that can support the attraction of investment, research and innovation. The space sector in Malaysia cannot be developed and implemented if we do not have the appropriate and adequate infrastructure. Thus, because of space technology can be utilized by all sectors, blue ocean strategy will be implemented to meet the desires and importance needs of the country. Enhancement of space infrastructure can improve the ability of the country towards strengthening the sovereignty and security and also increase the activities that can contribute to the economic generation.

Thrust 3: Accelerating Development of Space Science and Technology with Expertise

This thrust is aligned with the national desires to be as scientific country for socio-economic transformation and inclusive growth, research, development, commercialisation and innovation (R, D, C and I) to drive space science and technology development. Space field will be placed as one of the national R&D priority area due to its contribution to the country. The generation of knowledge will ensure that the country has the ability and the right understanding in order to deal with natural phenomena that affect the community such as the effect of climate change, natural disasters, unsustainable natural resources management and increasing of man-made applications development.

Space is an industry which needs a long term view. It is based on risky early R&D and a high skilled workforce. Malaysia space industry need to fill skills and knowledge gaps within the industry and workforce. If left unaddressed, these shortages will affect the ability to fulfil its growth potential. The initiatives under this thrust will also help to retain Malaysia's talent base to help further space economic development and efforts to create and grow other target industries. Highly skilled human resources is an important element in driving the development of the space sector. Human resources development take a long time and need to be implemented continuously and in line with the R, D, C and I, industry development and infrastructure usages. This thrust also stressed the need of close engagement and cooperation between research institutions and industry. Besides that, the awareness programs will be strengthened to educate publics on the importance of space sciences, technology and innovation.

Thrust 4: Contribute to the Economy and Nation's Prosperity

Space technologies have changed the existing industries and services and is able to create new industry. To ensure the continuity of the space sector development, the space industry should be driven although in small size and selective. It will open up opportunities to the local industry to be involved in developing, improving and exploiting the products, services and space applications. Currently, contribution of space to Malaysia GDP is still small compared with other major sectors. Economic benefits contributed by the space sector is estimated around RM 5.6 billion by 2020. As the largest contributor to the national revenue is from the space applications and services, the policy will focus more on the downstream industry. Therefore, a space industry strategic plan is to be developed soon.

Thrust 5: Increase and Strengthen the International Cooperation and Relationship

The development of space capabilities requires international relationship and cooperation in space technology and applications for peaceful use. Malaysia will strengthen and enhance its international relationship and collaboration to complement its national space capabilities. Active participation in the regional and international scientific initiatives and awareness program are necessary for a great returns and benefits to the national space science and technology initiatives and development. Malaysia will continue to support the international legal framework for ensuring the peaceful exploration and use of outer space and will ratify the international space treaties and instruments being a responsible space player to all her space activities.

Summary

The burgeoning of space activities and the huge involvement of public and private sectors insist Malaysia to formulate its National Space Policy. By having the policy, the Malaysian Government will be able to safeguard the interest of the country by recognizing the needs for access to space capabilities to improve the services needed by the people and national security, and to monitor and supervise its national space activities effectively in accordance with international law. The policy will become a reference and guideline in determining the directions of space sector development, to utilize the space capabilities and align with the national priorities. This will promote growth and expansion of space activity in the country. Moreover, Malaysia is focused to uphold the international responsibility and liability of its nationals appropriately at the national level. Therefore, support from all sectors; government, industry and academic are required to capitalize the space sector towards sovereignty and sustainable high income nation.

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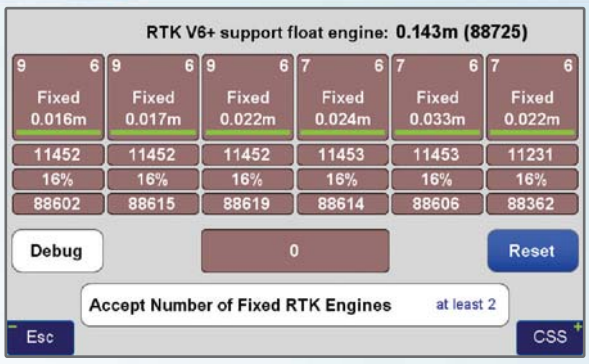
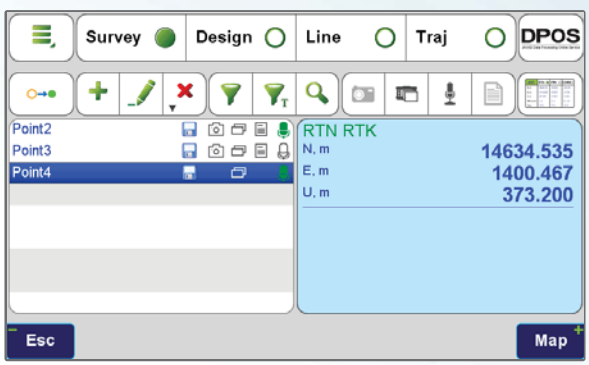
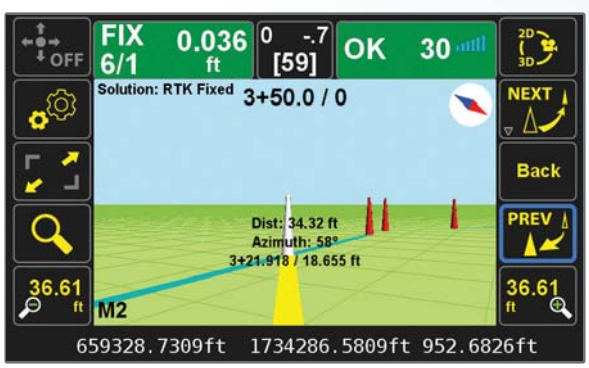
TRIUMPH-LS and J-Field

Hands free operation







J-Field is the embedded application program of TRIUMPH-LS. It has the following unique features for each point surveyed:

- Six parallel RTK engines to maximize solution availability.
- Automatic Engines Resets, verification and validation strategy.
- Several graphical and numerical confidence reports and documentation.
- Voice-to-text conversion for hands free operation and documentation.
- Lift & Tilt and automatic shots for hands free operation
- Visual Stakeout (Virtual Reality)
- "DPOS it" or "Reverse Shift it" features. The most advanced RTK verification.
- Photogrammetry and angle measurements with embedded cameras.
- Automatic or manual photo documentation.
- Automatic screen shots documentation.
- Audio files for documentation.
- Automatic tilt correction.
- Comprehensive HTML and PDF reports
- Comprehensive codes, tags and drawing tools.
- Over 3,000 Coordinate Systems.
- Automatic and free software update via Internet.

J-Tip

J-Pod

J-Pack

J-Shield

Front

Works Where Others Can't
Goes Where Others Won't

Why Javad? Because it works where nothing else will and it has abilities and features that nothing else does.

I got some ridiculous 'fixes' today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it.

The LS has increased our productivity 2:1

Using licensed professionals for development has been a brilliant idea. Tip of the hat to the programmers and designers that put the original box together it appears to me that they knew where they were going with this years ago.

Since I got the Javad system, I go places NEVER BEFORE possible, and WITH confidence, because, the quality checks are there.

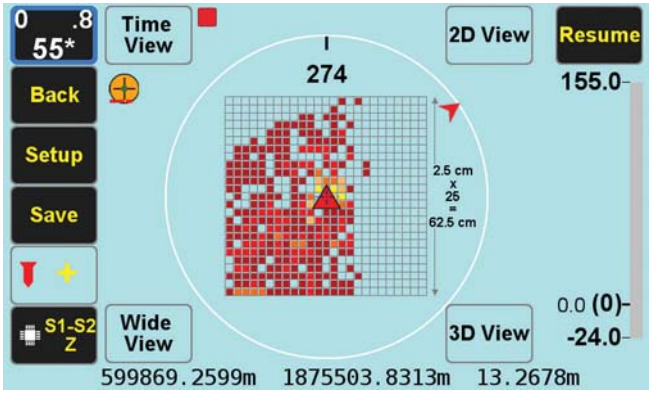
FL

J-Tip

Integrated Magnetic Locator

$850

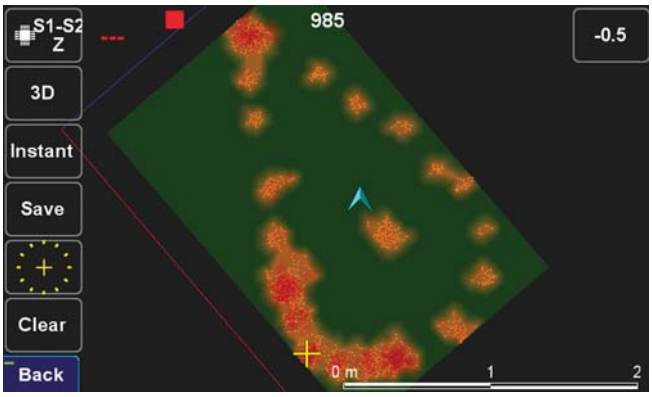
TRIUMPH-LS tags coordinates with magnetic values, It also guides you to top of the item to survey it.

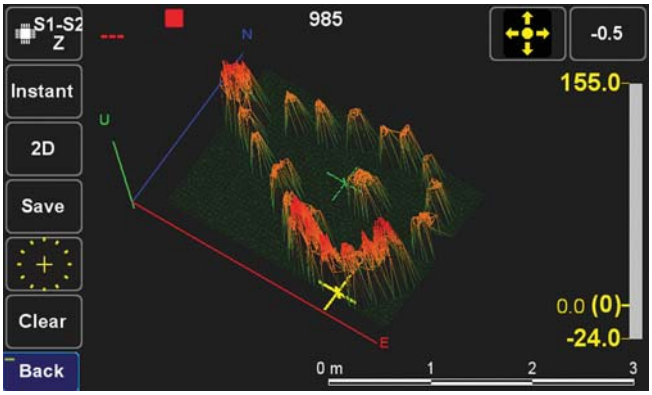


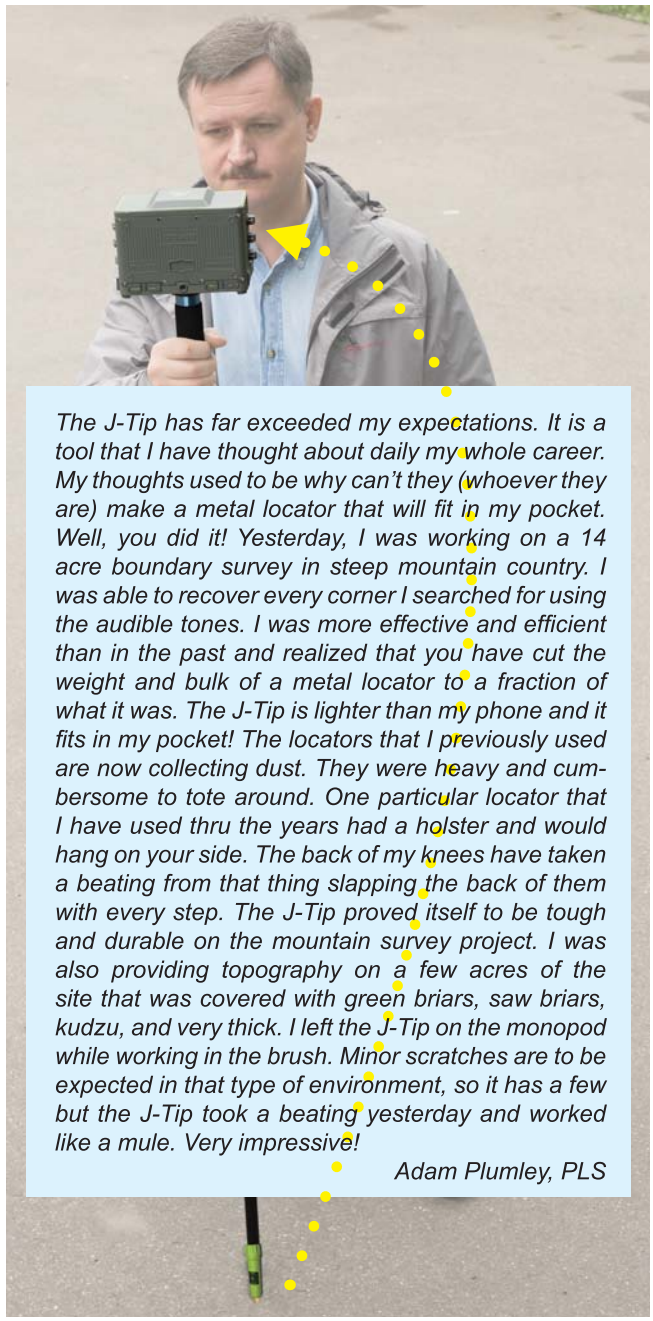
The Mag View focuses only on the mag object with the highest mag value.

The audio and graphical bar on the right side show the magnitude of the magnetic object.

In “Setup” you can select the cell size and the size of the field you want to scan.







The J-Tip has far exceeded my expectations. It is a tool that I have thought about daily my whole career. My thoughts used to be why can’t they (whoever they are) make a metal locator that will fit in my pocket. Well, you did it! Yesterday, I was working on a 14 acre boundary survey in steep mountain country. I was able to recover every corner I searched for using the audible tones. I was more effective and efficient than in the past and realized that you have cut the weight and bulk of a metal locator to a fraction of what it was. The J-Tip is lighter than my phone and it fits in my pocket! The locators that I previously used are now collecting dust. They were heavy and cumbersome to tote around. One particular locator that I have used thru the years had a holster and would hang on your side. The back of my knees have taken a beating from that thing slapping the back of them with every step. The J-Tip proved itself to be tough and durable on the mountain survey project. I was also providing topography on a few acres of the site that was covered with green briars, saw briars, kudzu, and very thick. I left the J-Tip on the monopod while working in the brush. Minor scratches are to be expected in that type of environment, so it has a few but the J-Tip took a beating yesterday and worked like a mule. Very impressive!

Adam Plumley, PLS

2D and 3D views of the field show the magnetic objects that have been scanned.

Zooming the 2D and 3D screens can show the shape of the magnetic objects under the ground.

For many sophisticated features of the J-Tip see its Users Manual in www.javad.com

J-Pod

A rugged Transformer-Pod

$850

Monopod, 8 and 40 sec level vials, compass, Accessory hooks.

Connect legs on demand to make bipod or tripod.

+ Bipod.

+Tripod.

Monopod >>> to + Bipod >>> to + Tripod… On demand.

Rugged, Light, Compact, Easy to level.

* Detachable landing and resting pads.
* Mace grips (concrete, asphalt, bricks, soil)

Travel mode.

Inside bag.

The most stable tripod. It will never collapse, even on wet glass.

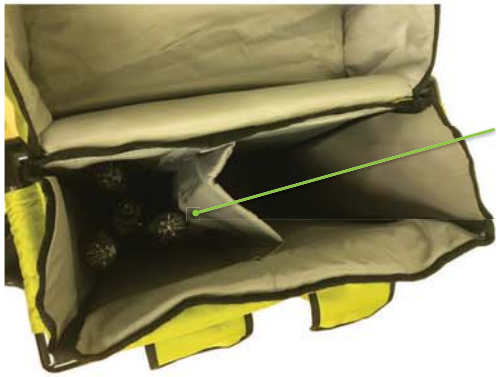
Think of it as a rugged Transformer-Pod, We call it **J-Pod.**

J-Pack

Nice and convenient survey bag

$290

It was not our job... You asked for it - we did it!



J-Pod

Landing Pads

Javad.....Bravo!!!!

The J-Pack is nicest bag I have ever seen for surveying. I especially like the pocket in the back and all of the places to tie down equipment and stuff.

Adam Plumley, PLS

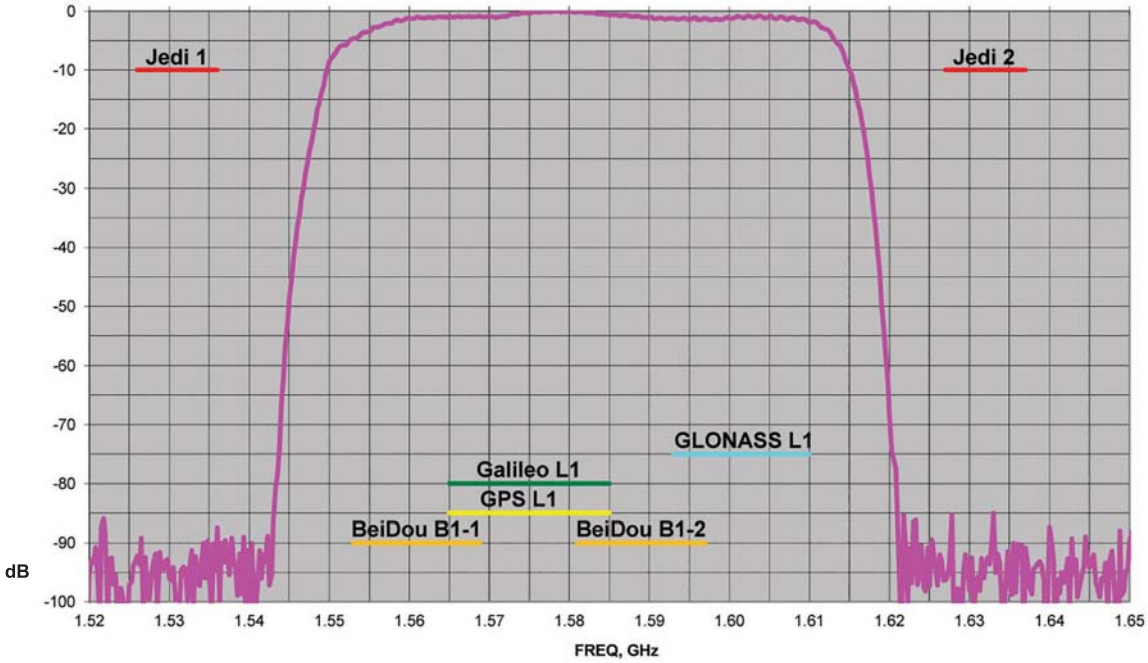
Ship date - January 2017

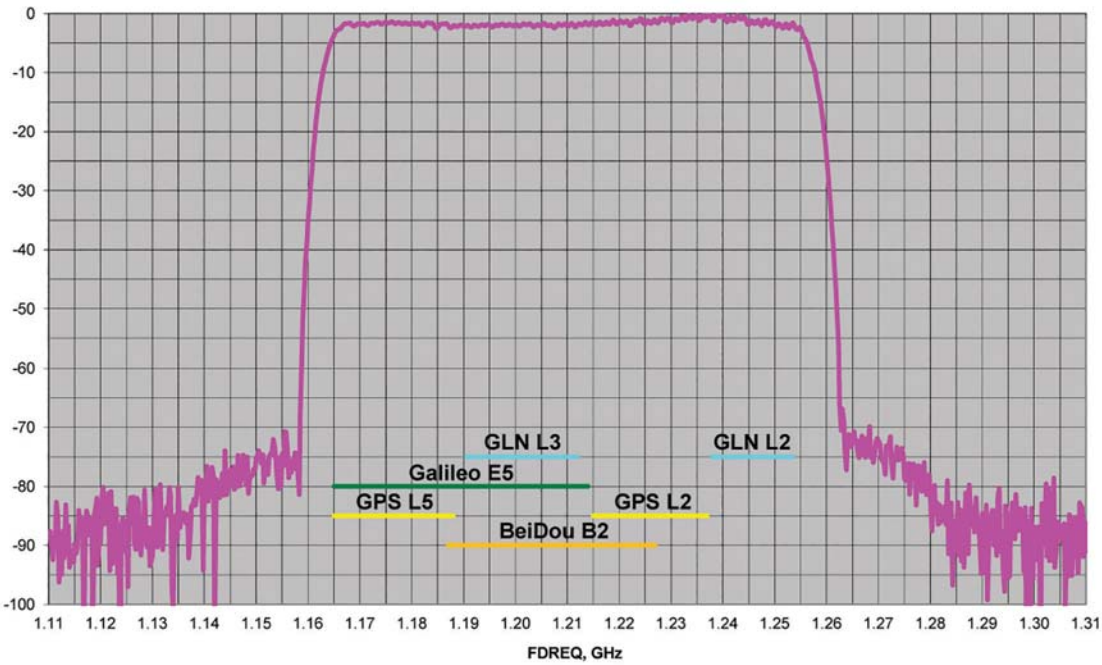
See full video “J-Pack & J-Tip in Use” www.javad.com

J-Shield

In case the **Jedi** returns

$450





J-Shield of TRIUMPH-LS
protecting all GNSS Bands.

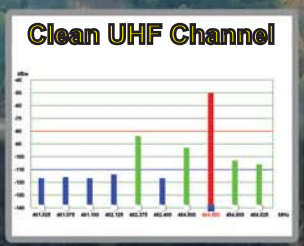
J-Field Software Features

I used “Beast Mode” on a small project yesterday and all I can say is WOW!!!! Did Javad and Red Bull team up to enhance RTK or did my system drink hypercaffeinated coffee when I wasn’t looking? Amazing accomplishment/development Javad. I can’t imagine using any other GPS equipment.

I surveyed 20 acres today and never used the total station.

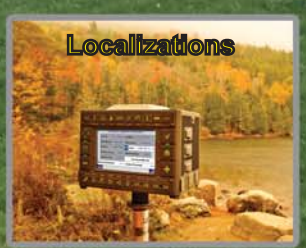
The only bitching now is for the crew that has to take out the Hyper V.

DPOSit
Data Processing Online Service



REVERSE SHIFT<<it

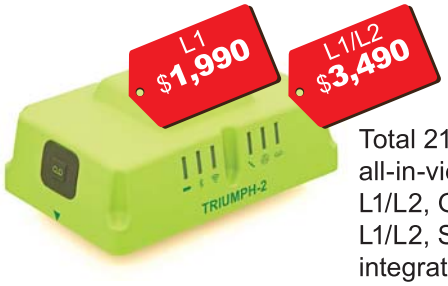
Thank you for the most awesome set of equipment I have had the pleasure of running in my 41 years of surveying. I am having the most fun I have ever had!



TRIUMPH-1M

864 channel chip, equipped with the internal 4G/ LTE/3G card, easy accessible microSD and microSIM cards, includes “Lift & Tilt” technology.

TRIUMPH-2



Total 216 channels: all-in-view (GPS L1/L2, GLONASS L1/L2, SBAS L1) integrated receiver.

The one and the only Digital Radio Transceiver in the world!

Unique adaptive digital signal processing, which has benefits: the full UHF frequency range and all channel bandwidths worldwide • the best sensitivity, dynamic range, and the highest radio link data throughput • embedded interference scanner and analyzer • compatibility with another protocols. Cable free Bluetooth connectivity with GNSS receivers and Internet RTN/VRS access via embedded LAN, Wi-Fi, and 3.5G

And all this with competitive prices!

HPT435BT/HPT135BT/HPT225BT*

$2,710

35 W UHF/VHF Transceiver

HPT404BT/HPT104BT/HPT204BT*

$1,640

4 W UHF/VHF Transceiver

HPT401BT/HPT101BT/HPT201BT*

$2,040

1 W UHF/VHF with internal battery

L-Band/Beacon*

$1,550

Receivers for multiple applications

JLink 3G LTE BAT*

$2,735

Web-interface Wi-Fi, Ethernet, 3.5 G, UHF/VHF/FH915, internal battery

OEM Solutions

$840

902-928, 360-470, 225-255, 138-174 MHz

*Power, data cables and antenna are included.

"Initial Services are the first step towards full operational capability of Galileo in 2020"

says Paul Verhoef, Director of the Galileo Programme and Navigation-related Activities (D/NAV), European Space Agency in an interaction with Coordinates

Galileo is Europe's own Satellite navigation system. It guarantees Europe's independence in this field but also encourage as well as maintain Europe's technological know-how. It's Open Service is fully interoperable with GPS. Galileo will also provide high quality positioning on its own

Congratulations for launching "Galileo Initial Services". Please explain what it is all about?

The Initial Services are the services offered by the Galileo satellite navigation system which became operational in December 2016: Open Service, Public Regulated Service and Search and Rescue Service. These services are provided according to pre-defined performances based on the availability of 9 satellites, although we will have in operation 18 satellites in a few months' time.

It is the first step toward full operational capability of Galileo in 2020. The Galileo Services will gradually improve as more satellites and the remainder of the ground segment will be deployed. Other services (e.g. commercial service) will be made available.

What is the current status and future plans of Galileo?

18 satellites have been launched to date. The last four, launched in November 2016 are still in their commissioning phase – i.e. they are being thoroughly tested – and they should join the constellation before the middle of 2017.

The build-up will continue to have the system fully operational in 2020.

What advantages Galileo offers to users compare to the other operational systems?

Galileo is Europe's own Satellite navigation system. It guarantees Europe's independence in this field but also encourage as well as maintain Europe's technological know-how. It's Open Service is fully interoperable with GPS. Galileo will also provide high quality positioning on its own. The quality of Galileo is better than the current GPS constellation, but of course our US colleagues can be expected to catch up with GPS-3

What are the anticipated technology changes anticipated in the GNSS in general, Galileo/ EGNOS in particular?

At the moment, GNSS in general is coping with an unprecedented increase in use and the development of many new markets of satellite navigation and timing. As there will soon be 4 systems

available world-wide, one element is of course the combined use of the systems, in addition to each specific use. Individually, each system is studying where markets are going, what demands will be made on the systems on the future, and what technology improvements can deliver on these demands.

What is the assessment on the utilisation of EGNOS both for aviation and non-aviation sectors? Is there any cost-benefit analysis available?

In March 2017, Eurocontrol registered 308 approach procedures in 187 airports all over Europe supported by EGNOS. We see at the moment a very strong interest in the maritime and railways sectors and we expect to see significant growth in all areas.

Has there been any mandate from the Government for the utilisation for EGNOS?

As far as we are aware, EGNOS is a service to be used as countries and users see fit and each country decides its own utilisation strategy. In part this has to do with the investment strategy in legacy infrastructure. For example, there is an increasing number of countries considering to stop investing in ILS installations (terrestrial Instrument Landing Systems, notably at smaller airport) and replace it with EGNOS landing procedures.

What are the plans for the expansion of EGNOS beyond the European Civil Aviation Conference (ECAC) regions?

EGNOS is foreseen as a service over Europe whereby a number of smaller extensions are still foreseen. Use of the underlying European technology is indeed happening in other parts of the world, e.g in Korea, but this is the result of public procurements to which the European technology suppliers react. We are of course hoping that, following Korea, there will be other that will follow.

> The Galileo Services will gradually improve as more satellites and the remainder of the ground segment will be deployed. Other services (e.g. commercial service) will be made available

What are the plans for moving towards Dual Frequency Multi Constellation (DFMC)? When will it be realised ?

European Space Agency (ESA) has been delegated by the European GNSS Agency (GSA) the procurement of EGNOS V3 which will contain DFMC features. However, this will be passed to the GSA for operational qualification and certification which dictates the date of service availability.

What are the efforts taken to work with other navigation satellites stake-holders to bring in synergy in the utilisation?

Regulars meetings are held with representatives of existing and foreseen SBAS systems around the world in order to harmonise the various systems in order to offer a harmonised service around the world.

With the reported atomic clock failures observed on-orbit, what are the plans for the realisation of Galileo?

The malfunctions are limited and do not affect the navigation signals coming from the satellites as we have more than enough redundancy on board. So the satellites are fully operational and Initial Services are not affected. Of course we are currently initiating actions on the clocks that are on board satellites still on the ground. So the completion of the constellation is continuing.

Are the problems noticed in Galileo clocks similar to the ones observed by other navigation space operators? Is the cause clearly identified?

The cause is under investigation but the tests and investigations are not yet fully completed.

Recently the issues related to interference/ jamming/spoofing are widely discussed. Given the dependence on GNSS on our day to day life, how important is it to develop the 'GNSS backup Systems'?

It is important, so therefore everybody is happy that there are a number of global systems. However, satellite navigation alone will not be providing a complete solution and further integration with terrestrial navigation and inertial systems and sensors is important, as well as integration with communication and other means. We can mention e.g. that certain sectors need navigation means in tunnels, cities, and other geographical specific areas. Moreover, autonomous driving, currently foreseen to commence in the next decades, can only work if there is such an integration with other space and terrestrial means and sensors. The same is true for 5G developments.

Do you see any implication of Brexit on Galileo?

There are likely to be implications although it is difficult to say what they will be as it depends to a large extend on the Brexit negotiations.

With e-Services towards transparent and trustworthy cadastre

The paper presents an overview of developments of e-services which are available in the Czech Republic in order to provide accessible cadastral data to any customer of a cadastral office

Libor Tomandl
Cadastral Branch Office Karlovy Vary
Sokolovska, Karlovy Vary, Czech Republic

Vladimira Zufanova PhD.
Czech Office for Surveying, Mapping and Cadastre, Czech Republic

Information has generally been one of the most precious goods in recent decades. It is possible to buy and sell it, to barter it or just only freely provide it. The value of the information itself is very often based on the fact that it is more valuable when the actual information is less accessible and more desired. Yet some of the information and its timely acquisition or providing may be crucial for conserving resources or rescuing material values, health or human and animal lives.

We have been witnessing an unprecedented growth in the number of demands for spatial data recorded on the territory in recent years. Information about properties and their owners and users is absolutely necessary for effective functioning of a real estate market, strategic decision making processes, environmental protection or other important human activities in the area. Access to cadastral information is not only important for public authorities or companies that deal in some way with real estate, but in many life situations it is very important for individuals as well. The principle of cadastral publicity can ensure equal access to information for all groups of stakeholders.

Principle of publicity

Public cadastre is connected with the principle of formal and material publicity (a principle of public trust). The principle of public cadastre in the Czech Republic states that the Cadastre of Real Estate is public and everybody is entitled to consult it, make copies, extracts and sketches for their need or obtain data from the collection of documents stored in document funds. When this principle was laid down in the new cadastral law at the beginning of the 1990s, legislators had in their mind primarily a visit to the cadastral office in office hours by a client who personally demanded required data at the information desk. With the development of information and communication technologies the principle of publicity and the right to obtain information from the cadastre is mainly based on easy access to the required information through the Internet and mobile applications. Authors of this paper want to present which historical and legislative reasons led the Czech society to a relatively liberal approach in this matter, what information can be obtained from the Czech cadastre and how it can be obtained.

Principle of Public Cadastre in Historical Context

The principle has been applied on the territory of Czech lands almost continuously since 1871, it means 145 years. The only time when the principle was slightly weakened, the period from 1964 to 1992, the law required an applicant to demonstrate a legitimate interest for consulting the real estate records or issuing extracts from the registry. However the usual practice in this period usually was such that the

extracts from the registry were issued without any formal verification of the interest legitimacy in these data.

In 1871, when the protection of confidence in the records on land rights kept in the Land Book was enshrined, the principle of formal publicity was significantly enhanced in the legal system of the Austrian tradition. By comparing systems of land registration in other European countries, which are based on different principles, we can demonstrate that the system providing a high degree of property rights protection, especially of buyers and mortgage lenders, always includes a widely understood principle of public land records, especially data on the property rights and defects encumbering the property. The Czech Republic is one of the countries with the Austrian tradition of land law originally based on the Common Civil Code from 1811.

Principle of Public Cadastre in European Context

Land Registries in European countries can be divided into three basic groups in terms of access to the contents of the register and issuing extracts and copies:

- "Austrian" group, which includes Austria, a northern province in Italy, Hungary, the Czech Republic, Slovakia, Poland, Slovenia, Croatia and other countries in the former Yugoslavia. This group of countries is characterized by very broadly interpreted principle of public data records, including land rights to real estate. Easy access to these data is also traditional in the Nordic countries, so they can be assigned to this group as well.
- Germany and Switzerland, where the access to the land register requires proving the legitimate interest. Without fulfilling this obligation only contact information on the registered owner of a particular parcel is available. Only notaries who draw up all real estate contracts and secure information for a specific real estate purchase contract are exempt from the obligation to demonstrate the legitimate interest.
- France, Spain, England, where legislation does not enable direct access to the land registry and written information can be provided whilst an approval of the registered owner with providing specific information may be required.

Outside Europe, the publicity principle is broadly applied e.g. in Canada and Australia, although their systems of land registration are often quite different from the Czech cadastre. Contracts on real estate are registered in these systems and it is permitted to consult these contracts.

It is necessary to mention that the extent of publicity of a land registration system relates with the whole real estate trade of each country and with the level of state guarantees for persons who work on the assumption of rightness of the land register. For example, in systems where every real estate contract is mediated by a notary, the notary´s access to land records is sufficient enough. For other purposes (real estate services, preparation for construction of public utility buildings etc.) being able to contact the registered owner is satisfactory as well.

Application of Publicity Principle in Czech Cadastre of Real Estate

The provision of data from the Czech cadastre is not totally unlimited. It is impossible to obtain a summary of ownership of a specific owner from all over the Czech Republic or given territorial area by simple consulting these data. The same applies to the collection of documents and real estate prices. The provision of data from the collection of documents is carried out by providing a certificated or simple copy. Only the person, who proves their identity and states the purpose for which the data are requested, can obtain the data. Cadastral offices keep records of persons who have demanded the data for a potential inspection by the Office for Personal Data Protection.

In systems that are very liberal, which is the contemporary one in the Czech Republic, any restriction of the cadastral publicity would bring great difficulties. The opportunity to get full information from the cadastral register on legal relations independently on a real estate owner enables buyers and pledgees to take fully into consideration major risks of a particular real estate transaction. It is also necessary to conserve the public collection of documents, on the basis of which registrations were carried out. It reduces the risk of fraud in real estate transactions. The public cadastre also enables to determine whether debtors own some properties. To satisfy outstanding claims creditor can suggest for example seizure of property. That is precisely how the new procedures in the implementation of a property seizure have contributed to greater discipline of debtors in debt payments in recent years. Proposals for a seizure of immovable property are registered in cadastre to the debtors and thus generally relate to all of their property. They are registered immediately, usually the same day or the day after delivering. So, decisive factors for completion of real estate transactions can be changed virtually overnight. That is why it is important not only to conserve cadastral publicity, but also enable the information access remotely via the Internet, so that the important data can be examined immediately before signing a contract.

The publicity of the Cadastre of Real Estate of the Czech Republic is not in conflict with the protection of personal data. The Law on Personal Data Protection explicitly counts on public registers such as the cadastre and also specifies how to handle the personal data that are included in such a public list. According to the law these personal data kept in a public list are considered as published.

The cadastre is a source of information that serves to protect property rights, for the purposes of taxes, fees and other financial fulfillments, to protect the environment, mineral resources, for protection of interests of state monument care, for territorial development, real estate valuation, scientific purposes, economic and statistical information and the creation of other systems. A broad concept of the public cadastre is necessary to fulfill above formulated purposes.

Ways of providing cadastral data

Cadastral authorities provide cadastral information to the public in several forms:

1. verbal form,
2. analogue form
   - printed form,
   - copies of deeds, owner's folios/ excerpt from the cadastre, cadastral maps, identification of parcels,
3. digital form
   - copies of deeds, excerpt from the cadastre, cadastral maps (PDF/HTML),
   - textual and graphic computer files (exchange format),
   - web sites,
   - notifications.

In the past the most common way to provide outputs (information, excerpts, duplicates and copies) from cadastre was a handover at individual cadastral branch offices. The reason of that situation was the fact that only cadastral offices had access to the data from their territorial scope of activity and because a large among of data (contracts, deeds, measurements ...) was only in analogue form.

The changes have started since 1992. Systematic management of cadastral data has been launched in an information system and was supported by digitalisation descriptive data (completed in 2000) and by digitalisation of geodetic data/ cadastral maps (1995 - 2017).

Electronic management of cadastral data continued in 2001 by creation a new Information System of Real Estates which included a joint management of descriptive data and geospatial information in one system and their continuous transport into a central database.

Electronic services of the cadastre of real estate

Some e-Services have been launched in the area of the cadastre of real estate, which enable to get a wide range of information from the cadastre for our customers. There are both free of charge services enabling to get some chosen data without any restrictions, as well as paid services providing verified documents serving as public documents, that is from the whole territory of the Czech Republic. Except for this, some other applications are for disposal facilitating the access to cadastral data and communication of inhabitants with cadastral offices.

Since 2013 there has been a legal obligation to submit the entry proposal on the form. The objective of this measure is to reduce errors that still occurred in the proposals for entry of right and get clearly formulated requirements for what should be registered into the cadastre of real estate according to the attached documents. In order to facilitate completing the form to the applicants a web application was launched enabling creation of the entry proposal in an interactive way. This application is interconnected to the cadastral database and draws some data from it. It leads the user through the entire process, and contains also some pre-prepared simplified scenarios for the most common situations. The application is very popular; in 2014 more than 629 thousands entry proposals were created via it. Since January 2014 it is possible not only to complete the entry proposal in electronic form but also to perform the registration into the cadastre of real estate on the basis of documents in electronic form. If the document is drawn up in electronic form, it must be provided with a qualified time stamp as well.

Thanks to the new Information System of Real Estates a first version of Remote Access to the Cadastre of Real Estate was launched in 2001. The Remote Access is a paid service enabling on-line access to the cadastre data via two options – a web application or web services (since 2005). The outputs are in digital form fitted with certified electronic signature.

To use the Remote Access application is necessary to have a user account. There are three types of user accounts - Ordinary accounts, Accounts for free Remote Access and Accounts for the purpose of issuing of authorized outputs from cadastre. The third one can be set up solely for subjects legally authorized for authorization of outputs from information systems of state administration (municipal authorities, notaries, Czech Post and Chamber of Commerce) and it enables to expand places where is possible to obtain outputs from Cadastre in analogue form.

From the beginning of 2004 was launched a web application Consultation of the Cadastre of Real Estate with limited range of digital information, without formalized outputs, nonauthorized but for free. The main reason to open this application was to tear down barriers between citizen and administration power and to publish detailed information about phase of procedures concerning requests for entry or record into the Cadastre. In the first instance there were only descriptive data that were followed by digital maps in 2008.

The latest news in a manner of provision of data is Service for monitoring of changes which was launched in 2014. This Service is based on communication by SMS, e-mail, data box or web services and follows changes on real estates and delivers short notifications. This is the first proactive utility for owners and associated persons to enable keep an eye on their own interests.

On-line applications for provision of data

Consultation of the Cadastre of Real Estate

The application has been operated since 1st January 2004. It is free to use, free of charge. From that time there were a lot of new versions with added features. The basic available information is about a real estate, cadastral procedures and cadastral maps. Descriptive data are usually updated daily; cadastral maps are updated up to their format – a vector format hourly, a raster format on demand.

Consultation of the Cadastre of Real Estate is the most frequently visited Czech governmental web page with average monthly visit 1.9 mil. Its content

Figure 1: Graphical menu for information about parcels, buildings, flats, cadastral procedures and cadastral map

contributes to put the work of Cadastral Offices under permanent public watch and contributes thus to their transparency as well. That is the way the users have access to currently updated complex information from the cadastre of real estate directly from their worktable.

Information about a Real Estate

In this section there are available data about parcels, buildings, flats and non-residential spaces and building rights registered in the Cadastre. The information can be obtained by inserting the proper identification parameters of the property of interest.

The outputs consists of universally data as a unique identification and technical characteristics of the property, a name of owner/co-owners with postal addresses and respective shares, rights concerned the property or an information about ongoing legal changes (reference to the number of procedure – if any).

The basic information is displayed on web browser and contains many links to the additive details. If the user has an interest into, he can display the property on the cadastral map, find out all properties of the current owner, find out neighbouring parcels and theirs owners or get know if there is any price written in Cadastre for the property.

Information about Cadastral Procedures

In this section it is possible to get the detailed information about the progress of entry, record, note or confirmation of survey sketch procedures into the Cadastre. According to the number of procedure and the name of proper Cadastral Office you can see the date of delivery, current state of progress (e.g. commenced, stopped, rejected, new record prepared and approved, decided, dispatched, closed). There are also names of participants in the procedure, list of procedural acts carried out with date and information about the type procedure (e.g. ownership rights, mortgage).

By inserting the number of a procedure it is possible to obtain also the information on nearest 40 procedures (20 before a 20 after) with date of delivery and state of their progress. In this way you can follow the sequence of handling of your particular case. You can also get information about all the petitions delivered the same day by inserting the date of delivery. (1)

Cadastral Maps

In this section it is possible to display cadastral map all over the Czech Republic. Currently there is less than 10 % of territory without cadastral map in a vector format available; there are used original maps in a raster format with definition point of parcels in these areas.

Besides a general map viewing you can search parcels and buildings, display the quality of the measurement of boundaries (red-bad/green-good boundaries) or display easement to the property (blue/pink/orange coloured area).

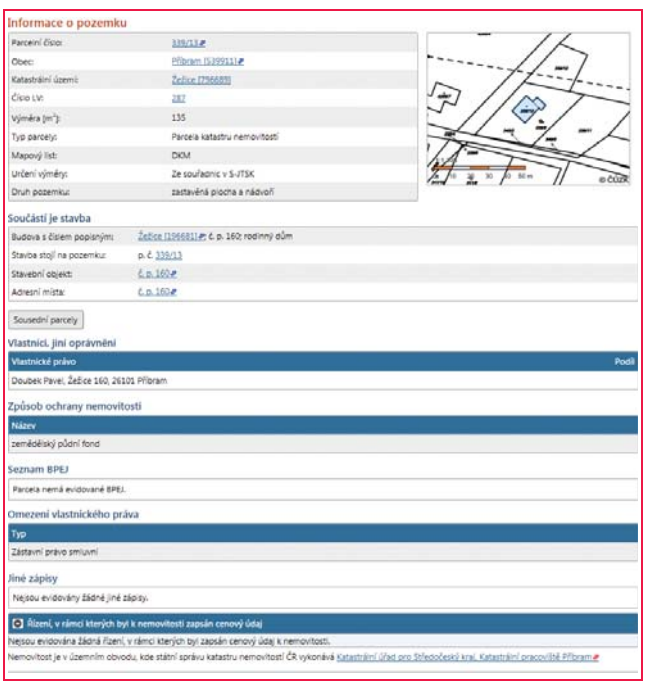


Figure 2: Output information about a parcel

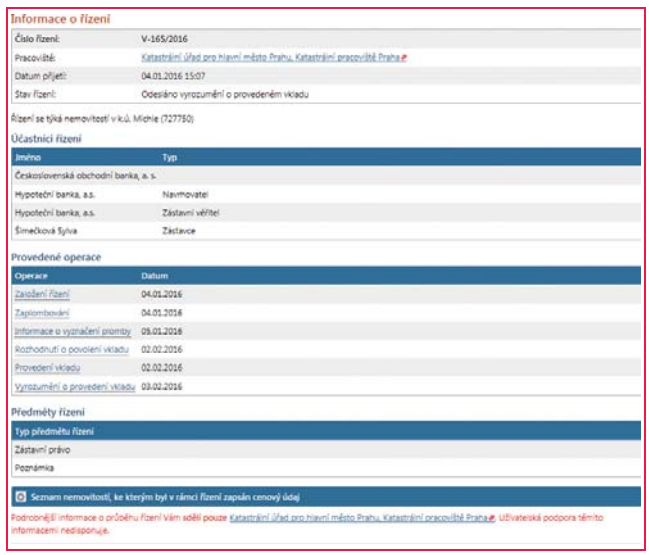


Figure 3: Output information about a cadastral procedure

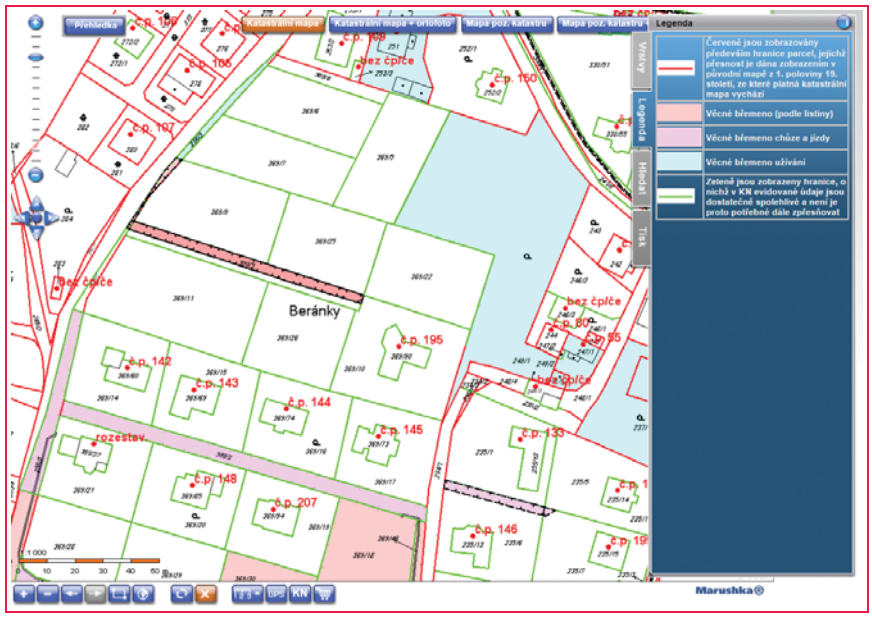


Figure 4: Cadastral Map with highlighted elements

Remote Access to the Cadastre of Real Estate

The application was launched in 2001 and it is still getting improved. The last year its users interface was completely redefined into a modern design.

Remote Access enables to get data from the Cadastre at the whole territory of the Czech Republic. However, this is valid solely for the text outputs:

- Excerpt from the Cadastre of Real Estate
- Information about Parcels
- Information about Flats and Non-residential Premises (Units)
- Ownership Overview
- Existence of Rights for a Person
- Course of Proceeding
- Depiction of Overview and Cadastral Map
- Copy of the Cadastral Map in PDF

...and other Special Outputs

Cadastral maps in digital form are not for disposal over the whole territory. In areas without digitized cadastral map the raster picture of the cadastral map is for disposal.

Outputs from the Cadastre acquired in this way (e.g. Excerpt from the Cadastre) are both formally and factually identical with the documents issued by the cadastral office. Certified electronic signature is embedded in the outputs. Data provided via Remote Access can be considered completely updated because all changes of internal central database are transferred in 20 minutes interval to the Remote Access database as a rule. The Remote Access allows providing historic outputs as well; it means it allows generating outputs that have the same content like as those, that were done on a historical day.

The Remote Access was designed for registered customers, what can be almost anyone – real physical person or legal person. The procedure of gaining the access to the Remote Access includes only fulfilling an application form and proving the identity. This is necessary for guarantee of a payment and to be able to declare which outcome was created by whom

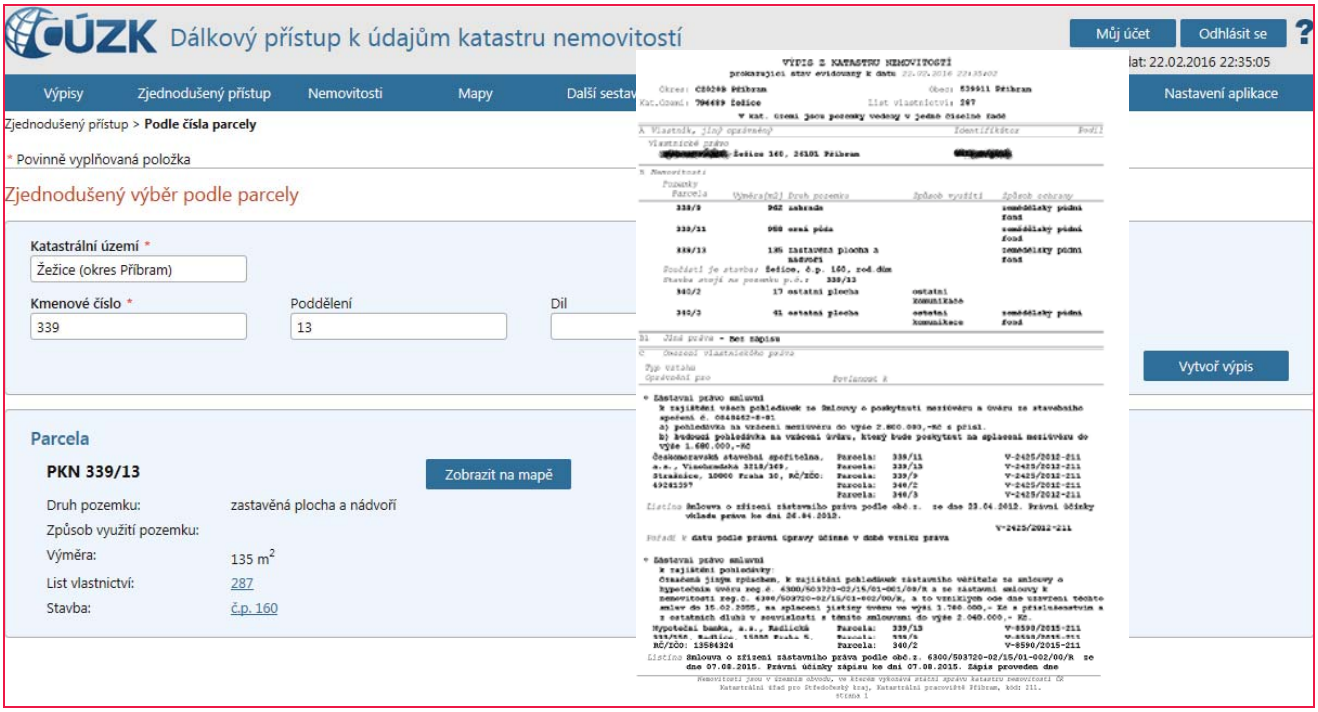


Figure 5: Output from Remote Access – excerpt from the Cadastre of Real Estate

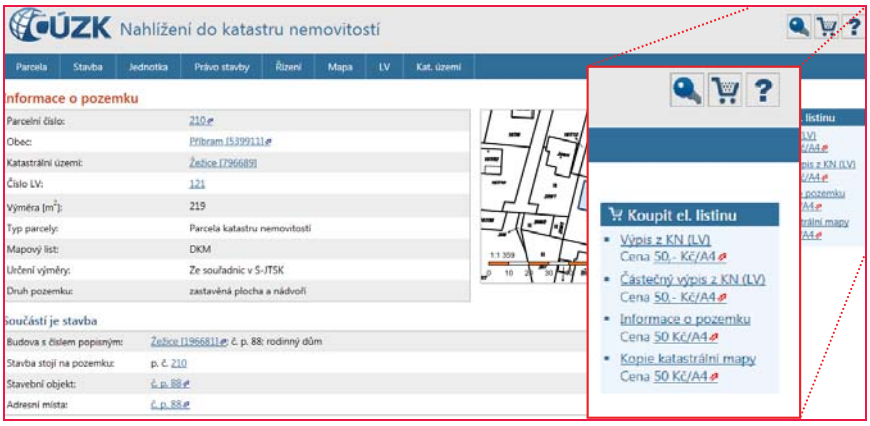


Figure 6: Access to payment portal

Web Services of the Remote Access to the Cadastre of Real Estate

Web Services of the Remote Access is the separate part of the Remote Access application with the programme interface for access to cadastral data. Application enables connection of information systems of single users to this interface and via it utilization of cadastral data. Web Services provide data in the PDF or XML format and the scope is:

- Excerpt from the Cadastre of Real Estate
- Information about Parcels
- Information about Buildings
- Information about Flats and Non-residential Premises (Units)
- Information about Building Rights
- Ownership Overview
- Existence of Rights for a Person
- Course of Proceeding
- List of coordinates of definition points (approximate centre of building or parcel)

Web Services application is charged and can be used solely by the registered users. The way to be registered is the same as in Remote Access, only the created account has to be different. The outcomes in PDF format are authorized by electronic signature.

Payment Portal

Payment portal allows anyone to obtain selected authorized digital outputs without having a user account. It is focused on customers that immediately need an authorized output and are able to pay for it online by credit card.

Payment portal is an element combining the Consultation of the Cadastre and the Remote Access to the Cadastre. The interested person selects data and type of output via the Consultation of the Cadastre and the output is done by Remote Access to the Cadastre. Before downloading the output has to be done payment via secured Payment Portal. There is possibility to choose between following types of outputs:

- Excerpt from the Cadastre of Real Estate
- Information about Parcels
- Copy of the Cadastral Map in PDF

Monitoring of Changes in the Cadastre of Real Estate

The Service for monitoring of changes in cadastral data is provided to those persons who have real right to particular real estate or to participants of proceeding about such a right. It can be:

- the Owner,
- the Pledgee or Subpledgee,
- Easement Beneficiary,
- Pre-emptive right Beneficiary in case it is stipulated as material right,
- Beneficiary of the Right to purchase back, Right of better purchaser, Leaseholder or Tenant.

The service automatically informs the user about the fact, that there occurred a change in the Cadastre regarding the monitored real estate. The change means:

- Notice marking that the rights to real estate are affected by a change,
- Entry performance,
- Record performance,
- Note registration.

Messages of the Service for monitoring changes are informing about the change of data connected to the property. The messages are being sent at the latest within 24 hours after the monitored incident occurs.

Information about changes can be sent as a notification via Data box, e-mail or SMS or via web services in XML format. The service is charged and can be used solely on demand of the authorized person.

Conclusion

Information about real estate and property rights to them is needed for proper functioning of public administration and a real estate market. All above mentioned cadastral electronic services significantly contribute to the ease of obtaining the required information, to more efficient electronic communication in matters of registration of rights in the cadastre and to increase the security of real estate transactions. The whole process of computerization of the cadastre is the result of long-term conceptual steps that reduce costs and allow satisfaction of the increasing demand for cadastral information.

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The paper was presented at FIG Week 2016, Christchurch, New Zealand, 2-6 May, 2016

Water quality estimate in the Isahaya Bay with UAV

In this study, in the Isahaya bay, the correlation among water quality indexes was very high and water quality could be estimated at high accuracy

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Water gates in the Isahaya bay were closed because of reclamation construction which started in 1989, and water conversion became a very serious problem. Then, the authors have carried out remote sensing research with a few centimeters of resolution and 6 bands. We took pictures by UAV and a camera on the ground with two infrared filters from May to August in 2016. The research had the following four processes. First process is acquiring picture data. The data of RGB was acquired by UAV directly, and we acquired the ocean temperature data from Japan Coast Guard. Second, we performed multivariable analysis. Multivariable analysis was applied for water quality in the Isahaya bay and picture data, and regression lines of water quality were obtained by calculating six bands. Third, using these regression water distributions were mapped by PhotoScan (three-dimensional structure software) each water quality. As a result, UAV was available for water quality estimate. Correlations among the water quality were very high. In this research, mapping water quality in the Isahaya bay was successful for environmental management using UAV. The advantage of mapping was visualization of numerical analysis for water quality.

Introduction

Recently, in the Isahaya bay, a critical problem with the worse environmental system occurred as well as rapid water conversion. After constructing the levee in the Isahaya bay, during winter, higher amount of solar radiation than usual and nutrient flow made red tide, then the color of laver seaweed became faded (Koibuchi, 2003), and the reclamation of the Isahaya bay made worse infections to the coastal environment and became a problem in the society. This is estimated that breaking down the periodic current made water quality worse by the construction of the levee in the Isahaya bay. However, preconstruction data in the Isahaya bay was so little. Some people of learning say there is the correlation between the construction of levee of the Isahaya bay and the water quality getting worse, others say there reveals no correlation (Tsukamoto and Yanagi, 2002, Odamaki *et al.,* 2003, Nishinokubi *et al.,* 2004, Komatsu *et al.,* 2004, Tai *et al.,* 2006). There is some correlation between fishery collapse in the Isahaya Bay and the Ariake Sea and construction of the levee. The Isahaya bay is damaged area on fishery. Especially, in summer in the Isahaya bay, dysoxic environment forms with density stratification in the low layer (Nakayama *et al.,* 2004). Moreover, in summer of 2008, as current due to southwest wind occurred, blue tide occurred near the levee in the Isahaya Bay because of advective flow in the dysoxic water body (Tada *et al.,* 2009). Also, in the north sea of the Isahaya bay, the density stratification was formed, and dysoxic water body occurred (Tada *et al.,* 2008, Tai, 2015). Especially, on dry beach in Kama district, Konagai-cho, Isahaya, Nagasaki, cultivated Japanese littleneck died in large amount because of dysoxic environment (Fujii, 2003), and then, compressed air by the pump was injected (Hirano, 2010). In the Isahaya bay, 77% of dissolved oxygen supply for the low layer was estimated as vertical diffusion, while 23% was estimated as advective flow (Yamaguchi and Keizuka, 2006). Therefore, to clear the development mechanism for occurrence of dysoxic water body in the sea area, relationship between DO in the low layer, formation of the density stratification and flow characteristics was required. Also, application for water

(a) Isahaya Bay

(b) UAV picture of the Isahaya Bay on August 10th, 2016

Figure 1: Isahaya Bay and its 3D model

quality with UAV was carried out in the Isahaya bay (Otsubo *et al.,* 2016). As above, remote sensing on water quality estimate in the Isahaya bay was still not enough. In this paper, 7 items of water quality were examined with high spatial resolution.

Materials and Methods

Study area

The Isahaya Bay is located in the Ariake Sea, Nagasaki prefecture, western Japan as shown in Figure 1 (a). The three-dimensional UAV picture of the Isahaya bay is shown in Figure 1 (b).

Data acquisition

Remote sensing data in the research was obtained by UAV in the field and from the seawater temperature by Japan Coast Guard. Also, wa ter quality data were obtained from water examination.

Table1: Bands, colors, and wave lengths

Band	Color	Wave length(μm)
band1	Blue	0.45-0.52
band2	Green	0.52-0.60
band3	Red	0.63-0.69
band4	Near-infrared	0.76-0.90
band5	Middle Infrared	1.55-1.75
Band6	Thermal Infrared	7.5-15

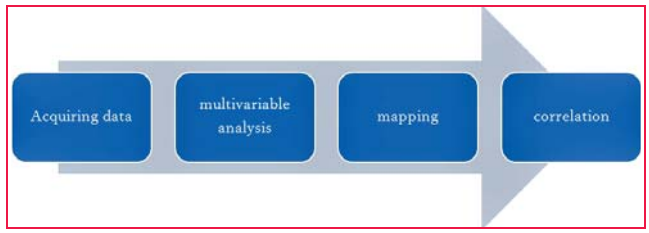

Figure 2: Flow Chart of methodology

Figure 3: Observation points in the Isahaya Bay

Table 1 shows six reflection bands, colors, and wave lengths. Bands 1 to 5 were obtained by UAV and a digital camera on the ground, and band 6 was obtained from MODIS and a thermal camera.

Methodology

The data was made through four processes. First, the authors acquired RGB data by UAV in the field directly, and the ocean temperature data were acquired from Japan Coast Guard. Second, from obtaining water quality and acquiring water image data, multivariable analysis was applied to get water quality regression lines. Third, for mapping of water quality, the authors substituted water quality regression lines by multivariable analysis into PhotoScan. Finally, for correlation, the authors collected the data from water quality correlation.

Acquiring data

Photograph data

The authors performed the field study on May 7 and August 10 in 2016 in the Isahaya bay, using UAV (Phantom3 and Phantom4) to take photographs from the sky and a digital camera on the ground. Each photograph has GPS information: latitudes, longitudes, and altitudes. The authors were able to construct the three-dimensional form by PhotoScan. Also, the sea temperature data were acquired from MODIS.

Water quality

On May 7, 2016, water was sampled with GPS at 7 observation points as

Table 2: Multivariable analysis results of water quality index

Chlorophyll-a(µg/l)	-0.42579band1+1.117162band2-0.20073band3-12.8229 (R^2=0.974)
Chlorophyll flu(ppb)	-0.3149band1+1.06639band2-0.23213band3-14.4288 (R^2=0.966)
Conductivity(µS/cm)	-0.00621band1+0.031521band2-0.01574band3-0.0706 (R^2=0.736)
EC25(µS/cm)	-20.2828band1+96.21022band2-39.8845band3-1423.55 (R^2=0.856)
Turbidity(FTU)	0.415342band1-3.21939band2+1.15969band3+146.5618 (R^2=0.997)
DO (%)	13.34633band1-161.143band2+54.28449band3+5342.509 (R^2=0.9998)
DO (mg/l)	1.226378band1-14.5166band2+4.888766band3+480.017 (R^2=0.999899)
Water temperature (°C)	-0.02538band1+0.084851band2-0.01792band3+18.47159 (R^2=0.424)
pH	-0.00779band1+0.047586band2-0.01211band3+7.403285 (R^2=0.809)
Salt (mg/ml)	-0.000979band1+0.046617band2-0.01933band3-0.69452 (R^2=0.863)

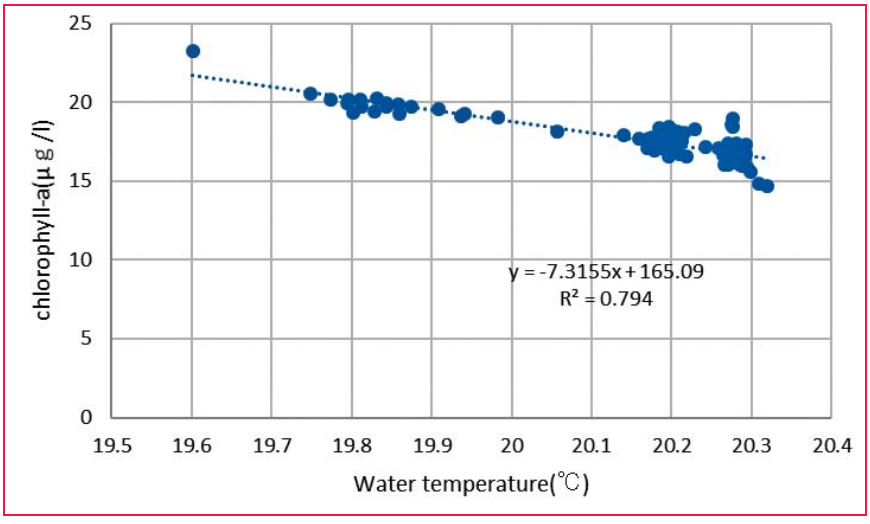

Figure 4: Correlation between water temperature and chlorophyll-a

shown in Figure 3. Water quality index were chlorophyll-a, chlorophyll-flu, conductivity, EC25, turbidity, DO, DO, water temperatures, and salt content.

Multivariable analysis

The multivariable analysis was applied for water quality data using bands1, 2, and 3 to get regression equations. Water quality was estimated by these equations, and then, the water quality indexes are shown in Table 2.

$$y = A \cdot band1 + B \cdot band2 + C \cdot band3 + D$$

Mapping

Mapping of the water quality indexes was made from the expressions of multivariable analysis using PhotoScan, which estimates water quality from RGB with functions.

Correlation

The correlation among water quality indexes were calculated at the observation station1, and then the correlation became high or low.

Results and Discussion

Correlation

Table 3 shows the correlations among the water quality indexes. Chlorophyll-a and water temperature negatively correlated as shown in Figure 4. In the Isahaya bay two types of water body exist, river flow and the sea water. The former has low temperatures and high nutrient salts

Table 3: Water quality correlation

	clorophyII a	conductivity	EC25	turbidity	DO (%)	DO (mgl)	water temperature	pH	salt content
chlorophyII a	1	0.82834485	0.829832	0.6985599	0.6638057	0.666518	-0.891082478	-0.88251	0.829332198
conductivity	0.8283448	1	0.999988	0.7641058	0.6390488	0.642467	-0.933428281	-0.87538	0.999961227
EC25	0.8298321	0.99998839	1	0.7653619	0.6404385	0.643856	-0.934705285	-0.87671	0.999974759
Turbidity	0.6985599	0.76410581	0.765362	1	0.4284337	0.431134	-0.683920723	-0.61624	0.768651956
DO (%)	0.6638057	0.6390488	0.640438	0.4284337	1	0.999988	-0.764416881	-0.79722	0.63901742
DO (mg/l)	0.6665181	0.64246668	0.643856	0.4311341	0.9999881	1	-0.767446777	-0.79982	0.64243261
water temperature	-0.891082	-0.9334283	-0.93471	-0.683921	-0.764417	-0.76745	1	0.967946	-0.93351276
pH	-0.882508	-0.8753583	-0.87671	-0.616235	-0.797219	-0.79982	0.967946465	1	-0.87498728
salt content	0.8293322	0.99996123	0.999975	0.768652	0.6390174	0.642433	-0.933512757	-0.87499	1

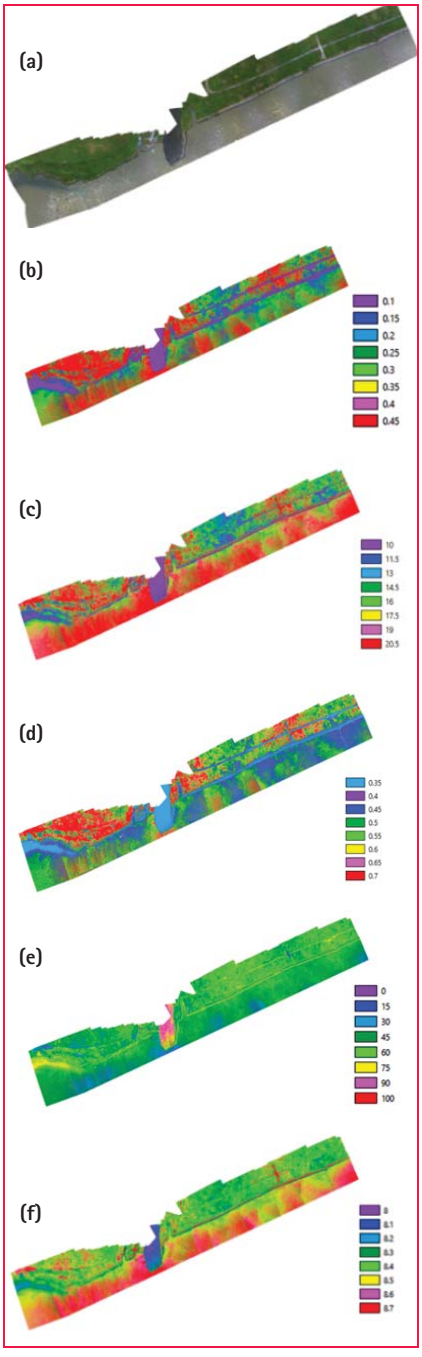

Figure 5: Spatial distributions of water quality indexes using UAV in the Isahaya Bay
(a) Orhophoto (d) conductivity
(b) salt content (e) turbidity
(c) chlorophyll-a and (f) pH

that relates with sewerage, while the latter has high temperature in summer and low nutrient salts. This mechanism suggests negative correlation between chlorophyll-a and water temperatures. Moreover, there is negatively-correlated between water temperature and DO, which suggests that water temperatures drive oxygen consumed. In Table 3, there are a lot of correlations among almost water quality indexes.

Mapping Data

Water quality index distributions are summarized in Figure 4. (a) is combined photos by UAV. (b) is salt content distribution, and it shows Hommyo river flows into the bay. Thus, the Isahaya bay was water conversion state. (c) is chlorophyll-a distribution. There were much Chlorophyll-a on the sea, while a little in the river. (d) is conductivity. Conductivity near the river was lower than the sea. Conductivity is almost proportion to salt content. (e) is turbidity distribution. Turbidity comes from mostly soils. (f) is pH distribution. pH depends on carbon dioxide, which relates chlorophyll-a.

Conclusions

Using the mapping data and correlations among water quality as well as multivariable analysis, the authors were able to study the water quality analysis. In this study, in the Isahaya bay, the correlation among water quality indexes was very high and water quality could be estimated at high accuracy. Therefore, water quality distribution could be obtained with high spatial resolution using UAV.

Acknowledgments

The authors appreciate Akihide Tada and Gaito Yamada greatly for technical assistance with the experiments.

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Galileo search and rescue service ready for green light!

The Galileo Search and Rescue (SAR) service is Europe's contribution to the international emergency beacon locating system called COSPAS-SARSAT. This essential Galileo service has the potential to dramatically reduce the time to locate and reach people in distress on sea and land.

In the 2017 Munich Satellite Navigation Summit held last month in Munich Germany, Mr. Xavier Maufroid of the European Commission welcomed participants to the first ever discussion of Galileo SAR by screening a preview of the service's launch video. The service itself will be officially launched on 6 April 2017 – a date chosen to highlight the COSPAS-SARSAT 406 MHz signal.

He described the Galileo SAR service as the fruit of a "long-lasting collaboration with COSPAS-SARSAT" that began with the early offer from the European Commission to host COSPAS-SARSAT signal repeaters on the satellites. The SAR antennae weighed only 8 kg and consumed just 3 % of the satellite's power. He stated that: "The SAR service represented just 1 % of total Galileo programme costs, but should result in thousands of lives being saved."

Steven Lett, Head of COSPAS-SARSAT Secretariat based in Montreal, described the service that had helped rescue some 42 000 people since 1982. It was not a regulatory agency, but enabled the delivery of global alerts to over 200 countries and territories, whether they were members of the organisation or not. It was the only system that can independently locate a distress beacon wherever it was on Earth. The Galileo service was part of an upgrade of the COSPAS-SARSAT system, which would eventually see it hosted on three medium-earth orbit (MEO) GNSS hosts: Galileo, GLONASS and GPS. "Galileo will be the first full constellation with global SAR capability," said Lett. "This new MEOSAR system has a larger footprint than the current low-earth orbit (LEO) system." It also provided improved location accuracy, and the return link available on the Galileo implementation allowed a reassuring response to be sent to the person who had activated the beacon.

The Galileo SAR is operated by the French Space Agency CNES in Toulouse. Jérémie Benoist from CNES described the various components of the system and highlighted the global nature of its reach. This will be further improved when a fourth element of the Galileo SAR ground segment is established on the French island of La Reunion in the Indian Ocean to better cover the southern hemisphere. The performance of the service was already impressive. "Even though only nine Galileo satellites are fully commissioned currently, the system is performing better than its specification," he said.

And the system has already proven its worth. Tore Wangsfjord is Chief of Operations at Norway's Joint Rescue Coordination Centre and is responsible for search and rescue operations in a huge region, covering from 55 degrees north to the North Pole. Most of his operations are in response to 406 MHz beacon alerts as there are no other communication systems in the area. The northern ground segment for MEOSAR has been hosted in Spitsbergen since 2013.

"The results with Galileo have been good so far and will improve with more satellites," he said. Wangsfjord compared a recent mission in response to a distress signal from a crashed helicopter in the far north of Norway. The distress signal from the Galileo SAR system arrived at his centre 46 minutes before the current LEO system and its position was within 100 metres of the actual crash site, while the LEO system position proved to be some 1.5 kilometres from the site.

"This is just one of several real life distress situations where MEOSAR has already shown improved accuracy and timing," he said. "Galileo SAR will undoubtedly contribute to saving lives."

Finally Eric Pautal from French 406 beacon manufacturer ELTA looked to the future and other potential applications for the COSPAS-SARSAT system. He reiterated that the MEO implementation gave better coverage and better accuracy, which may be appropriate to address the requirements of the new commercial airline regulations. From 2021, a new Global Aeronautical Distress Safety System (GADSS) to track and locate all international commercial air transport aircraft with a take-off mass of 27 tonnes or more will be required. "Flight location will be normally transmitted every 15 minutes," he said, "with autonomous distress tracking triggered by abnormal events increasing flight location transmission to once per minute." This could be yet another important opportunity for the use of Galileo SAR technology. *http://www.gsa.europa.eu*

Nepal is using GPS to catch Mount Everest cheaters

Some climbers attempting to scale Mount Everest during the upcoming spring climbing season will be strapped with a GPS device to locate them in case they are in trouble and to prevent false claims of reaching the summit.

Hundreds of climbers are expected to attempt to climb the world's highest peak in April and May, but only a few will be fitted with the devices as an experiment.

The chief of Nepal's tourism department, Durga Dutta Dhakal, said the devices, costing about $300 apiece, would help locate climbers who are in trouble on the mountain so rescuers can be sent.

The devices will also track the movement of the climbers while they are on Everest. The data will be checked after they get back from the mountain to determine whether they reached the summit and should be issued a climber's certificate. *http://nypost.com*

GLONASS ground station goes live in South Africa

A GLONASS ground station was officially commissioned in South Africa earlier this year.

"Assembling and pre-commissioning work was completed on Nov. 25 to set

up a measuring station on the premises of the Hartebeesthoek Radio Astronomy Observatory (HartRAO) as part of the agreement signed between Russia's High-Precision Instrument Systems Company and South Africa's HartRAO on Oct. 29, 2015," said the station developer, Russia's Precision Instrument Systems Corporation.

Sazhen-TM-BIS station in South Africa is the second station of the overseas network segment created for the GLONASS system. The first station was installed and commissioned in 2014 in Brazil. The station will continuous monitor GLONASS and GPS satellites' navigation signals, measurements of current navigation parameters of their travel, and receipt of navigation messages from the satellites.

GPS + Galileo = better navigation

The Australian government and Lockheed Martin intend to demonstrate how to combine two different satellite navigation systems. Lockheed Martin is partnering with the Geoscience Australia agency to combine signals from the GPS and the Galileo satellite constellation.

Basic GNSS signals will be monitored by widely distributed reference stations operated by Geoscience Australia, said Lockheed Martin. A SBAS master station will collect that reference station data, compute corrections and integrity bounds for each GNSS satellite signal, and generate augmentation messages. *www.c4isrnet.com/*

Aireon and Thales Begin Validation of Space-Based ADS-B Data

Aireon has announced that Thales has officially begun the testing and validation of the Aireon space-based Automatic Dependent Surveillance – Broadcast (ADS-B) data. Initially signing a Memorandum of Understanding (MOU) in June of 2015, the start of data validation marks a major milestone for Aireon and Thales' efforts to ensure the successful integration of space-based ADS-B into the TopSky–ATC automation platform. *www.aireon.com*

MapmyIndia and LetsVenture partnership

Mapmylndia and LetsVenture have recently announced their partnership to encourage startups and developers in India to leverage Mapmylndia's map and location technology stack to solve problems for Indian and global markets, and to get the opportunity to pitch for investments from leading angels and institutions that are part of the LetsVenture platform. *http://mapmyindia.com/eloc*

Bluesky 3D laser maps will help protect coastal heritage sites

The Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW) has commissioned aerial mapping company Bluesky to capture highly accurate laser maps of six coastal locations in the Irish Sea. The new five-year CHERISH project, funded through the European Union's Ireland-Wales programme, will analyse coastal and island archaeology and maritime heritage sites most affected by climate change, coastal erosion, storms and rising sea levels. The early acquisition of the Bluesky LiDAR data for CHERISH will provide the first 3D data for many of the Welsh islands under study. *Bluesky-world.com*

South Africa unveils a map for bioenergy

South Africa will be able to identify opportunities for bioenergy and make strides towards a 'green economy', thanks to The South Africa Bio-energy Atlas.

At the atlas' recent launch in Pretoria, the country's Science and Technology minister said: "What the Bio-energy Atlas shows is that we have much higher potential for bio-energy than we ever thought,» she pointed out however, that it was important the country moved to take advantage of the opportunities offered by the green economy, saying: «We need to get off the starting line.»

The atlas is designed to work both as a data source and a decision support tool. It will identify the effects of climate change on the country and aim to ensure South Africa does not become a victim to them, but a contributor to sustainable development. Specifically, it is hoped the new atlas will contribute to securing a provision of sustainable, renewable energy. *http://www.bioenergy-news.com*

Vadodara, Gujarat to conduct GIS-based survey of properties in city

The Vadodara Municipal Corporation (VMC) will be conducting a GIS based survey of properties in the city. The civic body will be deploying technique for the first time. VMC officials said that the system will map all the properties in the city on a map obtained by the civic body from the National Remove Sensing Agency (NRSA). A pilot project of the GIS-based system was conducted at the ward nine of the civic body. Officials said that the new system will have all data regarding the properties in the civic body's precincts like the status of the payment of their property tax, their area, purpose of their use and others. *http://timesofindia.indiatimes.com*

Maha Metro's Project Management goes hi tech

Setting up an industry benchmark with one of the most innovative uses of Information Technology for infrastructure industry, Maha Metro a joint-venture of the Govt. of India and Govt. of Maharashtra announced 'Go-Live' of its Digital project management platform. Maha Metro's Digital Project Management Platform (5D BIM & ERP) has gone Live exactly as planned. In line with the global best practices, Maha Metro has adopted this pioneering approach of digital project management on 5-Dimensional Building Information Modelling (5D BIM) integrated with SAP ERP supported by Owner's Support Office (OSO) to complete its Nagpur and Pune Metro Projects with sanctioned cost and time and with highest quality and safety. Maha metro will also have BIM level 3 which is being deployed in advanced countries like UK and Singapore. Mega projects like Cross Rail of UK, Transport London, Sydney Metro and Mass rapid transit Malaysia are managing the projects on such systems. *http://www.india-press-release.com*

Remote GeoSystems launches LineVision Google Earth Extension

Remote GeoSystems, Inc. have released the all new LineVision™ Google Earth Extension – commercial software for UAV, airborne & terrestrial mobile inspection and survey projects requiring georeferenced video playback, analysis, collaboration and reporting using Google Earth & other GIS applications. Now anyone with a GPS-enabled video camera, drone or geospatial DVR that can geotag video in the proper format can immediately load their videos and photos to Google Earth along with compatible KML and other traditional geospatial data. *https://www.remotegeo.com*

3D Repo wins European funding for C3ISP system

3D Repo is to play a key role in protecting industry from cyber attacks after winning a major research grant as part of a European Commission-funded project. Backed by a project fund of five million Euros, 3D Repo joins a consortium of 11 leading IT and communications organisations led by CNR, Italy's National Research Council. Other members include Hewlett Packard Italiana, British Telecommunications and SAP. The aim of the project (http://cordis.europa.eu/project/rcn/202687_it.html) is to define a collaborative and confidential information sharing, analysis and protection framework as a service for cyber security management.

A survey by the European Union Agency for Network and Information Security (ENISA) revealed that three quarters of businesses have seen cyber security as a concern for some time, and most believed their business had been a victim of a targeted attack. In the UK alone, cyber crime's annual cost is estimated at £27 billion, of which £21 billion involves companies.

China launches remote-sensing satellite into orbit

China has launched an experimental satellite ''TK-1'' from the Jiuquan Satellite Launch Center, in northwest China, that will be used for remote sensing, telecommunications and microsatellite-based experiments. The 'TK-1' is the first satellite developed independently by the China Aerospace Science and Industry Corporation (CASIC), while the 'KT-2' rocket, characterized by its high efficiency of load and adaptability, is one of five carrier systems in the commercial space plan of the referred company.

Chinese scientists use remote-sensing tech to digitize Great Wall

Researchers from the Chinese Academy of Sciences (CAS) recently used remote-sensing equipment in their efforts to restore a vanished section of the Great Wall in Northwest China's Xinjiang Uyghur Autonomous Region.

By analyzing the local conditions of the landscape with remote-sensing technology, the researchers were able to recreate a digital model of the Great Wall. This section of the Great Wall was

built nearly 1,000 years ago to protect Xinjiang from invaders, but was gradually eroded over the centuries by wind and sand. Similar to radar, remote-sensing technology used in archeology makes use of electromagnetic waves to detect and observe relics located underground.

"Different from other areas of China, the Great Wall in Xinjiang didn't have connected high walls but were separate fortresses located at main roads and passes and along river banks," CAS researcher Nie Yueping told the People's Daily. So far, more than 600 locations making up the Xinjiang Great Wall have been discovered. (Global Times) *http://english.cas.cn/*

Japan launches new spy satellite to keep eye on North Korea

Japan launched a new spy satellite, the country's space agency said, as the region grows increasingly uneasy over North Korea's quickening missile and nuclear programs. The Radar 5 unit was carried into space on Japan's mainstay H-IIA rocket from a launch site in the country's southwest. It is meant to replace an existing satellite that is approaching the end of its mission.

Tokyo currently maintains three optical satellites for daytime surveillance and three radar satellites for nighttime monitoring. Two of those are backups. The new satellite will succeed one of the three radar satellites that was launched in 2011. The satellites are officially for "information gathering" — a euphemism for spying — but are also used to monitor damage in the wake of natural disasters. *http://www.japantimes.co.jp*

China to contribute US$64 million to 'Egypt Sat 2' project

Egypt and China signed letters of cooperation on Egypt's satellite project "Egypt Sat 2" which the Chinese government is contributing toward with US$64 million. Egypt and China are yet to conduct feasibility studies on the project, and planning to establish a vocational training center in the Suez Canal economic zone through a Chinese grant equivalent to US$7 billion, Minister of International Cooperation Sahar Nasr said. The letters of cooperation came in accordance with agreements during the latest visit of the Chinese president to Egypt. China will contribute to developing the skills of Egyptians, especially in the field of scientific research and remote sensing, as China is considered a leading country in these fields. Beside "Egypt Sat 2", China will contribute to development projects in the Suez Canal axis, Nasr pointed out. *http://www.egyptindependent.com*

EEA and EuroGeographics Partnership

The cooperation agreement signed on 29 March between the European Environment Agency (EEA) and EuroGeographics signals a commitment to make more national authoritative geospatial information available through the European Commission's flagship initiative for earth observation and monitoring.

The partnership agreement has five main objectives:

- To improve Copernicus access to EuroGeographics data and services, produced using official geospatial data from its members.
- To enhance the dialogue between Copernicus and EuroGeographics members.
- To foster knowledge exchange between Copernicus and EuroGeographics members.
- To promote awareness raising activities.
- To support initiatives to provide pan-European harmonised data services.

To facilitate coordination and communication between the two organisations, EuroGeographics is establishing a dedicated knowledge exchange network to share expertise and experiences. Feedback from the EEA will also provide invaluable input into the delivery of future European Location Services which are being developed by EuroGeographics and its members. *http://copernicus.eu*

Integrated ADS-B Technology to Improve Drone Safety

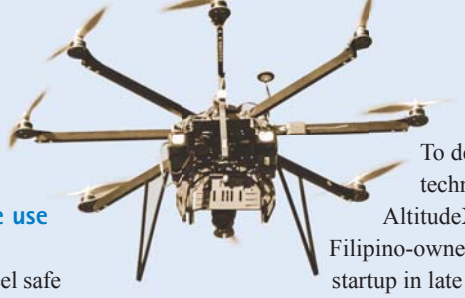
Kongsberg Geospatial has announced that with uAvionix, the two companies will be integrating Kongsberg Geospatial's IRIS UAS Airspace Situational Awareness Display with uAvionix's PingStation ADS-B receiver. Automatic Dependent Surveillance – Broadcast, or ADS-B transceivers help track the exact position of aircraft or drones in real time. uAvionix has created tiny, lightweight, and inexpensive ADS-B transceivers that can easily be installed in small UAVs, and the PingStation – a rugged, portable ground-based receiver that tracks the position of ADS-B-equipped aircraft within a range of up to 150 miles.

Kongsberg Geospatial has been providing real-time geospatial and spatial awareness technology to support air traffic management, air defense applications, and unmanned systems for nearly three decades. *https://www.kongsberggeospatial.com*

Insect-inspired fiberglass drone can survive almost any crash

Researchers at the Swiss National Centre of Competence in Research (NCCR) and the Floreano Lab at the Swiss Federal Institute of Technology in Lausanne (EPFL) have developed a new, crash resilient quadcopter, designed to withstand collisions. The drone is made of a central case and a thin fibreglass external frame with four arms held together by four magnetic joints. As this fibreglass frame is only 0.3mm thick, it is soft and flexible, making it able to withstand collisions without permanent deformation. The four magnetic joints connect the frame to the central case and rigidly hold the frame in place during flight.

Stefano Mintchev, the lead researcher on the project, developed a quadcopter utilising the dual stiffness properties seen in insect wings. Insect wings are composed of sections made of cuticle, a stiff material that takes the load bearing portion of the wing, connected with flexible joints made of the protein resilin that have evolved to be shock absorbent and compliant. www.epfl.ch



Measures to protect Canadians from reckless drone use

Canadians expect to feel safe on the ground and in the sky. The number of incidents involving recreational drones has more than tripled since 2014, prompting the Honourable Marc Garneau, Minister of Transport to introduce a measure to prevent the reckless use of drones that is putting the safety of Canadians at risk. The minister recently announced measures which will affect the operations of model aircraft and recreational drones of more than 250 g and up to 35 kg.

The key new rules are that recreational drone operators must mark their drone with their contact information, and may not fly:

- higher than 90 metres; at night; within 75 metres of buildings, vehicles or people; or within 9 kilometres of the centre of any airport, heliport, aerodrome or water aerodrome where aircraft take off and land.

Operators of drones for commercial, academic or research purposes are not affected by this measure. *www.canada.ca/drone-safety*

Philippines to use drone to regulate mining industry

The Government of Philippines is being urged to use and invest in drone technology in regulating the highly-scrutinized mining industry. Students from the University of the Philippines (UP) are now pushing for the use of drone technology that will make auditing mining firms cheaper, faster, and more accessible. Recent issues surrounding the Department of Environment and Natural Resources (DENR) and its recent closure of major mining firms throughout the country have sparked public outcry.

"Monitoring and auditing mining firms using traditional tools is an expensive procedure done over weeks and months, but with the use of drones, we can perform the process in mere days. This can help in making sure mining firms follow regulations," said UP student Luis Sia. To develop the technology, Sia started AltitudeX, a 100-percent Filipino-owned technology startup in late 2015, to provide fast, reliable, and cost-effective services using innovations in Unmanned Aerial Vehicle (UAV) or drone technology. *http://business.mb.com.ph*

PrecisionPoint hires sUAS Pilot to enhance 3D Reality Capture Services

PrecisionPoint Inc., a national provider of 3D reality capture laser scanning and SCAN-to-BIM Modeling solutions, has announced the hiring of Will Hirschfeld, an experienced Unmanned Aerial System (sUAS) pilot. Hirschfeld will assist PrecisionPoint as it enhances existing 3D documentation capabilities and expands into new services areas using sUAS technology, including Construction Monitoring, Precision Agriculture Inspection Monitoring, Infrastructure, and Forensics. *https://www.suasnews.com*

senseFly partners with MicaSense for End-to-End Drone & Data Solution

senseFly has signed a commercial agreement with agricultural data gathering, processing and analytics provider, MicaSense, that enables senseFly and its distribution partners to offer MicaSense's Atlas cloud processing platform alongside eBee drones. MicaSense Atlas is a cloud-based data processing and analytics platform. It generates specialized crop health outputs such as NDVI, NDRE, RGB and chlorophyll maps, providing quantitative information at the click of a mouse that can be used to properly interpret and understand the condition of a crop. *www.precisionfarmingdealer.com*

DJI's new range of drones minimise crash risk with other aircrafts

Drone manufacturer, DJI, unveiled its latest M200 series drone models with plane avoidance technology. It uses ADS-B (automatic dependent surveillance broadcast) receivers, which detect broadcasts from nearby manned aircrafts; including, planes and helicopters. ADS-B, which stands for Automatic Dependent Surveillance–Broadcast, is becoming a standard way for aircraft to share their own location and communicate with other nearby aircraft. It's more accurate than radar, and lets aircraft automatically do their own air traffic control. The new technology will allow drone users to see the position, altitude and velocity of nearby manned aircrafts. The drone user can then take necessary action if required. DJI says it's been hearing for some time that more industrial users need a more industrial drone.

Emissions mapping through drone-mounted sensors

Innovative Finnish cleantech startup Aeromon has developed a unique platform for rapidly mapping over 70 different industrial emissions. By deploying sensors in static, hand-held and drone-mounted configurations, Aeromon uses its cloud-based service to fluidly analyse emissions patterns in any industrial setting - including those that previously proved difficult to access. This enables Aeromon clients to save more time and resources than ever before when managing the environmental effects of their operations, and to protect members of the public from potential unforeseen hazards.

Aeromon successfully conducted pilots at the Ämmässuo waste treatment centre (operated by the Helsinki Region Environmental Services Authority HSY, Finland) in 2015, and in oil and gas industry sites in 2016. The pilots demonstrated the potential to make significant efficiency and financial savings in process industry monitoring applications. *aeromon.fi*

Rakuten and AirMap announce Joint Venture

Rakuten, Inc., and AirMap have announced the launch of a joint venture, Rakuten AirMap, Inc. The joint venture will provide Unmanned Traffic Management (UTM) solutions to drone operators and airspace managers in Japan. The partnership follows Rakuten's participation in AirMap's recent Series B investment round in February 2017. *https://soraraku.rakuten.co.jp/airmap/en/*

Hemisphere GNSS News

C321 RTK Base & Rover and SiteMetrix™ Site Mgmt Software

Hemisphere GNSS, Inc. debuts the C321 GNSS Smart Antenna and SiteMetrix Site Management Software. When paired with SiteMetrix, the next-generation multi-frequency, multi-GNSS C321 antenna can be used as an all-in-one construction base and rover site controller. Designed specifically for harsh construction environments, C321 adds another system component and empowers heavy equipment manufacturers to deliver their own machine control and guidance solutions to their customers.

Vector™ VR1000 Rugged GNSS Receiver

Designed specifically for harsh machine control environments, the multi-frequency Vector VR1000 multi-GNSS receiver offers RTK positioning and high-precision heading. It adds another system component and empowers heavy equipment manufacturers to deliver their own machine control and guidance solutions to their customers. The 744 channel VR1000 excels in difficult environments, tracking GPS, GLONASS, BeiDou, Galileo, QZSS, and IRNSS. www.HGNSS.com.

A326 GNSS Antenna for Machine Control

Purpose-built for harsh machine control environments, A326 adds another system component and empowers heavy equipment manufacturers to deliver their own machine control and guidance solutions to their customers. Designed to excel in challenging environments, the multi-frequency, multi-GNSS A326 uses Hemisphere's powerful Athena™ RTK engine and is Atlas® L-band capable. It is equipped with internal memory for data logging, download, and upload, and offers an on-board Wi-Fi hotspot. The addition of the easy-to-use webUI for quick and customized configurations makes the A326 one of the most versatile smart antennas available.

Trimble incorporates Galileo support

Trimble has introduced the version 3.10 of its Trimble® Pivot™ Platform software, a modular solution for real-time GNSS infrastructure management, ranging from a single- base GNSS Continuously Operating Reference Station (CORS) to a full Real-Time Network (RTN), serving thousands of end-users worldwide.

Version 3.10 provides improvements to network performance and office and field productivity. The new features and capabilities include Galileo support, GPS L5 support, Code Bias Calibration client and server improvements, Sparse Network: supports Galileo and BeiDou. Sparse Network, a Trimble technology, enables RTN operators to achieve the benefits of a full network-processed GNSS constellation even if the network is not fully covered with multi-constellation CORS and Dynamic Station Coordinates (DSC) module improvements. *www.trimble.com/rtn*

SBG Systems' new generation of the Ekinox Series inertial sensors

SBG Systems has announced the new Ekinox 2 Series, a new generation of the SBG's advanced and compact inertial navigation systems. With new accelerometers and gyroscopes, Ekinox 2 attitude accuracy has been enhanced by a factor of two while improving resistance to vibrations and integrating the Beidou constellation.

Ekinox Series is a line of tactical grade MEMS-based inertial navigation systems. Released in 2013, Ekinox has achieved a remarkable success thanks to its smart balance of accuracy, price, and weight. With the same form factor and price level, Ekinox 2 Series improve the precision of Mobile Mapping Systems whether they are aerial, terrestrial, or even pedestrian. This new generation provides 0.02° roll and pitch, 0.05° heading, and a centimeter-level position. It is ideal for LiDAR motion compensation and point cloud / images synchronization and direct georeferencing. *www.sbg-systems.com*

New versions of Bathy DataBASE, HIPS and SIPS

With HIPS and SIPS and the Bathy DataBASE (BDB) suites of products being closely aligned, the new BDB 4.3 release follows hot on the heels of HIPS and SIPS 10.2. These product lines now share a common core promoting tighter data interoperability.

The long anticipated 4.3 release of BDB now includes import and export for the generic Lidar format LAS 1.4. This is an important step in facilitating Lidar and laser scanning workflows and downstream data analysis. BDB 4.3 also supports the creation and management of Variable Resolution (VR) Surfaces. *www.teledynecaris.com*

Telit introduces SE868Kx-Ax series

Telit, a global enabler of the Internet of Things (IoT), has announced the introduction of new and advanced positioning modules in the SE868xx-Ax family featuring multi-constellation GNSS receivers with a 9 x 9 mm patch antenna. Telit's SE868Kx-Ax series offers unparalleled performance and is ideal for space constrained applications such as wearables, tracking, telematics, and security. The new integrated antenna modules include advanced features that significantly increase RF sensitivity, allowing for a much simpler integration without external components. *www.telit.com/gnss/*

OriginGPS launches world's smallest GNSS module

OriginGPS, has released new ORG 4500 series, a cutting edge, fully-integrated product that supports ultra-compact applications for both GPS and GLONASS. It addresses the ever-increasing demand for high precision with the smallest possible footprint, and takes the company's ground-breaking ultra-small form factor to a new level. *www.origingps.com*

Topcon Bundling ContextCapture in UAS Software Solutions

Topcon ContextCapture is built on Bentley's ContextCapture photogrammetry

Leica News

Zeno GG04 smart antenna

Leica Geosystems has announced the new Leica Zeno GG04 smart antenna, enabling a flexible solution to improve mobile devices' GNSS accuracy with Real-Time Kinematic (RTK) and Precise Point Positioning (PPP). Paired with the Zeno GG04, any Zeno or third party mobile device with Android or Windows OS can now collect highly-precise positioning data with Leica Geosystems' GNSS technology and industry-leading 555-channel tracking performance.

Leica ready now offered on John Deere motor graders

Leica Ready machine control kits will now be offered on G-series motor graders by John Deere, a world leader in providing advanced construction products and services. Leica Ready enables swift and fast installation of Leica Geosystems' Machine Control systems, such as Leica iCON iGG4 Dual GNSS for motor graders. The Leica Ready grader kits are made up of pre-installed cables and brackets, providing for an easier installation of Leica iCON grade solutions. *leica-geosystems.com*

ConX enables solutions to digitise construction processes

ConX is designed to increase collaboration and simplify the data handling of machine control operations by integrating workflows, enabling remote control of connected machines and real-time data exchange from the office to the field and back. This cloud enabled platform and web interface enables users to increase their efficiency on site and decrease their downtime while reducing the burden of data collection, aggregation and reporting.

tech. The solution targets the construction, surveying, and mapping markets, and comes in two flavors. The Standard version enables users to process photographic data into point clouds, reality meshes, and orthophotos, and comes with the Falcon 8 and Sirius Basic and Pro mapping solutions. The Advanced version adds functionality for processing data from "any UAS," as well as access to ContextCapture Editor.

German Mapping Authorities 40% faster

1Spatial, the global leader in managing geospatial data, automated map generalisation resulting in a 40 percent improvement in production time, from five to three years, for the participating members of AdV, the committee that coordinates surveying and mapping in Germany. AdV had previously worked to a five year production cycle for all of its high quality map products. However, this was no longer meeting the demands of customers who required information to be updated more regularly, and in shorter periods. Twelve of the 16 AdV members states decided to develop an automatic process to speed up production and reduce manual effort, and founded the IP-ATKIS-Gen project group. 1Spatial was selected as the IP-ATKIS-Gen partner for one of the largest generalisation projects in Europe. Together the two organisations developed an automated, "context-aware" solution using 1Spatial's experience and software tools. *https:///1spatial.com*

CMC introduces CMA-6024 GNSS for Helicopters

CMC Electronics introduces its new helicopter cockpit demonstrator and the CMA-6024 GNSS landing system. While not a new product from CMC Electronics, the CMA-6024 has been customized for rotorcraft operations to allow operators to achieve precision approaches to CAT II and CAT III minimums at helipads. CMC's CMA-5024 has long been available in a rotorcraft version and provides WAAS LPV approach capability. *http://www.ainonline.com*

Swift Navigation launches multi-band, multi-constellation GNSS

Swift Navigation's latest product, the Piksi Multi, is a multi-band, multi-constellation high-precision GNSS receiver. Measuring in at 48 x 71mm, it aims to create a revolution in advanced precision GNSS capabilities for the mass market. It supports GPS L1/L2 and is hardware-ready for GLONASS G1/G2, BeiDou B1/B2, Galileo E1/E5b, QZSS L1/L2 and SBAS. Multiple signal bands enable convergence times measured in seconds, not minutes. Multiple satellite constellations enhance availability in new environments.

Sokkia introduces GCX3 Integrated Receiver

Sokkia has introduced the latest addition to its GCX line of GNSS integrated receivers — the GCX3 — featuring advanced constellation tracking, open format software compatibility, and longer range base to rover communication. The receiver features radio-free RTK operation via multi-channel, long-range Bluetooth® technology. When used as a base station, one GCX3 may support up to three concurrent rovers at a range of more than 300 meters. *sokkia.com*

DFS and Unifly cooperate on the development of drone app

DFS Deutsche Flugsicherung based in Langen, Germany, and Unifly NV based in Antwerp, Belgium, signed a cooperation agreement recently to jointly develop and market a DFS drone app to be released on the German market later this year. This app will allow operators of UAS to determine where they can operate without posing a threat to manned aviation.

Pythagoras 15 officially released!

Pythagoras 15 is officially released with a lot of cool new features:

- Automated point cloud vectorization
- Classification of point cloud
- Enhanced DTM performance
- Updated profiling tools
- General performance upgrade

Data sets coming from total stations, GPS instruments, laser scanners, mobile mappers, UAV and drones, single and multi beam systems and other CAD and GIS software packages can be handled and processed with ease.

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MARK YOUR CALENDAR

May 2017

MMT 2017: The 10th International Symposium on Mobile Mapping Technology
6 - 8 May
Cairo, Egypt
http://mmt2017.aast.edu/index.php

XPONENTIAL
8 - 11 May
Dallas, USA
http://xponential.org

11th Annual Baska GNSS Conference
7 - 9 May
Baska, Croatia
www.rin.org.uk

The European Navigation Conference 2017
9 – 12 May
Lausanne, Switzerland
http://enc2017.eu

4th International Conference Geography, Environment and GIS, for students and young researchers
18 – 20 May
Targoviste, Dambovita, Romania
http://www.limnology.ro/GEG2017/abstract.html

3rd International Scientific Conference GEOBALCANICA 2017
20 - 21 May
Skopje, Macedonia
http://geobalcanica.org

GeoBusiness 2017
23 - 24 May
London, UK
http://geobusinessshow.com

FIG Working Week 2017
29 May - 2 June
Helsinki, Finland
www.fig.net

June 2017

10th International ESA Conference on Guidance, Navigation & Control Systems (GNC)
29 May - 2 June
Salzburg, Austria
http://esaconferencebureau.com

TransNav 2017
21 - 23 June
Gdynia, Poland
www.transnav.eu

2017 Baltic Geodetic Congress (Geomatics)
22 - 25 June
Gdansk, Poland
http://www.bgc.geomatyka.eu/2017/

July 2017

IGS 2017: International GNSS Service Workshop
3 - 7 July
Paris, France
www.igs.org

IEEE Frequency Control Symposium and European Frequency and Time Forum
9 - 13 July
Besançon, France
www.eftf-ifcs2017.org

Esri User Conference
10 – 14 July
San Diego, USA
http://www.esri.com/events/user-conference/papers

Geo4Africa Summit 2017 Conference
11 - 14 July
Kampala, Uganda
http://geo4africa.com

United Nations/United States of America Workshop on the International Space Weather Initiative
31 July - 4 August
Boston College, Massachusetts, USA
www.unoosa.org

August 2017

SEASC 2017
15-17 August
Brunei Darussalam
www.seasc2017.org/

September 2017

INSPIRE 2017
4 - 5 September, Kehl Germany
6 - 8 September, Strasbourg France
http://inspire.ec.europa.eu/events/inspire-conference-2017

Interdrone 2017
6 - 8 September
Las Vegas, USA
www.interdrone.com

ESA-JRC Summer School on GNSS 2017
4 - 15 September
Svalbard-Spitsbergen, Norway
www.esa-jrc-summerschool.org

56th Photogrammetric Week '17
11-15 September
Stuttgart, Germany
www.ifp.uni-stuttgart.de/phowo

ION GNSS+ 2017
25 - 29 September
Portland, USA
www.ion.org

Intergeo 2017
26 - 28 September
Berlin, Germany
www.intergeo.de

October 2017

ACRS 2017
23 - 27 October
New Delhi, India
www.acrs2017.org

KCS TraceME

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- Galileo: E1 / E1a / E5a / E5b / E6
- SBAS: WAAS, EGNOS , GAGAN, MSAS, SDCM
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