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 XV, Issue 9, September 2019

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

Is Blockchain a technological solution in land administration?

Galileo Outage

Reliability is a key factor for GNSS


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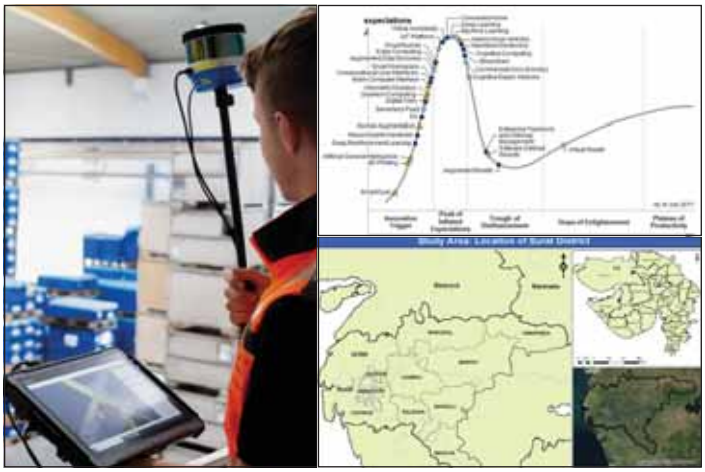

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This issue has been made possible by the support and good wishes of the following individuals and companies
Chris Rizos, David Last, Fabio Dovis, Kaisa Ridanpää, Kirsikka Riekkinen, Matteo Sgrenzaroli, Pauliina Krigsholm and Priti Deo and; CHC, EOS Positiong, Gexcel, Javad, Labsat, MicroSurvey, Pentax, SBG System, Tersus, Vexcel and many others

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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)

This issue of Coordinates is of 52 pages, including cover.

On the Moon

Despite the communication lost with the lander Vikram

On the early morning of September 7, 2019

Ninety five per cent of the mission Chandrayaan 2 objectives have been accomplished

As the Orbiter module

Will continue to carry out most of the scientific investigations

for over 7.5 years instead of one year as announced earlier.

Indian Research Space Organization's (ISRO) exploratory missions know no bounds

and will continue to dive deeper into the space.

Such space missions are more exploratory in nature.

They can neither be confined to the boundaries of success and failure

Nor be trivialized to premature celebratory blitz.

Instead, ISRO deserves accolades

for venturing in to an unexplored trajectory to reach south pole of the moon.

Though the lander Vikram could not land as planned,

We are on the moon, anyway.

Bal Krishna, Editor
bal@mycoordinates.org

"Our mission is to turn the latest scientific achievements in the field of Geomatics into hi-tech products and services"

Says Mr Matteo Sgrenzaroli of Gexcel srl, in an interview with Coordinates

Matteo Sgrenzaroli
co-founder and the person responsible for research and development at Gexcel srl.

Gexcel started with the mission to turn the latest scientific achievements in the field of geomatics into hi-tech products and services for wide areas of application. How far have you been able to achieve your mission?

We can say that we achieved our mission to create the route to move scientific achievements in the real world. Of course, it is a never ending task; the market is asking for more and more solutions and Gexcel is always more involved in hi tech R&D projects with key partners and scientific institutions, and working to introduce these achievements to the real world applications.

Gexcel began this mission 12 years ago by focusing on software applications to manage 3D point clouds and creating powerful tools for scans automatic alignment, meshing, texture mapping, and change detection that are merged into the well-known Reconstructor software.

Reconstructor engine is now adopted by several important Lidar manufacturers enabling their customers to achieve maximum results from their surveying systems. Building on this software skill, around 4 years ago we started to develop vertical solution as strong combination of hardware and software. We started with the Open Pit Mine Monitoring (OPMMS) solution for continues change detection with long range Lidar in dangerous areas, and we are going to launch a complete new version, very soon. Last but not the least, Gexcel HERON back pack for indoor mapping, positioning and real time change detection, is the last SLAM based solution that combines Lidar and 360° imagery, and is appreciated in the several applications field; construction, BIM, underground mining, industry, safety and security.

You call HERON solution 'More than a 3D mapping system'. Why? How this system has an edge over others and what applications is it best suited for?

The 3D mapping capabilities is just one of the functionality of HERON backpack. HERON was born as localization system and it provides the unique feature to automatically localize the user with respect to a previous acquired point cloud or CAD/BIM model. The user can then visualize in real time the differences between the reference model and the new acquisition.

Moreover during the post processing we introduced the possibilities to use portion of geo-referenced point cloud from different sensors as constrain in the SLAM process. HERON is having terrific feedback in the deep mining market and in the industrial field. The recent agreement with ClearEdge3D makes HERON a perfect solution for advancement work monitoring in construction and infrastructure. In the forensic and industrial field, the possibility to easily and automatically align outdoor MMS, hand held laser scanner, trypod scanner data, in the same platform is highly appreciated. The combination between HERON and the Gexcel's software Reconstructor makes the Gexcel iMMS an unique advanced productive tool.

Could you please tell us about Gexcel Lidar data processing software, Reconstructor? How has it benifitted your customers?

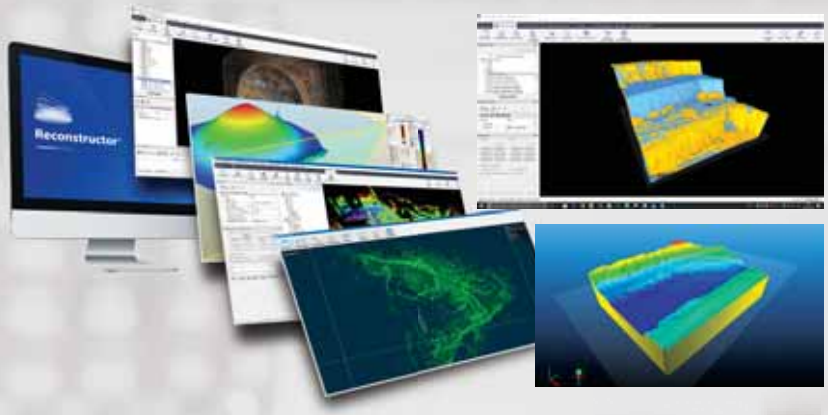
First of all Reconstructor is appreciated as a professional software platform independent from specific sensors but capable to manage in single platform raw data from multiple sensors including images. This benefit comes also from the strong Reconstructor capability of automatically aligning without target multiple point clouds.

In addition to that, our clients are choosing Reconstructor for vertical tools in the mining sector such as cut&fill volume calculation, DTM creation and crest&toe extraction.

In the construction and BIM sectors, Reconstructor is chosen for change detection, planarity and verticality tools, together with easy to use tools to create and share blueprints and orthophotos thanks to the new GoBlueprint free tool.

Could you tell our readers briefly about the presitigious collaboration between Gexcel and European Commission Joint Research Centre?

Gexcel was born as a Spin Off company of the University of Brescia and with a transfer technology agreement with the Joint Research Centre of the European Commission. The team that founded Gexcel is partially composed by researchers coming from the EU Commission Research labs.



Since its foundation Gexcel has defined a collaboration agreement with the JRC, having interesting and important technology benefits to Gexcel's products and solutions. It since 2008 that Gexcel has a transfer of technology and collaboration agreement with the European Commission, representing one of the best examples of how some technologies development in EU Research Labs can be transformed into excellent solutions for the real world applications. X

Multi-GNSS is making GNSS PNT commonplace

Says Chris Rizos, an Emeritus Professor in the School of Civil and Environmental Engineering and a co-director of the Satellite Navigation and Positioning (SNAP) Lab at UNSW

Chris Rizos is an Emeritus Professor in the School of Civil and Environmental Engineering and a co-director of the Satellite Navigation and Positioning (SNAP) Lab at UNSW. Chris is president-elect of the International Union of Geodesy & Geophysics (IUGG).

Professor Rizos' early fascination with old maps and Australia's exploring pioneers sparked his own exploration of what we know today as the global navigation satellite technologies of the future. His research in Global Navigation Satellite Systems (GNSS), and their applications extends across the whole spectrum of uses from Navigation to Geodesy. With over 20 years of service to some of the most prominent international geodetic organisations, he has had the opportunity to be part of the evolution of a field that has considerable global impact.

As a big picture thinker he has watched Geodesy rapidly evolve with its tools and datasets helping geoscientists monitor global change (including natural and climate change), changes in the environment (to ice sheets and atmosphere) and geohazards (volcanos and earthquakes), and surveyors and engineers applying these technologies from small-scale building works to international mapping projects. Through his research, Professor Rizos' aims to "spatially enable" all aspects of life, through the further development of technologies and systems that provide continuous, seamless, high accuracy positioning of objects, people and every feature on the surface of the Earth.

You have been active in international scientific unions, such as the IAG, and most recently you have been elected Vice President of the IUGG. Can you explain some of the activities of these organisations?

The international Union of Geodesy & Geophysics (IUGG – http://www.iugg.org), is the umbrella organisation for many of the geoscience disciplines which are organised as 8 Associations. The IUGG was established on the 28 July 1919, and recently celebrated its 100 year anniversary in Paris at UNESCO Headquarters (http://100.iugg.org). I have been elected Vice President for 4 years (2019-2023). The President is Professor Kathryn Whaller (Professor of Geophysics, University of Edinburgh), the first woman to hold this position.

As you can see from the Mission of the IUGG on its home page:

"The International Union of Geodesy and Geophysics (IUGG) is the international organization dedicated to advancing, promoting, and communicating knowledge of the Earth system, its space environment, and the dynamical processes causing change. Through its constituent Associations, Commissions, and services, IUGG convenes international assemblies and workshops, undertakes research, assembles observations, gains insights, coordinates activities, liaises with other scientific bodies, plays an advocacy role, contributes to education, and works to expand capabilities and participation worldwide."

- The 8 IUGG Associations (in alphabetical order) are:
- IACS (international Association of Cryospheric Sciences)
- IAG (Int. Assoc. of Geodesy)
- IAGA (Int. Assoc. of Geomagnetism & Aeronomy)
- IAHS (Int. Assoc. of Hydrological Sciences)
- IAMAS (Int. Assoc. of Meteorology & Atmospheric Sciences)
- IAPSO (Int. Assoc. for the Physical Sciences of the Ocean)
- IASPEI (Int. Assoc. Seismology & Physics of the Earth's Interior)
- IAVCEI (Int. Assoc. of Volcanology & Chemistry of the Earth's Interior)

Each Association operates in a semi-autonomous fashion, running their own conferences, programs, outreach, services, etc. Increasingly, however, the need for multi-disciplinary approaches to geoscience means that the associations are cooperating and running joint working

groups or commissions, supporting combined conferences, etc. This trend is expected to continue. Having said that, it is also true that all geoscience disciplines now use geodetic technologies (to varying extents), such as GNSS, gravity field mapping, InSAR, satellite altimetry, earth observation. Hence geodesy is increasing its "visibility" within the geosciences.

I was the IAG president for the period 2011-2015.

This is a world of multi-GNSS systems. What advantages do you see about this scenario?

The obvious advantages of multi-GNSS are related to measurements, signals and outputs. For example:

- More satellites increases redundancy and availability of signals, and increases precision of positioning results
- Multi-GNSS increases the number of signals, and hence increases robustness against jamming, etc.
- Multi-GNSS creates an environment of "friendly competition", whereby advances in signal design and capabilities are evident, hence increasing accuracy and reliability of positioning results

Other commentators may also suggest that there is increased "choice" in which constellations and signals may be tracked. However I believe that the manufacturers of systems & developers of services for professional (high accuracy) users will want to make measurements on ALL open signals from ALL GNSS (& RNSS) constellations. Interestingly, a similar trend is evident for mass market users (via smartphone devices), in that GNSS chips are now (& increasingly so) tracking ALL GNSS (& RNSS) constellations, but only on 2 frequencies: L1 and L5.

Having said that, there must be a optimal number of GNSS/RNSS/SBAS satellites that provide all the above advantages, but beyond which the "law of diminishing returns" comes into play. There is no agreed-to number, but in my opinion we have enough GNSS constellations, and probably hitting the limit of RNSS and SBAS constellations.

Many countries plan GNSS systems primarily because of defense and security needs. Do you think that this may trigger a race with more countries joining in? What would be the implications?

Following from my remarks above, I believe that it would be counter productive (not to mention wasteful) for more GNSS to be developed. We already have plans (or hints) that RNSS & SBAS will increase in the near future, with systems from Korea, Australia and Brazil, and perhaps Nigeria being added to these base constellations. All GNSS, apart from Galileo, are primarily funded for defence and security needs (although we could argue that Galileo's

I do predict that there will be a rush to develop "next generation" SBAS systems by many countries, as a means of delivering augmented PNT services to their nations (beyond aviation services). But I cannot rule out the possibility that even these will be ultimately out-numbered by systems launched and operated by private sector players

PRS is to some extent "militarised"). Some security component will no doubt be incorporated into ALL RNSS systems (e.g. so-called "restricted" or "authorised" signals). SBAS is a more complicated matter, as these "augment" the GNSS satellites, through provision of extra ranging signals and downlinks for augmented (accuracy and/or integrity) services to address only civilian applications.

I do predict that there will be a rush to develop "next generation" SBAS systems by many countries, as a means of delivering augmented PNT services to their nations (beyond aviation services). But I cannot rule out the possibility that even these will be ultimately out-numbered by systems launched and operated by private sector players. In fact, SBAS may evolve into systems that include (or be replaced by) downlink services from small, inexpensive LEO satellites (that do not require complex and expensive satellite clocks for GNSS signal generation).

How serious are the threats like interference, jamming and spoofing? How prepared is the GNSS community to deal with it?

Very serious! A day does not pass that we do not hear about jamming (and increasingly also spoofing) of user systems in localised areas. A few years ago we thought the threat was "misguided" individuals buying "privacy protection devices" from the internet, that jam GNSS at or near their truck, place of work, or home, in order to guard against unwanted (location) surveillance (where PNT or smartphone devices send coordinates to servers).

Though this is indeed a threat, it has not yet reached the predicted epidemic proportions. However, "state players" such as North Korea, Russia, Iran (& probably many other countries) have been denying PNT across

Unfortunately there is no alternative (non-GNSS) PNT (APNT) technology that simultaneously satisfies requirements such as low cost, low complexity, minimal infrastructure needs, wide/global coverage, adequate accuracy, high reliability & versatility

large areas, impacting mostly (currently) the aviation and marine user communities. E-warfare is of course what every country's military is gearing up as a capability to prosecute, and that means using means to deny GNSS capability to adversaries while somehow protecting their own capability. So there are no "bad guys" versus "good guys" in this respect. When President Trump visits another country, I suspect that there are localised GNSS jammers around his motorcade, just as is the case for Putin and Xi.

Spoofing is a more serious issue, as it is not a case of "GNSS denial of service" as in the case of jamming, but that it can result in seriously erroneous PNT results. Many instances of this have been identified, so this is no longer just a possibility, but a reality. Smarter receiver design, as well as some innovations in signals to protect against cyber attack, can go a long way to protect against spoofing. But currently we are a long way from these protective measures being implemented.

There have been a number of studies (and reports) on the impact of denial of GNSS service to society.

Thankfully, in "normal circumstances" (i.e. not a major nation-to-nation conflict) any such denial would be short-term, and relatively localised. Nevertheless we need, at the very least, detection systems that can alert users to jamming or anomalous GNSS operations. The recent 6 day Galileo outage was not caused by "nefarious players". Details of what did fail are not yet available. However, its outage did not impact users, as their receivers were able to continue to perform to specifications using measurements from the other GNSS/RNSS constellations. This reinforces (though does not entirely support) the notion that it is extremely unlikely that ALL GNSS can simultaneously experience an outage.

Jamming or spoofing of autonomous systems is of course the nightmare scenario. So we do need back-up technologies.

Given this, what's your opinion on GNSS back ups?

Unfortunately there is no alternative (non-GNSS) PNT (APNT) technology that simultaneously satisfies requirements such as low cost, low complexity, minimal infrastructure needs, wide/global coverage, adequate accuracy, high reliability & versatility.

Multi-GNSS is therefore seen as the ultimate "back-up" because it is assumed that not all GNSS/RNSS/SBAS signals and measurements will be denied to users for anything longer than perhaps a few hours. (But surely the most sophisticated GNSS denial will be using military-style e-warfare techniques, and we are seeing their effectiveness in the middle east and in baltic areas.)

There are some back-up options which have widespread applicability (not just global coverage, but also indoors), and most widespread is wifi-based positioning. But this is a relatively low accuracy positioning technology. With respect to navigation (especially autonomous systems), the solution is multi-sensor integration. In vehicles especially, GNSS may not even be considered essential for safety applications. As vision, Lidar and radar systems are better at "collision avoidance". Developments such as "clock-on-a-chip" can address the timing requirements of modern societies. New high-performance INS are likely to come down in cost and size over the coming decades, and may be used for more than just a back-up for GNSS.

Then there are the bespoke systems, such as high accuracy PNT technologies that operate where GNSS cannot operate reliably, such as indoors or in high multipath environments. Locata is one such example. However they cannot be considered back-ups, as they are expensive, deployed in "hot spot" mode, and due to them being based on terrestrial ranging signals, are able to provide coverage only over relatively localised areas.

You also worked on Locata terrestrial positioning system. Can you explain the significance of this system?

Locata is a high accuracy (centimetre-level) APNT technology based on terrestrial signals that are in many respects similar to GNSS signals. However the signals are transmitted in the non-licensed ISM 2.4GHz frequency band. Locata does have several innovative features that explain its high accuracy without the use of atomic clocks. However, in the short-to-medium term, there is no low-cost Locata receiver chip, and hence it remains only suitable for niche (and high-value) applications

such as autonomous vehicles in ports and open-cut mines. In the coming years Locata could be integrated into GNSS receivers intended for high-value professional markets.

Whats is your take on eLoran?

As a back-up its only advantage is wide area coverage (assuming there are transmitter towers), and relatively low-complexity (resulting in low-cost receiver solutions). Its accuracy is very poor (both in respect to timing and positioning), and would hardly be a true back-up except for some very specific marine and air applications (where wifi-based positioning cannot be used). I would rather see efforts made to test the "scaling up" of other PNT technologies across cities and later across provinces and states, such as Locata (and its competitors), as their accuracy is more comparable to GNSS than eLoran.

What influences you envisage in satellite navigation in the near future given the advancements in the field of AI, Autonomous Vehicles, UAV, etc.?

Advances such as those listed will impact users and applications. In general they will expand "automation", and in many instances increased automation (i.e. autonomous driving and transportation, automated mining, agriculture and construction, etc) will increase the need for PNT capabilities. Furthermore there will be increased demand for augmentation services, such as increased accuracy and increased integrity. As we mentioned above, such developments will drive the development of improved alternative PNT (APNT) technologies. Hence GNSS will become more important for the "digital transformation" revolution, in which AI, Big Data, 5G comms, UAVs, and automated systems all play their part. There is no doubt that without these requirements GNSS (and other PNT technologies) would remain a technology for primarily the professional markets, with its mass market use limited to LBS-smartphone applications (which have rather low performance requirements for GNSS-provided PNT results).

Geodesy has been an area where you have been very active. Do you think that Geodesy needs more attention as we do not find many Geodesists around?

Good question. Geodesy is becoming increasingly recognised as a vital component of what we might refer to as the Positioning Infrastructure, which underpins GNSS products and services (especially the augmented accuracy services).

I see the parallel development of alternative PNT technologies, being driven by mass market applications such as machine/vehicle automation. In some respects they would be complementary (able to operate when GNSS capability is unavailable), and even seen as back-ups to GNSS, but some of them, in some scenarios, will be true alternatives to GNSS

Geodesy is responsible for the reference frame in which high accuracy positioning is expressed. Geodesy also provides the basic services and infrastructure (national and international) that support high accuracy GNSS positioning. Hence geodesy is becoming more closely associated with all aspects of the geospatial disciplines, from positioning (3D, heights, etc) through to mapping (in 3D and 4D). This is a welcome development. (Another example is the UN resolution on the Global Geodetic Reference Frame – GGRF – championed by the UN-GGIM Committee of Experts.)

Geodesy is also increasingly providing the tools, services and infrastructure to support (geo)science. As indicated earlier, the visibility of the IAG (and hence geodesy) within the IUGG (its other 7 Associations) is much higher than it was a decade ago. For example, we now have new initiatives within the IUGG in "seismo-geodesy" and "volcano-geodesy".

Every discipline of science and engineering claims there is a shortage of qualified practitioners and researchers. Geodesy (and even surveying) is no exception. But where there are quality jobs and career paths, there will be incentives for highly trained individuals to "jump" sideways into areas where there is greater demand. Nowadays geodesists come through either the PhD training pathway (from many disciplines), or by receiving "on-the-job" training in geodetic institutes, government agencies, etc. What we need is a large pool of well-qualified scientists (in the geosciences, physical sciences and mathematical sciences) and engineers (geospatial, EE, IT, mechanical, civil engineering disciplines) to draw on. Exciting careers in geodesy, and in PNT technologies and applications in general, will be irresistible.

You had a long association with academia. Given the pace of technology evolution, would challenges you see before the academic community and GNSS education?

Academia educates professionals (such as engineers), and trains researchers (through PhD programs). The former obviously must educate graduates so that they are "job-ready". Some engineering disciplines will therefore use today's GNSS technologies. They will also be able to adapt to developments in GNSS/RNSS/SBAS. The postgraduates with PhDs will push the knowledge envelope, and hence will bring forth new ideas, new algorithms, etc, for GNSS technologies and applications. When these graduates are employed by companies, they will assist in the development of new products and services. When employed by government agencies they will assist in the implementation and operation of new or upgraded PNT systems (based on GNSS and APNT) for a whole range of applications.

Academics play very little role in promoting GNSS to the wider community. Nor in launching start-up companies that drive PNT innovation.

How do you perceive the direction of satellite navigation?

Multi-GNSS is making GNSS PNT commonplace. It is already a capability built into every smartphone. But I believe that there will be a "democratisation" of high accuracy (defined as being in the range of sub-metre down to centimetre), so that it will be available on many more devices (including smartphones) to non-expert users. This has challenges for the "experts" in academia (education and research) as well as the geodesy/geospatial professionals (implementing and operating the infrastructure to support high accuracy positioning).

I believe that the only area of expansion of satellite constellations and signals is for SBAS type systems (as mentioned earlier). These low-cost satellites could deliver augmented accuracy and integrity services by acting primarily as wide-area communications links, transmitting the correction/warning information necessary to enable augmented services.

But I see the parallel development of alternative PNT technologies, being driven by mass market applications such as machine/vehicle automation. In some respects they would be complementary (able to operate when GNSS capability is unavailable), and even seen as back-ups to GNSS, but some of them, in some scenarios, will be true alternatives (i.e. even competitors) to GNSS. I predict in 1-2 decades that vision systems, INS and alternative ranging systems (both terrestrial and those based on low-cost space transmitters) will have similar performance characteristics to GNSS. x

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Blockchain as a technological solution in land administration

In this paper we want to investigate what is the current state of blockchain technology and what kind of barriers relate to blockchain implementation

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A common view is that a cadastral system is needed to ensure efficient exchange as well as suitable use of real property units (e.g. Enemark et al., 2005). The role of cadastral system is to act as the 'where' component of property rights system by providing accurate information of real property units, their location and interests related to them. This can be, of course, achieved under various technical solutions. In many countries, the current cadastral system regime is based on a centralized database maintained by a public authority. New solutions are gaining interest though. For instance, blockchain technology and its implications for land administration have been under discussion lately (e.g. Anand et al., 2015; Vos, 2016).

Blockchain is still an immature technology and despite the application field, we are still discussing about 'use cases' and implications. There are many reasons why land administration field should not neglect the blockchain technology at this point. To begin with, similar to the banking industry, the main role of land administration authority is to act as a 'trusted third party' - exactly the role that blockchains promise to displace. Second, possibilities (as well as drawbacks) of a distributed ledger deserve more attention. Greater transparency and control over your own personal data, central features of a decentralized system, might be the future also for public data.

Blockchain is still an immature technology and despite the application field, we are still discussing about 'use cases' and implications. There are many reasons why land administration field should not neglect the blockchain technology at this point

As the maturity of technology evolves, more solutions based on blockchains will become possible. The change is fast: since 2009 there have been huge strides from the technology behind bitcoin to second generation blockchain networks, like Ethereum, which are faster and have more capabilities. Hence, we cannot underline enough the need to increase understanding of blockchain in the land administration industry. Lack of basic knowledge of the technology can create a huge barrier for horizon scanning and recognition of future possibilities.

In this paper we want to investigate what is the current state of blockchain technology and what kind of barriers relate to blockchain implementation. We define our research aim with following research questions:

RQ1: What can blockchain technology offer for land administration?

RQ2: What kind of issues need to be addressed if the plan is to apply blockchain technology?

The paper is structured in a following manner. First, in Section 2 we review literature on the blockchain technology and its basic terminology. We also review potential blockchain disruption from land administration point of view. Next, in Section 3 we present our empirical findings. We take a qualitative approach and ask more technically oriented experts about their views on implementing the blockchain technology. Section 4 concludes

Blockchain technology – basic concepts and current state

In this section, we go through some basic concepts related to blockchains. In particular, we focus on the basic features of blockchain and present the ground components of the technology. We then speculate blockchain disruption in land administration, mainly based on its technical possibilities and what previous studies have proposed.

Technology maturity and terminology

New technologies come and go and it can be challenging - or impossible - to accurately predict which ones will have a large scale impact on society. One commonly referred source for the maturity level of different technologies is the annually published Garner's hype curve (Figure 1). The curve positions different technologies based on their 'hype' and expected time to mainstream adoption. First stage on the figure is called 'innovation trigger', a phase when a new potential technology breaks through and catches media attention. Next follows a phase called 'peak of inflated expectations' that includes for instance reporting of first use case examples. Third phase is called 'trough of disillusionment', a period during which the fascination towards technology starts to decline due to some unsuccessful examples and projects. Then comes a 'slope of enlightenment' that shows a returning interest that usually stems from a growing understanding of real benefits of the technology. In general, at this phase the market players start to realize the potential of the technology for their own businesses. Finally, the technology life cycle reaches the phase of 'plateau of productivity'. At this phase the technology is mature enough and its introduction is profitable.

As we can see from Figure 1, blockchains are currently on a transition from second to third phase, with expected 5 to 10 years to mainstream adoption. Indeed, we have witnessed several use case examples of blockchain in recent years, also in the field of land administration.

Blockchain can be given at least three interpretations. It can be defined as a societal phenomenon, as a technology pile or as a database structure. The Gardner's hype curve, for instance, presents the blockchain and its maturity as a societal phenomenon. Blockchain as a technology pile, on the other hand, means that the utilization of technology consists of several levels. For example application, platform, processing and protocol levels can be distinguished for blockchain. Often firms specialize on one of the aforementioned levels. Finally, blockchain as a database structure usually refers to the technical operations of blockchain and to the facilities that make possible storing of information (Mattila & Seppälä, 2017). Blockchain enables a platform for decentralized database that can be used for a constantly growing data register. This type of register is called a public ledger since it contains information on all transactions. Thus, blockchain can be used for instance for storing some sort of transaction accountancy or script of code.

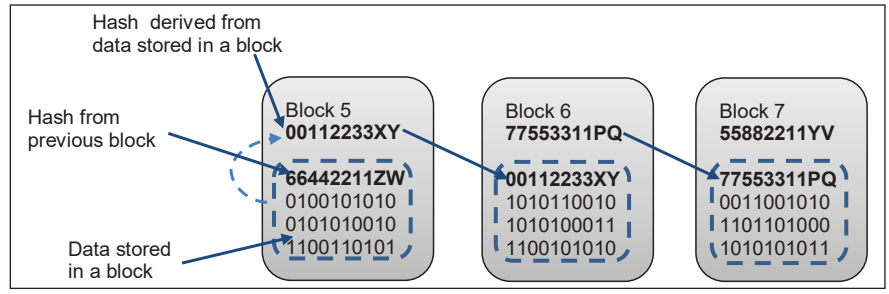

Figure 2 Blockchain mechanism illustrated, modified from Kotilainen 2017

In a blockchain, data is stored in blocks and each new block is linked to the previous block with a mathematically computed, mixed character string called hash. Certain data always produces a similar hash, which guarantees that data in (the previous) block is same for all users. The hash is also called a digital fingerprint since it embodies a time stamp of previous actions. Hence the date and time of each transaction can be traced from the blockchain. We illustrate the operational principles of blockchain in Figure 2. Here we can see graphically how each new block contains a hash from the previous block. The first row, or each block's own hash, is computed from the contents of the block.

Node is another concept central to blockchain upkeep. Nodes denote host computers of blockchain administrators

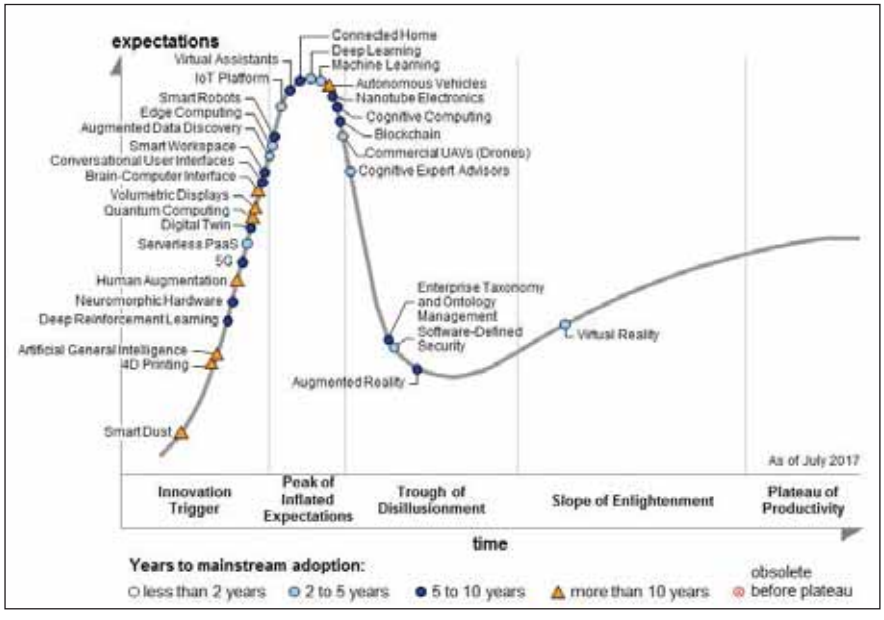

Figure 1 Garner's Hype Cycle in 2017 (adapted from Gartner 2017)

we note that several types of blockchains exist. First step in implementation planning is to decide what kind of actors are allowed to act as an administrator. Further, we can divide blockchains into public and private chains. Both types can operate in either a permissionless or a permissioned network

where blocks and their content are saved. Data is available for all contributing nodes, and thus transaction processes become more transparent when an objective intermediary is used as part of the process. Every node also has a full or partial copy of the blockchain and the stored transactions. This feature guarantees that an individual user cannot falsify information. If someone would try to finger the information stored into the blockchain, this would influence a hash as described above. Only a one character change in a hash would influence the following blocks, so other administrators would notice the attempt and they could interfere the situation.

The blockchain technology is based on a peer-to-peer network. Peer-to-peer network refers to a computer-based network where each computer can act both as a server and a customer device. For instance, in the Internet peer-to-peer networks are used for file and software sharing. In the blockchain technology an important component is a decentralized peer-to-peer network that is needed for consensus creation. In this context, a p-2-p network consists of several independent nodes maintaining the blockchain that follow certain rules. Nodes verify transactions happening in the chain following the rules. This is how consensus is reached in a p-2-p network and verified transaction can be stored into the blockchain. We can easily see how this mechanism could have implications to centralized organisations whose role is to maintain and secure transactions and related registers (e.g. Anand et al. 2015).

An important difference between a completely decentralized p-2-p network and a traditional database is how data evolves over time. In the p-2-p network participants may add data to the decentralized register, and a concensus mechanism is used to determine which version of database is the valid one. With centralized database, in contrary, there is only one trusted party who verifies the authentity of added data. Thus the role of consensus mechanism is to create trust and mutual understanding between blockchain network actors. Several consensus mechanisms exist but the most common ones are Proof of Work and Proof of Stake mechanisms. Proof of Work mechanism, which for instance the Bitcoin network utilizes, is considered to be easily verified. Biggest downside of Proof of Work is that the mining procedure that is needed for data extraction requires lots of computing power and, hence, lots of energy. (Anand et al. 2015; Lin and Liao, 2017.)

Another basic component of the blockchain technology is a public key infrastructure (PKI). The idea is that a user has both a public and a private key that are used to control access to data stored into blockchain. Private key is randomly created, and it usually consists of a long string of numbers and letters. Public key, on the other hand, is derived from the private key mathematically so that the keys together form a pair. Using again the Bitcoin network as an example, the public key is used for receiving bitcoins whereas the private key is used for user verification when a user wants to transfer or use bitcoins. (Antonopolous, 2014.)

Next concept that needs to be explained is a smart contract. Smart contract is a solution that utilizes the blockchain technology for creating contracts between two or more parties in a decentralized environment (Yli-Huumo et al., 2016). In its simplest form smart contract is a coded programme that is read and also executed automatically if certain pre-defined provisions are fulfilled. If contracts are made in a blockchain-based decentralized environment, they can be executed safely even without trust between contract parties. Smart contracts have then potential to lower transaction costs (using a trusted third party verification has costs) as well as to decrease frauds and other malpractices.

Finally, we note that several types of blockchains exist. First step in implementation planning is to decide what kind of actors are allowed to act as an administrator. Further, we can divide blockchains into public and private chains. Both types can operate in either a permissionless or a permissioned network. In a permissionless network participation does not require permission from a central body or other network actors. In a permissioned network, as the name implicates, a permission is required (Kinnunen et al., 2017).

Blockchain disruption in land administration

There are certain criteria or prerequisites studied by Mattila et al. (2016) when planning to utilize the blockchain technology for a certain purpose. We will present these prerequisites and after that compare them with an application to land registration. First prerequisite wells from the essence of blockchain technology basing itself to a peer network. Thus, the application purpose benefits from the decentralized database structure. Second prerequisite is that there is a need for several users to update the database at the same time. If there is no such need, the centralized structure of a conventional database should be enough. Third prerequisite is the consensus mechanism. If the database is updated simultaneously by several users, there is a risk that several versions of that database are created. Overlapping and simultaneous modifications must be able to unify. The potential applications for blockchain are decentralized databases with one correct version. Fourth prerequisite is that the modifications done in the database need to communicate with each other. The need for blockchain might not be justified, if there is no need for interaction with the data and if the modifications are not

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We can note that the use of blockchain in applications for land administration is not yet made its breakthrough. The success of existing and emerging pilot applications will show, how the future of blockchain and land administration will look like

dependable or do not affect each other. The fifth criteria is trust, or the lack of trust. Trust is usually related to a situation where some party might benefit from deleting or forging data, or in the current system there are problems with keeping the data safe. Often these problems can be solved by using a trusted party, for example a land registration authority, to update a database. Still, sometimes the use of this trusted party is not reasonable due to high expenses, or some cases this trusted party does not even exist.

Thinking about the essence of land administration and especially the land register, we can tick the boxes of prerequisites for using the blockchain technology. Decentralized database together with the several users updating the register at the same time resulting to one correct version of the database are certainly essential features of land registers. Not to even mention the importance of interaction between the registered data, and trust. We can state that land registration fulfills the criteria set for using blockchain-based application. Let us next have a short overview of the actual use of blockchain technology in tasks related to land administration.

The purpose of using blockchain for land registration is rather easy to justify in a country where the land administration system is not trusted, either due to corruption, bad governance or just the lack of quality of that register (Vos 2016). Anand et al. (2015) rank land administration to be amongst the top most corrupted sectors in the world. There is no doubt that blockchain technology in these cases would be the answer for organizing land administration efficiently and trustworthy. Indeed, the use of blockchain in these cases is reasonable. But Vos (2016) poses a question: should we try to replace a well-functioning land registration by blockchain, and why?

Graglia and Mellon (2018) recognize eight theoretical steps towards integrating blockchains as part of society can be distinguished, starting from public blockchain for recording documents ending up with interoperability where different blockchain-based registers merge. Examples on the adaptation of the blockchain technology in land administration can be found on the first levels: Several countries have started to record either documents related to land transactions (Brazil, Georgia, UAE) and also to record the workflow, the progress of transaction (Sweden). Georgia has built its whole land registration basing itself on blockchain, and so has the city of Dubai in UAE. Still, most of the world is no yet at the stage of utilizing the blockchain technology, especially for land administration.

We can note that the use of blockchain in applications for land administration is not yet made its breakthrough. The success of existing and emerging pilot applications will show, how the future of blockchain and land administration will look like.

Empirical findings and discussion

In this study we apply a qualitative research methodology. As part of the research process, both primary and secondary qualitative data are collected. To answer the research questions we combine information from the literature and interviews. The literature is also used for identifying the adequate expert profiles to share their viewpoints about the second research question. At the second phase, eight interviews were conducted. In order to achieve broad enough knowledge base, the interview participants were selected from different backgrounds ranging from academia to business sector.

The interviews were semi-structured by nature and built around predetermined topics and key questions. Data collection method was flexible enough for the purpose of this study as it allows the researcher to develop new questions also during the interview session. Interviews were conducted either face-to-face or via Skype between October 2017 and November 2017. The interviews were recorded and they last between 30 to 80 minutes. The interviews started with a short introduction to present study and its goals, after which following topics were covered: (1) General questions about blockchain technology, (2) Technical implementation, (3) Introduction and use of (blockchain) technology, (4) Legislation, and (5) Future possibilities. For this study, we utilize only part of collected material.

We organize our findings and discussion into two sub-sections, according to our research questions.

What can blockchain technology offer?

The interviews started by charting the expert views about what new the blockchain technology could provide compared to the traditional technical configurations. The common impression among the interviewees was that from technical point of view the technology does not provide much novelty - in technical sense it is more about combining existing technologies into one solution. For example peer-to-peer networks or decentralized systems are utilized in many other methods as well, which means that some of the features provided by the blockchain technology could be executed with traditional database solutions as well.

Combining different techniques creates, however, new possibilities that cannot be achieved with other methods. Indeed, the promise of simultaneously decentralized

The blockchain technology can provide trust and transparency in an environment where there is no certainty about the reliability of other parties, nor about the permanence of stored information

and reliable database is perhaps the biggest reason behind excitement towards the blockchain technology, especially in governance. Decentralized architectures could be carried out with other solutions, yet the blockchain technology and the mathematical algorithms it uses enable preservation of trust among all parties as well. Trust remains since the data that is stored into a block is extremely difficult to forge. In addition, the blockchain technology can provide trust and transparency in an environment where there is no certainty about the reliability of other parties, nor about the permanence of stored information. Some interviewees pointed this ability to maintain integrity, reliability, and originality of data in situations where trust is missing between parties as the most important reformation of the blockchain technology. Few experts wanted, however, further stress that the new features provided by the blockchain technology depend strongly of the application field. Besides the mere facts of how and where the technology is applied, also previous solutions set many boundary conditions: for instance the type of blockchain (as presented in previous section) should be chosen considering the application field and existing technical solutions.

Besides the transparency and reliability aspects mentioned above, the experts saw some other potential benefits as well. One foreseeable benefit would be that with the blockchain technology, it is easier to produce such services that have been impossible to provide thus far due to a missing trusted third party. Lack of trust might have hindered the creation of business or services in some areas, but the blockchain technology could be part of the solution for such situations. Then, on the other hand, we could imagine a situation where a lack of transparency or the previous centralized solution has caused issues in past. Under such circumstances a need for new type of 'trust services' might arise. One possible horizon that was mentioned in the interviews was a solution that is no longer tied to a certain occupational group or controlling organization to act as a trusted party. Nonetheless, this suggestion should not be interpreted too extremely, said some of the interviewees. Getting rid of trusted third parties might cause unwanted consequences as well: their role as intermediaries in case of conflicts or faulty actions is indisputable and hence should not be undervalued.

Another potential benefit stems from the 'tracking feature' of blockchain. As explained in the previous section, with blockchain it is more difficult to falsify or eradicate information, or at least it is possible to trace down at which point of the chain information has been fudged. In addition, due to the decentralized structure, a blockchain based system has a high tolerance for faults since the maintained database locates at several servers simultaneously. This means that a single server is not alone in a critical position in case of possible attacks or other faults. Further, some of the interviewees pointed out the additional value from smart contracts. With smart contracts it is possible to programme and automate certain processes and thus create long transaction chains.

Barriers to blockchain implementation

General challenges

A fundamental challenge is whether blockchains will be used in a right way in right targets of application. Our interviewees stressed that the use of blockchains will never reach its potential benefits unless the chosen solution is a right fit for the application area. As mentioned above, some of the features can be achieved with more traditional solutions as well, and there should be an actual need or requirement for the added benefits so that implementation of the blockchain technology is the right choice.

Another general challenge is that the blockchain is not a feasible solution for storing large amount of data. Instead of data, it is usually more worthwhile to store important transactions related to the target of application. Moreover, it is possible to store the hash derived from the data instead. What comes to the 'actual data', it can be stored for instance into another decentralized system tailored especially for storing documentation. Documents can be found through the system and their originality can be checked from the hash stored to the blockchain. Thus, when considering the application of blockchain, it is advisable to assess what is going to be stored into the blockchain and whether it is feasible to do that. That is only way to avoid expanding the blockchain into a too large entity.

Also the complexity of technology and lack of knowledge were considered as general challenges. The blockchain technology brings many reformations

The blockchain technology brings many reformations related to both technological solutions and business models, but there are no common practices or standards for guidance available yet. Existing systems based on the blockchain technology are scarce in number, thus learning from historical examples is not an option either

related to both technological solutions and business models, but there are no common practices or standards for guidance available yet. Existing systems based on the blockchain technology are scarce in number, thus learning from historical examples is not an option either. Understanding the operations of blockchain technology, its application as well as the consequences of larger scale implementation will require expertise from several fields. It is imperative to raise the knowledge base at least to a level where people understand what the blockchain technology is all about and how it could be applied under different solutions. Furthermore we need more knowledge of impacts and risks related to the use of blockchain technology in long run. Currently the number of blockchain specialists is low and many of the interviewees suspected that lack of human resources is one factor hindering the implementation of the technology. There is, however, a growing interest towards the technology and its possible applications, which should eventually widen the knowledge base.

Few interviewees mentioned also the usability of blockchain applications as a challenge. For example in open Bitcoin network a mistake in writing the recipient's address or losing your own private key can lead to loss of assets. This results from the fact that in the Bitcoin network there is no central body that could be reached in problematic situations. If permissionless blockchain applications like that gain more ground, a solution for such examples is needed. This would require that some party is trusted over others. Due to problems related to everyday operations, more closed and cross-organizational versions of blockchain become more frequent first, since trust (at least to someone extent) is a built-in feature in them.

Finally, high energy consumption that results from the use of consensus mechanisms such as Proof of Work can be categorized as a general challenge. Especially for public and permissionless networks the energy consumption can become an issue.

Scalability

Already a quick review on the literature of blockchain reveals that scalability is a big issue in permissionless blockchains like the Bitcoin. Scalability problems relate to the ability of blockchains to handle large amounts of information. Our interviewees stressed that ensuring the scalability is a challenge especially for the permissionless and public blockchains. For the permissionless blockchains, it is difficult to evaluate beforehand how many users and network actors there will be. A growing number of actors makes the scalability a challenge since all data that has been accumulated into a net must be decentralized in a way that was agreed on in the beginning.

According to our interviewees, one fix to the scalability problem is to create such a governance model to the blockchain where the chain can be modified afterwards if there is a need for that. Thus the scalability is not necessarily only a technological barrier. Current view is that the technology may enable storage of several transactions into one block in the (near) future. So it is more essential to reach a consensus about governance of blockchain and whether it is possible to make changes to the current blockchain in order to support the scalability. The planning phase of a blockchain should include good technological choices that support the scalability but it is equally important to plan carefully the governance model and leave room for modifications as the technology inevitably continues to develop.

Another solution to the scalability problem is to leave older blocks out of the storage. Depending on the target of application, older events and transactions might not have such relevance that they should be stored in the beginning of the blockchain. For instance on top of the Bitcoin network some new technology has already been planned: this so-called lightning network would be a substantial help to the scalability issue. With the lightning network transactions could be executed faster and in higher volume than at the moment. The lightning network would create a separate channel for transactions happening between parties. Currently the Bitcoin network is burdened with ongoing transaction events and the lightning network would address this problem. What we can learn from this example is that technological advancements may help with the scalability problem but also the decisions of the network administrator as well as the governance model of the blockchain have important roles.

Another viewpoint that came up frequently in the interviews was that the scalability is not such a big issue for private and licensed networks. Such networks often have much less users and network actors, and the amount of storable data is not comparable to transactions happening in permissionless networks such as the Bitcoin. It is important, however, to acknowledge the restrictions on use already in the initialisation phase. As it was mentioned earlier, the blockchain is not a good solution for storage of actual data, but better suitable for recording transactions and hashes. Thus the scalability is less likely to turn into a serious problem if this is kept in mind since the very beginning.

Data protection and privacy

Data openness in blockchain creates many possibilities but also challenges related to data protection and privacy especially in permissionless and public blockchains. That type of networks usually have the whole transactions history and transaction paths available. However, alternative solutions where open data could be partly hidden are already under development. Different encryption methods also aim to prevent the ability to connect transactions to a certain person. Nevertheless, some evidence exists that with the current regime, it is not particularly difficult to connect transactions to certain accounts in the Bitcoin network. Again, this issue has been already addressed and a heavier encryption method that would increase data protection and privacy has been proposed. With this kind of add-ons there is a drawback also: the feature can become a subject of misuse and attract for instance actors with criminal goals.

Our interviewees emphasized that the challenges related to data protection and security as well as privacy are also

connected to the governance model of the application. Further, what type of data is stored into the blocks and how it is encrypted matters too. Actors of blockchain network can be given for instance different kind of access rights to data by defining that certain actor only has access to data that is integral to his own actions. This type of feature could be utilized for example as part of a cross-organizational blockchain solution. According to our experts, it is not rational to store highly sensitive data into blockchains yet. In principle anything you store into a blockchain remains there till eternity, and even though different encryption methods could be applied, it is likely that in the future there is enough computing power to decrypt these encryptions. Another viewpoint that arose in interviews related to data security was that a possibility of attacks should be considered as well. It is important ponder beforehand different scenarios for attacks and how they could be prevented.

We further asked if it is possible to create a blockchain where part of the data is public and part of it is accessible only to a certain group of actors. The experts evaluated that it is technically possible to partially hide information with encryption methods and then define who has access to what information. For instance in the case of registries of cadastral system this kind of feature would be useful. According to the interviewees, personal information (such as personal ID) and other partly hidden information could be stored into a blockchain as some sort of identifier. These identifiers would then be used to trace down the original personal information from external database. A suggestion is that this would be possible only through a certified key so that predefined actors exclusively could perform this kind of connecting operations.

Social barriers

Our experts conceived that social barriers relate mainly to knowledge base and the usability of blockchain based systems. In addition, the overall understanding and acceptance of new technologies such as the blockchain technology was brought up as a social barrier. Few interviewees also wanted to emphasize that the blockchain technology will not magically solve 'deeply rooted' problems of register keeping. For instance, even though the blockchain technology could provide a reliable and functioning technology system, people in control of storing the information can still be bribed or forced into false entries. Further, it should be kept in mind that values and attitudes of authorities matter as well. We provide a simple fictional example: a blockchain based register could show reliably that a person owns the real property unit but another person is currently occupying the unit. If the authorities neglect the register information and leave the issue aside, the blockchain based register is as worthless as any other technical solution.

In addition to social challenges that where brought up in interviews, we note the importance of surrounding society and its values and attitudes should be considered as well. In some cases blockchains can help in increasing trust and transparency but the significance of social barriers should not be underestimated. Few of the interviewees even stated that thus far it seems that blockchain-based systems function best in societies that do not necessarily need such solution. We argue that explanation for signals like that call for wider perspective than just evaluation of technical and economic feasibility.

Juridical barriers

We addressed also the interviewees' perspectives on juridical barriers. Answering that question was, however, a challenging task since there is currently no legislation regarding the blockchain technology, at least in Finland where the study was conducted. Further, at the time the material was collected, there was no precedents either to give a form to judicial custom. To make the assessment of juridical barriers even more challenging, it is still unclear which laws should be taken into account when implementing the blockchain technology. Thus many of the interviewees perceived blockchains as juridically challenging environment and partly as a 'grey area' that hinders the introduction of technology.

There was a consensus among the experts that legislation should be included as part of the blockchain implementation, since new technological solutions and business models cannot be formed if they are illegal. This was seen as an imperative to include legal scholars into the development and application of the blockchain technology. Some of the experts thought that the legal barriers for the blockchain implementation are currently underestimated and the legal issues should be considered more thoroughly in different applications. However, the only way to find out how big changes different laws require due to the technology implementation, is to wait and see first how common and influential the technology will be.

Smart contracts fall also under juridical issues that need more clarification and clear guidelines in the future. If the smart contracts become common practice, there should be clear rules how they are formulated and how they fulfil their function. We also need clarity on the question whether transaction based on a smart contract is juridically secure. Then a question arises how far the current contract jurisprudence can be stretched to cover the smart contract transactions. We note that the smart contract as a name is a bit misleading since it does not always cover all the features of a contract. Also we know that there are many things in legislation that cannot be captured into a programmed code. Thus we need to first define which articles (and details related to them) can be automated with the smart contracts.

Table 1 Blockchain technology barriers summarized.

Technical	Large data volumes
	Complexity
	Correction of errors
	Safety
	Usability
	Scalability
	Energy consumption
Social	Lack of knowledge
	Values and attitudes
	Surrounding society
	'Deeper' issues in register keeping
Juridical	Lack of legislation
	EU general data protection regulation
	Smart contracts and their juridicality

The blockchain technology offers a possibility to make a decentralized, transparent and reliable database. It is still unclear, however, how disruptive the technology will be for land administration industry

Another topical issue related to the legal barriers of blockchain implementation is the new European Union (EU) general data protection regulation (GDPR). Problematic part of GDPR in relation to blockchains and their technical mechanism is the so-called right to be forgotten which states that "the data subject can have his or her personal data erased if the data is no longer necessary or if legal grounds for processing no longer exist" (Castrén & Snellman 2015). This is in contrast with the principle that once a piece of data is stored into blocks, it cannot changed or erased afterwards. Another aspect of the GDPR that is open to interpretations is the question of whether we are maintaining a person register or not. The GDPR obligates those companies and operators that process personal data.

We summarize the findings related to the blockchain technology barriers in Table 1. The barriers are categorized into three groups: technical, social and juridical barriers. We emphasize that the barriers are in no particular order here, nor did we even try to assess their importance in relation to other barriers. We note, however, that even though we chose to interview experts with technological background, our results raise social and juridical perspectives as well.

Conclusions

The blockchain technology offers a possibility to make a decentralized, transparent and reliable database. It is still unclear, however, how disruptive the technology will be for land administration industry. In order to get forward with this question, more research on potential uses and implications, but also on challenges related to introduction of the blockchain technology is needed. In this study we address this gap by examining new possibilities that the blockchain technology offers for land administration as well as barriers of implementation. Our approach was to interview experts that have proven expertise of the blockchain technology. We summarize our findings as follows: besides technical barriers, also social and legal barriers should be acknowledged when a blockchain implementation becomes topical.

Main contribution of this study is that it can be seen as guidance for future endeavours. The study has both academic and practical value since it combines basic knowledge on blockchains with expert views about blockchain implementation.

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The paper was presented at FIG Working Week 2019, Hanoi, Vietnam, April 22–26, 2019.

Where Have You Been with Your TRIUMPH-LS Lately?

Clay Davidson

"The LS really is really tough. When I 1st got mine I flipped my 4 wheeler. The 4 wheeler flipped down a hill 9x. It rolled over the LS twice and the LS was still going.

Also I replaced my 4 wheeler with a side by side and one day the LS fell out while I was driving. The LS is still working. Never had any trouble except I try to be careful. However accidents happen.

I personally vouch for the LS being the toughest GPS rover I have ever used in 15 years of using GPS."

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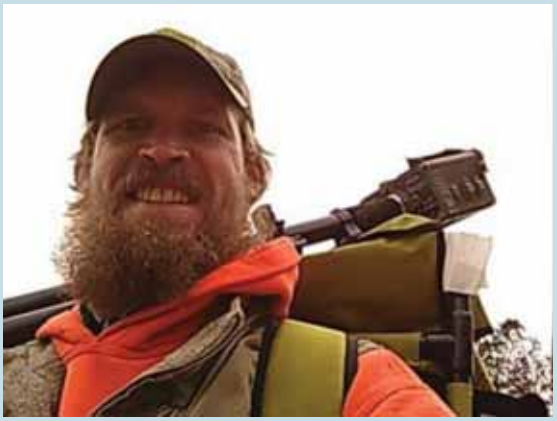


Adam Plumley, PLS

I probably won't be carrying a sh*t stick with me anymore. Notice the red dot on top of the pipe.

Introduction to J-Mate

Let's set the record straight: J-Mate is not a total-station. **J-Mate and TRIUMPH-LS together** make the **"Total Solution"** which is a combination of GNSS, encoder and laser range measurements that **together do a lot more than a total station**. For long distances you use GNSS and for short distances (maximum of 100 meters) you use the J-Mate along with the TRIUMPH-LS. Together they provide RTK level accuracy (few centimeters) in ranges **from zero to infinity**.

As with the TRIUMPH-LS, with the J-Mate we also provide software improvement updates regularly and free of charge. Download the J-Mate update in your TRIUMPH-LS and then inject it to the J-Mate. The J-Mate SSID will be in this format JMatexxx, where xxx is your J-Mate's serial number. After a Wi-Fi connection is established, click the J-Mate icon and then click Setup. When you are prompted to connect to the J-Mate, click yes and then follow the remaining prompts.

Connecting the TRIUMPH-LS to the J-Mate

TRIUMPH-LS communicates with the J-Mate through Wi-Fi. Turn on both the TRIUMPH-LS and the J-Mate. Click the Wi-Fi icon on the TRIUMPH-LS Home screen to connect to the J-Mate, much the same way as you connect TRIUMPH-LS to your Wi-Fi access point.

After connection, click the J-Mate icon on the TRIUMPH-LS Home screen and then J-Mate/ Collect/Next to get familiar with the Main J-Mate screen.

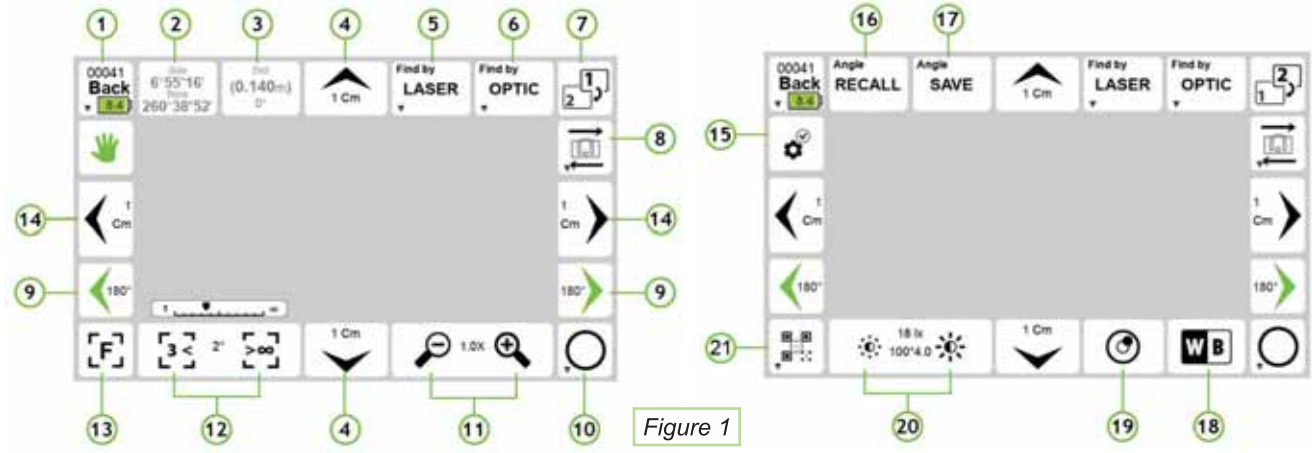


Figure 1

Measure angles between two points:

Aim at the first point and click button **“2”** of Fig. 1. Then Aim to the second point and click this button again. You will see the horizontal angles between the two points. You can save the measured angles in clip boards and use it elsewhere when you need.

Taking a point

Aim at your target and click **“10”**. J-Mate will take 10 readings and average them. The average, RMS and spread of the ten readings are shown. Optionally, you can specify four points around the target point to be measured too, to ensure that you have aimed at the desired target. To specify the distance of the four points around the target, hold **“10”**.

Instantaneous angular and range measurements are shown in boxes **“2”** and **“3”** in Fig. 1.

Camera operation and settings

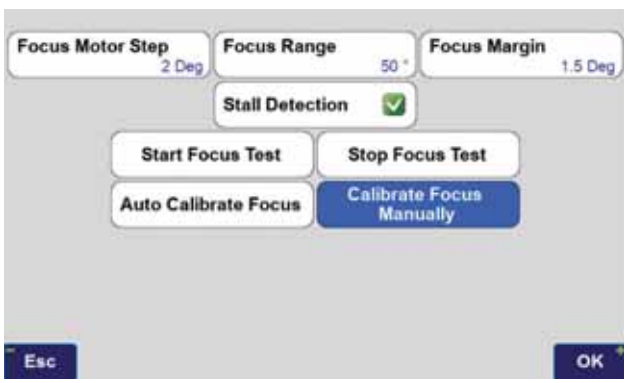
White balancing the J-Mate camera when the light setting changes: 1)Put a white paper in front of the J-Mate camera about few meters away, such that it covers at least half of the viewing angle of the camera. 2) Click **“18”** to start white balancing. It will take about 10 seconds to finish.

Zoom buttons: **“11”**

Contrast/Brightness buttons: **“20”**

Focus: use buttons **“12”** to focus manually. Click **“13”** for autofocus on the subject.

Occasionally you may need to calibrate the Focus motor. Click Setup **“15”** → “Focus” → “Auto Calibrate Focus” or “Calibrate Focus Manually”. In Manual focus, 1)click “Rest Focus Calibration”, 2) using **“12”** buttons, focus to infinity, 3) Click “Set Focus as Infinity”.



Searching and finding objects by laser and Object types

Hold the Laser button (**"5"**) to see the setup screen for laser target selection and parameters. If you know the approximate distance to the target, click the check box and enter the distance and accuracy percentage. This will help J-Mate to ignore targets that are outside the range.

Horizontal and Vertical Limits are the limits that J-Mate will search around the starting point to find targets. In this example is 15 degrees on left and right, and 15 degrees up and down.

"Keep Fixed Height" check box, scans horizontally on fixed target height. You may rarely need to use this feature. It will reduce the scanning speed by a factor of 2.

In Target Selection screen, the following targets are defined:

- **J-Target** is a printed pattern glued to 166x166 mm plywood of about 25 mm thick. It can be attached to a 226x226 mm plywood of 10 mm which provides flaps around the pattern. Select check boxes related to Sides, Top and Bottom flaps, if they exist and you want J-Mate to consider the depth of the flap (about 25 mm).

- If the J-Target is not sitting on another object and its bottom boundary is clear, then check the box Measure to Bottom. If not checked, J-Mate will measure to the top and will come down half of the height to aim at center. This feature applies to other target types too.

- In laser scanning and finding, the pattern on the J-Target has no effect.

J-Target Custom: This option allows you to build your custom J-Target type.

TRIUMPH-LS Back: searching for an object similar to the back of TRIUMPH-LS.

Search Tube: Searches to find a tube with given diameter and height. If Measure to Bottom is not checked, it will go to the top of the tube and then come down half of the specified height, irrespective of the actual height of the tube.

Measure Tube: Searches for a tube that has the given width and then it measures the tube depth.

Corner identifies an abrupt change on a flat surface.

Snap: scans with the resolution given in "Step" and stops when range changes by "Edge Depth".

Scan: Scans according with the resolution given in "Step" and saves the scanned files if the box is checked. The scanned files can be viewed in the Main screen / Collected by User .

Selected objects and their parameters can be saved and recalled by **"Save"** button on this and **"Recall"** button of the previous screen.

Aiming at targets manually

You can find targets manually or automatically.

Backsight point and the Sun

Similar to using conventional total station, to use the J-Mate you need to first establish its accurate position and calibrate its vertical and horizontal encoders. Then proceed to shoot the unknown points. This is similar to using any total station, but we have improved and automated the process.

With J-Mate you can do these in three different ways as shown in the J-Mate screen of the TRIUMPH-LS. Via the J-Mate Backsight; One Point, Resect, and Astro-Seek icons.

If GNSS signals are available at the site, click the One Point icon.

This screen appears which guides you to determine the accurate positions of the Occupation Point and a Backsight Point to establish an azimuth and calibrate the J-Mate angular encoders.

The tripod is setup at the “Occupation Point” (OP). The J-Mate is secured on top of the tripod.

Next, TRIUMPH-LS is put on top of the J-Mate with its legs registered to the matching features on the J-Mate.

Next Use the RTK Survey feature of the TRIUMPH-LS to quickly determine the accurate location of the Occupation Point. You can use your own base station or any public RTN.

Next, slide the J-Target on top of the TRIUMPH-LS, lift it from the J-Mate and move to the “Backsight Point” (BP). The camera of the J-Mate will search the J-Target. The camera’s view is visible from the TRIUMPH-LS screen, which mostly focuses on this J-Target. When at the Backsight Point, its accurate position is determined by the TRIUMPH-LS, and the Azimuth from the Occupation Point to the Backsight Point is determined, and the J-Mate is calibrated and ready for use.

After this calibration is complete, if the tripod is disturbed, the red LED on the front of the J-Mate will blink to show that re-calibration is required.

We can now replace the TRIUMPH-LS on top of the J-Mate at the Occupation Point and proceed to shooting as many “Target Points” as the job requires. From now on TRIUMPH-LS is used as a controller and you can hold in your hand too, but it is more convenient to put it on its place to have free hands.

If GNSS signals are not available at the Occupation Point, click the “Resect” icon to shoot two known points to establish its accurate position and calibrate its encoders. Then continue to shoot the unknown points.

Astro-Seek feature: Sun as the Backsight point!

We have added a new innovative feature to the J-Mate that it can automatically calibrate itself via its automatic Sun Seeking feature.

Attach the Sun filter to the camera of the J-Mate, click the “Astro-Seek” icon, set Occupation Point, and click the “Sun” icon in the screen which appears and J-Mate will scan and find the Sun, and use its position to calibrate the angular encoders automatically.

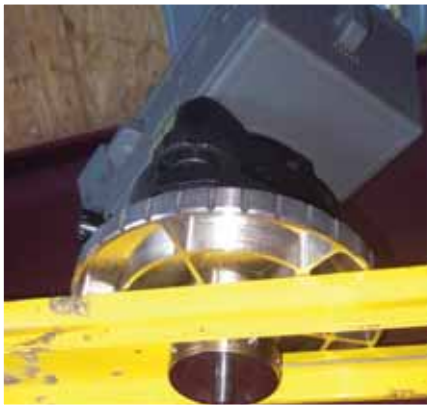
Javad gets a Blue Ribbon for best invert measuring device I've ever used.

No total Station I've seen can do this the way the JMate does. The offset camera/vertical action hasn't been done before and I see huge advantages.

I've measured many inverts in my career. Anyone who says they can measure them to the hundreths with a sh*t stick (pipe mic or not) (handheld laser or not) is full of it. Today I measured the most accurate inverts I ever have. Relative accuracy of a mm or two at most on elevation. Yes the inverts were recessed. I'm embarrassed to tell you folks what I measured with the sh*t stick a few weeks ago and thought it was good. It wasnt, matter a fact it put the sh*t flowing uphill. A tenth or two, sometimes it matters , sometimes it doesn't. JMate gets an A+ plus for this task.

This is the setup I should have used today.

Aluminum 4 ft level, the Jmate top plate and 3/8 3/8 adapter. Quick and Easy. I would have had a better view too.



FR

TRIUMPH-3

The new TRIUMPH-3 receiver inherits the best features of our famous TRIUMPH-1M.

Based on our new third generation TRIUMPH chip enclosed in a rugged magnesium alloy housing.

The TRIUMPH-3 receiver can operate as a portable base station for Real-time Kinematic (RTK) applications or as a receiver for post-processing, and as a scientific station collecting information for individual studies, such as ionosphere monitoring and the like.

It includes options for all of the software and hardware features required to perform a wide variety of tasks.

- UHF/Spread Spectrum Radio
- 4G/LTE module
- Wi-Fi 5 GHz and 2.4 GHz (802.11 a, b, g, n, d, e, i)
- Dual-mode Bluetooth and Bluetooth LE
- Full-duplex 10BASE-T/100Base-TX Ethernet port
- High Speed USB 2.0 Host (480 Mbps)
- High Speed USB 2.0 Device (480 Mbps)
- High Capacity microSD Card (microSDHC) up to 128GB Class 10;
- “Lift & Tilt”
- J-Mobile interface

Ideal as a base station

Galileo outage - Reliability is a key factor for GNSS

Is it time for Europe not just to think about the Galileo second generation, but also to start thinking beyond Galileo?

Fabio Dovis (Ph. D)
Associate Professor at the Department of Electronics and Telecommunications of Politecnico di Torino. He coordinates the Navigation Signal Analysis and Simulation – NavSAS -, research group that works in the satellite navigation field

"Until further notice, users may experience service degradation on all Galileo satellites" the Notice Advisory to Galileo Users (NAGU) issued by the European GNSS Service Center on July 18 2019, was not very reassuring for the people using and working on Galileo. When then the outage lasted for several days, things became even more scaring. What was going on with Galileo?

For a pure scientific purpose, and also out of curiosity, thanks to the processing tools available in our research group we started our independent investigation, trying to see what the problem was.

A thing was clear: the position estimated using the Galileo-only satellite or hybrid GPS-Galileo solutions were showing errors on the order of 500 meters or even more, and a dummy receiver not implementing proper checks might have been cheated by the unreliable signals. For some time the Signal in Space (SIS) Accuracy Index (SISA), giving indication of the minimum standard deviation of an overbound of the SIS error, was still at acceptable level, and the only clear evidence that something was wrong and the system should not be used was provided by the ephemeris parameters, that were not up-to date. In fact, according to the Galileo OS SDD (issue 1.1, May 2019) they should not be used when older more than 4 hours [1].

This is the event, as seen by the users, without any insight on what actually happened in some block of the control chain of the overall system. But what could be our remarks on such a global event, and the lesson learnt?

First of all, it is clear that an event like this cannot be underestimated or just considered as a temporary technical issue for a GNSS system that is still providing Initial Services (anyway, this should not be forgotten). Without considering this disruptive event, in the previous months the system was showing very good performance in terms of signals and functionalities, and even during this event it was shown that, replacing the content of the navigation message with valid ephemeris, it was still possible to achieve very good position estimations [2]. The number of Galileo users is constantly growing [3], expectations for the new features of the system such as the High Accuracy Service or the OS NMA are high on the user side, so this event felt like a "stop" to this growing enthusiastic attitude toward the Galileo system. It can also be imagined that the outage might have triggered a number of political issues, considering also the debate at European level about the funding for the satellite, the sensitive balance for the involvement of the different European countries in the management of the programme, and the Brexit coming up.

Reliability is a key factor for GNSS. We know it very well when talking of jamming and spoofing attacks, and we consider not just the technical fact, but the consequences this might have on

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critical infrastructures, sensitive services and also on mass-market applications used by a large number of people. Still, this kind of attack would deny, partially, some services, in a limited area, while a full system outage like this one made it unusable on a global scale.

An interesting report published in June 2019 [4], analyzes what would be the impact of a 30 days outage of GPS, but also the large economic benefit of using GPS in many different Industry Sectors. The report shows how most of the economic benefit of civil GPS (about 90%), have accrued since 2010. Until some years ago, an event like the Galileo outage would have probably not even be covered by the news, while this event was reported by magazines and tv all over the world. This is a clear evidence of how much our dependency on positioning and timing services grew in the past years, and we see and taste the impact on many ordinary services we use everyday. On the other hand, it confirmed a relevant attention toward Galileo, that, for sure, since its design phase, raised the bar for the civil GNSS, targeting high performance levels and innovative signals and services.

There are for sure a couple of lessons learnt from this event.

GNSS systems are quite a complex infrastructure and that there is still room for improvement. GNSS is fast evolving both on the system side and on the users' side with more complex receivers and platforms being designed. We are not just yet at the time of implementation of consolidated technologies, and, especially in Europe, there is a strong need for a *culture of GNSS* which is still developing. Education and training on the multifold discipline of satellite navigation is needed now, to consolidate, for the years to come, a critical mass of researchers, scientists, technicians, service providers, businessmen, skilled on the specificity of GNSS.

The other lesson learnt is that users, and in particular application developers, should be aware of the limitation of GNSS despite of its relevance and utmost importance. For many services it can be the ultimate solution and it needs backups that can compensate temporary outages. This is a fact to be taken into account not just because of the possibility of disruptive system events like the one we faced in July for Galileo, that anyway we expect to be rather rare, but also in case of unavailability on a more local scale. Harsh environments, natural and anthropogenic interferences might always affect and deny the GNSS positioning.

The great emphasis put in these years on the promotion of the downstream market to motivate and justify the development of the new GNSS and the modernization of the old ones, has sometimes made users overconfident in GNSS as the ultimate solution to any positioning problem. The use of navigation units integrating GNSS and other sensors should be driven not just by the search for improved accuracy and precision, but also by the need of robust navigation units embedding sensors with complementary features.

Redundancy of the constellations is another way to increase robustness for some applications, but this road cannot always be pursued when you target the use of advanced features such as authenticated signals, or frequencies which are not interoperable.

It is interesting to see how, even in the United States, there are discussions going on, at the highest level, on the need for one (or more) backup technologies to GPS, in order to grant continuity of a positioning service for different classes of applications.

GNSS remains one of the most relevant enabling technology that came into the full light in the past years, and there is no doubt that Galileo represents for Europe a historical step into a new world of science, technology, industry, and business. Anyway, is it time for Europe not just to think about the Galileo second generation, but to start thinking beyond Galileo?

[1] Galileo OS SDD (issue 1.1, May 2019) available at https://www.gsc-europa.eu/system/files/documents/Galileo-OS-SDD.pdf

[2] F. Dovis, A. Minetto, A. Nardin, E. Falletti,D. Margaria, M. Nicola, M. Vannucchi, "Analysis of the Signal Outage" GPS WORLD. - 30:8(2019), pp. 10-12.

[3] GSA press release: https://www.gsa.europa.eu/newsroom/news/usegalileoeu-tracking-rapid-uptake-galileo-initial-services

[3] O'Connor, A.C., Gallaher, M.P., Clark-Sutton, K., Lapidus, D., Oliver, Z.T., Scott, T.J., Wood, D.W., Gonzalez, M.A., Brown, E.G., and Fletcher, J. 2019, June. *Economic Benefits of the Global Positioning System (GPS)*. RTI Report Number 0215471. Sponsored by the National Institute of Standards and Technology. Research Triangle Park, NC: RTI International.

"Galileo combined with eLoran would provide a robust technology"

says says Professor David Last in an interview with Coordinates while sharing his views on recent Galileo outage. Professor David Last is a Consultant Engineer and Expert Witness specialising in Radio Navigation and Communications Systems. He is a Professor Emeritus at the University of Bangor, Wales and Past-President of the Royal Institute of Navigation

In July this year, Galileo suffered a week-long outage? How do you regard this 'technical incident'?

Outages can happen. The thing that grabbed attention was the way it was handled. For the first few days there was more information coming from the US than from Europe. The operators of Galileo kept themselves as hidden as if it were a state secret! We've come to expect that with military systems, but Galileo was set up to be a civilian operation. You can't persuade folk to rely on your technology then, when there's a problem, hide behind a wall of silence.

You have emphasised several times the threats like interference, jamming and spoofing. Does not this incident highlight that there could be some threats beyond as well?

Certainly; interference, jamming and spoofing are not the only threats – GPS and Galileo have suffered service failures. Faulty GLONASS data uploads caused kilometres of error. But many recent incidents and surveys have shown that the threats of interference, jamming and spoofing are real, serious and much more frequent. Interestingly, our professional GNSS community has come to accept that; many technical meetings are now dominated by papers on these problems and proposed solutions. But among policy-makers and governments recognition of this vulnerability is still rare. We're now beginning to see it in the US. But in many other countries and regions, notably in Europe, the need to defend one's own high-cost GNSS program has resulted in denial of the issue of vulnerability. Until there is acceptance of these problems by governments, the critical national infrastructure of their nations will remain at risk.

The recent government-commissioned report by London Economics estimated the cost to the UK economy of a one-off 5-day loss of GNSS at £5.2B (USD7.1B). In my book, that's a serious threat!

Given this, what's your opinion on GNSS back-ups?

It would be hard now to find a satellite navigation professional who has studied the question of vulnerability and still believes that a single GNSS alone can provide resilient PNT. Equally, most now agree that in many situations one GNSS cannot back-up another GNSS, given that they use the same radio frequency bands and are, in effect, slightly different versions of the same technology. The need

for our various GNSS to be mutually compatible and interoperable means that when one is lost to interference and jamming, they all may be. And there are now even low-cost, multi-GNSS spoofers!

So, any effective back-up must employ a different technology from the GNSS it is to complement. For precise timing that might be a very stable clock. In the air it will be one of the many non-GNSS systems – DME, ILS, VOR, NDB, inertial – that have been retained for both commercial and general aviation. The best back-up depends on your application.

You strongly support eLoran as GNSS back-up? Do you think after this incident, it again needs a serious consideration?

I am strongly in favour of enhanced Loran (eLoran), having closely watched the UK and Ireland trial system that demonstrated its technical viability and excellent performance over more than 2 years. At sea it met IMO requirements and reached Initial Operational Capability. This prototype used the transmissions of the legacy LoranC stations across North-West Europe until they reached their closedown dates, adding a data channel broadcast from a new UK station. The system operated in both stand-alone and differential navigation modes and delivered precise timing.

eLoran, originally proposed by the US Federal Aviation Administration, has the great benefit of sharing almost no vulnerabilities with GNSS: it operates at low frequencies (not the microwaves of GNSS), with high-power transmissions (not the very low powers of GNSS) and terrestrial transmitters (not space-based). In many applications, eLoran can take over automatically and seamlessly when GNSS is interrupted, allowing operation to continue, meeting similar standards. That has been demonstrated at sea, on land and in the distribution of data and precise time, with receivers outdoors, indoors and under-ground.

eLoran comes up against a profound prejudice: GNSS replaced an earlier generation of terrestrial radio navigation aids. Recommending a terrestrial system to overcome the vulnerability of a satellite system is to swim against a powerful tide!

The London Economics report identified eLoran as one of two technologies that offered “the most applicable mitigation strategies for the largest number of applications”. The UK government then signalled its support for the system.

If eLoran is that good, then why it has not yet been adopted in Europe?

eLoran comes up against a profound prejudice: GNSS replaced an earlier generation of terrestrial radio navigation aids. Recommending a terrestrial system to overcome the vulnerability of a satellite system is to swim against a powerful tide!

Galileo combined with eLoran would provide a robust technology; they can even share chips. The obstacles are not technical or financial, but political. Look: Europe has invested more than 10B Euros in Galileo; the last thing they want to hear about is its vulnerability! Norway – which had the best legacy Loran set-up in Europe - blew up its towers, filming their collapse as entertainment on Youtube. Absurd! The US Congress, in contrast, is now well aware of the weaknesses of GPS and has fostered an eLoran system. China, Russia, South Korea and Saudi Arabia have similar ground-based navigation stations. Europe is lagging some 20 years behind; the disappearance of Galileo in July came as a shock!

Moreover, the provision of a US Loran system for 20 years would cost the equivalent of a single GPS satellite! Satellite navigation is much more attractive to industry and creates lots of jobs. Maybe Loran is just too cheap to survive; that’s frustrating! x

Geo-spatial techniques: An Instrument for regional planning

The present paper focuses on the geo-spatial approaches used to determine the changes occurring on the land surface using GIS tools and techniques, followed by a case study to demonstrate its usage in regional planning

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Remote Sensing Systems optimizes the usage of advanced camera sensor technology for capturing satellite imageries of objects present on the earth, by means of transmitting signals and spectral radiance captured through a different wavelength region from a distance. Rationally, the remote sensing system has three main indelible constituents: electromagnetic radiation, remote sensors and platforms that capture remotely sensed images (commonly known as satellite images). Wherein, Geographic Information Systems allows performing spatial analysis on the data procured through remote systems. In-depth understanding of the above systems is a precondition for data capturing and data analysis. By and large, the strong analytical capabilities of the software are well recognized by planners, decision-making authorities, and policy makers.

Sivakumar (2010) highlighted the significant advances of sensor technology have allowed the subdivision of spectral ranges of electromagnetic radiation into several bands for constructing multispectral images. The spectral bands information present in a particular scene of an area is used appropriately to undertake spatial analysis on satellite imagery for constructing the composite image by combining all the bands of particular scene. Each gray scale single band image is theoretically known as the pan-chromatic image, but a combination of three or more bands generates color composite images known as multispectral images.

Exceptional progress was made towards improving the spatial resolution of satellite image which specifies the size of the pixel in an image in addition to in the spectral resolution of the electromagnetic wavelength region that records the reflectance from ground features to produce higher-resolution images. These systems are capable of producing information about the smallest separable feature located on the earth's surface. The information captured through this system is stored in pixels. Every single pixel has a specific digital number ranging between 0 to 255 wherein 0 represents no or minimum light and 255 represents very bright or maximum light radiated from an object.

Oman (2011) emphasized the benefits of geo-spatial techniques and provides solutions to resolve the associated issues and their causes related to vegetation cover. A study by Rai et al. (2016) emphasized that land cover / land use change detection is a vital for sustainable planning and for managing land and other natural resources. Pattanayak and Diwakar (2016) defined land cover as the actual surface cover utilized by vegetation, buildings, or water bodies. Such features or objects could be observed or monitored through a remotely sense system. Tamilenthi and Baskaran (2013) deliberated upon the various social, economic, cultural, administrative, and chronological factors affecting changes in land surface of area of interest. Such explanations demand the procurement of higher resolution satellite imageries.

Necessity of change detection

Change is inevitable and reliable change detection techniques provide information about the areas of change, the pace of change and types of change. The growth and development of necessary social, economic and physical infrastructure in the

limited available space bring major changes to the land. Chen (2002) emphasized the role of land cover / land use planning in regional and socio-economic development, which has lately been acknowledged as a vital instrument for measuring changes in the land cover. A sound knowledge of the technology and its usage is a prerequisite for data handling and for performing the change detection analysis. Recently, Zhou et al. (2011) examined the reversible and irreversible land cover / land use changes and also identified the factors responsible for such changes. Several techniques and methods are available to detect spatial changes on the land surface; these have some advantages and limitations.

Moreover, the peculiarity of a place can be ascertained through its location, morphology, vertical profile, spatial pattern, socio-economic functions, environment, and government and private institutions. All these aspects are interrelated and interdependent on each other, based on the nature of their interaction. It is often possible to determine these changes using the census data on population; however using the spatial technology and remotely sensed data, such spatial changes can be determined to check the situation on ground conditions as well as useful for making future growth trends and potentials.

Overview of change detection techniques

This section presents a comprehensive study of various techniques and approaches, including their advantages, limitations and relevance in planning studies. An effort has been made here to exploit the potential of geospatial technology to demonstrate its relevance and application particularly in spatial or regional planning through a case study. Here, we shall look at the three salient indices of land cover change indices: Vegetation Index, Water Index and Built-up Index.

Vegetation Index or Normalized Difference Vegetation Index (NDVI)

The vegetation index examines the relation between spectral wavelength changeability and the vegetation growth. To compute the vegetation index, red spectral band and near infrared spectral band are used due to their absorbance and reflectance properties. Tucker (1979) presented a detailed study by observing the linear combinations between the visible red spectral band and near infrared spectral bands. He concluded that, such linear association between red band and photographic infrared bands provides information that is highly essential to monitor the photo-synthetically active biomass of plant canopies. NDVI values range from -1 to +1. Zhou et al. (2011) expressed that higher NDVI values imply healthier vegetation condition, wherein NDVI values less than or equal to zero represent land with low or no vegetation cover or bare land. The lower value of indices also represents drought condition or water scarcity in the region.

In the given NDVI equation, the reflectance values of red band need to be subtracted from the reflectance values of near infrared band (NIR) and then divided by the submission of the above mentioned bands (Paul and Florian, 2017). In the given equation (1), Landsat 8 data of Band 4 (red) and Band 5 (NIR) are used.

$$NDVI = \frac{NIR(Band5) - R(Band4)}{NIR(Band5) + R(Band4)} \quad \ldots(1)$$

Water Differencing Index or Normalized Difference Water Index (NDWI)

The Water Differencing Index has been formulated to distinguish water features from the remotely sensed imagery using the near infrared band and visible green band light (Zha et al. 2016). In 1996, McFeeters derived information on water bodies employing the Band 3 of Landsat 8 and Band 6 of Landsat 8 bands due to high optical density and low reflectance in the near infrared band and beyond. NDWI values range from -1 to +1. Higher NDVI values imply presence of water bodies, wherein NDWI values ranging from less than 0 to -1 represent land with low or no vegetation cover or barren land. The NDWI can be formulated using the equation (2).

$$NDWI = \frac{NIR(Band5) - SWIR(Band6)}{NIR(Band5) + SWIR\ (Band6)} \quad \ldots(2)$$

However, the results of the index couldn't manage to provide the desired results. To redress the issues, Xu (2005) developed modified water index using the green and shortwave infrared bands from electromagnetic wavelength region. In the equation (3) below, Band 3 and Band 6 of Landsat 8 are used. The water index value ranges between -1 and +1. The modified water index was computed using the equation (3). To understand the indices values of modified water index, the resulting value of greater than 0.5 represents presence of high amount of water in the region.

$$MNDWI = \frac{Green(Band3) - SWIR(Band6)}{Green(Band3) + SWIR\ (Band6)} \quad \ldots(3)$$

Index Base Built-up or Normalized Difference Built up Index (NDBI)

Urbanization is a dynamic concept, more commonly referring to a process of transformation that leads to urban sprawl. Serious efforts are being made to map such sprawl and analyze their patterns of growth. Historical archives have been given considerable recognition in mapping and assessing the urban sprawl that occurs over a place at a particular period of time (Bhatti and Tripathi, 2014). Zha et al. (2016) presented an index for mapping rapid and accurate changes resulting from urbanization. In today's context, satellite based systems have proven to be an invaluable resource for mapping built-up areas and providing a comprehensive view of larger areas. The NDBI index is computed using the Band 6 and Band 5 of Landsat 8 respectively (Kaplan et al. 2018). In the equation (4) below, Band 5 and Band 6 of Landsat 8 are used. NDBI values range from -1 to +1. Positive values of the NDBI imply presence of built or hard surfaces and negative values represent presence of water bodies, and values in between imply the presence of vegetation. Generally, the resultant values of built-up features range from 0 to 0.2.

$$NDBI = \frac{SWIR(Band6) - NIR(Band5)}{SWIR(Band6) + NIR(Band5)} \quad \ldots(4)$$

The fig.1 provides an overview of spectral bands, their resolutions, bandwidths and their uses. Practically, the usage of band combination for performing change

analysis is slightly complicated, as the wavelength region of each Landsat band is different. Primarily, Landsat 1-5 and multispectral scanners capture objects using four spectral bands. Subsequently with improvements in spectral wavelength regions the Landsat 4, Landsat 5, Landsat 7, TM and ETM-1 capture objects' information through nine bands. Following the consecutive developments in the sensor technology, Landsat 8, OLI, and TIRS has allowed satellites to capture objects on land through eleven different spectral bands.

The fig.2, fig.3 and fig.4 shown below illustrate the indicative values representing various features of land and water, and vegetation in particular. The values may vary due to spectral enhancements, reflectance and absorbance properties of an object at the time of capturing the image through camera installed on satellite. At times, deviations occur due to temperature variation, seasonal variation, time and most importantly, the location of an area. To measure the accuracy of the results, we also need to exercise other relevant techniques.

Study methodology

The subsequent section covers the description of the case study area, data procurement methodology and spatial data analysis techniques. Selective techniques and methods have been used here to demonstrate the potential of satellite data and GIS software for carrying out regional scale studies. NDVI, MNDWI and NDBI maps have been generated using the given equations in ArcGIS software.

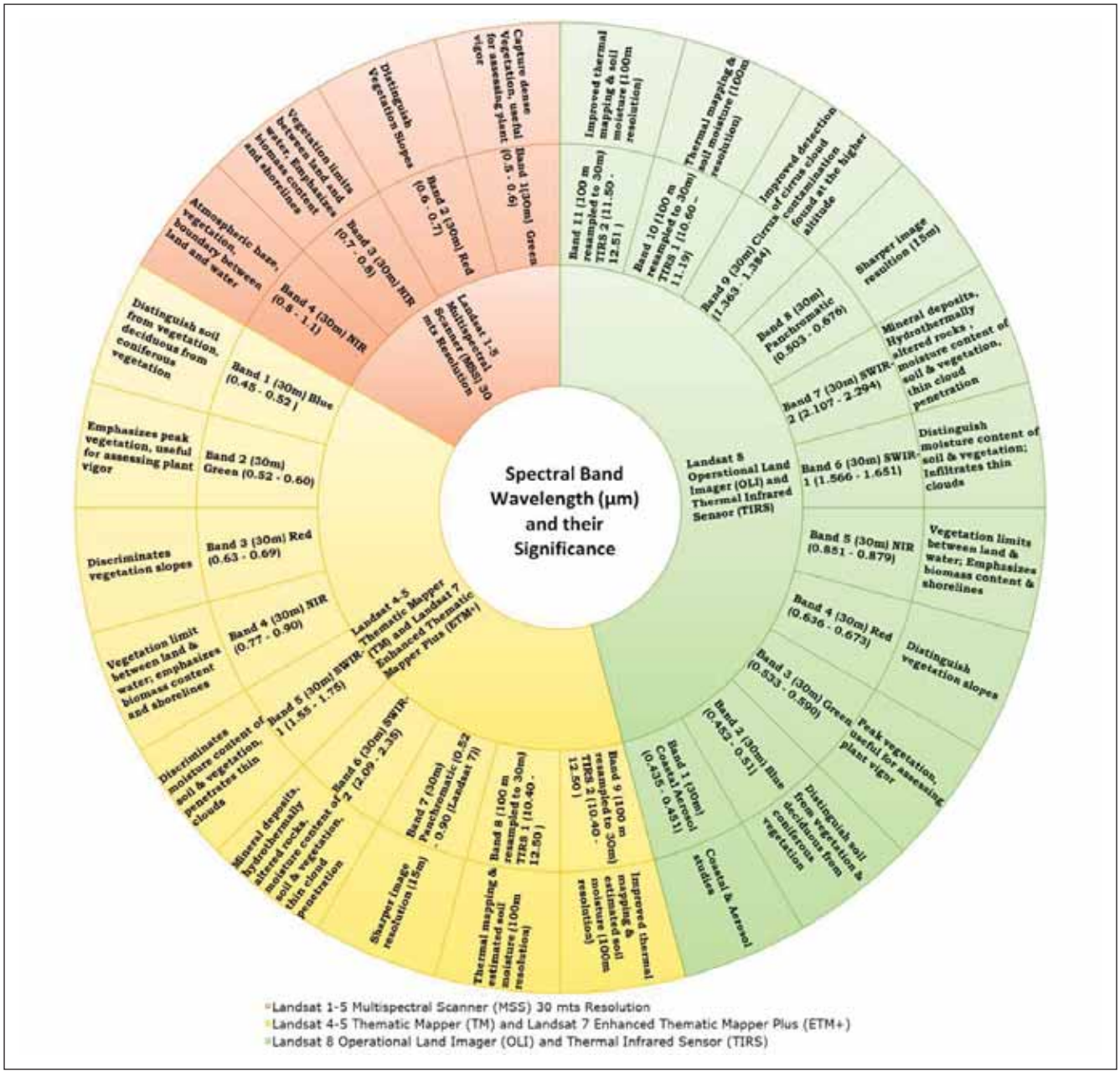

Figure 1 Landsat 1–8 Spectral Wavelength Regions, Bands and their Significance

Source: Prepared using data available on https://landsat.usgs.gov/what-are-best-spectral-bands-use-my-study. Accessed 18, July 2018.

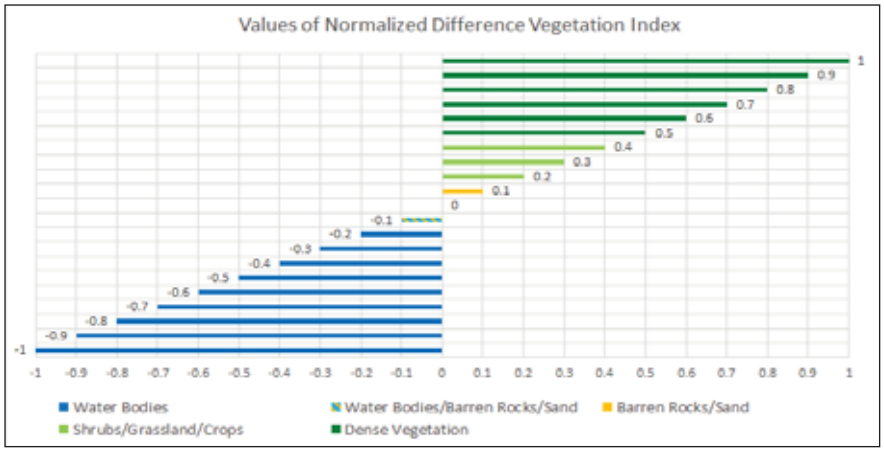

Figure 2 Values of NDVI calculated using NIR and Red Band of Landsat 8 Image
Source: Author

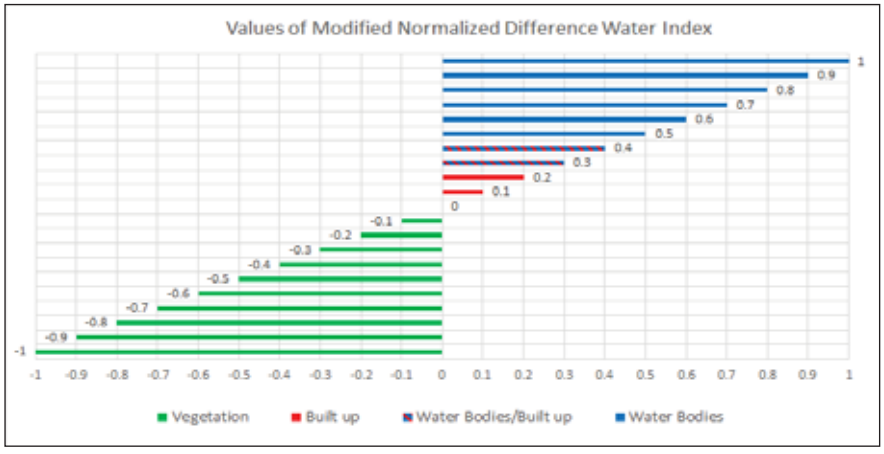

Figure 3 Values of Modified NDWI calculated using Green and SWIR of Landsat 8 Image
Source: Author

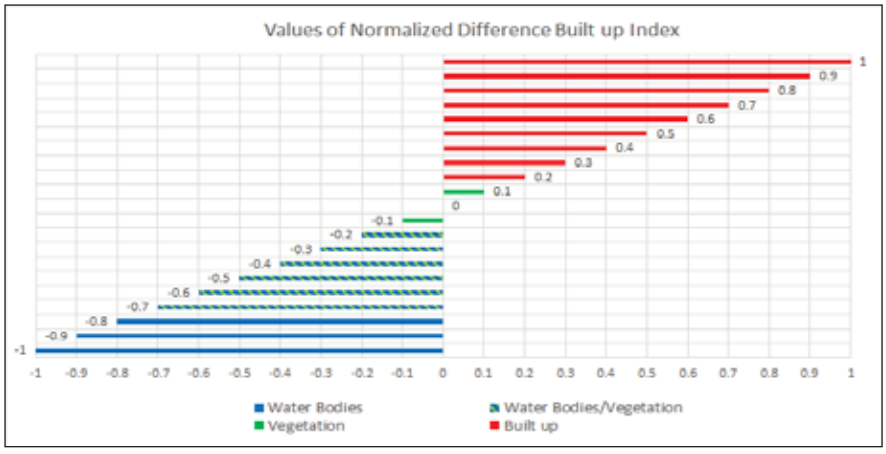

Figure 4 Values of NDBI calculated using SWIR and NIR of Landsat 8 Image
Source: Author

Introduction to case study

Surat is the second most populated district in Gujarat state after Ahmedabad and it covers an area of 4,549 sq. km—2.32% of Gujarat's total area according to 2011 census records. The district has experienced 42.24% population growth from 2001 to 2011. The district had a total population of 60.81 lakhs in 2011 and a density of 1337 persons/ sq.km, which had been almost half in the previous decade. The urbanization level in the district has increased from 60% in 2001 to 79.74% in 2011. Presently, the district consists of 10 talukas, 8 statutory towns, 14 census towns and 713 villages.

The district is geographically the part of Gujarat Plains and located in the south between the 20.81° to 21.58° North Latitudes and 72.61° to 73.71° East Longitudes. It has seven sub micro regions following climatic zones, topography, geological features, natural vegetation, and soils types. The district has minor hill ranges belonging to the Deccan Peninsula's western coastlines. The main Sahyadrian range is located slightly outside the limits of the district. The district is surrounded by the tapi district in the east by the Bharuch and Narmada districts in the north by the Navsari district in the south and the Khambhat gulf.in the west. There are four main rivers in this district: Tapi, Kim, Purna and Ambika. Among them, the Tapi River is the largest perennial of the district. The map (fig.5) shows the location of case study aera.

Resources and material

Several steps, including data procurement, generation, processing and analysis, were performed. The ArcGIS software was used to digitized the study area map; the spatial analysis was conducted on satellite images downloaded from the United States Geological Survey (USGS) earth explorer, which is an open source website where one can download georeferenced and non-georeferenced satellite images for research and academic purposes. The vector data layers were generated using the digitization or geoprocessing tools available in the ArcGIS software. The process of vector data creation is known as digitization. Some open source websites allow you to download or provide already digitized layers of various features. In the present study, the shape files of Surat district up to the taluka level and the associated physical features were extracted from Open Street Map and DIVA-GIS. Since, both raster images and digitized vector layers were obtained from different platforms, standard accuracy has been

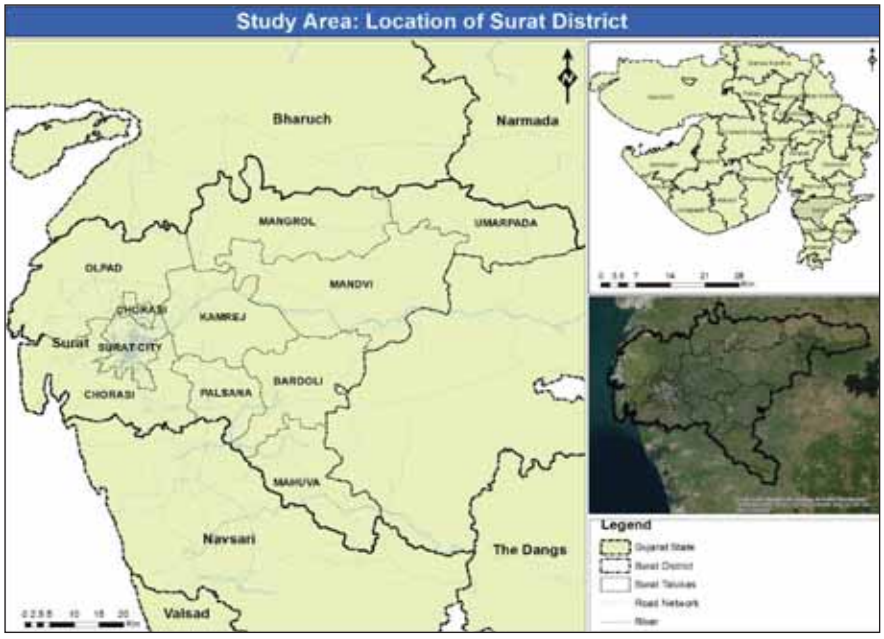

Figure 5 Location of Surat District
Source: Prepared by author in ArcGIS

ensured using functions and tools such as georeferencing and redefining projection; raster processing includes mosaic raster, composite bands, and clip, and spatial analysis includes the raster calculator and related tools and functions.

For assessing change detection, satellite data from Landsat 8 Level-I was obtained from the USGS earth explorer site. Creating a user login ID is a prerequisite for obtaining data from USGS. The study is based on the approaches used for feature extraction—the NDBI, the NDVI and the NDWI. For the present study, satellite images from May 2015 and May 2018 were procured and have been used for a detailed analysis for assessing the changes in the objects on the earth's surface. Prior to analysis, all the scenes of study area were mosaicked to create one single image of an area. These images were then clipped using the vector layer of the Surat district boundary to extract the study area.

Spatial analysis of indices

The present study investigates the changes in the main components of land cover i.e. vegetation, water and built-up space, over four years. Processed images were used to conduct spatial analysis for constructing the NDVI, NDWI and NDBI indexes, which ensure the timely provision of information required for planning and management of human and natural resources.

Normalized Difference Vegetative Index (NDVI)

In ArcGIS, several methods are available for determining the changes in vegetation cover. The NDVI of Surat district was generated through the ArcGIS Spatial Analyst raster calculator tool that uses Map Algebra as its analysis language. The tool helps you to insert the NDVI function and generates a new image displaying the intensity of vegetation cover. The resulting NDVI image (fig.6) represents the vegetation change between 2015 and 2018. The trifling changes in the brightness values of vegetation cover between the two periods is be due to noises in the atmosphere, even after the radiometric normalization of the satellite images (Sharma and Jalan 2013). The results indicates high vegetation cover in the Kamrej, Bardoli, Mangrol, Olpad, and Mahuva talukas due to the presence of large agricultural fields, shrubs or barren land. The colors in Fig. 6 represent the respective features on the land surface. Green represents vegetation; red shows built-up areas; and blue shows water. The zero values indicate no-change areas; negative values represent the reduction in vegetation density; and positive values indicate high vegetation density. The classification of these images reveals the apparent change in the pixel values of the resultant NDVI images. Ideally, the pixel values of vegetative index ranges between 0.2 and +1, which includes shrubs, grassland, cropland and dense vegetation. There was a substantial decline in the NDVI values over the last five years from 0.224 to +0.578 in the year 2015 and from -0.326 to +0.563 in 2018. From this, it can be concluded that there was a decrease in vegetation cover from 2015 to 2018.

Modified Normalized Difference Water Index (MNDWI)

The result from the MNDWI analysis depicts the increase in water bodies around the coastal belt of Surat district over the last five years. However, the values of water index range from -1 to +1, and values greater than 0.5 represents the water features. Likewise, colors have been chosen appropriately to represent the features present on the land surface. The existing analysis was done using the Band 3 and Band 6 of Landsat 8 to extract the water features. The MNDWI of Surat district was generated using the ArcGIS Spatial Analyst tool available with spatial analyst extension.

The resulting MNDWI images (fig.7) highlights the changes in water bodies from 2015 to 2018. The classification of MNDWI image revealed changes in the values of the water index from 0.560 in 2015 to 0.529 in 2018.

Normalized Difference Built up Index (NDBI)

Likewise, the NDBI of Surat district was generated using the same tool available in spatial analyst. The Landsat 8 satellite data, particularly the Band 5 and Band 6, were used to determine the changes in the built up space of Surat district. Generally, negative NDBI values represent water bodies and higher values (towards +1) represent intensive built up areas. The values on the lower side represent vegetation. In the present case, the values of NDBI images

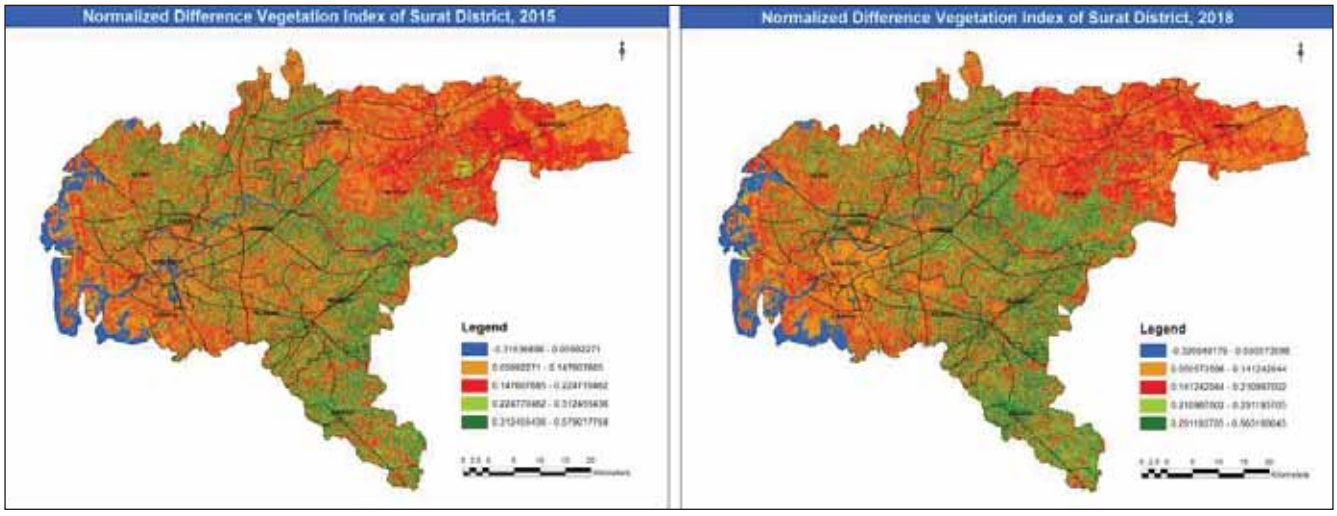

Figure 6 Vegetation Index – 2015 and 2018
Source: Author

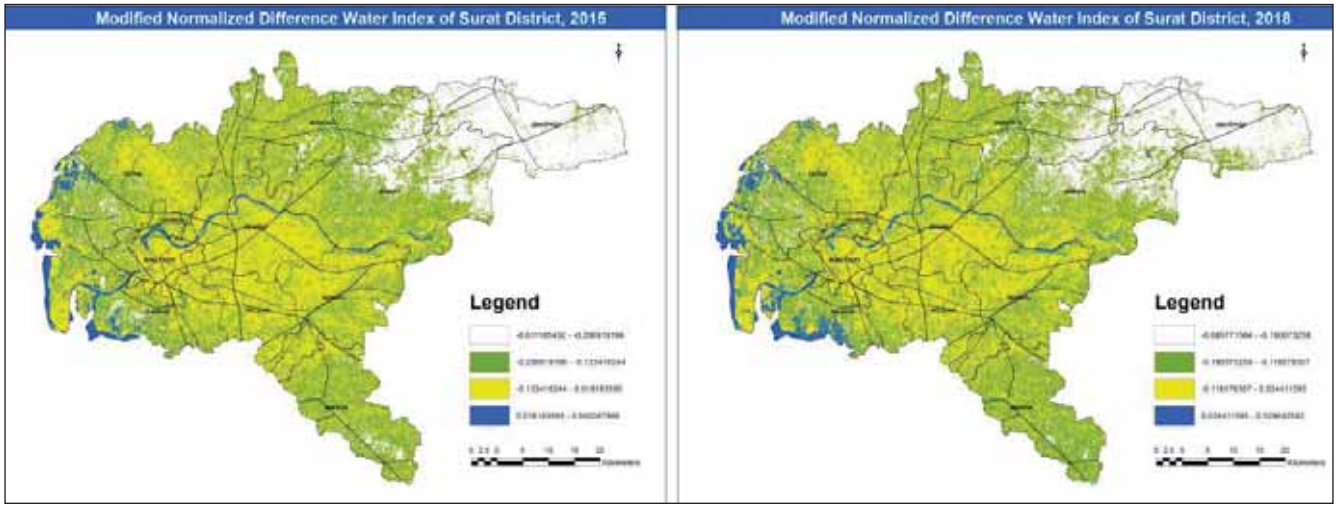

Figure 7 MNDWI – 2015 and 2018
Source: Author

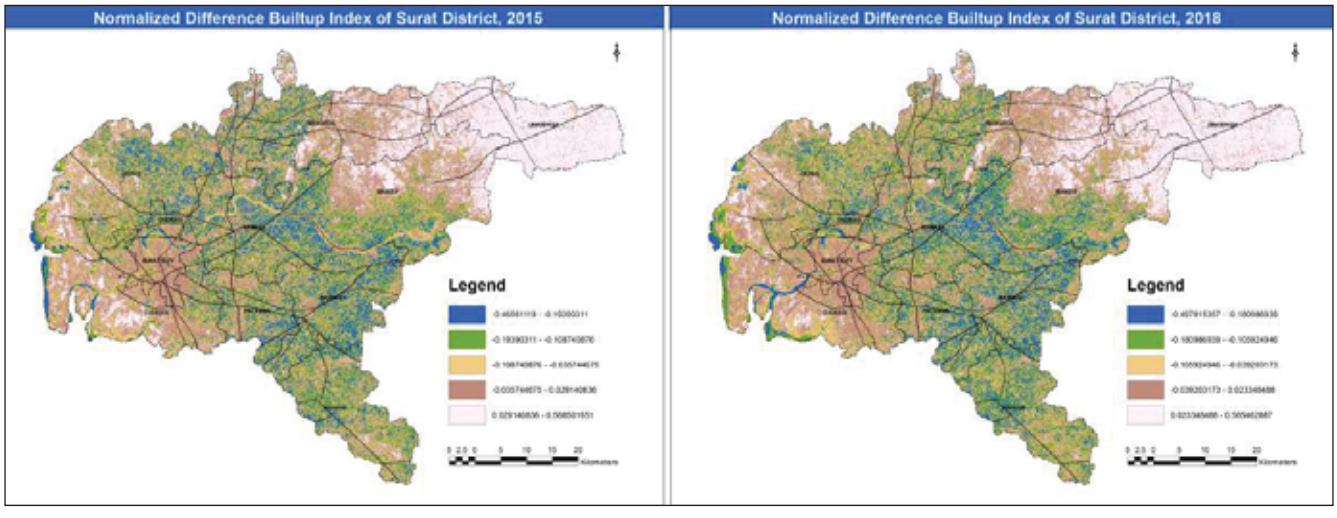

Figure 8 NDBI – 2015 and 2018
Source: Author

were classified to highlight the changes in built up area during the two respective years. The resultant images clearly reveals the increase in built up space from 2015 to 2018 (fig.8). The changes in built up index between the two periods indicates the increase of built up space particularly in Surat city. This is due to the fact that, nearly 80% of the district population lives in the city, according to the 2011 census, resulting in a population density of 13500 persons per sq. km. Known as a dynamic city and a major employment center with several manufacturing industries the city attracts migrant population from the nearby district or states.

Spatial Indices and their Application

The NDVI index helps in monitoring the changes in vegetation densities. It is also useful for determining the distribution of specific features, such as water bodies, transport networks, settlements, agricultural land and concrete structures. The MNDWI index allows the monitoring of changes in water bodies. It helps in effectively enhancing and assessing the surface water features in terms of quality and quantity. It further reduces or removes the vegetation and soil cover noise, thus enhancing the water features. The NDBI index aids in monitoring the changes in built up area. Nonetheless, these observations only provide a general viewpoint. The actual application and utility depend fairly upon the study area under consideration and are further subject to field studies.

Conclusions

The above regional-level study very effectively exhibits the utility of geospatial technologies. However, in case of urban areas, the accuracy of the results could be further ground-tested by field verification. This is required because the equations used to determine these indices uses spectral bands information that enhances certain specific feature and show the slight changes in the reflectance and absorbance properties of any object. Such errors or a change in the spectral values of any objects needs either technical correction on the image itself or through field verification.

The discussed techniques are highly beneficial for the preparation of regional/ district plan, development plans, land suitability analysis and environmental studies. These studies are sometimes expensive in terms of both time and money, because they require high-end hardware and software, followed by extensive field surveys. Nonetheless, such studies could be conducted or verified through other available techniques, such as, supervised classification and accuracy assessment. The need of the hour is to acquire an in-depth understating of the application of these geo-spatial tools and techniques.

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UN-GGIM recommends establishing a Global Geodetic Centre of Excellence

The UN-GGIM Subcommittee on Geodesy has recommended establishing a Global Geodetic Centre of Excellence to strengthten the capacity to implement the UN General Assembly resolution. The subcommittee is presenting the second iteration of the position paper defining appropriate governance arrangements.

The Global Geodetic Reference Frame (GGRF) is in acute danger of degradation, due to aging infrastructure, insufficient coordination and financing, and diminishing human capacity.

The GGRF is the foundation for virtually every aspect in collecting and managing of spatial information and global monitoring of the Earth. It is imperative to ensure its sustainability and enhancement.

Data to reducetraffic congestion

A partnership between Ordnance Survey, the Department for Transport, the British Parking Association, and GeoPlace, could dramatically reduce traffic congestion on UK roads by making crucial data on planned changes to the road network available to tech companies to build artificial intelligence routing platforms.

Through the Department for Transport's review of legislation around Traffic Regulation Orders (TROs), the data could soon be made available to tech firms to develop and enhance navigational apps. It is hoped the apps could warn drivers up to months in advance of planned disruption to routes and offer alternatives, potentially saving them time and money. *www.Os.uk*

Transformation of common land a

Software by SCISYS UK Ltd., has been chosen by Welsh Government to enable the on-going implementation of the Commons Act 2006. The software will enable the development and introduction of electronic registers for common land and town or village greens throughout Wales. The Commons Act 2006 was introduced to protect common land from development, allow more sustainable management of common land and to improve the protection of common land from neglect and abuse.

The Commons Act 2006 includes a new provision allowing the creation of digital registers and maps leading to the decision by Welsh ministers to develop and introduce electronic registers in Wales. *www.scisys.co.uk*

New geospatial cloud platform by MyCRM

MyCRM, based on the Isle of Wight, is building up to the worldwide launch of its new mapping technology suite. Mapsimise will enable businesses to connect live data from Salesforce, SugarCRM and Microsoft Dynamics. Using other services with Google Maps and, crucially, store it all securely in the cloud.

Organizations of any type will be able to visualize and map data, either via connectors or by uploading data to create representative maps. These geospatial technologies will help businesses to build targeted mailing lists by location and help sales teams plan appointments by location. Mapsimise will be released in late 2019, hosted with data centres in the US and the EU. *www.mapsimise.com*

OGC seeks to modernize its Observations & Measurements standards

Newly revised O&M SWG will update the existing O&M standards to conform to modern web architecture requirements and best practice, and create a new OGC standard for JSON encoding of O&M data. The Open Geospatial Consortium (OGC) requests public comment on the recharter of the OGC Observations and Measurements (O&M) Standards Working Group (SWG).

The O&M standard was originally defined within the OGC Sensor Web Enablement Initiative in 2003-2007. Version 2.0 of the standard was co-published as the OGC Abstract Specification Topic 20 and ISO 19156:2011. The latest version of OGC Abstract Specification Topic 20 is from 2013. As such, the standard requires revising to accommodate technical issues discovered in various standard implementations and harmonization with recent W3C/OGC standardization work on sensor network terminology and concepts defined in the Semantic Sensor Network (SSN) and Sensor, Observation, Sample, and Actuator (SOSA) ontologies. The ISO 19156 revision will be carried out by the ISO/TC 211 in parallel, and in close co-operation with the O&M SWG revision work on the OGC O&M encoding Standards.

The OGC Observations and Measurements - XML Implementation (OGC 10-025r1) Standard defines an XML encoding for the concepts defined in OGC Abstract Specification Topic 20 and will also be revised to accommodate the changes to the OGC Observations and Measurements Abstract Specification.

Notably, and in addition to the revision of the O&M XML Implementation Standard, there is an identified need to standardize an O&M data encoding for formats like JSON/GeoJSON. These formats are preferred in modern Web APIs, including those conforming to the OGC API - Features - Part 1: Core Draft Standard (OGC 17-069r2).

Both the Observations and Measurements conceptual data model and its standardized XML encoding are used extensively in Spatial Data Infrastructures such as in the EU INSPIRE. There is also on-going work to additionally provide INSPIRE O&M datasets in JSON/GeoJSON based formats, but no standard has yet been identified describing an interoperable way of doing this. *www.ogc.org*

Dubai Municipality opens geospatial training centre

Dubai Municipality has recently launched an internationally accredited training centre for geospatial courses by ESRI. It is the only accredited centre in Dubai to offer specialized courses in the field of GIS and Geospatial Service, the civic body said in a press release. *www.dm.gov.ae*

US Space Command established

In a move to enhance the United States' space superiority capabilities, President Donald J. Trump, Vice President Mike R. Pence, Secretary of Defense Dr. Mark T. Esper and Air Force Gen. John W. Raymond formally established the United States Space Command during a ceremony held Aug. 30 at the White House.

At the direction of the President of the United States, the Department of Defense established U.S. Space Command as the 11th unified combatant command, with Raymond as its congressionally confirmed commander. Establishing USSPACECOM is a critical step that underscores the importance of the space domain and its strategic contributions to U.S. national security. The USSPACECOM establishment will accelerate the United States' space capabilities to address rapidly evolving threats to U.S. space assets and the importance of deterring potential adversaries from putting critical U.S. space systems at risk.

USSPACECOM is a geographic combatant command with a global area of responsibility defined as the area surrounding the earth at altitudes equal to or greater than 100 kilometers above mean (average) sea level. The new command is globally integrated with the other geographic combatant commands and prepared to support its partners to meet today's threat on a global scale. *www.af.mil*

EDRS-C successfully launched

The second satellite to join the constellation that forms the European Data Relay System (EDRS) has been successfully launched. It was launched on board an Ariane 5 from Europe's Spaceport in Kourou, French Guiana, on 6 August at 21:30 CEST (19:30 UTC).

EDRS enables people to observe Earth almost live, accelerating responses to emergency situations and spurring the development of new services and products that create jobs and increase prosperity. It is dubbed as the 'SpaceDataHighway' by its private operator Airbus – uses innovative laser technology to dramatically cut the time needed for Earth observation satellites to deliver information to the ground. The satellites can transmit data at a rate of up to 1.8 Gbit/s. The latest satellite, called EDRS-C, will operate in geostationary orbit. It will join its sister EDRS-A, which was launched in January 2016.

EDRS is a new, independent European satellite system, and is a public–private partnership between ESA and Airbus as part of ESA's efforts to federate industry around large-scale programmes, stimulating technology developments to achieve economic benefits. *www.esa.int*

Chinese scientists test satellite positioning technology

Chinese scientists have successfully tested a satellite positioning technology called pulsar navigation, catching up to the United States, which was the first to do so last year.

Researchers with the Institute of High Energy Physics at the Chinese Academy of Sciences in Beijing said on Thursday that a Chinese scientific satellite had managed to calculate its own position in space by using the X-ray emitted by a small, distant star for reference.

With a margin of error of just 3.3km (2 miles), the accuracy was an improvement of more than 30 per cent on a similar Nasa experiment last year, which had a 5km margin of error.

Many nations have joined the race to develop new satellite positioning and navigation systems that can work independently in space without the need for reference signals from ground stations, but none are yet ready for use in the field. There are many challenges, including developing detectors with extremely high sensitivity that can pick up weak signals from tiny stars thousands of light years away.

China's Insight-HXMT satellite and Nasa's NICER/SEXTANT instrument, which is mounted on the International Space Station, are both aimed at neutron stars that emit pulses of electromagnetic radiation with a regularity that makes these pulsars more stable than an atomic clock for timekeeping. That means the absolute position and relative speed of a satellite or spacecraft can be deduced by measuring the difference in arrival time of signals from the pulsars, which usually take the form of X-rays.

It would be an improvement for existing satellites and spacecraft – including global navigation systems such as the American-owned GPS, China's Beidou and Russia's Glonass – which depend on signals generated by command centres on the ground to perform such calculations.

The X-ray pulsar navigation technology was initially developed for deep space missions in which communication with Earth is challenged by the enormous distance involved. Nasa has already announced plans to use the technology on spaceships taking astronauts to the moon and Mars.*www.scmp.com*

China's super-thin atomic clocks achieve mass production

China's super-thin rubidium atomic clock, which is just 17 millimeters thick, has been put into mass production, said its manufacturer. The clock, developed in 2018 by a research institute under China Aerospace Science and Industry Corp Ltd, is the key to the positioning and timing accuracy of BeiDou navigation satellites.

Compared with the previous generation, the new clock is smaller in size but performs better. It adopts a plug-in design, making it easy to insert and remove on circuit board. With stronger resistance to high temperatures, it can work at 70 C. *www.chinadaily.com*

Law on ratification of the agreement on the application of GLONASS and Beidou systems

At a meeting of the Council of the Federation of the Federal Assembly of the Russian Federation on July 26, 2019, the Federal Law on the Ratification of the Agreement between the Government of the Russian Federation and the Government of the People's Republic of China on Co-operation in the use of GLONASS and Beidou for Peaceful Purposes was approved.

The Intergovernmental Agreement was signed on November 7, 2018 in Beijing during the 23rd regular meeting of the heads of government of Russia and China.

The agreement creates the legal framework for cooperation in the development and production of civil navigation equipment using GLONASS and Beidou systems, as well as the development of Russian-Chinese standards for the use of navigation technologies using both systems, in particular, standards for the control and management of traffic flows crossing Russian-Chinese border.

In particular, within the framework of the Agreement, it is planned to deploy on a reciprocal basis GLONASS and Beidou measuring stations in the territories of the People's Republic of China and the Russian Federation. *www.roscosmos.ru*

Fiji, Cuba, Vietnam to have GLONASS stations

Roscosmos has conducted negotiations with a handful of countries, including Cuba and Fiji, about placing GLONASS satellite stations on their territory, according to the company's 2018 annual report. As of now, there are 11 GLONASS stations outside of Russia.

Factory warranty of half of operating glonass satellites expired

More than half of satellites of the Russian global navigation system GLONASS are operating despite the expiry of the warranty period established by the manufacturer, according to data of the satellites' operator, GLONASS System Control Center.

13 out of 23 operating satellites, which were launched between 2007 and 2011, exceeded the warranty period established by the manufacturer, Information Satellite Systems Reshetnev (part of Roscosmos). All of them belong to the Glonass-M series, which have a guaranteed 7-year lifespan. The oldest satellite, which was launched in 2007, exceeded the warranty period by five years.

All in one GNSS/INS Navigation

Australia's Advanced Navigation, which specializes in a broad range of fields including sensors, GNSS, inertial navigation, RF technologies, acoustics, robotics, AI and algorithms, offers the GNSS Compass, a fully integrated wheelmark certified GPS/INS navigation and heading solution.

It contains a 9 axis IMU that is integrated with a dual antenna GNSS system with high performance antennas. It is designed to provide higher heading accuracy than magnetic systems and does not require any calibration or setup. The system is plug and play for NMEA 0183 and NMEA 2000 integrations, requiring no setup or configuration. *www.advancednavigation.com*

NASA and METI release ASTER Digital Elevation Model Version 3

The US National Aeronautics and Space Administration (NASA) and the Ministry of Economy, Trade, and Industry (METI) of Japan jointly released Version 3 of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM), recently. The ASTER GDEM is available at no charge to users worldwide via electronic download from Japan Space Systems and from NASA's Land Processes Distributed Active Archive Center (LP DAAC).

The ASTER instrument was built by METI and launched aboard NASA's Terra spacecraft in December 1999. It has an along-track stereoscopic capability using its near infrared spectral band and its nadir-viewing and backward-viewing telescopes to acquire stereo image data with a base-to-height ratio of 0.6. The spatial resolution is 15 meters in the horizontal plane, with a 60 kilometer by 60 kilometer ground area.

The methodology used to produce the ASTER GDEM involved automated processing of 2.3 million scenes from the ASTER archive, including stereo-correlation to produce individual scene-based ASTER DEMs, masking to remove cloudy pixels, stacking all cloud-screened DEMs, removing residual bad values and outliers, averaging selected data to create final pixel values, and then correcting residual anomalies before partitioning the data into 1° by 1° tiles. *https://lpdaac.usgs.gov*

NASA targets coastal ecosystems with New Space Sensor

NASA has selected a space-based instrument under its Earth Venture Instrument (EVI) portfolio that will make observations of coastal waters to help protect ecosystem sustainability, improve resource management, and enhance economic activity.

The selected Geosynchronous Littoral Imaging and Monitoring Radiometer (GLIMR) instrument, led by principal investigator Joseph Salisbury at the University of New Hampshire, Durham, will provide unique observations of ocean biology, chemistry, and ecology in the Gulf of Mexico, portions of the southeastern United States coastline, and the Amazon River plume – where the waters of the Amazon River enter the Atlantic Ocean.

The instrument was competitively selected from eight proposals considered under NASA's fifth EVI solicitation released in 2018, with an award of $107.9 million. This is the largest NASA contract award in the history of the University of New Hampshire. Salisbury and his team have proposed the instrument as a hosted payload, for which NASA will provide access to space.

EVI investigations are small, targeted science investigations that complement NASA's larger Earth-observing satellite missions. They provide innovative approaches for addressing Earth science research with regular windows of opportunity to accommodate new scientific priorities. The investigations are cost-capped and schedule constrained. The missions are managed by the Earth System Science Pathfinder (ESSP) program office at NASA's Langley Research Center in Hampton, Virginia, for the Earth Science Division under the Science Mission Directorate.

ICEYE releases world-first under 1 meter resolution radar imagery

Under 1 meter resolution radar satellite imaging from ICEYE breaks previous

ICEYE, is the first in the world to achieve better than 1 meter resolution imagery from under-100kg (220 pounds) SAR satellites. The new Spotlight imaging capability builds on ICEYE's legacy of leading the way on small satellite SAR since its history making first small SAR satellite launch in January 2018. Since then the company has continued to launch more satellites, the latest in July 2019 with two new units. With new satellites being launched still during 2019, ICEYE continues to develop and optimize its imaging capabilities further for customers in both commercial and government segments. *www.nasa.gov/earth*

FlytGCS Enterprise for remote drone fleet operations

FlytGCS, is a cloud-based remote operations solution for drone operators and service providers. As the commercial drone market matures, professional drone operations are maturing to enterprise ones – with corporations across the world building in-house drone fleets and programs, runnings PoCs and pilots for multiple use-cases, and investing in – and even acquiring – drone technology vendors. Taking cognizance of this market evolution from the 'early adopters' to the 'early majority', FlytBase has now launched FlytGCS Enterprise. *https://flytbase.com*

Airbus Aerial Receives waiver for Urban BVLOS UAS flight operations

Airbus Aerial has been granted a waiver by the Federal Aviation Administration (FAA) to conduct Beyond Visual Line of Sight (BVLOS) Unmanned Aerial Systems (UAS) operations in Grand Forks, ND without the need for a visual observer. The waiver allows Airbus Aerial to conduct such operations as part of North Dakota Department of Transportation's UAS Integration Pilot Program (IPP).

In 2018, the US Department of Transportation selected NDDOT as one of 10 state, local or tribal entities to participate in the FAA's UAS IPP. The North Dakota team is working to safely incorporate UAS technology in three core challenge areas: conducting flights over people, night operations and BVLOS operations without the need for visual observers (VOs). *www.airbus.com*

Lido Surface Data NEXTView for UAS market

Intermap Technologies has launched its Lido Surface Data NEXTView ("NEXTView") data solution, co-developed with Lufthansa Systems, for the Unmanned Aircraft Systems (UAS) market. It is a high-accuracy, global 3D elevation dataset customized for aviation applications. It is continually refreshed to ensure currency and compliance with regulatory update requirements. *www.intermap.com*

FAA approves solar drone flights over Hawaiian Island

Federal Aviation Administration (FAA) has approved Japanese drone company HAPSMobile to fly its solar-powered unmanned aircraft HAWK30 over Hawaiian Island. HAWK30 drone will provide a stratospheric telecommunications platform system across the stratosphere of the Hawaiian island of Lanai.

HAPSMobile partners with the University of Alaska Fairbanks, which manages the PPUTRC, and the University of Hawaii to conduct stratospheric test flights using HAWK30. The University of Alaska Fairbanks applied to the FAA for the COA2 on behalf of the partnership. *www.hapsmobile.com*

Advanced thermal, multispectral, and high-resolution imagery by ATMOS UAV

Atmos UAV, the Delft-based drone manufacturer for mapping and surveying, continue to expand its payload options now including the new MicaSense sensor, "Altum", which integrates a radiometric thermal camera with five high-resolution narrow bands, producing advanced thermal, multispectral and high-resolution imagery in one flight for advanced analytics. Marlyn, the fixed-wing VTOL surveying platform developed by Atmos UAV, is now the only drone in its class capable of carrying this new high-end sensor. *www.micasense.com*

Input south on Recreational Drone Operator Testing by FAA

The Federal Aviation Administration (FAA) has issued a Request for Information (RFI) seeking to work with stakeholders on the administration of a new aeronautical knowledge test for recreational drone operators.

Section 349 of the FAA Reauthorization Act of 2018 requires new conditions to operate recreational small unmanned aircraft systems (UAS). Many drones can be flown today with minimal training or knowledge of aviation rules or safety practices. The new statute is an opportunity to educate recreational flyers on UAS safety and to bring new flyers into the existing aviation safety culture. The law requires that flyers of recreational drones pass an aeronautical knowledge and safety test.

The FAA is developing the test content and the training in consultation with stakeholders. The test must be administered electronically by the FAA, community-based organizations, or other persons designated by the FAA. The FAA's objective is to work with third party entities to allow them to administer the knowledge training and test content on various platforms for the recreational flyer community. *www.faa.gov*

HEISHA launches new pilot free VTOL fixed-wing

HEISHA has recently launched the new unattended system. D.NEST F300, combined the auto-charging station C300 with VTOL fixed-wing is available for sale. It's expected to revolutionize the way how drones are used in daily life and it can be used for farm/pasture/privacy land inspection anytime, anywhere. *www.heishatech.com*

DroneShield releases RfZero

DroneShield has released a new product, RfZero, which is an omnidirectional drone detection device with a 1km range. It is designed to be a cost-effective fixed site alternative to DroneShield's higher end product, RfOne (a 5km radiofrequency direction finder) *www.droneshield.com*

Large scale mapping by drones in Maharashtra, India

Survey of India, the national mapping agency of India has signed an MoU with Department of revenue & Land records, Govt of Maharashtra to undertake the Large scale Mapping of Village Gaothan (Aabadi) areas in the State of Maharashtra using drones.

This large scale mapping project is being carried out using Professional Survey grade Drone covering more than 40,000 Village Gaothan (Aabadi) areas in Maharashtra State. These village Gaothan areas not been surveyed earlier will be mapped at 1:500 scale covering all land parcels in the village for preparing the accurate revenue maps and GIS database. Drone survey will be pivotal to fix locations of village boundaries, canals, canal limits and roads in these villages.

A detailed presentation about this Large scale Mapping Project was also made in the National Workshop and Conference of Sarpanch and Upsarpanch organized jointly by Department of Rural Development, Govt of Maharashtra and All India Sarpanch Association Shirdi, Ahmednagar district on 31st July. *https://pib.gov.in*

Echodyne and Iris Automation ensure safety for pioneering drone flight over

Echodyne, the manufacturer of innovative, high-performance radars for government and commercial markets, has announced that its EchoGuard airspace management radars were the ground-based sensor for the first-ever UAS mission to operate beyond-visual-line-of-sight (BVLOS) flight without ground observers. The ground-based sensors worked in coordination with Iris Automation's onboard detect-and-avoid system. The demonstration of a nearly four-mile linear inspection mission along the Trans-Alaska pipeline was designed and conducted by The University of Alaska's Unmanned Aircraft Systems Integration Pilot Program (UASIPP) and the Alyeska Pipeline Service Company and is a true first for the UAS industry. All other BVLOS missions required ground observers, which is too logistically complex and costly for business applications.

The U.S. Department of Transportation's UASIPP is conducted in multiple locations across the US, and Echodyne's sensor technology is a key part of these programs. The program encourages government authorities at all levels to cooperate with drone operators and sensor technology manufacturers to accelerate the safe adoption of drones into the nation's airspace. *www.simactive.com*

BasicAI OnPrem data labeling platform

BasicAI has announced the availability of a suite of enterprise software designed to enable organizations to directly manage the often complicated and time-consuming data annotation process in their own secure environments, either on-premises or in a private cloud deployment.

BasicAI OnPrem represents a ground-breaking approach to proprietary labeled data set creation and management for AI/ML applications. It further enhances the leading functionality and features of BasicAI Cloud Platform while empowering users to manage internal annotation workflows from end-to-end including project definition, workforce management, labeling template customization, acceleration and pre-processing tools, progress monitoring, quality control, and more. *www.basic.ai*

Lytx help clients reduce drowsy driving rates

Lytx®, a leading global provider of machine vision and artificial intelligence-powered video telematics solutions for commercial and public sector fleets, has shared its data showing drowsy driving and falling asleep behind the wheel are dramatically declining among commercial drivers who use the Lytx Driver Safety Program.

Lytx data reflects reduction in drowsy driving events among Lytx clients from June 2018 to June 2019, and a reduction in drivers falling asleep behind the wheel.

The data reflects a 39 percent reduction in drowsy driving events among its clients and a 66 percent reduction in drivers falling asleep behind the wheel. The data also shows morning hours between 5 and 8 a.m. had the highest concentration of events recorded for drowsy driving, falling asleep behind the wheel, and collisions, while 6 to 9 p.m. had the fewest instances. *www.lytx.com*

Zenuity and CERN team up for Autonomous Driving

Zenuity, the autonomous driving software company headquartered in Sweden, has become the first automotive company to team up with CERN, the European Organization for Nuclear Research, in the development of fast machine learning for autonomous drive cars.

One of the main quests at CERN is to study the standard model of particle physics by collecting large quantities of data originating from particle collisions produced by CERN's Large Hadron Collider (LHC). Both particle physics and autonomous vehicles require fast decisions to be made. CERN has approached this challenge by using Field-Programmable Gate Arrays (FPGAs), a hardware solution that can execute complex decision-taking algorithms in micro-seconds. The synergy between Zenuity and CERN aims to use FPGAs for fast Machine Learning applications, to be used in the AD industry and in particle physics experiments.

The research to be conducted under the collaboration concerns so-called 'deep learning', which is a class of machine learning algorithms. In recent years such algorithms, commonly referred to as AI, have been applied to a multitude of fields with great success, even exceeding human performance on certain tasks. *www.zenuity.com*

HERE Technologies to power WorkWave's mapping functionality

HERE Technologies, has announced that WorkWave®, a provider of cloud-based software solutions that support every stage of a service business's lifecycle, has replaced Google's Map and Geocoder products with the HERE Location Suite.

WorkWave's cloud-based GPS and route planning solutions will utilize industry leading mapping data, reliable routing options and robust geocoding functionality from HERE to enable WorkWave's solutions to maintain scalability and reliability for its customers. *https://openlocation.here.com.*

Spirent Sim3D – Realistic multipath simulation

Spirent Communications plc has announced the availability of its innovative multipath simulation solution, Spirent Sim3D. It enables the testing of realistic multipath and obscuration effects on GNSS signals in a true-to-life synthetic environment.

Historically, researchers and developers of GNSS receivers have had to rely on statistical models and time-consuming field testing to study the effects of multipath on GNSS signals. With Sim3D, the industry can now gain a greater understanding of the impact of multipath and obscuration in a broad range of real-life situations. It offers the level of control and traceability needed for developers to improve their customers' experience in the most challenging environments.

The unique system has been developed in partnership with OKTAL Synthetic Environment. It offers the ability to simulate multipath effects in a range of life-like geo-typical environments, using different models to recreate locations such as urban highway, an inner city or a forest. Geo-specific models of real locations can also be commissioned. *www.spirent.com/products/sim3d*.

Next generation GPS III satellite responding to commands

The U.S. Air Force's second next-generation GPS III satellite, built by Lockheed Martin is responding to commands, under control and now using its own internal propulsion system to get to orbit following its successful launch.

GPS III SV02 is the second GPS III satellite designed and built by Lockheed Martin to help the Air Force modernize today's GPS constellation with new technology and capabilities. It provide 3x greater accuracy and up to 8x improved anti-jamming capabilities. It also provides a new L1C civil signal, compatible with other international global navigation satellite systems, like Europe's Galileo. *www.lockheedmartin.com*

Rohde & Schwarz completes industry's first 5G LBS session

Rohde & Schwarz, in collaboration with Qualcomm Technologies, Inc., have successfully verified an A-GPS control-plane LPP test session over 5G NR using a device powered by the Snapdragon X55 5G modem and Qualcomm(R) RF Front-end solutions. The device was able to successfully establish a 5G non-standalone (NSA) connection and then perform GPS fixes according to 3GPP requirements.

The R&S TS-LBS test system, which consists of the R&S CMX500 and R&S CMW500 radio communication testers and the R&S SMBV100B vector signal generator, covers 3GPP conformance and network operator test plans for 5G NR, LTE, WLAN, WCDMA and GSM location based services. Test coverage includes all minimum performance and protocol tests, which can easily be extended to cover R&D-level control testing or VoNR E911 in 5G NR Standalone mode. *www.rohde-schwarz.com/wireless*

GPS III satellite launches with RAD750™ single board computers

The U.S. Air Force has launched its second GPS III satellite, the most powerful GPS satellite ever built. BAE Systems' RAD750™ Single Board Computer (SBC), part of Harris Corporation's navigation payload for GPS III prime contractor Lockheed Martin, will provide radiation hardened, high-performance onboard processing capability for the satellite's mission. *baesystems.com/space*.

L3Harris Technologies delivers eighth GPS III navigation payload

L3Harris Technologies delivered its eighth navigation payload to GPS III satellite prime contractor Lockheed Martin.

The GPS III navigation payload features a Mission Data Unit (MDU) with a unique 70-percent digital design that links atomic clocks, radiation-hardened processors and powerful transmitters – enabling signals three times more accurate than those on current GPS satellites. The payload also boosts signal power, which increases jamming resistance by eight times and helps extend the satellite's lifespan. *L3Harris.com*

CHC Navigation introduces new corporate website

CHC Navigation is proud to announce the launch of its brand-new website which conveys its expanding role as a global leader in Geospatial Solutions. It provides a clear insight about the company and its ambition when developing, delivering and supporting high-end, professional and innovative GNSS-based solutions to its customers.

NovAtel unveils RTK from the sky corrections for precision agriculture

NovAtel introduced a new addition to its corrections portfolio - TerraStar-X service is available for use in precision agricultural applications across the Midwestern United States. It delivers RTK From the Sky performance by providing convergence in under one minute with 2 cm RMS accuracy and 99.9% uptime while reducing equipment needs and increasing productivity for end-users.

By combining global and regional correction technology with L-band delivery of data for precision agriculture applications, TerraStar-X provides users the precision and speed of traditional RTK networks without the need for base stations, saving growers time and money. *www.novatel.com*

Komatsu dozing control logic combines GNSS/INS for machine control

Komatsu America Corp. has introduced Proactive Dozing Control logic, a fully-integrated dozing control system that allows operators to perform auto-stripping, auto-spreading, high production dozing and finish grading.

Built on the company's intelligent machine control, the system uses GNSS positioning in conjunction with an inertial measurement unit (IMU) to calculate precise position. The two sensors work together to calculate exactly where the tracks are on the ground.

New technology makes GPS more secure and reliable for military systems

Raytheon received security certification for new GPS modules and receivers from the Global Positioning Systems Directorate at the U.S. Air Force Space and Missile Systems Center.

The new modules and receivers will give military aircraft, ships, ground vehicles and weapon systems secure and reliable access to modernized GPS. Raytheon's military code common GPS module was certified, along with its ground-based GPS receiver, or GB-GRAM, and the avionics GPS receiver, or GRAM-S/M. GB-GRAM and GRAM S/M are jointly developed with Trimble Inc., while General Dynamics provides cryptographic capabilities for the modules. *www.raytheon.com*

Drotek releases Sirius RTK F9P GNSS rover

The new Sirius RTK GNSS Rover F9P is meant to be mounted on the vehicle that's moving. Whereas the base is supposed to be immobile (even though it can be mobile, which implies a loss of accuracy), the rover is the module receiving the corrections, providing the information to the autopilot with its position, heading, height…

This new rover module has a built-in active antenna patch. It is capable of interacting with the Galileo satellites network, along with GPS, BeiDou, GLONASS and Galileo networks, which is designed to provide more accuracy for its positioning.

Precise Positioning for Autonomous Vehicles

Swift Navigation has announced nationwide coverage for its network-connected Skylark™ precise positioning service in the USA. Full contiguous United States (CONUS) coverage reduces initialization times

to seconds, ensuring high-accuracy—and high-integrity—positioning is available when customers need it.

Unlike legacy Real-Time-Kinematic (RTK) services that are designed for smaller regions and Precise Point Positioning (PPP) services that suffer from slow convergence times, Skylark is a high-performance hybrid nationwide U.S. network that delivers initialization times in seconds, better than 10 centimeters of accuracy and integrity required by the most demanding safety-of-life critical applications. *swiftnav.com/skylark*

MicroSurvey introduces a new generation of data collection software

MicroSurvey Software Inc. released FieldGenius for Android version 1.0. This first release of our new multi-platform field software is built on the Android platform and supports most popular GNSS sensors on the market today. FieldGenius continues to be the world's premier third-party, brand-neutral data collection software choice amongst surveyors. This new release builds on decades of innovation MicroSurvey has invested into the original FieldGenius software, providing users with an easy to use and intuitive mobile data collection software package for the next generation.*www.microsurvey.com/fga/*

EagleView sets up R&D centre in Bengaluru

EagleView Technologies has opened its Research and Development centre in Bengaluru on of the southern state of India.

The centre is EagleView's third R&D centre other two are located in Bellevue, Washington and in Rochester, New York. While the former is focussed on Machine Learning and Applications development, the latter is focussed on the hardware side of the company's business. *www.eagleview.com*

Compact-sized tablet for geospatial field applications by Trimble

Trimble has announced the launch of the latest addition to its portfolio of data collectors—the Trimble® T7 tablet. Purpose-built for survey and GIS data collection applications, the next-generation tablet connects to Trimble's suite of survey instruments and GNSS receivers in a portable and ultra-rugged package. Equipped with a tough 7-inch multi-touch screen, modular expansion capability, multiple connectivity options and featuring a Windows® 10 Professional operating system, the T7 streamlines the flow of geospatial data between the field and office for maximum efficiency and productivity.

A professional grade built-in GNSS receiver supports GPS, GLONASS and BeiDou constellations as well as Satellite-Based Augmentation System (SBAS) capabilities for accurate real-time positioning. *https://geospatial.trimble.com/t7*. X

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ISDE 11
24 - 27 September
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digitalearth2019.eu

October 2019

The 8th FIG Land Administration Domain Model Workshop (LADM 2019)

4th International Conferenceon Smart Data and Smart Cities (SDSC2019)

Geomatics Geospatial Technology (GGT2019)
1 - 3 October
Kuala Lumpur, Malaysia,
http://isoladm.org
www.geoinfo.utm

40th Asian Conference on Remote Sensing (ACRS)
13 - 18 October
Deajuong City, Korea
www.acrs2019.org

Commercial UAV Expo Americas
28 - 30 October
Las Vegas, USA
www.expouav.com

ISGNSS 2019
29 October - 1 November
Jeju Island, South Korea
www.ipnt.or.kr/isgnss2019

November 2019

International Timing and Sync Forum 2019
4-7 November
Brighton, United Kingdom
http://itsf2019.executiveindustryevents.com

GEO Week 2019 and the GEO Ministerial Summit
4-9 November
Canberra, Australia
www.earthobservations.org

The Commercial UAV Show 2019
12 – 13 November
London, UK
www.terrapinn.com

International Navigation Conference 2019
18 - 21 November
Edinburgh, Scotland
https://rin.org.uk/events

December 2019

Amsterdam Drone Week
4-6 December 2019
Amsterdam, The Netherlands
www.amsterdamdroneweek.com

International Committee on Global Navigation Satellite Systems (ICG)
8 - 13 December
Bengaluru, India
www.icg14.org

39th INCA International Congress
18 – 20 December
Dehrardun, India
http://inca2019.org

January 2020

Precise Time and Time Interval Meeting (PTTI)
21 - 24 January
San Diego, USA
www.ion.org

March 2020

Munich Satellite Navigation Summit
16 - 18 March
Munich, Germany
www.munich-satellite-navigation-summit.org

May 2020

GISTAM 2020
7-9 May
Prague, Czech Republic
www.gistam.org

FIG Working Week 2020
10 -14 May
Amsterdam, the Netherlands
www.fig.net

European Navigation Conference 2020
11-14 May
Dresden, Germany
www.dgon.de

GeoBusiness 2020
20 - 21 May
London, UK
www.geobusinessshow.com

ICCM 2020: International Conference on Cartography and Mapping
21 - 22 May
London, UK
https://waset.org

June2020

XXIVth ISPRS Congress
14 - 20 June 2020
Nice, France
www.isprs2020-nice.com

July 2020

Esri User Conference
13 - 17 July
San Diego, USA
www.esri.com

September 2020

ION GNSS+ 2020
21-25, September
St. Louis, Missouri, USA
www.ion.org

October 2020

INTERGEO 2020
13 – 15 October
Berlin, Germany
www.intergeo.de

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