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# Coordinates

Volume XIX, Issue 1, January 2023

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND


Survey of leisure walking behaviours and activity tracking use

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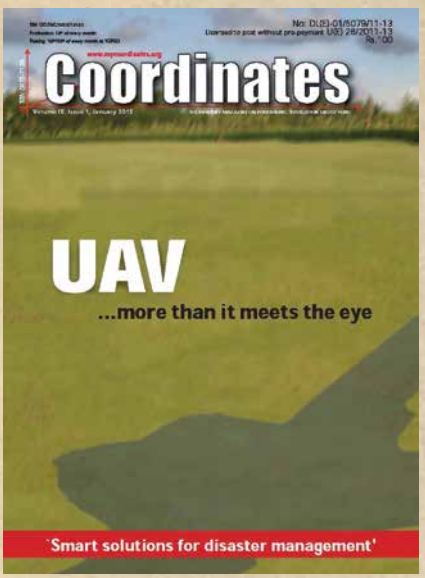


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## Pilotless Aerial Vehicle Systems: Size, scale and functions

**George Cho**
Institute for Applied Ecology and Faculty of Applied Science, University of Canberra, Australia

The general impression is that there is an increasing need among industry groups, private users and researchers to use UAVs for their own purposes. The relative absence or exception to policy from stringent air safety regulation makes the small UAV an attractive platform for users and manufacturers alike. Whether this hypothesis is sustainable is yet to be tested. However, this observation alone suggests the pressing need to clarify the policy, regulatory and collateral issues including personal privacy before the industry is to develop further. In addition, there may be significant ethical issues arising from the military as against civilian uses of the technology.

## Smart Solutions for disaster management

**Shunji Murai**
Professor Emeritus, University of Tokyo, Japan

Construction of smart communities would be the best solution for preparedness against future catastrophic disasters. There is nothing absolutely safe in the case of Nuclear Power Stations. Therefore a small country such as Japan which also is disaster prone should not allow construction of any more nuclear power stations in order to ensure sustainable happiness.

## UAV project - Building a reality-based 3D model

**Rongjun QIN**
PHD student of ETH, Singapore ETH Center, Singapore

**Prof em Dr Armin GRUEN**
Principal Investigator of the Future Cities Laboratory, Singapore

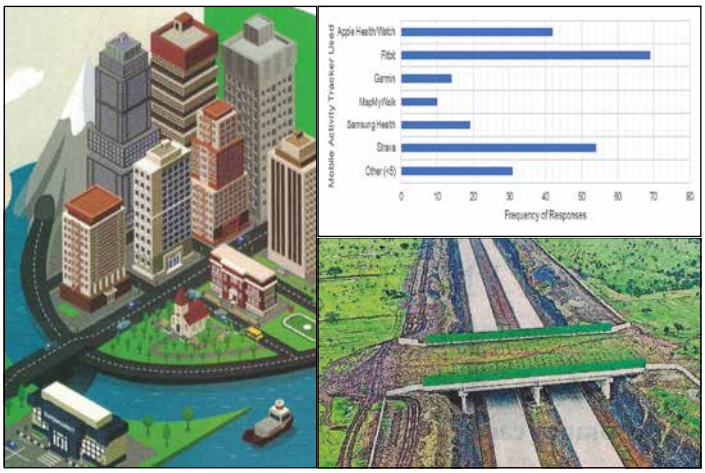
**Dr Xianfeng HUANG**
Researcher, Singapore ETH Center, Singapore

In this paper, we report about the difficulties encountered in the data acquisition stage, including various aspects of flight planning, selection of take-off and landing positions, data pre-processing, triangulation, bundle adjustment, 3D modeling, and then introduce our solutions to solve for these steps.

## On the high precision prediction of short-term polar motion

**Erhu WEI and Zhixiang YIN**
School of Geodesy and Geomatics, the Key Laboratory of Geospace Environment and Geodesy, Ministry of Education, Wuhan University, Wuhan, China

This paper uses LS+ARMA (p,q) to forecast polar motion values, numerical experiment shows its advantages and applicability. But we find that it's only suitable for short-term forecast. When the span is longer than 20 days, its accuracy is lower than other models.




# In this issue

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## Articles



## Columns



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# Widening chasm

Many residents of Joshimath, a small town in Uttarakhand, India,

Are compelled to leave as it sinks.

Some consider it as a consequence of reckless developmental activities,

Whereas some opine it as a natural disaster, instead of man-made.

Meanwhile, a recent ISRO report that mentioned the rapid subsidence of the city,

Has been taken off from its website,

As the National Disaster Management Authority has asked the concerned organizations not to interact with media or share data on social media.

However, as the tragedy unfolds in Joshimath, it raises the questions again,

On dam-building spree, developmental projects, tourism promotion, and many more,

Affecting this ecological fragile world,

Though it is a lost world for those who are affected.

**Bal Krishna, Editor**
**bal@mycoordinates.org**

# The convergence of 5G, high precision data delivery and AI

New technologies are constantly being deployed to address two key issues: workforce shortages and supply chain demands

**Arn Hayden**
Business development manager,
Trimble Positioning Services

**Brandon Sights**
Engineering director, Trimble Autonomy

When we sit back and look at market conditions plaguing the economy today, we see two key issues: workforce shortages and supply chain demands. New technologies are constantly being deployed to address these issues, but the most impactful and successful ones are yet to come. Workforce shortages are driving the need for more autonomous solutions, and supply chain is driving the need for better tracking, autonomous equipment, and a more efficient deployment of resources.

While autonomous solutions are not new, they need to be expanded and improved to truly address these issues. This can be done by expanding autonomy into a wider spectrum of equipment beyond the largest mining vehicles and farming tractors of today. Along with this expansion, there is a greater need for situational awareness around these vehicles and equipment.

To advance autonomous solutions, we look to the convergence of greater data capacity and increased worldwide network coverage of 5G, high precision location data over cellular, and evolving artificial intelligence (AI) models in 2023. This technology combination will push greater efficiencies and accuracies in the real time-based applications needed to address both workforce shortages and the supply chain.

## Tying 5G and AI Together

The increasing availability of high data capacity 5G, evolving AI models, and highly precise location data can now more easily address the future demands of the rapidly advancing capabilities of autonomous vehicles and equipment. But this technology combination can also enhance the interactions between vehicles and people. The 5G networks (and private 5G – an alternative to Wi-Fi, LTE and public 5G) being deployed today bring to the market much greater speeds, capacity, the number of connections and reduced latency that will be critical to transport data for AI models and autonomy. AI models will be called upon to orchestrate these autonomous interactions, but also to collect and utilize data on traditional vehicles as well. Models are only as good as the data they ingest, and precise location data is an important part of any AI model related to mobility and autonomy. Trimble's RTX technology is designed to deliver this highly accurate and precise location data

The increasing availability of high data capacity 5G, evolving AI models, and highly precise location data can now more easily address the future demands of the rapidly advancing capabilities of autonomous vehicles and equipment. But this technology combination can also enhance the interactions between vehicles and people.

across the globe, making it well-suited to address autonomous applications.

Chipset manufacturers are now developing platforms with Trimble's precise location technology that are available to mass markets in the newest smartphones and robust Internet of Things (IoT) devices. The availability of this capability will proliferate more, higher accuracy location data and applications than ever before. It will not only create better data, but also far more data points for AI models to digest, providing safer and more efficient operations. AI models that merge data analytics, sensor data, precise location data and video will improve personal safety, improve operational efficiency, lower insurance costs, create better user experiences, alert drivers of poor driving behavior, reduce delivery costs and may even improve crime fighting capabilities.

## AI Today and in the Future

In the past five years, the adoption of AI has more than doubled, according to a recent study from McKinsey. Today, AI is being used primarily in the agriculture, construction, transportation, and mining industries to plan fleet operations, route trucks and machines, generate designs, monitor worker efficiency, or optimize the use of inputs automatically such as fertilizer or seeds. With the benefits of 5G combined with highly precise location data, AI solutions will be used more and more to alleviate many common workforce challenges, whether it's making unpleasant tasks better or helping optimize around staffing shortages or freeing up time for workers to focus on tasks that cannot be handled by AI. On the supply chain side, AI models will be able to get data from anywhere in the world and into the cloud to train new models, which is difficult to do over today's cellular networks. Similarly, the local 5G mesh networks will allow for real time sharing of the as-worked data from each machine or worker, further enhancing accuracy and productivity.

# Evolving GNSS Spectrum Situational Awareness / RADAR Technologies

The RF spectrum is a critical resource, for both practical military and civilian PNT users

**Graeme Hooper**
Managing Director
GPS Satsystems

The endless stream of global media articles on GPS/GNSS spectrum vulnerabilities discussing both spectrum blocking (jamming) and counterfeit timing signals (spoofing) attempting to disrupt GPS/GNSS continue to roll out daily. One might easily formulate the impression that the GPS/GNSS service providers are not doing enough to address the problem. However, that is not quite accurate. In late 2019 European GNSS Agency initiated their "Development of an Advanced Interference Detection and Robustness Capabilities System" project, while, in early 2021 a number of US Government policy announcements were also issued.

From the US, first was the White House Jan 15th Space Policy Directive-7 (SPD-7) to cabinet officers, directing them to take specific steps to protect, toughen and augment GPS signals with other PNT services, encouraging the development of alternative PNT technology and improved security. New technologies such as *"quantum sensing, relative navigation and/ or private alternative PNT services"* were then promoted.

All very nice, but there is still at least one problem. Other than quantum sensing, all other suggested alternatives still use the RF spectrum, so logically the RF vulnerability problems would still remain with any new RF services. Malicious RFI agents can quickly adapt to these new frequencies and signals. How soon will quantum sensing become a "main street" commercial reality? Who really knows, but practical realisation is still best guess many years into the future.

Also, SPD-7 included the directive to authenticate future GPS signals, notionally to be introduced on future GPS NTS-3 satellites, due for launch this year. Currently, GPS signals do not have authentication features, although new technologies such as the Chips Message Robust Authentication (CHIMERA) signals are expected to be experimentally transmitted from the new NTS-3. This will add both data and signal authentication to the L1C signal, similar to, Galileo's combined Open Service Navigation Message Authentication (OSNMA) and E6 Commercial Authentication Service (CAS) initiatives.

At this point, one might believe that combined with daily announcements of new "Jamming/ Spoofing (J&S) Resistant Receiver technologies combined with new

signal authentication strategies, that all PNT spectrum vulnerability problems are solved. Well, NO, the problem is NOT solved. Neither of these solutions do anything for the billions of daily users dependent on existing "in-service" Receiver technologies, while also, glosses over ongoing vulnerabilities associated with RF front-end Antenna and Low Noise Amplifiers. If the RF front-end antenna & LNA chain are compromised, then no technology down at the PNT Receiver cable end will still be operational.

Enter the US government's second announcement late March 2021 by the Army's Assured Positioning, Navigation and Timing/Space Cross-Functional Team's (APNT/Space CFT) announcing the new Navigation Warfare Situational Awareness (NAVWAR-SA) development initiative. The development of new technologies with the ability to "sense/ sweep" wide area PNT environments in real-time at a distance. A civilian equivalent would be real time PNTSpectrum-SA management tools that provide the ability to instantly detect, identify and uniquely geolocate multiple malicious J&S (intentional and unintentional) sources with high precision simultaneously.

With this type of technology, there will not be any significant perceived differences between Jamming and/or Spoofing transmission. They will both be simply resolved by any SA sensor network's directional antennas, as RF energy/signals arriving from unexpected directions (azimuth/elevations), where there should not be any. Furthermore, with these types of SA technologies, where all legitimate GNSS SVs are individually beam locked by directional antenna arrays, any spoofing attempts (signals from wrong directions) become easily detectable and geolocatable.

To implement this real time/wide area PNTSpectrum-SA vision requires significant departures from traditional GNSS ways-of-thinking, through adoption of other advanced technologies not normally associated with the GNSS. These are more aligned with aerospace passive electronically scanned RADAR (RAdio Direction And Ranging) and astronomy's weak signal object processing technologies, to name a few.

Some might argue that existing multi-station CORS networks, GNSS Interference Detectors, and/ or, mobile phone apps cloud sourcing RFI localisation already provide adequate SA. Sadly, this is not the case. Although they might detect small regional RFI problems, they cannot provide the accurate 3D RFI geolocation dat required for an effective SA solution. This requires precise 3D geolocation and signal characterisation intelligence married with appropriate telecommunications EM/ RF propagation models, (eg. ITU's ITU-RP.452 and/or ITS_ITM-1.2.2) to produce the desired end-user regional 3D Area Of Influence Prediction (AOIP) projections.

To implement this real time/wide area PNTSpectrum-SA vision requires significant departures from traditional GNSS ways-of-thinking, through adoption of other advanced technologies not normally associated with the GNSS. These are more aligned with aerospace passive electronically scanned RADAR (RAdio Direction And Ranging) and astronomy's weak signal object processing technologies.

These regional 3D AOIP projections are then viewable much like weather prediction reports, presenting regional RFI spectral power distribution information as a 3D "fog heat map". With changing colours to represent the differing levels of RF power intensities predicted across wider regions. These projections would include the combined effects of all RFI signal sources in the region of interest, (many 10s of square kms). For the AOIP projections to be both accurate and meaningfully, the PNTSpectrum-SA sensor network needs long range 3D scanning detection and ranging functions, just like weather radar hence the reference GPS/GNSS Radar.

Extending the PNTSpectrum-SA AOIP vision further, the Geospatial industry came to the rescue with their well evolved 3D display/ visualisation tools and agility to manage large datasets efficiently and quickly. Within geospatial software environments, the AOIP 3D projections are then overlayed 2D/3D digital twin representations of the terrestrial area of interest. This area might for example be an airport or container terminal, etc. Visualising RFI hot spots and their relative terrestrial location then becomes easily discernible to system operators and other site managers.

Like for weather reports, automated PNTSpectrum-SA warnings can then be issued to mission critical/ safety GNSS users, while also, presenting meaningful and accurate RFI geospatial information to the officials responsible for maintaining the regional GNSS spectrum integrity. Quickly and efficiently eradicating the RFI sources, whether or not, either intentional or unintentional origins.

This new March 2021 US APNT/Space CFT initiative, is a very welcome government acknowledgment that the RF spectrum is a critical resource, for both practical military and civilian PNT users. Total dependency lasting for many years to come. Making new PNTSpectrum-SA technologies available to the policing and enforcement authorities will ensure ongoing access to a free and unadulterated GNSS spectrum, for all PNT users and their legacy equipment.

# Precise positioning techniques will continue to grow

Solutions to deliver resilient PNT systems must be diverse, incorporating a mix of technologies

**Andy Proctor**
MA, CEng, FRIN, FIET
Director
RethinkPNT

As we know, the use of PNT information penetrates every sector, including military, aviation, transportation, agriculture, and many others. It is now well recognised that the years of increased reliance on the single source of satellite-based PNT systems, such as GPS, need to be reversed in terms of the technology mix used for PNT systems. Even though the deployment of new constellations and signals are making space-based systems more accurate and reliable.

There is and for the future will not be, one technology to fit all. Precise positioning techniques will continue to grow, such as Real Time Kinematic (RTK), Precise Point Positioning (PPP) and other High Accuracy Services (HAS) technologies. These are finding their niche in the autonomous sector for self-driving vehicles or positioning for commercial drone/unmanned air platform (UAP) services. New Low Earth Orbit derived PNT services will also target these areas as they grow. Customers and corporations in these areas are actively investing in technologies that give them a precise positioning advantage, such as the recent announcement of GM investing into Focal Point Positioning.

Other technologies on the up in the commercial domain are the development of low-power, low-cost PNT solutions for use in Internet of Things (IoT) applications. These solutions are designed to enable the precise positioning and timing of many devices, even in challenging environments where satellite signals may be weak or unavailable. Examples include the use of ultra-wideband (UWB) technology and the continued miniaturisation and use of Micro Electro-Mechanical System (MEMS) Inertial Measurement Units (IMUs) for dead reckoning. We should not forget the innovation and advances in the timing community also, new distribution techniques for time such as wide-area time distribution over fibre and "networks as a clock" are starting to become reality.

The danger and opportunity in this diverse technology mix is that of resilience. Resilience refers to the ability of a system or network to continue functioning and providing critical services, even in the face of disruptions or failures. In the context of systems that use PNT information, such as our critical services, system resilience must and will grow to be an important consideration. We should also recognise that resilience is different from assurance as a "Resilient PNT system" is not the same as an "Assured PNT system".

Solutions to deliver resilient PNT systems must be diverse, incorporating a mix of technologies and to achieve PNT System resilience we should stop thinking about it as a simple Boolean function (i.e., a system is not merely resilient or not resilient). No system is 100% resilient to all threats. Resilience is always a matter of degree, based on the risk profile of the end user application against the expected threats, and typically not measurable on a single ordinal scale of levels. In other words, it might not make sense to say that system A is more resilient than system B.

The trend I predict therefore is that a greater formality in requirements and systems engineering, and standards will be seen as the importance of PNT becomes more widely known. Basic questions that need to be asked for any PNT installation are:

- What critical PNT capabilities/ services must the system continue to provide despite threats?
- What types of threat can disrupt the delivery of these critical capabilities (i.e., what threats must the system be able to tolerate)?
- What are the types and levels of threat to what assets, that can cause harm?

The trend I predict therefore is that a greater formality in requirements and systems engineering, and standards will be seen as the importance of PNT becomes more widely known

In this way a commonly understood definition of resilient PNT systems can be determined "A resilient PNT system protects its critical capabilities (assets) from harm by using protective resilience techniques to passively resist or actively detect threats, respond to them, and recover from the harm they cause."

Within the next few years, the importance of non-technology approaches with respect to resilience in all these new commercial domains will also rise. For example, establishing robust and well-coordinated communication and coordination systems can help to ensure that information about disruptions or failures is quickly disseminated and that appropriate actions are taken to mitigate their impact; the importance of skilled resources, training and education of engineers, customers and value chains, in particular about threats to PNT systems; the use of standards to properly facilitate PNT information exchange between the different PNT technologies and the higher level systems that they interface to; and having the right operational checks and balances in place such as processes, verification procedures and formalised testing.

In summary, building resilience into PNT systems is essential for ensuring the reliable and continuous operation of critical applications, meaning business and revenue critical as well as critical infrastructure. The growth areas mentioned here will be the driver behind implementing PNT system resilience as the industrial sectors will move faster than institutionally led endeavours. It will be achieved through a combination of technical approaches, such as the use of diverse technologies such as being championed by the European Space Agency navigation programme (NAVISP), and non-technical factors such as resources (skills, education), processes (verification, documentation), and threat/risk analysis.

## Simulator uses GNSS to track railway positioning

A recent activity with TDE and Hitachi Rail in Italy, has developed a testbed simulator to see how GNSS can be utilised on a railway.

The Sim4Rail Project developed, verified, validated, installed and commissioned a simulation testbed, suitable for the of GNSS Performance in a Railway Environment, at the ESA/ESTEC TEC Navigation Laboratory. In the frame of this activity, laboratory software tools have been developed as building blocks for a simulation testbed of positioning technologies in railway signalling applications.

As part of the activity, different versions of feared events had to be well characterised, modelled and simulated; to validate the simulated outputs. With this approach, conditions that are statistically unlikely to be observed in the field can be tested repeatedly in a highly controlled environment.

Five scenarios were tested. The first is a normal scenario where the train ran completely as expected with no obstacles and just one train per track. The second was more similar to an actual rail environment, with three different channels such as urban or rural rail use.

The third scenario involved the most feared events. On a railway-like simulation the activity included some of the worst situations a train can face, such as a jammed signalling system. The fourth and fifth used different equipment and data sets.

The testbed has been installed and commissioned for use in the ESA/ESTEC TEC Navigation Laboratory; while no further development is currently envisaged for the testbed itself, potential follow-ons include developing a multipath channel model for the railway environment. *www.esa.int*

## Improving situational awareness of satellite positioning with research expertise

Satellite positioning (GNSS) is used by many critical functions in society, such as the construction sector, rescue services, the finance industry, telecommunications networks and electrical grids. However, GNSS signals are weak and therefore sensitive to interference, which could be caused by, for example, the environment and atmosphere (particularly the ionosphere) or various unintentional equipment malfunctions. Signals can also be deliberately jammed or spoofed.

Currently, the quality of the satellite positioning signal in Finland is monitored by the GNSS-Finland service developed by the National Land Survey of Finland and funded by Traficom.

This new project will further develop the GNSS-Finland service. The project will start by identifying what kind of services end-users need and in what format the information should be available. The project will run from 2022 to 2023. It was commissioned by the National Emergency Supply Agency and is being implemented by the Finnish Geospatial Research Institute of the National Land Survey of Finland, which specialises in research, methodology and development. As the competent authority responsible for the monitoring of radio frequencies and keeping them interference-free, Traficom is responsible for providing situational awareness of GNSS.

The Finnish Geospatial Research Institute of the National Land Survey of Finland will bring in a dedicated unit to support the security of supply of satellite positioning. Funded by the National Emergency Supply Agency's Digital Security 2030 programme, the project will improve national security of supply while promoting scientific research in the field. *www.maanmittauslaitos.fi*

# "We are proud to have contributed to the modern use of Photogrammetry"

With the help of computer vision, AI and ML, we can extract meta data information for decision making. Photogrammetry plays a key role in this process says Alexander Wiechert, CEO of Vexcel Imaging in an interview with Coordinates

**Alexander Wiechert**
CEO of Vexcel Imaging

**Congratulations on completion of 30 years of Vexcel Imaging. Could you briefly summarise this journey highlighting some of the milestones achieved and challenges faced.**

Thank you so much for your kind words. It has been a journey, indeed. Describing it in detail would probably fill your magazine, so let me be brief here.

Vexcel's mission has always been to develop leading products through innovative technology and software. We aim to leverage software to enhance hardware and combine that with industry expertise and a customer-focused approach to create products that set industry standards and help our customers succeed.

Vexcel started with the successful photogrammetric film scanner, UltraScan 5000, in the late 90s. The company then transitioned to digital cameras with the release of the UltraCam D in 2003, followed by the UltraCam X and Xp in 2006. In 2011, we introduced the UltraCam Eagle Mark 1 and later expanded our camera family with the addition of the Osprey and Condor models. 2020 marks the introduction of our 4th UltraCam generation, again a major step forward.

Along with hardware developments, we also released many versions of our UltraMap software, introducing new features such as distributed processing, automated color balancing, and monolithic stitching.

So, a lot happened on the product side. But Vexcel as a company went also through some transformations. In 2006, Vexcel became part of Microsoft and contributed to the Bing Maps initiative with knowledge, specialized aerial cameras and software. The company left Microsoft in 2016 and became privately owned again, with new cameras and software being developed. In 2017, we launched the Vexcel Data Program (VDP) which is now the largest imagery program worldwide. We've grown to more than 500 employees worldwide, owning around 100 planes, collecting data in more than 35 countries and offering the most innovative camera line-up for large aerial camera systems.

So, in a nutshell, it was a fantastic ride and a great success story which was only possible thanks to a fantastic team that is committed, capable and full of energy and ideas, and I am looking forward to how we develop ourselves further in the future.

**How do you see the growth of Photogrammetry technology over the years. How important role do you envisage for it in future?**

Photogrammetry is an old technology, but we are proud to have contributed

to its modern usage. As the world faces significant challenges such as climate change, water crisis, and infrastructure growth, data and knowledge about the environment are crucial. With the help of computer vision, AI and ML, we can extract meta data information for decision making. Photogrammetry plays a key role in this process and there is still much to be developed in this field.

## Vexcel Imaging recently released UltraCam Eagle 4.1 and UltraNav v7. What kind of innovation have gone into it to make it a 'cutting edge' photogrammetric aerial camera systems?

The UltraCam Eagle 4.1 represents the flagship of aerial photogrammetric cameras and the latest spin-off based on the 4th camera generation. With the introduction of the 4th UltraCam generation in 2020, we literally touched every screw of the cameras again and further developed every aspect of the system. North star for the development of the 4th UltraCam generation has been a further improved flying efficiency through an increase of footprint and a shorter frame rate, utmost image quality through new lenses, new electronics, new CMOS sensors and the Adaptive Motion Compensation (AMC), and further improved usability and customer experience through the new housing concept.

The new UltraNav system offers a range of features for 3D mission planning, including oblique flight planning. The Eagle is a high-resolution camera that captures PAN, red, green, blue, and near-infrared images separately, resulting in richer images and wider flight mission parameters. It sets the new industry standard for photogrammetric cameras.

## As we have observed over the years many innovations in the camera division, what has been your expansion plan for UltraMap photogrammetric software suite?

The processing software is an important part of the overall solution. Efficient aerial surveying can only take place if the massive amount of data collected can be processed in an efficient and intelligent way.

The focus of UltraMap is to generate aerial imagery with a maximum of image quality and accuracy and a minimum of manual effort and time. We strive for a high level of automatization, a user-friendly interface, sophisticated features, and huge throughput. UltraMap is a key investment area for us, and we just launched the customer preview of version 6.0 which sets the industry standard in water masking and handling through usage of ML, eliminating again huge manual effort from the workflow while also improving the overall image quality.

UltraMap's ability to efficiently handle large amounts of data is proven every day in our Vexcel Data Program. In 2022 alone, we processed nearly 36 million images, collected by UltraCams world-wide within the program. That is a massive production which is only possible due to the powerful and feature rich UltraMap processing solution.

## Could you please tell us about Adaptive Motion Compensation (AMC) technology solution developed by Vexcel Imaging and few of its advantages.

Absolutely. To achieve a well-exposed image, photographers typically adjust the triangle of exposure time, aperture settings, and ISO value. However, in aerial photography, the aperture is often fixed, leaving only the ISO setting and exposure time to adjust. To maintain the highest image quality, the ISO setting should be kept as low as possible. This means that the correct exposure time must be used to achieve the desired result.

Now the challenge of aerial photography comes into play: a fast-moving plane resulting in a fast-moving camera. That adds uniform motion to any captured image. And adding to that, planes also rotate along three axis which adds non-uniform motion blur to images, as stabilized mounts cannot eliminate the rotations completely.

Compensating for motion blur in aerial photography is essential. Using CMOS sensors, the cheapest solution is to increase the ISO value for a shorter exposure time, but it results in a significant loss of image quality. This is not an option for high-end cameras. A better solution is to use mechanical methods such as moving the CMOS sensor along an axis or two, which avoids high ISO settings but this still only eliminates motion blur along a specific axis or two and adds complexity to the camera.

We developed a software-based solution called Adaptive Motion Compensation (AMC). It allows for low ISO settings and corrects all types of motion blur, regardless of direction or image scale, which is important for oblique imagery. AMC is a post-processing solution that uses a detailed knowledge of camera movement, shutter movement, camera geometry, and terrain to calculate a blur-kernel on a per-pixel basis. It then uses a deconvolution algorithm to restore the image to its original crisp, sharp state.

AMC is available for all 4th generation UltraCams and represents the most innovative solution for motion blur compensation on the market. We are really impressed by the stunning results we achieve with this new methodology.

# Survey of leisure walking behaviours and activity tracking use

In the emerging analysis we identified design considerations for future walking-focused applications, emphasizing the subjective and personal nature of walking routes

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**James Pinchin**
Nottingham Geospatial Institute, University of Nottingham

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Mixed Reality Laboratory, University of Nottingham

**Gary Priestnall**
School of Geography, University of Nottingham

## Abstract

In this paper we present a work in progress analysis of a leisure walking behaviour survey that focuses on walkers' habits and experiences. We are specifically interested in the use of mobile tracking applications in this context to help design and deploy future technologies that can better support engaging leisure walks through synthesising previous behaviours and experiences. This survey collected 329 responses relating to self-reported walking behaviour patterns and mobile activity tracker use. In the emerging analysis we identified design considerations for future walking-focused applications, emphasizing the subjective and personal nature of walking routes.

## Introduction

Mobile activity trackers are an increasingly common feature of our everyday activities and routines. They populate our smart phones and adoption of activity tracking wearables is becoming ever more ubiquitous. Such technologies support users exercise (e.g., Diaz et al. 2015), health and well-being routines (e.g., Murphy et al. 2020). This data can be used in social exercising, which allows for the sharing of routines with a broader community (Couture 2020), and gamification where it is used to encourage physical activity (Shameli et al. 2017). Shin et al's (2019) review of activity tracking technology research highlights understanding human-information interaction as an under explored area. We are interested in how digital technologies can better support leisure walkers, their choice of routes, their engagement with places of interest and how they reflect and share their experiences. We will then look to investigate how this ambient and volunteered geographic information can be applied within a walking route recommendation framework. The survey charted here begins this journey by capturing leisure walkers' current practices through collecting data on three aspects of leisure walking: (1) the frequency and duration of the activity; (2) the use of technology in walking; and (3) an identification of themes in the experiential factors of walking.

This paper is structured in five sections; the following section explains the survey design and recruitment, while *section 3* presents the preliminary results. *Section 4* is a discussion of design considerations and *section 5* is the conclusion.

## Survey design and recruitment

We designed an online self-reported survey of five sections and 19 questions, split into: walking behaviours, reasons to walk, two on mobile technologies and demographic data relating to the participant. The question format used

was a combination of behavioural questions to collect data on activity patterns and qualitative open questions to help identify subjective opinions and themes. We recruited 329 participants through social media and snowballing; participants were thus allowed to self-select for involvement. Our participant group included a range of age and genders, interestingly 52% reported their age as being between 45-64 and 81% of respondents were reported as female.

## Preliminary results

Analysis of the survey are work in progress. A sample of emerging results are presented in the following sections.

### Activity tracking usage

We gathered responses about the duration and frequency of leisure walking and the use of mobile activity trackers. Our preliminary analysis finds that 65% of participants used a mobile activity tracker; most of which used the application either 'often' or 'always' as in Figure 1. The current findings suggest that both walking frequency and duration influence a partial role in activity tracking use. For instance, filtering out participants who walked for less than one hour or once a week found that 70% of the remaining responses used an activity tracking application.

### Applications used

We asked participants what activity tracking applications they used and found the most popular were Fitbit, Strava and Apple Health as in *Figure 2*. Our emerging analysis also investigated those who did not use an activity tracking application. For this purpose, we identified several themes from an open-ended question, we found 70% of these responses were just not interested, 15% found the technology too difficult to use, and 10% wanted to be completely offline while walking.

### Route planning

Participants were asked whether they planned routes using technology or local knowledge. We found a significant association between these variables, with 51% of respondents saying that they never used technology to plan walks, contrasting with the 77% which said they sometimes or always use local knowledge in this process. In addition, we identified the effect that meeting other people had on the willingness to travel to start a walk. Respondents who usually met 1-3 other people were more likely to travel (54%) when compared to those who walked individually (30%).

### Walking rationale

The participants were presented with two open ended questions asking what they enjoyed about leisure walks and their rationale for taking them. These question responses have been coded to reveal some emerging themes, for example, 72% of respondents enjoy walking due to being able to get outside, 30% enjoyed walking for wellbeing, and 17% enjoyed exploration. Similar themes were identified in the rationale for walking, with 70% of participants walking for health and exercise purposes, 9% for social activities and 20% for dog walking. We found participants who walked for health or exercise to be the most likely to use an activity tracking application.

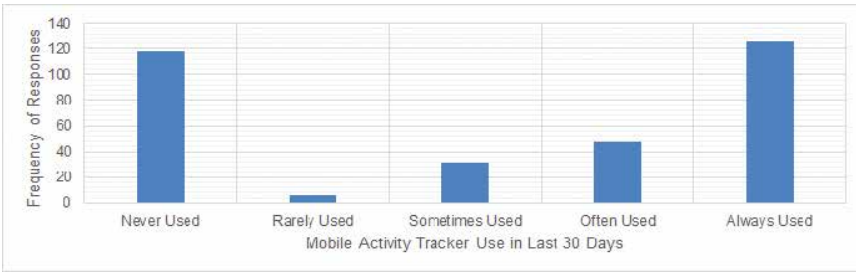


**Figure 1. Frequency of mobile activity tracker use.**

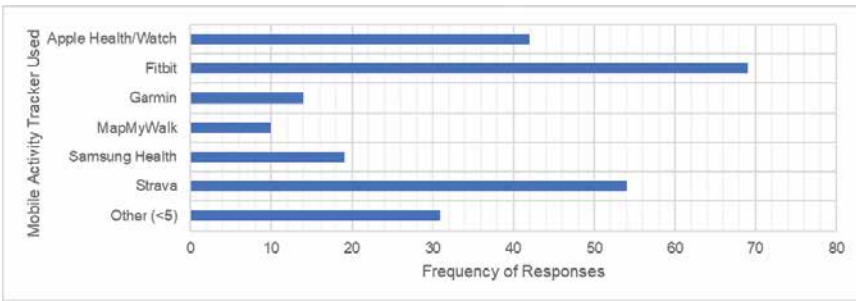


**Figure 2. Highest frequency walking activity trackers used by respondents.**

## Discussion

This work in progress survey is to lay the groundwork for further study and development of a framework that can shape the design of future technologies that can support and curate engaging leisure walking experiences. Our emerging findings point towards the following design considerations:

Capturing and harnessing users' local knowledge to help support route planning appears to be an important consideration, of which sharing could also factor as an important facilitator. The ability to effectively capture and process high quality crowdsourced geographic information (See et al. 2016) could thereby contribute to the potential relevance of a design.

Escaping or avoiding technology while walking offers an interesting challenge, and one that could be addressed through careful design, but also whether the role of the technology is to support the route planning process, rather than the walk

People can walk for leisure for a variety of reasons, so the target rationale should be explicit in the design. The nature of each activity should be carefully considered, and relevant constraints should be identified, for example, a walk for exercise may need to be circular and of a certain distance or time. A challenge in this respect is linking these demands to other contextual factors to increase the enjoyment of a walk.

itself. The adoption of mobile activity tracking should also be considered in this context as previous research has found older demographics less likely to engage with such technology when difficult to use (Mercer et al. 2016).

People can walk for leisure for a variety of reasons, so the target rationale should be explicit in the design. The nature of each activity should be carefully considered, and relevant constraints should be identified, for example, a walk for exercise may need to be circular and of a certain distance or time. A challenge in this respect is linking these demands to other contextual factors to increase the enjoyment of a walk.

## Conclusion

In this work we presented the emerging results of a self-reported leisure walking behaviour survey. The analysis captured statistics and identified themes for the rationale and enjoyment of walking, notably the importance of getting outside and exercise to our respondents. We discussed the potential design implications of the work which support the notion of capturing local knowledge, escaping technology and activity constraints. To further develop this knowledge, we will continue to study the contextual variables of walking to help in the design of a leisure route recommendation framework.

## Acknowledgements

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# Urban informatics for sustainable and smart cities

The paper dwells on the range of key ICT enabled planning, smart, green and intelligent infrastructure services- energy, public utilities, mobility, community frameworks, disaster management, telecom networks, e governance and urban management

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## Abstract

*The ICT (Information and Communication Technology) enabled informatics, planning and infrastructure development can make the cities and its services more efficient and sustainable.*

*The breakthrough in technology with the application of microchips, micro-computers, microwaves, nanotechnology, blockchain, GIS, GPS, cyber-space, 5G/6G wi-fi and e-topia are changing the familiar borders like inside-outside, private-public, here-there, city-country and yesterday-tomorrow. These are characterized by intelligent and smart services, dynamic networks and floating nodes. The paper dwells on the range of key ICT enabled planning, smart, green and intelligent infrastructure services- energy, public utilities, mobility, community frameworks, disaster management, telecom networks, e governance and urban management.*

The collapse of the Morbi suspension bridge in Gujarat on October 30, 2022, killing 135 people, has shocked everyone. A 206-meter-long bridge in Begu Sarai (Bihar) on Burhi Gandhak river, costing Rs 13 crore, collapsed on December 18, 2022, even before it was opened up for traffic. The recent floods in Bengaluru and Chennai indicate the lack of information, deficient urban planning and infrastructure. After 75 years of Independence about half of the population lives in unplanned areas and slums. The 2021 Niti Ayog report states that 65% of 7938 cities and towns in India do not have a Master Plan. Still, we follow the colonial model of 20 year Master Plans, which do not address urgently to the impending urban issues of pollution, water and energy shortages, joblessness, climate change, transportation, utilities and pandemics. Not much has changed in urban planning systems to engage with the Sustainable Development Goals.

## Sustainable Development Goals–2030 and climate resilience

In view of threats of climate change, pollution and disasters, the sustainable development goals were adopted by the United Nations, comprising 193 countries, including India in September 2015. These focus at human wellbeing, infrastructure and conservation of natural environment (Fig. 1). These aim at sustainable and integrated social, economic and environmental development of land, water and air and reduce the carbon emission and effluents from the transport, industries, construction and power generation.

The 17 SDGs cover the gaols of Wellbeing (1, 3, 4, 5, 10 and16), Infrastructure (2, 7, 8, 9, 11 and 12) and Natural Environment (6, 13, 14 and 15) and Goal 17 deals with implementation. The goal on Sustainable Cities and Human Settlements - Goal 11 aims to make cities and human settlements inclusive, safe, resilient, and sustainable. Other goals including those on ending poverty (SDG1), food security (SDG 2), health (SDG 3), education (SDG 4), water and sanitation (SDG 6), sustainable energy (SDG 7), resilient infrastructure SDG 9), inclusive economic growth and productive employment (SDG 8), gender

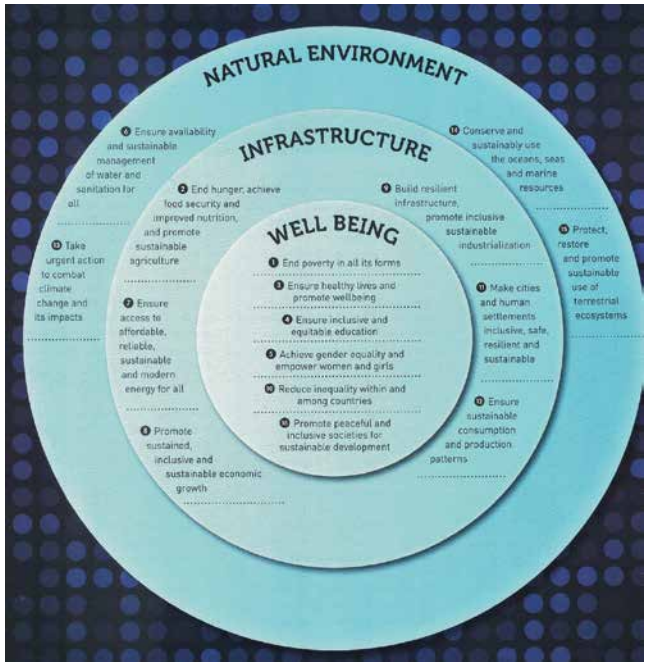


**Fig. 1; Sustainable Development focuses upon human wellbeing, infrastructure and conservation of natural environment**
**Source: UNESCO (2015)**

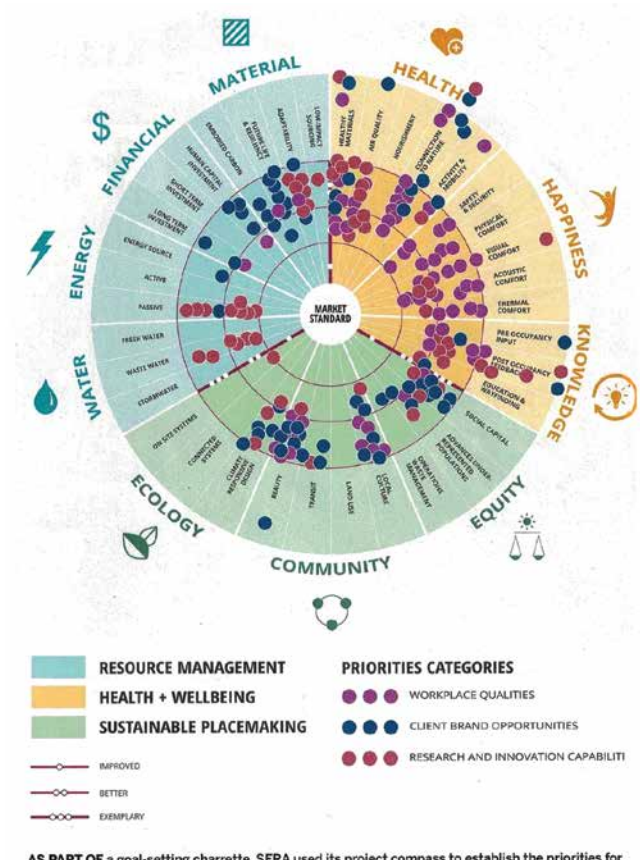


**Fig. 3: Sustainable Project Compass Developed by SERA Architects Converges Health, Happiness, Knowledge, Equity, Community, Ecology, Water, Energy, Financial and Material aspects in its Planning (Portland, Oregon)**
**Source: Kathrine Logan (2022) The Conversation, Architectural Record, April**


**Fig. 2: A Circular Economy is Restorative or Regenerative aimed at Minimising Wastes and making the most of Resources**
**Source: Khan, Khalil Uttah (2022) Wastewater Reuse, Linear Economy to Circular Economy, Shashwat, TERI, New Delhi**

**Fig. 4: The Climate Centre for Cities**
**Source: NIUA (2022) Climate Centre for Cities, New Delhi**

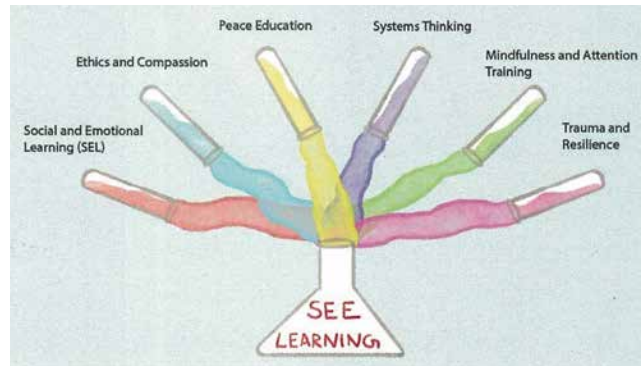


**Fig. 5: SEE Learning Integrates Social, Emotional and Ethics with Evidence based Approach in Learning and Practice**
**Source: seelearning.emory.edu**

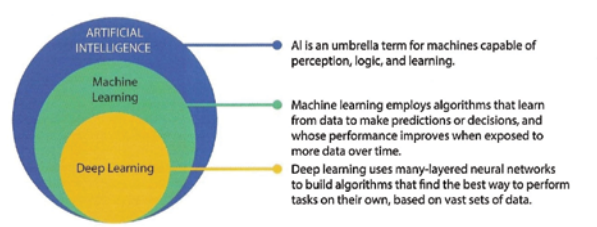


**Fig. 6: Components of Artificial Intelligence**
**Source: Verma, Seema, Towards Data Science, Reproduced in Shashwat (2022), TERI, New Delhi**

equality (SDG 10) and climate action (SDG 13) are intimately linked to Goal 11. These linkages aim to change the linear economy to circular economy (Fig. 2).

Climate change has become an imminent reality with a rise in global temperatures, changes in rainfall, floods, droughts and intense heat waves. A drastic increase in atmospheric concentrations of water vapours, carbon-dioxide, methane and nitro-oxide, and other greenhouse gases help trap heat near the earth's surface. The increasing emissions, heat, fossil fuel usage, urban growth, and growing air conditioning demand are affecting health and productivity. These issues have taken the center stage at policy deliberations at COP and other platforms.

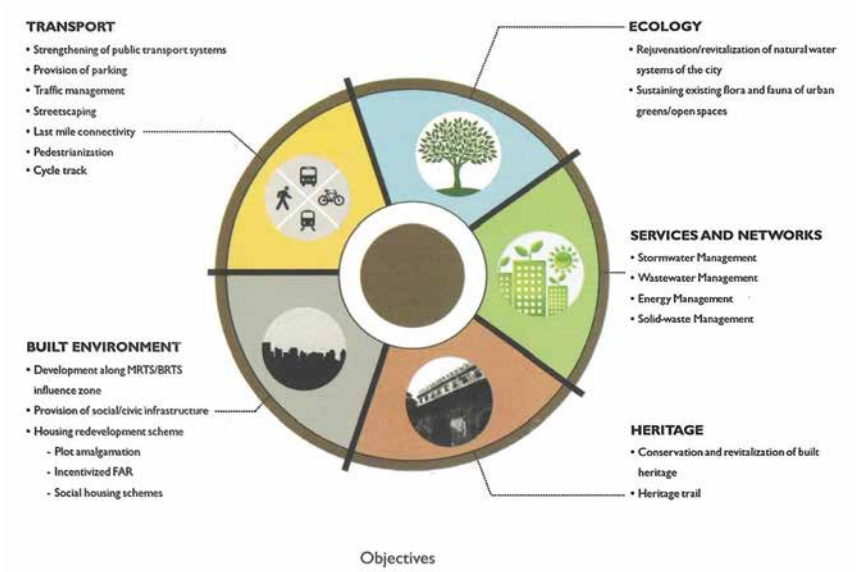


**Fig. 7: The Local Area Plan of Ward Level Provides a Pragmatic Canvas to Address the Local Issues, while Integrating the Ecology, Services and Networks, Transport, Built Environment and Heritage**
**Source: DUAC/Amit Ghoshal (2015) Punjabi Bagh Project, DUAC, New Delhi**

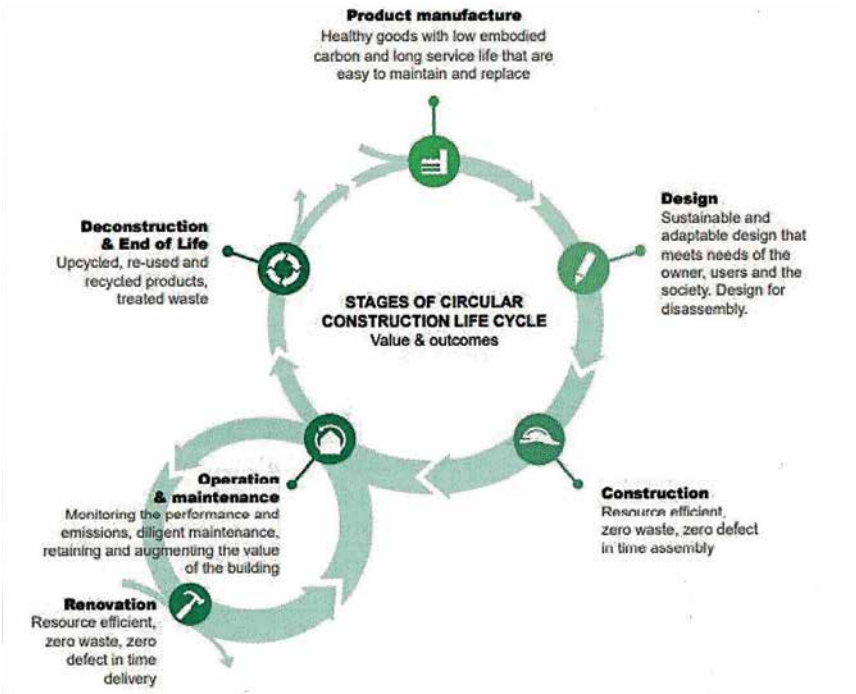


**Fig. 8: Stages of Circular Construction Life Cycle- Values and Outcomes**
**Source: Ninni Westerholm (2021) Developed from UNEP**

## UN Conference of the Parties (COP 26 and COP 27)

The United Nations Conference of the Parties (COP 26, Glasgow, 2021) deliberated upon various measures to limit global warming to 1.5 degree Celsius by the year 2100. Indian delegation led by PM Narendra Modi put forward the need to scale up clean technologies and renewable energy. Under the International Solar Alliance (ISA), One Sun-One World -One Grid envisions an interconnected trans-national solar energy grid. The COP 26 agreed to reduce the use of fossil fuels and coal by new sources, such as solar voltaic, green hydrogen, green metals, carbon capture, solid state batteries, electric vehicles and ethanol blended fuels, heat pumps, electric and hydrogen powered transport and next generation solar PV.

At the COP 27 (2022, Sharm-el-Sheikh, Egypt), India launched its long-term Low Emission Development Strategy (LT-LEDS). It focuses on transition towards expanding renewable energy, strengthening power grid, and energy conservation, rational use of fossil fuels, nuclear energy, green hydrogen, fuel-cells, and biofuels for low carbon growth. This calls for a rethinking in the urban sector, including infrastructure services.

The climate compass is closely linked with the urban processes- ecology, resources, health and wellbeing and place making. Accordingly, a project compass can be developed to establish the priorities (Fig. 3). This also needs establishment of dedicated climate centers for cities, as done by the National Institute of Urban Affairs, New Delhi (Fig. 4). This involves capacity building with social, emotional and ethics as the basis of learning and practice (Fig.5). Technology, Artificial Intelligence, Inclusive Learning and Deep Learning can help in this task (Fig.6).

## Towards a paradigm shift in planning

In this digital age, the 20-year model of land use-based Master Plan does not address the urgent issues of climate change, air and water pollution, public health, employment and disasters. It is also incongruent with the objectives of speed, scale and sustainability. It is necessary that the local area plans are prepared for a five-year horizon, while their vision may extend to 20 years. The Delhi Urban Art Commission, in pursuance of the Delhi Master Plan 2021, undertook the preparation of Local Area Plans at Ward Levels (about 50,000 population), which integrate the ecology, built environment, service network, transport and heritage (Fig. 7). These plans manifest innovative yet pragmatic concepts of sustainable and circular economy, low carbon energy, climate resilience, circular construction, interlinked greens, circular water systems and waste management.

The cornerstone of making a city resilient and low carbon is to adopt a circular construction lifecycle approach (Fig. 8). It entails an integrated approach towards the nature (climate, greens and low carbon), the people (socio-economic, circular economy, culture, education, health, mobility, community participation) and fourth industrial revolution (digital planning, smart, intelligent and interconnected processes, SCADA, blockchain, discreet optimisation, algorithm, AI, big data, etc.).

## Urban informatics for urban planning and infrastructure services

The ICT can be a game changer in this transition towards a green and clean economy, smart, resilient, and low carbon infrastructure services, transport and community. This needs specialised inputs in urban planning by domain experts in GIS, GPS, EIA, SDI, big data analytics, ERP solutions, digital dashboard, blockchain, AI, ML DL, etc.

Some specific key areas concerning sustainably, smart and speedy urban development are given below:

**Table 1: Urban Informatics for Urban Planning and Infrastructure Services**

| | ICT Enabled Fields | Some Specifics Key Areas |
|---|---|---|
| 1. | Digital Informatics Smart Cities and Green Buildings | • CAD and CAM enabled Planning, Design and Construction<br>• Integrated Digital Planning, Conservation of Land, Natural Resources, Heritage and Environment<br>• Digital Land Information System, Digital mapping, SDI, Geo-portal, GIS based property records, plans and transactions<br>• GIS, GPS, Remote Sensing, Total Station/Drone/ Satellite Surveys, Gyroscope/Accelerometer based High Resolution Imagery, Photogrammetry, Alphanumeric Pin, High-definition Dynamic Digital Mapping, Laser Scanning and Penetrating Surveys for Infrastructure, Foundations and Structures<br>• Big Data Analytics, ERP Solutions, Artificial Intelligence, Machine Learning and Deep Learning<br>• EIA, Heritage/Transport Impact Analysis, Experience Simulation, Concept Generating Matrix, Morphological synthesis, LiFE Platform, Digital Ledger and Dashboard<br>• Apps for Public Participation, such as wEconserve by SPA New Delhi<br>• Climate Resilience Environmental Management, Urban Heat Mitigation, Sky View Factor<br>• Smart/Green Buildings, Net Zero Energy and Water, Parametric Design, Morphotectonic Strategies, Animation, Simulation, Algorithm and Equations, 3-D Modelling and Printing, Augmented and Virtual Reality, Computational Design, Design Thinking, User Experience and Interface.<br>• Digital Fabrication, Morphogenic Geometry, Biomimicry, Adaptive Systems, NURBS Curves and Surfaces, Spline Topology, Voronoi, Genetic Computation, Fuzzy Logic, Robotics, stereolithographic, etc.<br>• Building Information Modelling<br>• Online digitise building plan approval and clearances (the competent approving officer to give on the spot decision as in the Passport Officer |
| 2. | Land Management | • Digital Blockchain, Land Administration Digital Model (LADM), Land Pooling<br>• Accommodation Reservation, Transferable Development Rights, etc., Optimising FAR and Densities |
| 3. | Energy | • Common Digital Platform<br>• Energy networks, smart grids, smart meters, smart buildings<br>• Renewable energy, Trigeneration<br>• Electric vehicles, Green Hydrogen, Hybrid CNG<br>• Power quality monitoring<br>• Energy conservation, storage, and efficiency<br>• Bionic Controls, Passive Evaporative Draught Cooling, Earth Air Tunnel, Daylight design<br>• Intelligent management/maintenance, MIS |
| 4. | Public Utilities | • Realtime Digital Platform for Utilities, Pollution, Quality and Quantity standards<br>• SCADA (Supervisory Control and Data Acquisition)<br>• ERP Solutions<br>• Intelligent water and sewerage networks with minimum losses and leakages, Micro-Irrigation, Plug the Non-Revenue Water (NRW) losses, Intelligent flood control and sustainable urban drainage<br>• Intelligent metering, billing and payment<br>• Solid and Liquid Waste Recycling<br>• Non-invasive techniques and advanced analytics for managing the water supplies and pressure in the network, which reduce energy consumption |

| | | |
|---|---|---|
| 5. | Smart mobility | • Transit Oriented Development, Origin-Destination Adaptation and Traffic Optimisation modelling,<br>• Roadside Sensors for Traffic Monitoring and Real time congestion information<br>• Simulation modeling and analysis<br>• Smart cards, driverless vehicles<br>• EV, Green Hydrogen, Ethanol blended CNG Network of Charging Stations<br>• Greening and Revamping of Streets as pedestrian and cycle friendly Boulevards<br>• Intelligent Multi-Modal/Public Transit, NMTs<br>• Replacing On-Street Parking by Multi-Level Parking<br>• Smart signals, traffic controls, variable signage, mobile enabled real time maps/routes, way finding, etc.<br>• ICT enabled traffic control, vehicle safety, communication, Dynamic Regional Network Modelling, Multi-modal Integration, Fleet Optimisation Modelling<br>• Safety and security, accident monitoring, forensic analysis<br>• Infrastructure integration, Smart City Pole with Air Pollution Sensors<br>• Digital Taxi/Car/Bus/Auto Pools<br>• Maintenance, MIS and management |
| 6. | Intelligent Community Frameworks | • Digital Intelligent Community Planning<br>• Networked Education, Health, Recreation and Other Facilities,<br>• Urban Farming<br>• Digital Data on Residential Types, WFH, Hostels, Night Shelter, Social Rental Housing, etc. |
| 7. | Disaster Management | • Public Security System and Safety<br>• Intelligent Public Security System and Safety<br>• Early Warning System, Emergency Aid, Rescue, Relief, Repair, Restoration and Reconstruction, Medical Aid, Life Support, Digital Information with regard to Fire and Structural Safety of Buildings<br>• Intelligent and Integrated Digital Control and Command Center , CCTV Network |
| 8. | Telecom Networks | • Broadband development, home automation, Internet access,<br>• ICT support, capacity building and training<br>• Consolidated billing<br>• Business incubation center, Climate Centre, Electronic trade office, City Administration, Technology and Innovation Centre<br>• Geo-portal, mobile based supervision and control |
| 9. | e Governance and Urban Management | • E-Governance, engagement with India Urban Data Exchange, National Urban Learning Platform, Smart Code, National Urban Development Mission<br>• Planners, architects and engineers have a Shorter Shelf Life unless they Refresh and Rebuild capacities<br>• A Shift from Long Range Planning to Strategic Planning<br>• Interdisciplinary/Transdisciplinary teams and Collective Intelligence |

## Digital informatics and smart cities

The breakthrough in digital technology and informatics has multiplied space, energy and time. It is time that new forms of energy, services, construction and recycling evolved, which are characterized by online exchange of information, interactions, dynamic networks and floating nodes.

Integration of land use, utilities, transport and building on a common network helps optimize space efficiency use and space configurations, eliminating unused or underperforming space. Utilities need ways to maximize the resources and equipment while minimizing "windshield time", the spent traveling to and from sites.

By developing sector–focused, cluster–based intelligent city strategies, territories can set in motion innovation mechanisms and enhance substantially their services and systems. The ICT can help in the integration of citizen participation, governance and online consultation over plans and programmes of local development. The urban processes need to be compatible to circular economy by adoption of new technologies, such as digital blockchain, combinatorial and discrete optimisation, algorithms, complexity theory, artificial intelligence, big data, and the ubiquitous cloud.

Global positioning systems are increasingly being used for construction, laying of services by satellite-guided tools and GPS devices. By 'on-site' virtual system, pipe work installed in a building can be inspected by a worker. Before installation, a contractor digitally tags every pipe and electrical system; once installed the engineer can view an augmented version of reality through 3D glasses that recognizes the tags and displays exactly where a misplaced pipe should be, relaying data back to a central control unit via a handheld computer. The 3 D cameras recognise the objects and material, and whether they are being used at the right place and with accuracy. The way of measuring distances could become more accurate with 'smart fingers', which measure the distance between the two points.

## Green and resilient buildings

A low carbon and green building aims to be resilient, sustainable and net zero. It is a synergy between various components such as energy, water, materials, wastes, land, indoor environment, etc. (Fig.9). The heating, lighting, cooling, ventilation, and powering of buildings are responsible for approximately 40% of the total energy use. As buildings are the largest energy users, incorporating energy storage into them will increase the resilience of the total energy distribution network and enable widespread use of renewable energy.

By passive design and low embodied materials, the buildings can be more


**Fig. 9: The Green Building Synergises 12 Key Factors**
**Source: www.ibc.org.in**

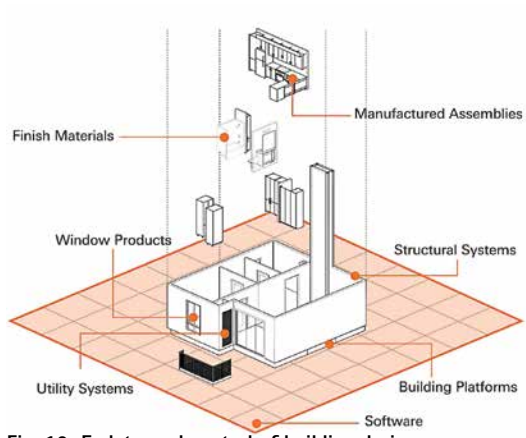


**Fig. 10: End-to-end control of building design, manufacturing, construction, and operations achieve targets at lower cost and time**
**Source: Kattera, Key Assemblies, and Curtis, Craig (2020) Architecture at Scale: Reimagining One-Off Projects as Building Platforms, Architectural Design**

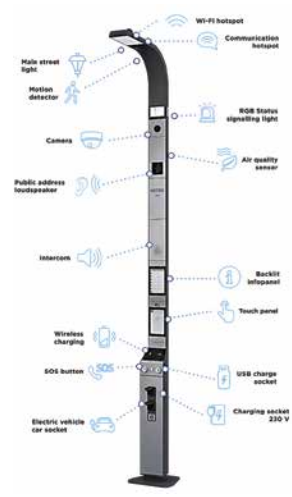

**Fig. 11: Intelligent Smart Pole**
**Source: http://www.elkoep.com/smartpole**

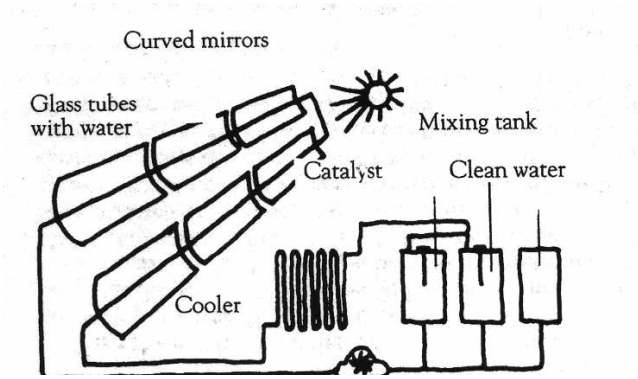


**Fig. 12: The Water is heated at a temperature of 30° C by curved mirror**
**Source: Røstvik, Harald N (1992) The Sunshine Revolution, Sun lab Publications, Stavanger, Norway**

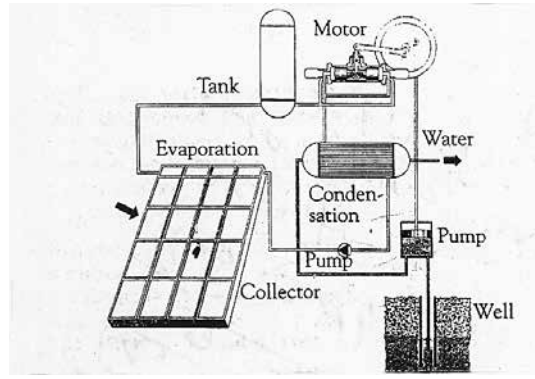


**Fig. 13: Solar Water Pump**
**Source: Røstvik, Harald N (1992) The Sunshine Revolution, Sun lab Publications, Stavanger, Norway**

climatically comfortable. Such materials include carbon-negative cements, low carbon steel, fibre, gypsum, basalt, fibre composite bars, bamboo, etc. Prefabricated and pre-engineering systems contribute to lower the carbon emissions, dust, time and costs in construction (Fig. 10).

Building Information Modelling (BIM) can simulate the entire construction sequence beforehand addressing sustainability issues and reducing carbon emissions. Computer-Aided Manufacturing (CAM) and Computer Integrated Manufacturing (CIM) are useful in reducing emissions, dust and GH Gases. The simulation of construction process enables better control of time, machine, expenditure and the manpower, and could reduce carbon emissions, costs and time by half to one-third.

After the corona pandemic, the trend is shifting towards healthy spaces and work from home (WFH). This emphasises upon open office, biophilic design with natural light, greenery, atrium and courtyards which help in better indoor air quality. The building must conform to accessibility standards for people with disabilities. The space design must prioritise sustainability and health by way of light, ample ventilation, bionic and energy efficient equipment. A Power-Over-Ethernet (POE) lighting system enables smart lighting from a solar grid.

## Urban heat mitigation and climate resilience

In a dense built-up area, the hot air dome i.e. heat island, affects the microclimate. There are irregular rains or dry spells or flash floods. The greenery and open space in windward direction and cooler surface materials (roads, parking, buildings, roofs, etc.) help in mitigating the effects of climate change and urban heat island. This needs preparation of a city-wide Heat Mitigation Plan and mandatory use of heat reflective and permeable materials for rooftops, pavements and roads, insulated with white paint and cavity walls. Water fountains, vegetation and cross ventilation can also mitigate the urban heat.

## Air quality

Air quality data is significant to gaining a thorough understanding of local air pollution. Recent technological advancements have made it possible to

gather data, with low-cost monitoring devices and advanced methods of collating and analysing it. This helps to gain an understanding of pollution levels, their causes and effect.

Now-a-days smart electricity poles with sensors are available to monitor pollution parameters along with light, CCTV, wi-fi, etc. The New Delhi Municipal Council (NDMC) has been using them in New Delhi (Fig. 11) . Citywide air quality monitoring networks can provide data of air quality.

The Google plans to map street by street air pollution that will be available to the common man. The active sensors will measure $CO_2$, CO, $NO_x$, $NO_2$, ozone and particulate matter. CEMS and Air quality Data can be used to identify major components, sources, quantification and projects. It can also help the government to apply monetary incentives and penalties for polluting companies. This can also be used to introduce a cap-and-trade system, instead of the existing 'command-and-control' regulations. The data can be used to analyse the issues, sources and project various options and actively schedule to assign the responsibilities, project management, including timelines and monitoring.

Airshed planning, use of cooler and light shaded surfaces/materials are some other methods to reduce urban heat and air pollution. The use of prefabricated and recycled materials, including construction and demolition wastes in construction and repair of roads and buildings can help in reducing urban heat, air pollution and dust.

## Green energy

Low carbon energy can be derived from renewable sources, such as biofuels, wind, tidal and solar power (Figs. 12, 13). The concept of energy efficiency, renewable energy and Zero-fossil Energy Development (ZED) can reduce the energy demand and consequential pollution. Smart Micro-Grids, Distributed Energy Systems (DES), Micro-Districts and Anchor Microgrids should be linked with renewable energy network and energy efficiency. A series of low carbon zones across the city with co-located tri-generation energy systems (combining power, cooling and heating), can lead to 'green energy.

The energy guzzling air-conditioning can be avoided by innovative methods like Net Zero Energy Design, variable refrigerant volume (VRV) system, earth air tunnel (EAT), thermal storage and Passive Evaporative Draught Cooling (PEDC) systems. Lower ambient lighting with bionic controls and integration of natural light with high performance glazing combined with light sensors can save energy use in a building.

Synchronized lighting control systems can be designed to match building loads and schedules, which are segmented into multiple zones to allow intelligent controllability. The Energy Conservation Building Code (2017) provides clues for low carbon energy efficient building design with green roof, light coloured finishes and insulation (Figs. 14 & 15).

## Water conservation and management

With increasing river pollution and drying of water bodies, several cities in India have become water stressed. Only 18% of the renewable water resource is being recycled, and only 10% of the annual rainfall is being harvested in

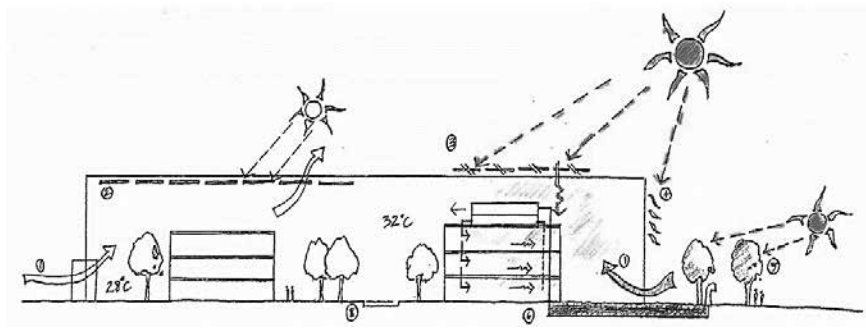


**Fig. 14: Design of Research Centre in Wageningen, Netherlands (Behmisch, Behmisch & Partners) Features the Sun, Photovoltaic, Courtyard, Skylight and Atrium for the Energy Efficiency**
**Source: Muller Dominique (2004) Sustainable Architecture and Urbanism, Birkhauser, Basel**


**Fig. 15: Typical Section of Proposed Residential Building in Compliance with Energy Conservation Building Code**
**Source: DUAC/Amit Ghoshal (2014), Punjabi Bagh Project, DUAC, New Delhi**

India. To overcome these problems, water sources need to be planned and managed as the circular systems (Fig. 16). The water bodies and the rivers need to be protected by sanitation/sewerage interception, and by recycling and treatment of wastewater (Fig. 17). Zero run-off drainage needs the provision of swales, retention ponds, etc. (Fig. 18). Besides the conservation of rivers and water bodies, water efficient taps/fittings, dual plumbing, recycling of wastewater by DEWATS (Fig. 19) and adoption of new technologies, such as Blockchain and SCADA systems, can help in a more efficient water supply.

A city should be able to grow its own food and minimize its footprint. This is possible by vertical farms, rooftop and household agriculture and by using wastewater for irrigation. Satellite controlled park and lawn micro-irrigation system cuts water consumption and pumping power. Wastewater recycling, with dual piping would reduce water demand. Vertical farms could reduce fertilizer and freshwater use, shorten transport and recycle gray water otherwise dumped by treatment plants (Fig. 20). Collecting rainwater and growing food locally in urban areas can respond to the challenges of transport, urban-rural divide, biodiversity, social equity, waste minimization, and energy.


**Fig. 16: Circular Water Management**
**Source Baudh Raj, Kumar and Mohammed Salim (2022) Ancient Waters for the Future, TERI, New Delhi**

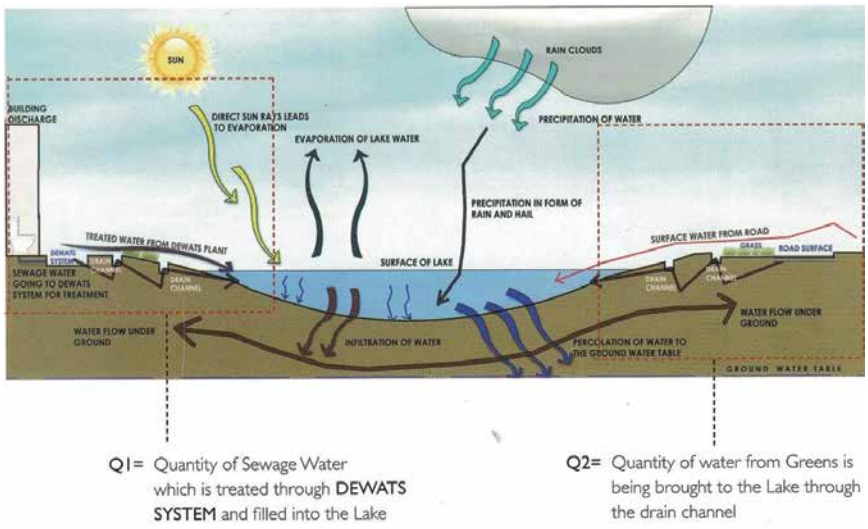


**Fig. 17: DEWATS and Stormwater Harvesting for Revival of an Urban Water Body**
**Source: DUAC/Rahoul B Singh (2014) Hari Nagar Greens, DUAC, New Delhi**

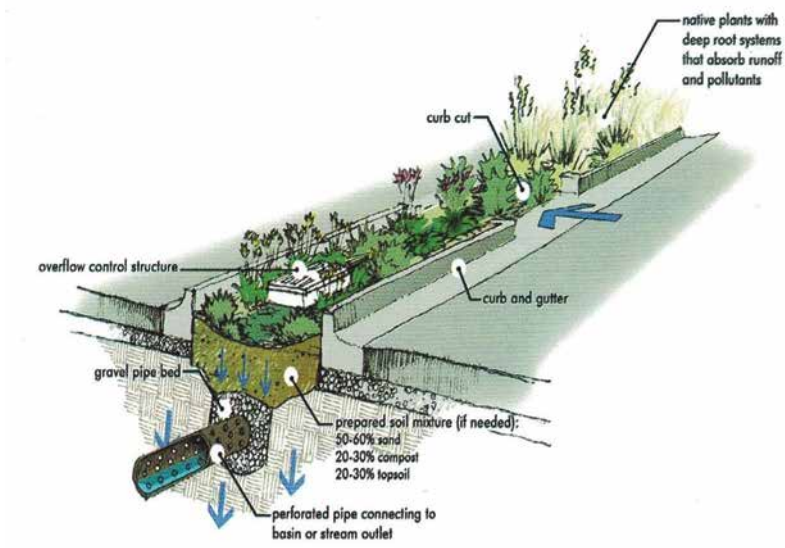


**Fig. 18: A Bioswale for Sustainable Urban Drainage**
**Source: http://thewhiteriveralliance.org/eaglecreek//involved/images/bioswale%20enlargement.jpg**

## Decentralised and Intelligent Utilities

Surveys reveal that approximately 40% of urban population in India is not covered by sewerage, sanitation, drainage and solid waste disposal. Various alternative technologies, based on the use of IT, simulation, blockchain and automation can make the services smart and intelligent. The common method of land filling for solid waste disposal is an environmental disaster. Instead, decentralized systems based on 5 R strategy of reduce, refuse, reuse, recovery and recycling should be explored (Fig. 21). Three bins provide separate bins for trash, recyclables and compost (Figs. 22 & 23). Biotechnology, enzyme based STP, bio-remedial treatment, vessel system, sludge gas/energy recovery, vermi-culture, fossilization and compositing options can be adopted for solid and liquid waste management. Underground pneumatic conveying systems can be adopted, which are more hygienic, economical and avoid movement of trucks for transportation of wastes.

## Clean transport and transit oriented development

As urban transport contributes nearly two-thirds of the total suspended particulate matter and 18 per cent of carbon emissions, it is necessary

to provide sustainable modes of transit run by alternative fuels, like electric batteries, green hydrogen, ethanol blended gasoline, etc. Integrated Transit Corridors (ITC), integrating BRT, Metro, and trains, together with pedestrian and cycle

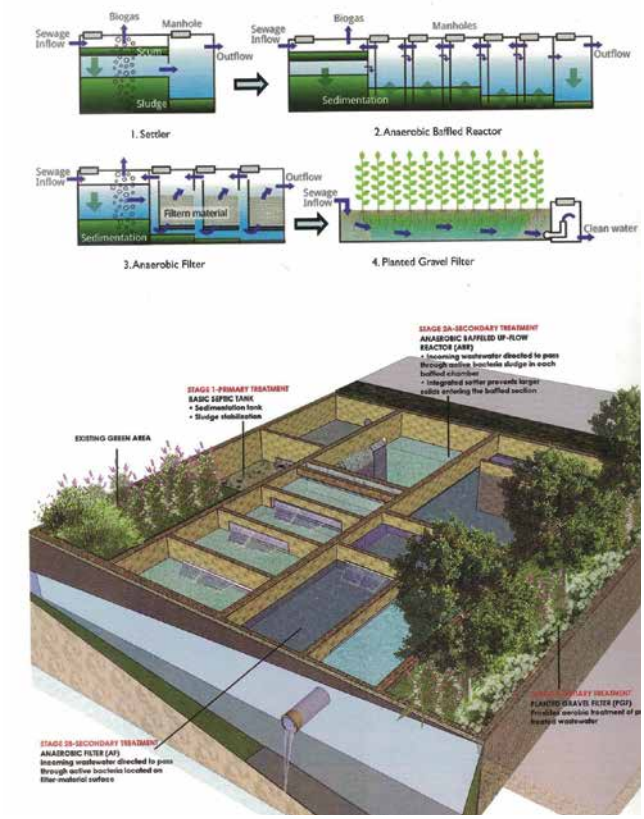


**Fig. 19: 3-D Model showing Process involved in DEWAT System**
**Source: DUAC/Rahoul B Singh (2015) Rejuvenation of Najafgarh Waterway, DUAC, New Delhi**

**Fig. 20: Retrofitted Shipping Containers used for creating multi-storied urban farms-cum- apartments in Seattle's Proposed Centre for Urban Agriculture (Mithun Architects)**
**Source: Azure, September 2008**

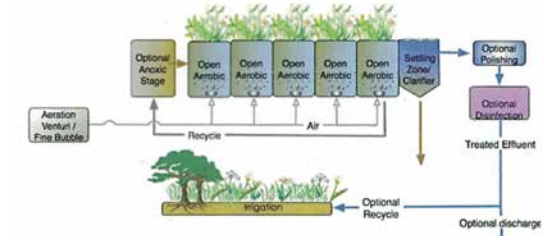


**Fig.21: Process of Secondary Organic Treatment using Plants and Enzyme Dosing**
**Source: DUAC/M.N. Ashish Ganju (2014) Aya Nagar Urban Development, DUAC, New Delhi**

**Fig. 22: Hi-Tech Waste Recycling Depot**
**Source: DUAC/Amit Ghoshal (2017), Solid Waste Management Chittaranjan Park, DUAC, New Delhi**

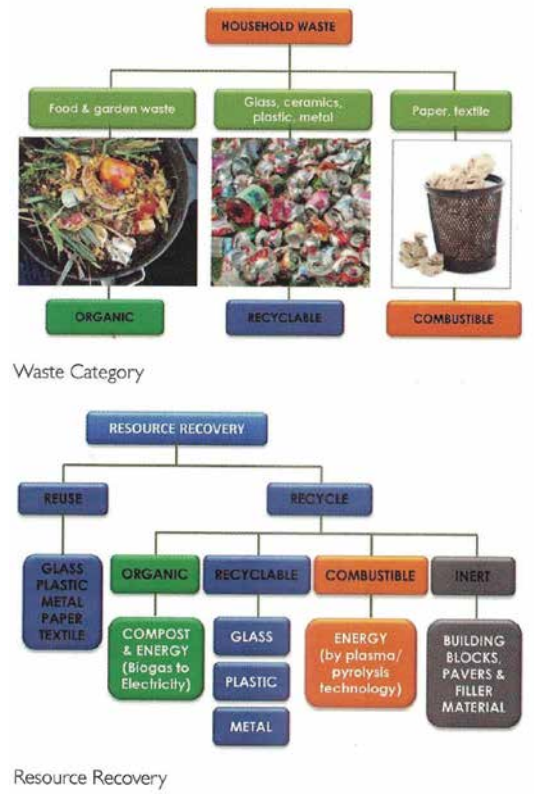


**Fig 23: Waste Segregation and Recycling**
**Source: DUAC/Amit Ghoshal (2014), Chittaranjan Park Project, DUAC, New Delhi**

lanes, can be flanked by high-density developments. In existing Indian cities, the 15 minutes Paris model, can be adapted, which means maximum 15 km distance by metro/trams, 8 to 10 km by bus/car/2 wheelers, 2 km by cycle and 1 km by walk

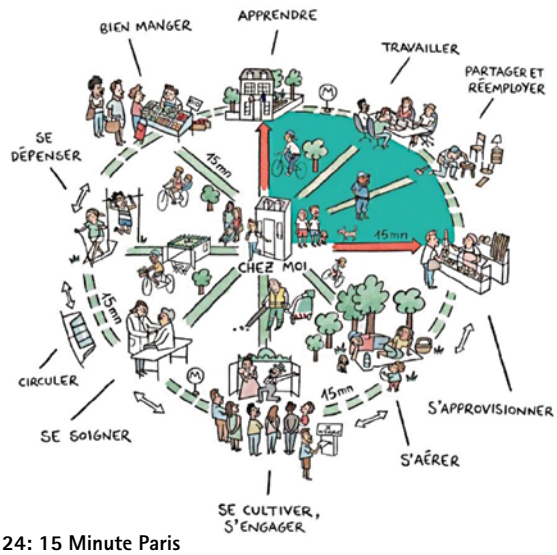


**Fig. 24: 15 Minute Paris**
**Source: https://www.theguardian.com/cities/2016/may/17/superblocks-rescue-barcelona-spain-plan-give-streets-back-residents**

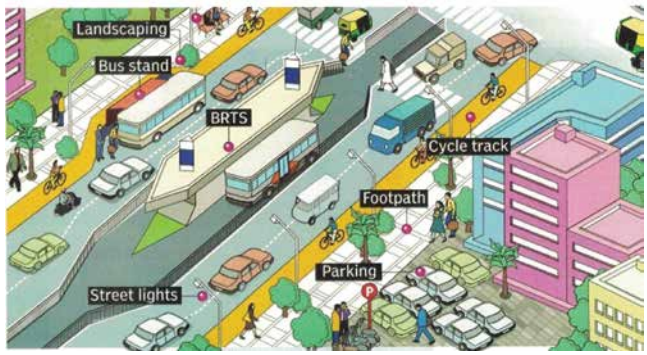


**Fig.25: Road Redesign with Dedicated Cycle, BRT Tracks and Footpaths**
**Source: DUAC/Amit Ghoshal (2015), Punjabi Bagh Project, DUAC, New Delhi**

**Fig. 26: Existing Street, Govindpuri**
**Source: DUAC/Kavas Kapadia (2014) East of Kailash and Kalkaji Project, DUAC, New Delhi**

(Fig. 24). Existing roads need to be revamped and landscaped to enhance space for pedestrians, cyclists and public transit systems (Figs 25, 26 &27). All highways and railway/metro lines should provide safe crossings for pedestrians, wheelchairs, prams and animals (Fig. 28). Multi-modal integration, last mile connectivity and e-governance are the pillars of sustainable urban mobility. It is necessary to digitise all the parking space including under stilts, multi-level structures, on roofs and in underground spaces. Seamless multimodal public transport system would work better by adoption of single ticketing and restructuring of land uses by transit-oriented development. Digital parking meters tell mobile phone when a space opens, reducing traffic caused by drivers trolling for parking.


**Fig 27: Proposed Streetscape**
**Source: DUAC/Kavas Kapadia (2014) East of Kailash and Kalkaji Project, DUAC, New Delhi**

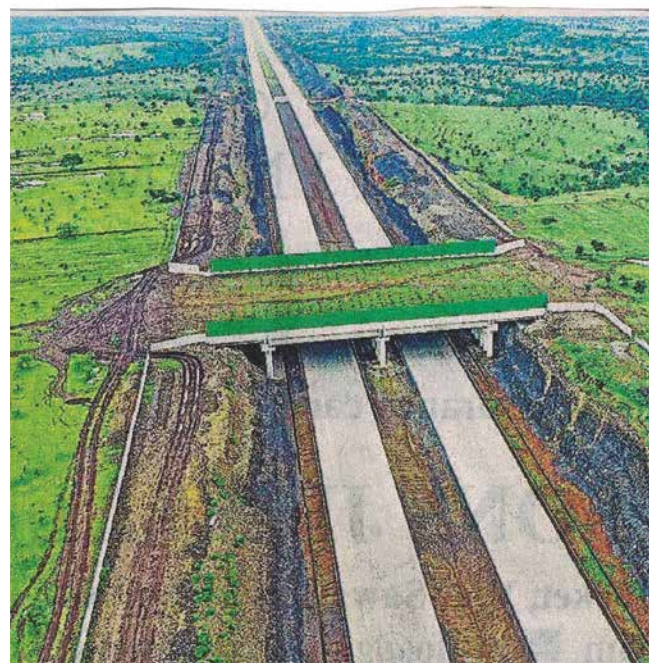

**Fig. 28: Highway/Railway Lines may be provided with an Overpass for Safe Crossing of Villagers, Animals, etc**

## An Intelligent community network

An intelligent geo-portal can bring together various line departments and communities on a platform for e-service delivery. The system is mobile and internet based, dynamically scalable. It helps in technology enabled management of land and infrastructure, planning and development. This yields better co-ordination and exchange of information, cost and time management. Citizen engagement becomes much easier and viable by virtual town halls.

Smart chips and systems can be embedded almost in every urban service and structure, making them smart and intelligent. These enable self-diagnosis and self- repair. The future is already upon us. With digital chips getting embedded in a city's epidermal and exoskeletal level and its connective tissues, cities are increasingly getting digitally scripted and coded.

The Parametric Model allows the users to adjust building parameters while the tool calculates the manifestation of these changes on the total carbon impact of individual buildings and the city. Designers, planners and building owners can take advantage of this tool to inform their decisions about energy, water, mechanical, facade or lighting systems. Where the Data Model is designed to shed light on the performance of urban environment, the Parametric Model is a crucial tool to enable their integrated performance in terms of green and sustainable built environment. This manifests the ''smart nodes on a smart grid'' concept. Information technology can be used to provide services to enhance users experience, such as high-speed communication and data management, carbon-emission accounting and performance objectives. This implies integration of green concepts with smart, ICT based technology to optimise their performance, monitoring and maintenance.

## Conclusions

There is a need for a paradigm shift in urban planning and infrastructure services which addresses the impending issues of climate change, air and water pollution. For a city to be resilient and low carbon, it is necessary to promote conservation of transport, energy and water, nature and resources. Net zero urban development not only gives an environmental benefit, but also promotes jobs, urban variety, gender equity and socio-economic transition by invoking digital planning and governance. Optimum use of land and natural resources, lifestyle for environment and new partnerships are critical elements of a sustainable habitat, which connect the nature with the people. This involves integrating a long term, telescopic vision with microscopic local plans by new technologies, innovative financing and speedy institutions. A vision without a strategic action plan and how to get there would remain just a dream.

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https://www.theguardian.com/cities/2016/may/17/superblocks-rescue-barcelona-spain-plan-give-streets-back-residents

## Advanced LiDAR by Bowman geospatial division

Bowman Consulting Group Ltd. USA announced that Cuhaci Peterson has teamed with Bowman's geospatial division to deliver time and cost savings for their clients by utilizing Bowman's minimally invasive ceiling scanning techniques. Prior to developing this technique, ground level 3-D scanning in an open interior environment was simple enough. However, tying that information to the scanning data above the ceiling tiles was difficult unless they were all removed, which is inefficient and time consuming. *bowman.com*

## Planet and NASA Harvest partnership

Planet Labs PBC and NASA Harvest, the federal space agency's Global Food Security and Agriculture Program, recently announced a partnership to further support the joint Food Security and Agricultural Monitoring Solution. The offering aims to deliver policy-grade agricultural monitoring and assessments of potential threats to global food security.

The offering will combine Planet's satellite data and other publicly-available datasets with the analytics expertise of the combined NASA Harvest team, facilitated by the University of Maryland and University of Strasbourg – creating an assessment tool that could play a key role in anticipating and averting food shortages and famines. This work was first piloted to monitor fields in Ukraine in 2022 to track frontline agricultural activity and assess the impact of war on crop production. *www.planet.com*

## UltraMap version 6.0 for professional aerial data production

Vexcel Imaging has released the latest version of its all-in-one photogrammetric software suite UltraMap, with sophisticated and best-in-class water handling features, an enhanced Ortho module performance and a redesigned Ortho reprocessing workflow. The new version introduces True Pixel Processing (TPP), a proprietary raw data processing approach in the Essentials module and supports professional data production for the recently launched UltraCam Eagle 4.1.

The new highly automated features for water handling are enhancing the quality of nearly every product throughout the workflow. This includes tools like the new Water Mask & Geometry Editor to efficiently quality control and edit water masks as well as the updated Seamline & Blending Mask Editor for intuitive generation of homogenous water surfaces in orthomosaics. In addition, performance for most efficient large-scale data production has been optimized by introducing more effective file management, leading to faster loading times, viewing speeds, saving and export of products in the Ortho Viewer. *vexcel-imaging.com*

## Successful deployment of Surya Satellite-1 of Indonesia

Indonesia has successfully deployed its first student satellite from the International Space Station (ISS). Students from Surya University constructed the SS-1 satellite as the awardee of the 3rd round of the KiboCUBE programme.

The KiboCUBE programme is a joint initiative by the United Nations Office for Outer Space Affairs (UNOOSA) and the Japan Aerospace Exploration Agency (JAXA) under the Access to Space for All initiative.

This SS-1 CubeSat mission is a technology demonstration that will test communication between an Automatic Package Reporting System (APRS) payload and the ground using amateur radio frequency. Through the development and operation of SS-1, Surya University and the supporting organizations aim to disseminate nanosatellite technology in Indonesia, especially to students and universities. Given the full involvement of academia in this capacity-building process, the country hopes that the gained knowledge and experience will benefit future generations. *https://global.jaxa.jp*

# National Geospatial Policy 2022

The Government of India has notified the National Geospatial Policy 2022. Here are the excerpts

## Vision and Goals

To make India a World Leader in Global Geospatial space with the best in the class ecosystem for

- To develop a coherent national framework in the country and leverage it to move towards digital economy and improve services to citizens.
- To enable easy availability of valuable Geospatial data collected utilizing public funds, to businesses and general public.
- To have a thriving Geospatial industry in the country involving private enterprise.

Following are the milestones in the journey towards realization of the aforesaid vision:

## Year 2025

- Put in place an enabling policy and legal framework that supports liberalization of Geospatial sector and democratization of data for enhanced commercialization with Value Added Services.
- Improve availability of and access to better location data across organizations and sectors to enable innovations and encourage enterprise.
- Establish and strengthen an integrative interface for all digital data having location dimension collected or developed utilizing public funds, for easy access, sharing, use and reuse.
- Redefinition of National Geodetic Framework using modern positioning technologies and provision of online access.
- High accuracy Geoid for the entire country.
- Develop and strengthen national and sub-national arrangements in Geospatial information management and related infrastructures with participation of government, industry, private sector, academia and civil society.

## Year 2030

- High resolution topographical survey & mapping (5-10 cm for urban & rural areas and 50 cm-100 cm for forests & wastelands).
- High accuracy Digital Elevation Model (DEM) for entire country (25 cm for plain, 1-3 metre for hilly and mountainous areas).
- Develop a Geospatial Knowledge Infrastructure (GKI) underpinned by Integrated Data and Information Framework.
- Enhance capabilities, skills and awareness to meet the future needs of the country.

## Year 2035

- High resolution/accuracy Bathymetric Geospatial Data of inland waters and topography of shallow/deep seas - to support Blue Economy.
- Survey and mapping of sub-surface infrastructure in major cities and towns.
- National Digital Twin of major cities and towns.

## Strategy and Approach

The focus of the Policy is to make Geospatial technology and data as agents of transformation for achieving the Sustainable Development Goals (SDGs), bringing efficiency in all sectors of economy and instilling accountability and transparency at all levels of governance.

**Atmanirbhar Bharat:** The Policy recognizes the importance of locally available and locally relevant Maps and Geospatial Data in improved planning and management of resources and better serving the specific needs of the Indian population.

**Integrated Geospatial Information Framework (IGIF):** The Policy seeks to draw on international best practices, such those of United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) including the IGIF, to strengthen national-level spatial information management arrangements across our country.

**Data and Information & Communications Technology (ICT) Infrastructure:** Building on the existing Data Holdings and ICT Infrastructure, the Policy will promote establishment of a Geospatial data infrastructure, which through well-defined custodianship model and data supply chain, will enable best practices in collection and management of Geospatial data/information and availability of quality, real /near-real time data/information that will be appropriate to ensure cross sector and multidisciplinary collaboration involving all stakeholders.

**Innovation:** The Policy will enable and support innovation, creation and incubation of ideas and start-up initiatives in the Geospatial sector.

**Standards:** The Policy will encourage open standards, open data and platforms.

**Capacity Development:** The Policy will encourage enduring capacity development and education programs so that the value and benefits of integrated Geospatial information management is sustained in the long term.

**Ease of Doing Business:** Continued liberalization in line with the Guidelines will be carried out and supported.

**Democratization of Data:** The Survey of India (SoI) topographic data and other Geospatial Data produced using public funds would be treated as common good and be made easily available.

## Institutional Framework

The Government shall constitute a Geospatial Data Promotion and Development Committee (GDPDC) at the national level which shall be the apex body for formulating and implementing appropriate guidelines, strategies and programs for promotion of activities related to Geospatial sector. GDPDC shall drive the overall development of the Geospatial ecosystem. GDPDC would replace

and subsume the functions and powers of National Spatial Data Committee (NSDC) constituted through GoI Resolution dated 13.06.2006 and Geospatial Data Promotion and Development Committee constituted vide DST Office Memorandum dated 04.03.2021. GDPDC will appropriately modify the concept and functioning of National Spatial Data Infrastructure (NSDI). DST shall continue to be the nodal Department of the Government and GDPDC shall make suitable recommendations to DST in the discharge of its functions relating to the Geospatial regime.

## Strengthening Geospatial Infrastructures

**Geospatial Data Infrastructure**

UN-GGIM recognizes 14 Global Fundamental Geospatial Data Themes considered fundamental to development of a country's Integrated Geospatial Information Infrastructure and supporting the Sustainable Development Goals. GDPDC will adopt and develop these Data Themes as National Fundamental Geospatial Data Themes.

Provisions for efficient access to the National Fundamental and Sectoral Geospatial Data by all stakeholders in the country will be made through operationalization of a National Geospatial Data Registry (NGDR) which will be a commonly accessible set of registers/ catalogue of data sets and services.

Unified Geospatial Interface (UGI), an electronic data querying and processing service, will be operationalized for provision of consumer-oriented products, applications, services and solutions using the Geospatial data and metadata contained in the NGDR and utilizing the data supply chains from the Central and State Level Partnering Agency Data Nodes.

Survey of India shall be the agency responsible for developing and operating the NGDR and the UGI in collaboration with Bhaskaracharya National Institute for Space Applications and Geo-informatics (BISAG-N), other institutions and the private sector, under the guidance and supervision of GDPDC in relation to the scope, functionality, and performance of the NGDR and the UGI.

Standards related to National Fundamental and Sectoral Geospatial Data Themes would be developed and promulgated after consultation with a broad range of data users and providers and, to the maximum extent possible, national and international standards adopted by voluntary and open standards consensus bodies would be used.

## Mapping Infrastructure

While SoI will continue to be the overarching nodal agency for Geospatial Data, only the generation/ maintenance of minimal foundational data/ core functions would be performed by Sol. SoI yam ysla involve private sector and other surveying entities such as GSI, FSI, etc. Amongst the 14 National Fundamental Geospatial Data Themes, Geodetic Reference Frame, Orthoimagery and Elevation are most pivotal because together they provide the Geodetic and Digital Spatial Framework that act as common reference (X,Y,Z) for the assembly and maintenance of data pertaining to all other Fundamental and Sectoral Data Themes.

SoI would be responsible for maintaining Geodetic Reference Frame, Orthoimagery, Elevation (DEM), Functional Areas (Administrative Boundaries) and Geographical Names (Toponymy) in collaboration with various stakeholders including the private sector by suitably aligning with the priorities of the Government, while adhering to the Goals set out in the Policy.

While within the government SoI would play the lead role for maintaining high resolution / high spatial accuracy Orthoimagery, private sector will be free to take up creation, maintenance and use of such data suitable to their requirements. Department of Space will similarly play the lead role for generating Orthoimagery of high temporal accuracies using space-based technology. SoI will act as facilitator in harmonization of the data sets created using public money to ensure that data generated from various mapping activities by various stakeholders get seamlessly integrated into Geodetic Reference Framework and develop a mechanism to facilitate consolidation of the data sets into the national topographic template to meet the demand of periodically updated, high-resolution and accurate topographic data for the country.

The organizational structure of SoI would be aligned with the changed Geospatial data regime, with focus on facilitating and nurturing a vibrant domestic Geospatial services industry. SoI would be transformed into a fully civilian organization. Defence stream of recruitment in SoI would be discontinued and defence stream officers seconded to SoI would be permanently reverted to Military Survey, Ministry of Defence.

## Role of Private Sector

While there are nodal Ministries/Departments for each of the National Fundamental Geospatial Data Themes, this does not imply that the entire work has to be necessarily done departmentally or through SoI or only government/public sector entities. Actual collection and collation of data and development of Data Themes would be increasingly done with private sector participation consistent with February, 2021 Guidelines. Needs and requirements of the citizens related to various Geospatial/location-based solutions will predominantly be serviced by the private sector, with SoI and nodal ministries/agencies of various Geospatial Data Themes in a facilitative role. The Private Sector will play a key role in creation and maintenance of Geospatial and mapping Infrastructures, innovations and process improvements and monetization of Geospatial data.

## Sub-surface and Hydrographic Infrastructure

The subsurface or underground is a complex environment which hosts vital infrastructure such as water and energy supply, communication systems, sewers and drainage. A concrete strategy for mapping the subsurface infrastructure in cities in 3D mode and collating or updating data in cases where it has already been done, will be developed.

Fisheries, deep sea mining, and offshore oil and gas make up a large component of India's blue economy. Such resources in the streams, ponds, lakes, rivers, and seas on and around the shore-lines are required to be surveyed and mapped. Bathymetric Geospatial Data is also

a crucial resource for a vibrant blue economy that would require active participation of the private sector in their acquisition and use, apart from traditional agencies like the Indian Navy, etc. GDPDC will develop strategies for facilitating such surveys and for the development and maintenance of suitable hydrographic data infrastructure with the active participation of private and public sector Indian companies. In order to promote growth in hydrographic infrastructure and related data products, DST would be empowered to undertake hydrographic surveys and preparation of navigational charts with the involvement of appropriate government agencies and/or private sector.

## National Digital Twin

National Digital Twin strategy, which is geospatially aware and built on a dynamic Geospatial infrastructure, would be devised by GDPDC to provide for the following:

- Reliable, accessible, usable, interoperable, continuously updated datasets for both 'above the surface' and 'subsurface' environments as per the required attributes;
- Precise positioning data from Global Navigation Satellite System (GNSS) systems, or resilient Positioning, Navigation and Timing (PNT) systems and Internet of Things (IoT) sensors.

## Geospatial Knowledge Infrastructure (GKI)

GKI will provide the critical Geospatial component to knowledge and automation. GDPDC will create an enabling environment to promote innovations towards GKI enablement, with active participation of private industry.

## Geospatial Education and Skill Development

Geospatial education is imparted in around 200 universities/institutions at different levels in colleges, universities, Industrial Training Institutes and National Skill Training Institutes. However, there is lack of standardization of Geospatial curriculum. Geospatial education is not adequately integrated in the innovation system. To fill this resource gap, DST and SoI, together with experts from Industry and academia will work with the National Skill Development Council (NSDC) to create a Geospatial Skill Council. The Geospatial Skill Council will conduct skill gap studies, develop Qualification Packs, Occupational Standards as part of multi-level National Skill Qualification Framework (NSQF) for various job-roles/competencies in the Geospatial sector.

## Surveyors' Registration and Certification

In order to maintain the quality of survey professionals, Surveyors' registration and certification will be developed through industry driven benchmarks and standards, in line with global best practices. These benchmark and certification standards will also be developed to appropriately provision for Aerial Survey Professionals, UAV Survey Professionals, GIS Professionals, Remote Sensing Professionals, etc. who are different from traditional surveyors.

## Geospatial Enterprise

An advisory body named as Geospatial Industrial Development Board (GIDB) headed by an eminent industrialist, will be constituted by DST under the aegis of GDPDC, with representation from Ministry of Commerce and Industry, Department of Science and Technology and Department of Revenue among others. It would be assisted by a panel of members from the Geospatial industry who would provide valuable inputs to the Board for advancing the growth of the Indian Geospatial entities. The Board would assist and advise GDPDC and DST on matters related to Geospatial industry. Geospatial Incubation Centres and/or Geospatial Industry Accelerators would be established in collaboration with Geospatial industry, user sectors, academia and the civil society to promote innovation in the sector.

GDPDC as constituted by the Government will be the apex body for implementation of the Policy, its various provisions, formulation of guidelines and steering the course of the development of Geospatial sector in the Country. DST shall be the Nodal Department of the Government for the Policy.

## National Geospatial Policy 2022 at a glance

National Geospatial Policy 2022. Some important features for Survey of India have been stated here.

2.2.4 Redefinition of National Geodetic Framework.

2.2.5 High accuracy Geoid for the entire country.

**Up to 2025**

2.2.7 High resolution topographical Survey and mapping (5_10 cm) for urban and plain areas and 50cm to 100cm for hilly and mountainous areas.

**Up to year 2030**

2.2.11 High resolution accuracy Bathymetric Geospatial Data of inland waters and sea surface topography of shallow/deep sea to support blue economy.

2.2.12 Survey and mapping of sub surface infrastructure in major cities and towns.

**Up to 2035**

3.9 Democratization of Data.

The Survey of India (SOI) topographical Data and other Geospatial data produced using public funds would be treated as common good and made easily available.

5.1.1 Survey of India be the agency responsible for developing and operating the NGDR.

5.2..2 Role and organization of SOI.

5.2.2.1 SOI will continue to be overarching nodal agency of Geospatial Data.

5.2.2.3 SOI would be responsible for maintaining Geodetic Reference Frame, Elevation ( DEM).

5.2.2.7 SOI would be transformed into a fully civilian organization. Defence stream of recruitment in

SOI would be discontinued and defence stream officers seconded to SOI would be permanently reverted to Military Survey, Ministry of Defence. Requirement of fast changing skill sets in SOI would be met by domain experts from the market.

The last point mentioned above is most important.

**- N K Agrawal.**
*Former Director of Survey of India*

## Swift Tactical System to build a platform for UAVs and UAMs

Swift Engineering announced its Japanese Subsidiary, Swift Xi, signed an agreement with Japan's New Energy and Industrial Technology Development Organization (NEDO) in a project called "Digital Infrastructure Development Project for Digital Transformation of Industries: Research and development on 3D spatial information infrastructures." Both Swift Tactical Systems and Swift Engineering will support the project. Swift Tactical Systems and the Swift group are collaborating with Zenrin Co. Ltd., LocationMind Inc., Intelligent Style, and Space Service Innovation Lab (SSIL) to develop a 3D spatial information infrastructure using the spatial ID. There needs to be a platform for understanding and identifying flight safety information.*www.swifttacticalsystems.com*

## TOPODRONE synchronized LiDAR and bathymetric surveying methods

TOPODRONE has synchronized airborne photogrammetry, and LiDAR and bathymetric surveying methods, which was used to study a floating solar farm. The synchronization was performed for ERELIS to conduct a pilot project of reservoir surveying with a UAV in Northern Israel. ERELIS performed two-stage drone surveying to deliver a high-precision 3D model of the reservoir. First, aerial photogrammetry and LiDAR surveys were performed to determine the location of possible obstacles. Second, an underwater bathymetric survey using a Topodrone Aquamapper mounted to the same drone was conducted avoiding detected obstacles (cables, solar panels and other objects). *topodrone.com*

## DroneAcharya Aerial Innovations expands operations

DroneAcharya Aerial Innovations Limited, India is commencing operations in Thailand, in association with the Asian Institute of Technology (AIT). The partnership will pave the way for the company into the Southeast Asian market. The primary goal of the collaboration with AIT is to co-develop projects involving Drones and GIS in Thailand and the surrounding countries.



## UKHO identifies key drivers for maritime industry

The UK Hydrographic Office (UKHO) recently presented a white paper on the opportunities and challenges facing the maritime industry as it transforms through decarbonization and digitalization. The paper was presented at the sixth International Hydrographic Organization (IHO) Council meeting in Monaco, which was attended by representatives of 26 countries. The meeting focused on the maritime sector's transition to digital data services and the development and implementation of the new S-100 data standards.

The IHO's S-100 data standards will greatly enhance our understanding of the ocean and the portrayal of the maritime environment. It will provide a coherent framework for high-fidelity maritime data applications, which are fundamental to the shift from Electronic Navigational Charts (ENCs) to digital geo-information systems. Those systems will be capable of receiving and processing information on a wide range of applications, including imagery and gridded data, high-density bathymetry, dynamic tidal monitoring and surface currents. *https://iho.int*

## Czech Railway Administration will use digital maps

Hexagon's Safety, Infrastructure & Geospatial division announced Ness Czech will supply the Czech Railway Administration with the Digital Technical Railway Map (DTRM), a railway-specific GIS that will provide the state organization access to information about its transport and technical infrastructure to better and more efficiently prepare investments and repair work. The basis of the project is the Technical Map Information System (ISTEM), a unique solution developed by Ness and Hexagon.

The Railway Administration, as a railway operator, needs precise information about the railway network and surrounding area. By acquiring accurate and detailed geodetic measurements and digitizing asset and infrastructure information, the Railway Administration can meet its own needs and those of the state, which is developing the Digital Technical Map of the Czech Republic, a national map which should be operational in 2024. The national map is being built across the country by connecting regional digital maps and others from the Railway Administration and the Directorate of Roads and Highways. The connection is provided by the Czech Land Surveying and Cadastral Office, which has extensive experience in successfully managing cadastral mapping. *hexagon.com*

## CCTech's HVAC-Twin is Powered by iTwin

CCTech has announced the addition of HVAC-Twin to Bentley Systems' powered by iTwin program. It enables quick turnaround between HVAC design iterations—leading to energy and cost-efficient HVAC designs. Designers and engineers can add sensor data, make connections, and start visualizing data such as temperature, occupancy, and CO2 levels—to diagnose and improve the performance of HVAC systems.

HVAC-Twin is a web-based, physics-informed 3D digital twin that is built for easy accessibility and enhanced collaboration, providing quick turnaround between design iterations leading to energy and cost-efficient HVAC designs. *www.cctech.co.in*

## Esri India launches Policy Maps

Esri India recently unveiled Policy Maps to facilitate data-driven policymaking in India. The announcement was made during Esri India's User Conference.

The Policy Maps have been designed to provide meaningful insights for various government functions with a special focus on Sustainable Development Goals (SDGs). The maps for SDGs provide detailed insights into how India is faring in the achievement of the 17 SDGs. It provides data at the granular level and help in analyzing the progress achieved.

The data used in Policy Maps is sourced from authoritative government sources.

As a unique feature of the Policy Maps, relationship Maps created through the dashboard can help in identifying patterns and understanding how working towards one SDG can lead to creating better conditions for another SDG.

## AI/ML for natural resource mapping

The Defense Advanced Research Projects Agency (DARPA) and the US Geological Survey (USGS) are exploring the use of artificial intelligence and machine learning (AI/ML) tools for critical minerals assessments.

In order to solicit innovative solutions, DARPA collaborated with USGS, MITRE, and NASA's Jet Propulsion Laboratory on an industry competition: The USGS Map Georeferencing Challenge and the Feature Extraction Challenge of the Artificial Intelligence for Critical Mineral Assessment.

At the virtual awards ceremony for the competition held on December 7th, Sanborn earned fourth place and an Honorable Mention. It successfully demonstrated ways to automate the georeferencing of scanned and raster maps, as well as feature extraction. *www.Sanborn.com*

## Implementing GIS for map charting

Kuwait Oil Company (KOC) is enhancing the quality and accuracy of the data used for daily planning to support production operations and the decision-making process for the implementation of current and future projects.

This was done by contracting with one of the international companies specialized in this field. This project, for the first time since its inception, helped to possess three-dimensional maps of all terrain of the oil fields, and capture high-quality aerial photographs with an accuracy of 10 centimeters. The project aims to integrate with GIS used for operations. *www.arabtimesonline.com*

## 3D Live navigation

Mapbox 3D Live Navigation combines 3D lane models, real-time sensor information, sign data, environmental models, 3D landmark buildings, dynamic lighting conditions and weather data to deliver an accurate, more natural navigation experience. It combines map data from millions of vehicles on the road and aerial imagery into a comprehensive map with 3D lanes together and relevant sign post information. It then uses the car's sensor information to display the lane-level location of the vehicle and adjacent vehicles, and simplifies navigation in complex intersections and multilane highways. Using real-time sensor information, Mapbox 3D Live Navigation also displays Advanced Driver Assistance Systems (ADAS) hazard warnings on the map to ensure the driver's situational awareness is consistent with the surroundings of the vehicle. *www.mapbox.com*

## HERE and AWS to provide indoor/outdoor positioning services

HERE Technologies and Amazon Web Services (AWS) to deliver developers with improved performance for indoor/outdoor positioning capabilities to track and manage any number of internet-of-things (IoT) devices.

Recently at re:Invent 2022, AWS introduced the new AWS IoT Core Device Location feature to make it possible to track and manage IoT devices without relying on GNSS/ GPS hardware. HERE Positioning is being supported by AWS IoT Core Device Location for more accurate, indoor/outdoor position estimates globally. *www.here.com*

## Hayden AI launches new tool to calculate emissions savings

Hayden AI, an artificial intelligence and machine learning technologies company, has built an emissions calculator for transit agencies to measure the environmental impact of automated bus lane enforcement (ABLE) technology.

The new online tool highlights how automated enforcement keeps bus lanes clear of illegally parked vehicles, reducing emissions by increasing bus speeds and keeping buses on schedule. *www.hayden.ai*

## Pony.ai receives permit to deploy fully autonomous vehicle

Pony.ai has been issued a fully driverless autonomous vehicle road test permit by the Beijing Intelligent Connected Vehicle Policy Pilot Zone. This applies to ten driverless robotaxis for testing in specific locations. They can be tested in challenging urban traffic scenarios across a 20 square kilometer area in the pilot zone in Yizhuang, Beijing.

## Continental and Ambarella partnership

Continental and Ambarella, Inc., an edge AI semiconductor company, announced a strategic partnership. Both will jointly develop scalable, end-to-end hardware and software solutions based on artificial intelligence (AI), for assisted and automated driving (AD), on the way to autonomous mobility. The strategic collaboration builds on Continental's announcement in November to integrate Ambarella's energy-efficient System-on-Chip (SoC) family into its Advanced Driver Assistance Systems (ADAS). *www.continental.com*

## Iridium and Qualcomm collaboration

Iridium Communications Inc. has entered into an agreement with Qualcomm Technologies, Inc. to enable satellite messaging and emergency services in smartphones powered by Snapdragon® Mobile Platforms. Qualcomm Technologies' new Snapdragon ® Satellite solution is supported by the fully operational Iridium® satellite constellation. Emergency messaging using Snapdragon Satellite is expected to debut starting in the second half of 2023 in premium Android smartphones launched in select regions. *www.iridium.com*

## Honeywell, U.S. Army to deliver next-gen navigation solution

Honeywell announced it is ready to deliver its EAGLE-M Embedded GPS/Inertial Navigation System (EGI) with M-code capabilities this year, after the United States Army completed the first test flight.

The Army tested the EGI units with enabled M-code on the MQ-1C Gray Eagle unmanned aerial system and validated it to be deployed on military aircraft. This year, the Army will begin migrating its fleet to the Honeywell EAGLE-M EGI with M-code, as this navigation solution enhances the resiliency of GPS navigation to enemy actions. *www.honeywell.com*

## Movella and Fixposition partnership

Movella, provider of sensors, software, and analytics, has formed a partnership with precise positioning sensor manufacturer Fixposition to accelerate the development and commercialization of GNSS inertial navigation sensors that implement visual inertial odometry. Movella has introduced the first product to emerge from the partnership between the two companies: the Xsens Vision Navigator. *www.fixposition.com*

## Synaptics launches SYN4778

Synaptics released the SYN4778, a small, low power, GNSS integrated circuit for IoT devices. It is designed to extend battery life, reduce product size, and enhance performance of advanced location-based services for IoT devices, including wearables, mobile accessories, asset tagging and tracking systems, UAVS and transportation navigation. *www.synaptics.com*

## Rod-less GNSS receiver for surveying

ComNav Technology launched its Venus Laser RTK, a GNSS receiver with a millimeter-level laser that enables rod-less surveying. It comes with an inertial measurement unit (IMU), which can be used in its traditional mode, with a range pole or in laser mode, which does not require a range pole, enabling GNSS surveying beyond typical limitations. www.comnavtech.com

## Quectel launch 03 combo antennas

Quectel Wireless Solutions has launched three new combo antennas - YEMN016AA, YEMN017AA, YEMA013AA to help IoT solution designers and developers optimize device performance. *www.quectel.com*

## Hexagon advances the integration of its positioning solutions

Hexagon AB has announced a key partnership with ZF Group that will advance the integration of its software positioning engine and GNSS correction services into mass-production ADAS (advanced driver assistance system) and autonomous driving systems. Hexagon's safety-certifiable software positioning engine and correction services will be integrated into ZF's ProConnect connectivity platform, which enables full vehicle communication (vehicle-to-vehicle, vehicle-to-satellite and vehicle-to-network). *hexagon.com*

## Ban on U-blox GNSS modules in war

U-blox banned the use of its GNSS modules in military UAVs in the war between Russia and Ukraine. The company had become aware that its GNSS modules were being used in certain Russian reconnaissance UAVs and stated that this use was against company policy. It obtained media reports that Russia had stocked up on components in anticipation of war, then integrated products from the company in UAVs it manufactured after attacking Ukraine. *www.u-blox.com*

## Leica Geosystems launches new locator technology

Leica Geosystems announced its latest solution for utility and excavation professionals. The new Leica DD175 utility locator and Leica DA175 signal transmitter complement the existing Leica DD100 series and help operators easily detect underground utilities to ensure site workers' safety.

The DD175 is a smart utility locator that connects to the Leica DX Field Shield/ DX Manager Shield software to enable users to connect the site to the office in real-time with fast and stable data transfer. *https://leica-geosystems.com*

## HawkEye 360 to monitor global GPS interference

HawkEye 360 Inc., announced that Slingshot Aerospace awarded the RF data provider a contract to provide data for Slingshot's space-based monitoring and detection of RF threats and to support Slingshot's proliferated Low Earth Orbit (pLEO) Data Exploitation and Enhanced Processing (DEEP) program for the U.S. Space Force's Space Systems Command (SSC).

Slingshot Aerospace's RF analytics solutions help the U.S. Space Force exploit existing commercial satellite telemetry data to readily identify sources of electronic interference, characterize any potential emerging threats, and provide actionable Positioning, Navigation and Timing Situational Awareness. *he360.com*

## ASIL positioning engine

Point One's FusionEngine software, which is rated for automotive safety integrity level (ASIL), is now compatible with STMicroelectronics' Teseo ASIL Precise Positioning GNSS chipset (TeseoAPP). This assures functional safety as ASIL-B, a requirement for Level 3+ advanced driver assistance systems (ADAS).

FusionEngine can be integrated into several different host processors that are used for enabling high level ADAS and autonomous driving systems. The combination of TeseoAPP's receiver and the STA5365S external RF front-end provides dual-band measurement data for all visible GNSS satellites to the main host processor into which FusionEngine is integrated. *pointonenav.com*

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### February 2023

**GeoWeek 2023**
13-15, February
Denver, CO, USA
**www.geo-week.com**

### March 2023

**Munich Satellite Navigation Summit 2023**
13-15 March
Munich, Germany
**www.munich-satellite-navigation-summit.org**

**RIN Baska GNSS Conference (& Smart Maritime Workshop)**
14-19 May 2023
Baska, Croatia
**https://rin.org.uk**

**GEO CONNECT ASIA**
15-16 March, 2023
Singapore
**www.geoconnectasia.com**

**Drones Asia**
15-16 March 2023
Singapore
**https://dronesasia.com**

**Digital Twins 2023 (Virtual)**
23 March 2023
**www.digitaltwins2023.com**

**DGI 2023**
27 Feb-01 March
London, UK
**https://dgi.wbresearch.com**

### April 2023

**GISTAM 2023**
25-27 April
Prague, Czech Republic
**https://gistam.scitevents.org/Home.aspx**

### May 2023

**International Conference on Geomatics Education**
10-12 May 2023
Hong Kong
**www.polyu.edu.hk/lsgi/icge22/en**

**Geo Business 2023**
17-18 May
London, UK
**www.geobusinessshow.com**

**9th International Conference on Geomatics and Geospatial Technology**
22-25 May 2023
Kuala Lumpur, Malaysia.
**http://ggt2023.uitm.edu.my**

**FIG Working Week 2023**
28 May - 01 June
Orlando, Florida, USA
**www.fig.net/fig2023**

### June 2023

**TransNav 2023**
21-23 June
Gdynia, Poland
**https://transnav2023.umg.edu.pl**

### September 2023

**Commercial UAV Expo**
5-7, September 2023
Las Vegas, USA
**www.expouav.com**

## Deepspatial announces $1.5m contract in the agricultural sector

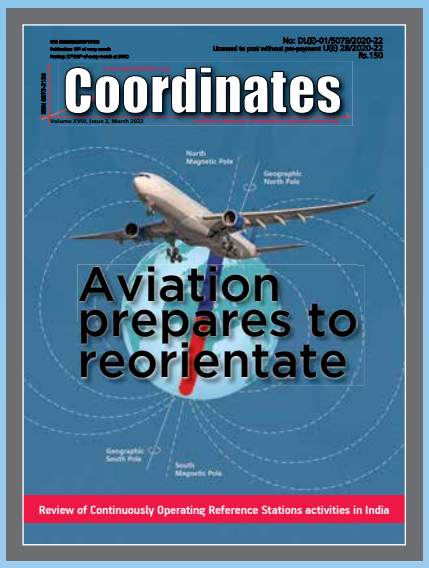
Deepspatial has announced that it had won a 3-year contract valued at CAD $1.5M. Using the Company's Geospatial AI platform and solutions, Government bodies will be able to efficiently conduct and validate crop-cutting experiments, on-field surveys, and other key processes for farmland activities across the state of Uttarakhand, India. The Agricultural project is an initiative of the Directorate of Agriculture, Government of Uttarakhand and is one of the first states in India to roll out a data collection project of this magnitude using new technologies. Overall, the project focuses on providing key data insights for better decision-making and an advanced support system for farmers and government decision-makers. *deepspatial.ai*

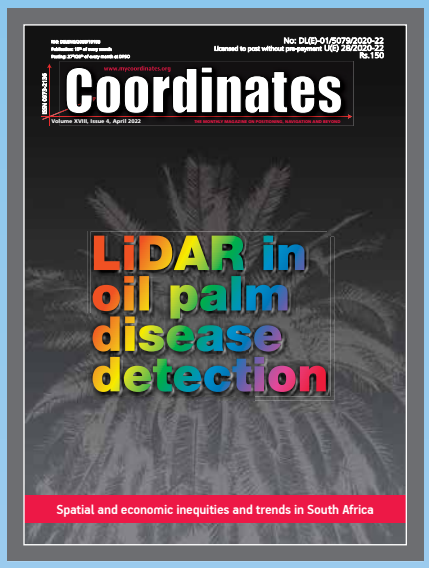
## Rallis India signs MoU with Garuda Aerospace

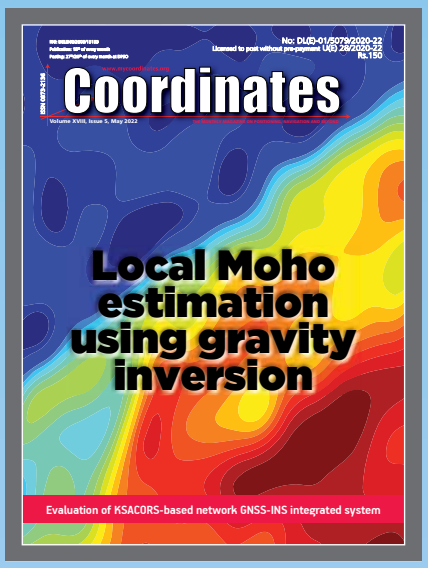
Garuda Aerospace, India recently signed a MoU with Rallis India Limited, a subsidiary of Tata Chemicals in the agriculture industry. Rallis will supply pesticides and crop nutrients to Garuda Aerospace for a pilot demonstration and spraying of pesticides on fields through drones mainly in the state of Maharashtra and Andhra Pradesh. The drone pilots will conduct demonstrations on approximately 1000 acres of land. This drone-based solution will also enable businesses to achieve their sustainability goals by helping drive the efficient use of resources. *www.garudaaerospace.com*

## Russia to launch three Glonass Satellites in 2023

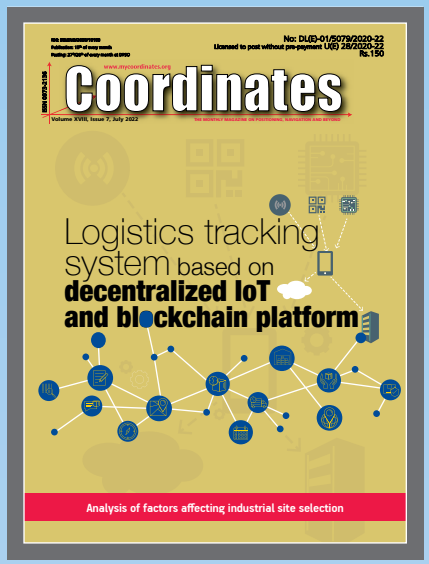
Russia plans to add two Glonass-K satellites and one Glonass-K2 to the constellation this year, Glavkosmos, a subsidiary of the Russian space agency Roscosmos, informed. It also plans to launch one lightweight Angara-1.2 rocket and one heavy-lift Angara-A5 rocket from the Plesetsk cosmodrome in 2023. *https://en.mehrnews.com*

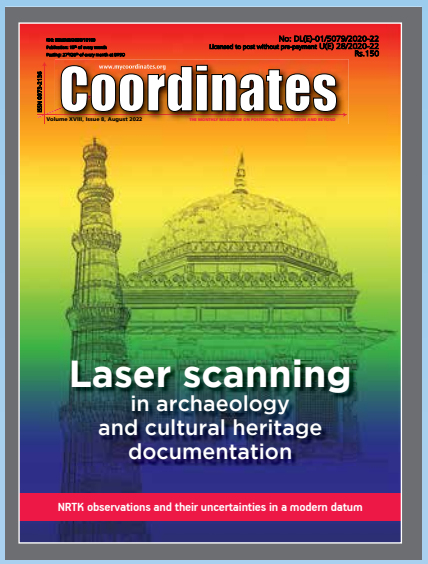


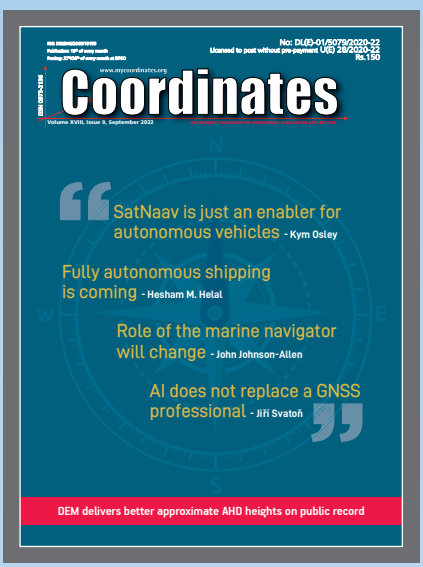



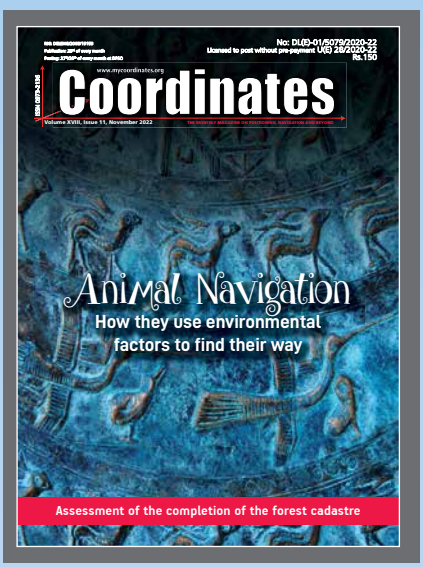






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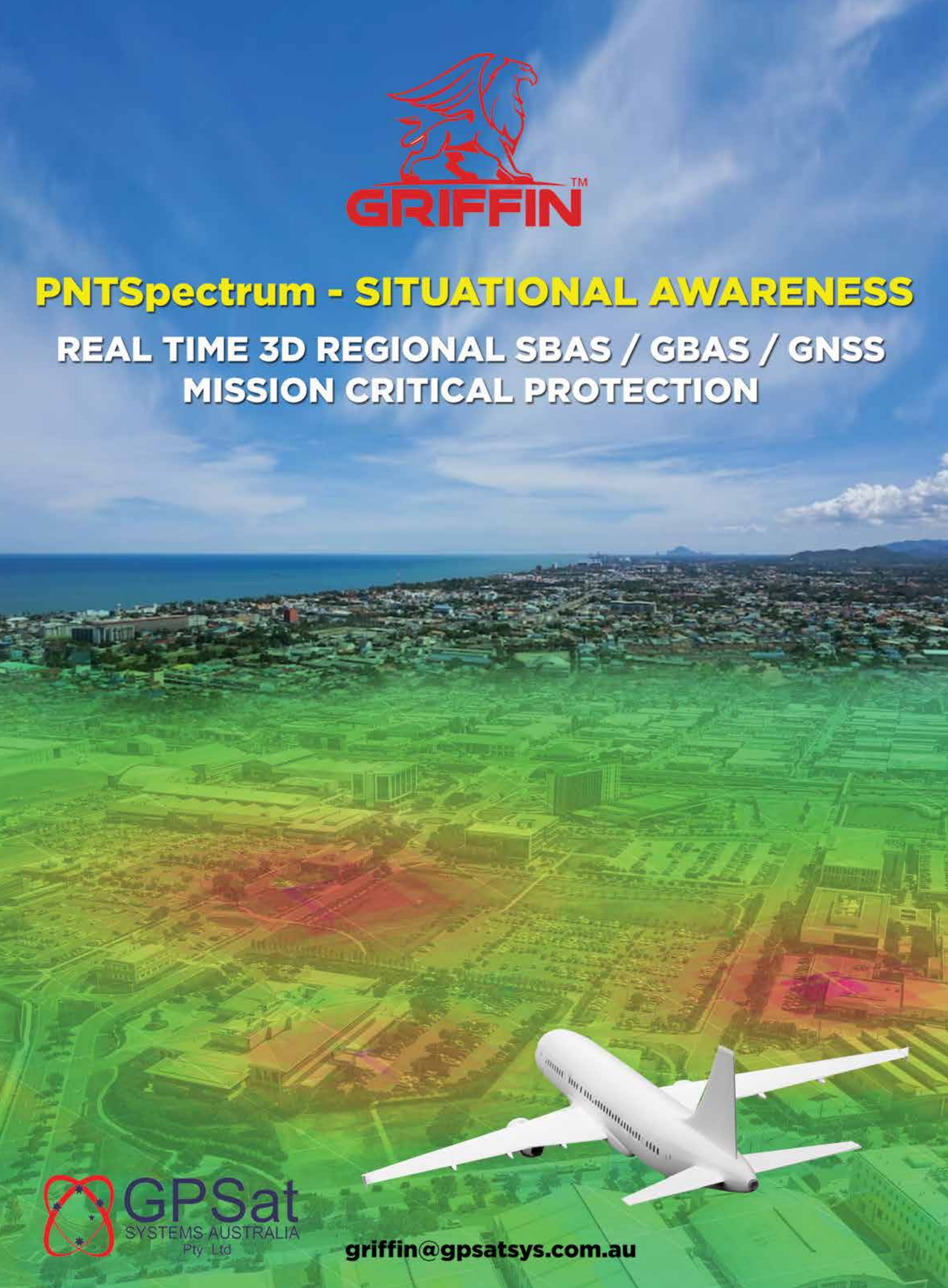
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