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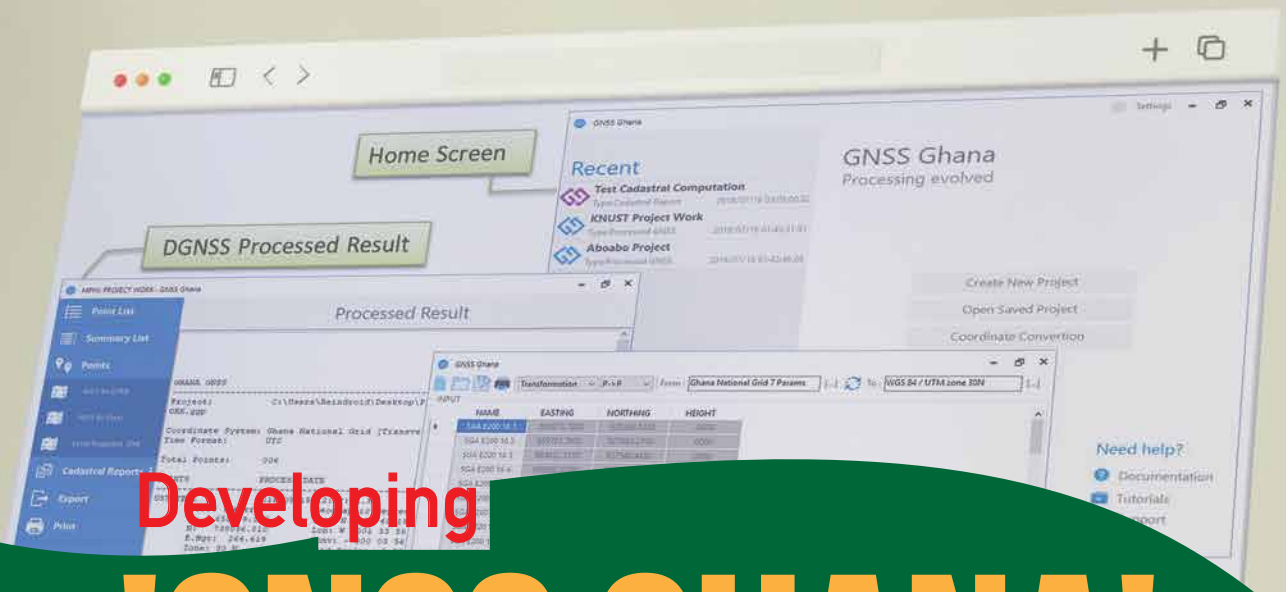
# Coordinates

Volume XIX, Issue 5, May 2023

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

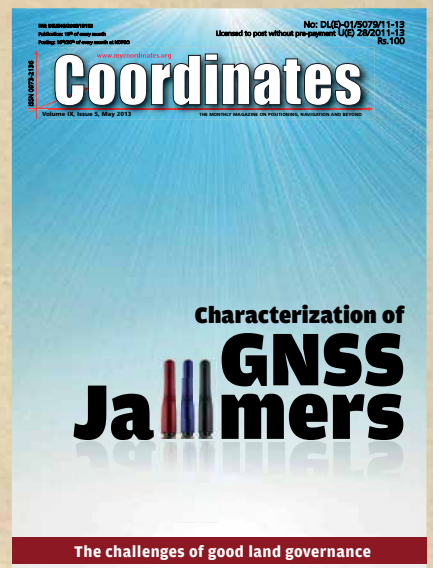



## Developing 'GNSS GHANA' SOFTWARE

**Energy transition in Nigeria: A technological and philosophical perspective**

# In Coordinates

## 10 years before...




mycoordinates.org/vol-9-issue-5-May-2013

## Characterization of GNSS Jammers

**Daniele Borio, Joaquim Fortuny- Guasch and Cillian O'Driscoll**
Joint Research Centre, Institute for the Protection and Security of the Citizen, European Commission

In this paper, signals emitted by several GNSS jammers have been analyzed and spectral and spatial characterizations of jamming signals have been provided. From the signal characterization it emerges that jamming signals can sweep large frequency ranges in short time periods. In particular, it was found that the smallest frequency range covered by a jammer is about 10.5 MHz with a sweep period of about 9 s. The transmitted power varies signi¿cantly depending on the jammer type. Combining results from the literature and experimental ¿ndings, it was shown that the transmitted power can vary from about -10 to more than 30 dBm.

## The challenges of good land governance

**Dr Keith Clifford Bell**
Senior Land Policy Specialist for the East Asia and Pacific Region, World Bank, Washington, D.C., USA

**Shivakumar Srinivas**
Consultant for the World Bank and the United Nations Food and Agricultural Organization (FAO) Jakarta, Indonesia

While the Indonesian government and political leaders struggle to reform land laws, local communities and local governments seem to have taken the lead in forging new relationships and patterns in land management creating new challenges for land governance.

## Elements, issues and challenges in implementation of NSDI

**Hayder Abd Al- Razzaq Abd**
Department of Civil, Faculty of Engineering, UPM University, Serdang, Malaysia.
Department of Surveying, Faculty of Engineering, University of Baghdad, Iraq

**Abdul Rashid Bin Mohamed Shariff**
Geospatial Information Science Research Centre (GISRC), University Putra Malaysia, Malaysia

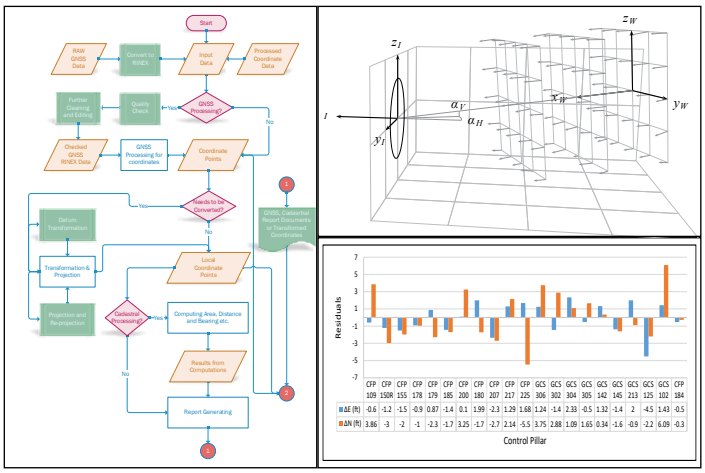
SDI can create a successful environmentfor both stakeholders and decision makers to achieve goals at different levels (administrative or political) when they both cooperate with their work, share their achievements, and use technology that will improve their work without wasting time and cost.

## Geospatial Data Infrastructure of the KSA Border Guard

**Dr Ulrich Lenk**
Gassidian - an EADS Company, Germany

**Dr Ahmed S Alzahrani**
Ministry of Interior, Kingdom of Saudi Arabia

With the introduction of a comprehensive Geospatial & Environmental Reference infrastructure the KSA Border Guard geoinformation working group will be well prepared for its future challenge to support the geographically enabled applications in the future KSA Border Security system with up-to-date data in a consistent and reliable way. The geospatial architecture and data to be supplied inherently support a high level of interoperability as to an outmost extent open standards were adopted for the design of the architecture and the speci¿cation of data.




# In this issue

Coordinates Volume 19, Issue 5, May 2023

## Articles



## Columns



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Acheampong Akwasi Afrifa, Gameti Charles, Jesse Huff, John Ayer and Mike Iroh; SBG System, and many others.

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**This issue of Coordinates is of 36 pages, including cover.**

# The 'trust'

The concerns regarding Generative AI keeps widening -

From cheating on home assignments in education sector

To further proliferation of fake news, copyright issues, employment concerns and so on.

Open AI CEO Sam Altman in his representation before the US Congress

Reportedly emphasized on the importance of government intervention

In reducing the implications of increasingly powerful AI.

At the recently held summit G7 summit in Japan,

The world leaders have noted the urgency of legislative and regulatory responses,

To balance the advantages and the hazards of the technology.

It is desirable that the AI systems should evolve as more accurate and reliable,

However, the risks associated are too grave to ignore.

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

# "Advances in technology have allowed the survey community to push the limits of GNSS"

Says Jesse Huff - Vice President of Sales and Marketing, JAVAD GNSS in an interview with Coordinates

Jesse Huff

**'Founded in 2007, JAVAD GNSS today continues with its original vision of innovation and excellence' – Could you please elaborate on this.**

The designs innovations of JAVAD GNSS have paved the way for the GNSS industry for years. JAVAD GNSS Patented and Patent-pending technology have helped shape what the market demands today. Innovation is at the core of JAVAD's mission to make our customers' lives easier and more productive through products that deliver these needs. Excellence through quality management through our own manufacturing facility in San Jose California, USA delivers end to end quality control through every aspect of product development and manufacturing.

**Dr Javad Ashjaee was one of the pioneers of the GNSS industry. How is his legacy being carried forward at Javad GNSS? How have the company transitioned and repositioned itself?**

JAVAD GNSS is building off the years of remarkable technology and product innovation Javad Ashjaee pioneered in the survey industry. With 200 patents the company is deploying these innovations focused on market driven products such as the recently launched Complete Survey Solution. This features the TRIUMPH-1M Plus and the TRIUMPH-3NR receivers and the Victor-2 and Victor-4 field computers continue the innovation founded by Dr. Ashjaee.

As part of its continued growth plan the company is expanding its global market presence indicated by the recent opening of its EU office in Vilnius, Lithuania. This will provide increased product and customer support throughout Europe and the EU. In addition, a new Cincinatti U.S. based engineering office opened in May to further strengthen its engineering capabilities on a global scale.

## Land Surveying technology has been one of the forte at Javad GNSS. How do you see the growth of the technology over the years?

Advances in technology have allowed the survey community to push the limits of GNSS to new heights. JAVAD has remained at the forefront of this technology push with patented technology such as multi-engine RTK. This has provided the survey community with tools to operate in more challenging environments such as urban canyons, tree coverage and other high multipath environments. This can be further evidenced through our RTPK capabilities, which are patent pending and stand-out in the Survey technology.

## How do you see the growth of surveying as a profession. What are the key challenges for a present-day surveyor?

Overall surveyors have evolved from basic measurements to the use of 3D visualizations, the use of Big Data, and the use of unmanned systems to capture datasets in hours that could have taken weeks previously. We see a shortage of qualified surveyors in some markets due to the lack of public knowledge as to where their data originates, which can impact the growth of the industry. Continual learning and keeping up with technology are two important challenges to overcome to increase productivity and business success. Mobile 3D mapping, large 3D terrain models and photo-based data along with the ability to understand and proactively respond to data are other areas that can enable the growth of the profession. Bringing a strategic approach to building a business, including customer engagement, retention and growth while investing in product technology increases productivity and innovation. The education of the end users of the survey deliverables presents a challenge for the profession as each customer has unique requirements.

## Tell us something about the OEM business at Javad GNSS. What are key challenges it faces as of today?

For over 20 years JAVAD GNSS Aerospace has provided aerospace and defense companies around the world with GNSS OEM receivers delivering accurate positioning and tracking performance in challenging environments. Our solutions are in the majority of commercial launch vehicles, and we have built long-term growing relationships with existing and new customers in the aerospace market.

One of the key challenges facing aerospace customers is the need to meet their requirements for Size, Weight, Power, and Cost (SWaP-C) for demanding applications. We can meet these requirements due to our OEM GNSS solution's proven history of innovation in OEM boards which are products that combine high integrity, high-performance, delivered in small, lightweight, resilient form factors.

We see a shortage of qualified surveyors in some markets due to the lack of public knowledge as to where their data originates, which can impact the growth of the industry

Extreme operating conditions is another challenge that our HDA (High Dynamic Applications) OEM boards address utilizing specialized components, manufacturing processes and a conformal coating that ensures performance and reliability under the most adverse conditions.

## How according to you has been the evolution of GNSS as a technology. How do you see its vulnerability and possible mitigation?

Not all GNSS technology is created equally. Positioning has become part of our daily lives. GNSS has evolved to become expected in modern technology. It can be seen as a commodity, which undervalues the importance of professional tools. Smartphones, in-vehicle navigation and location based online searching are built on a long-established geospatial framework that has been kept and maintained by geospatial professionals for decades. The need to maintain and communicate the value of that framework to mitigate vulnerabilities increases as the general population demands better positioning from their devices.

## Usage of commercial UAV technology has been rising at an exponential rate for various surveying and allied applications. What is your view on its massive growth. Does Javad have any plan to get into this segment again?

JAVAD GNSS continues to provide the core positioning technology to the UAV market. Providing this industry with professional level products for developers to leverage remains a core value to JAVAD. Any building or product development begins with a solid framework. GNSS and positioning are as much a critical component of the UAV industry as innovations in composite materials and sensing technologies that rely on a solid base for growth.

# Development of GNSS software for Ghana Survey and Mapping Division

"GNSS Ghana" Software (GGS), a GNSS standalone Windows-based application with a modern user-friendly interface was developed for geodetic applications

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## Abstract

Processing of Global Navigational Satellite System (GNSS) data forms the basis for the usage of differential systems for obtaining spatial data. All open sources or commercial software packages developed for data processing give specific details to suit the intended purpose of the software. To obtain a uniform format for submitted survey data, Survey and Mapping Division (SMD) in various jurisdictions have specified formats for data submission for all kinds of surveys. In this regard, "GNSS Ghana" Software (GGS), a GNSS standalone Windows-based application with a modern user-friendly interface was developed for geodetic applications such as, projection and datum transformation worldwide, GNSS data post-processing of Receiver Independent Exchange Format (RINEX) files, and generating reports to meet Ghana SMD reporting standards including cadastral computations and reports for submission. To assess the developed software, GNSS data from two International GNSS Service (IGS) stations (BJCO and YKRO) were processed using GGS and three other commercial software such as GNSS Solution Software (GSS), Spectrum Survey Software (SSS), and Leica Geo Office (LGO), and the positional results compared against the existing coordinate. The results revealed that the GGS outperformed the remaining three commercial software packages with a sub-meter level of accuracy. Further assessment was conducted on datum transformation using the coordinates of 21 existing geodetic control points in Ghana. Utilizing the 7-transformation parameters of Ghana, the results gave uncertainties of [0.10ft. ± 0.99ft.] in the eastings and [0.02ft. ± 1.61ft.] in the northings with a 99% confidence level.

## Introduction

Global Navigational Satellite System (GNSS) is a system widely used by the military, civilian, industrial and scientific communities due to its capabilities and relative advantages, such as 24-hour observation time and all-weather global positioning. Improving the accuracy of long-distance GNSS positioning is still an important topic in current research and development (Bender et al., 2011; Rao et al., 2013; Tsushima et al., 2014; Verhagen et al., 2010; Wang et al., 2016; Yozevitch et al., 2014; Zhang et al., 2013). The important and ever-growing demand for GNSS-related techniques in various areas has spurred on a wealth of research. GNSS receivers designed for survey and mapping applications come in different satellite support systems, components and have autonomous operations with each having its software and online services for processing data. Several different data processing techniques have been developed over the years, and these techniques must meet high precision and accuracy standards (Salazar, 2010). Most GNSS receivers have propriety software for processing data included in the package. Processing of the data is based on the algorithms used in these individual

applications, each having its pros and cons. Some also include predefined datums, and coordinate systems, which tend to work best in some regions.

Processing of data from receivers forms the basis of the use of differential systems as a method of deriving the collected spatial data and most processing systems give specific details in the processing reports generated. However, the authorities in charge of Survey and Mapping Divisions (SMD) for most countries have their specifications and report formats to be submitted upon completion of survey projects. These are implemented to avoid confusion and conflicts in data reports from different surveyors. Several online processing services provide GNSS processing results to the user free of charge and with unlimited access. Output solutions/reports are based on differential methods via reference stations or precise point positioning, using precise orbit and clock data (El-Mowafy, 2011; Furones et al., 2012; Ghoddousi-Fard & Dare, 2006; Landau et al., 2009; Leandro et al., 2011; Teunissen et al., 2010). Usually, the outputs are to their specific standards and therefore making GNSS data processing and management.

Unlike most other developed countries, Ghana has no GNSS processing system. Therefore, many surveyors use the default software that comes along with their manufacturers GNSS receivers or any other software they get hands-on to process the data. As a result, when projects are submitted to the SMD, there are discrepancies in the processed data report format from different surveyors. The differences in processing algorithms used in writing programs may also result in different coordinates or outputs (reports) and therefore cause non-conformity in the data gathered at SMD. It is necessary to develop a central GNSS processing software capable of processing most data from all receivers in Ghana using Receiver Independent Exchange Format -RINEX (Gurtner & Estey, 2009) files as input data for consistent homogeneous accuracy standards and easy data integration and achieving.

Little, if any research has been done on the concept of developing computer software for processing GNSS data for local/national purposes in Ghana. Osah, 2013 developed "GeoSuite" a geodetic application for GNSS data post-processing, Datum transformation, and Direct & Inverse geodetic computation for Ghana but does not generate report documents for SMD report use or submission. Open-source GNSS applications like the goGPS (Herrera et al., 2016), RTKLib (Takasu, 2013), and gLab (Sanz et al., 2012) have been researched and tested to be efficient and produce accurate results after processing data as compared to other commercial software (Videkull, 2015), but most of the information produced is not needed for some survey works.

This study was to determine and minimize some of these issues that arise in SMD (due to differences in processing software) by developing a computer program that uses some of the open-source algorithms to process data and produce relevant reports based on the user's preference by work by modifying the existing algorithm to suit the needs and ensure that the reports conform to the standards of SMD and for easy querying. It is to help simplify processing and reports for general purposes and accept a particular format irrespective of the instrument used by the surveyor.

## Software platform and installation

The software suite was developed using visual C-Sharp (C#) programming language, compiled as an executable program, for use in most popular operating systems including Windows, macOS, and Linux. As a result, it was necessary to develop the software for post-processing and that used external plugins from other developers to stimulate the development process. Some of the downloaded plugins included in the project are:

- SQLite (Kennedy et al., 2017) management of data and some settings were stored in the system, which was generously licensed in the public domain and does not require extensive configurations.
- MetroSuite 2.0 (Gather, 2018) and MetroFramework (Denric, 2016) enhance the user- friendliness and aesthetics of the program.
- MapWinGIS and DotSpatial for the map part of the program from GIS opensource projects (Ames et al., 2018).
- A modified version of ProjNet4GeoAPI (NetTopologySuite, 2019) library to support for 10-parameter transformation and other Spatial conversions.

The algorithms used in the development of the software are based on existing open-source codes. The major part implemented

Unlike most other developed countries, Ghana has no GNSS processing system. Therefore, many surveyors use the default software that comes along with their manufacturers GNSS receivers or any other software they get hands-on to process the data. As a result, when projects are submitted to the SMD, there are discrepancies in the processed data report format from different surveyor

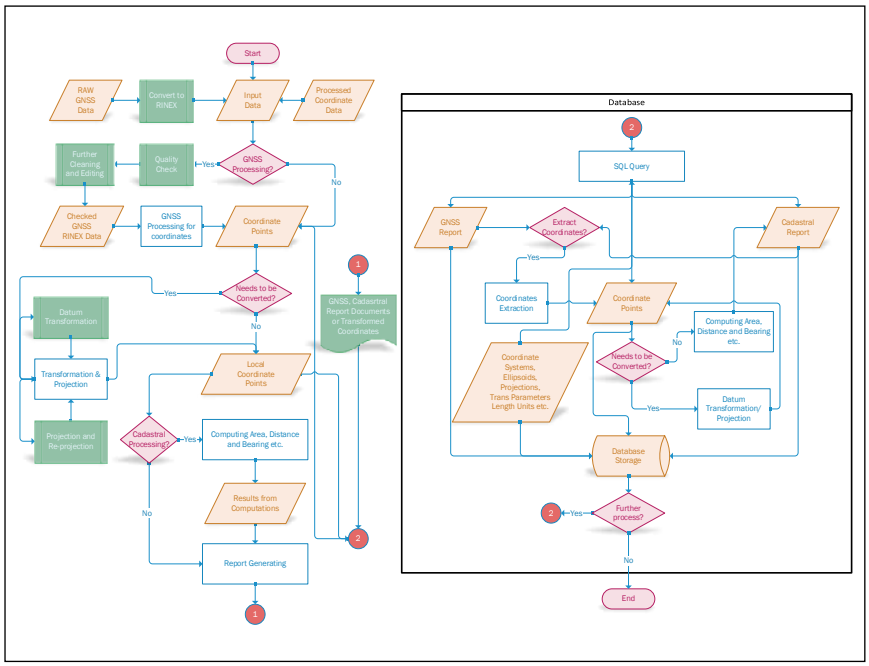


**Figure 1: General flow of software design.**

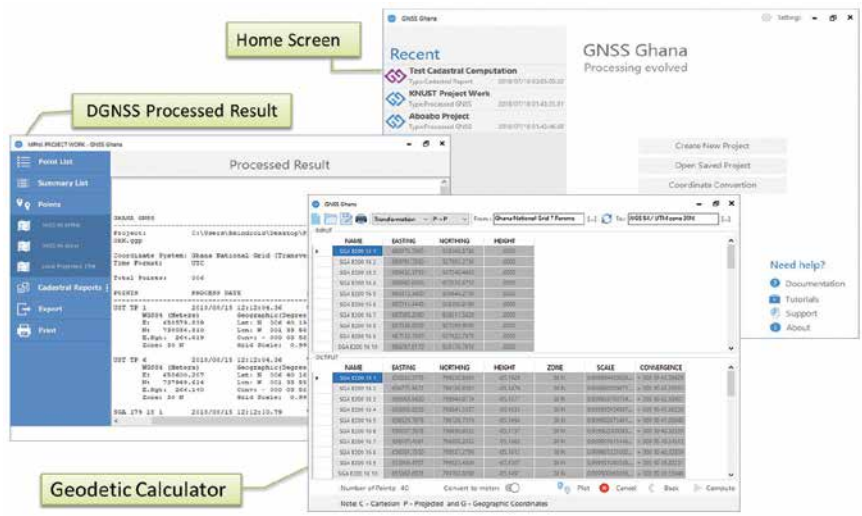


**Figure 2: GNSS Ghana home screen and result pages.**

**Table 1: List of documents required by SMD Ghana**

| *No.* | *GNSS Post-Processing Reports* | *Cadastral Reports* |
|---|---|---|
| *1* | Point Lists | Beacon Index |
| *2* | Summary Lists | Distance and Bearing |
| *3* | Extracted Points (Geographic and pro-jected coordinates) | Plan Data |
| *4* | GNSS Observation Data | Area Computation |
| *5* | | Optional report to be used on the map called "Map Data" |
| *6* | | History of survey |
| *7* | | Diagram of survey |
| *8* | | Cadastral Map |

for post-processing of GNSS RINEX data is from RTKLib class libraries with some features modified to suit the standards for processing data and document presentation for cadastral survey in Ghana. The software currently supports all the navigation systems supported by RTKLib version 2.4.3 class libraries (i.e. GPS, GLONASS, BeiDou, GALILEO, QZSS, SBAS). The GNSS Ghana Software has only the executable file for installation and does not require any pre- installed applications.

## Software introduction and features

The software developed at the end of this study comes packed with three main geodetic processing modes (i.e., DGNSS using baseline computation vectors, Cadastral computation, and Projection/ Datum Transformation). GNSS Ghana Software (GGS) currently two input formats, RINEX as GNSS post-processing data format and a delimited data file for other inputs. The entire ecosystem has been designed to help make processing using GGS very simple, and Figure 1 shows the flow chart in the software design.

Currently, GGS can produce all of the necessary computational documents needed to submit a cadastral report to SMD Ghana, and geodetic calculations (such as exporting cartesian, geographic, and projected coordinates to file or for printing). A screenshot of the Graphic User Interface (GUI) of GGS which allows the processing of GNSS baseline data and performing several calculations is shown in Figure 2.

GGS's reports are export into formats: PDF and spreadsheet. All GNSS processed reports are exported in PDF format with optional spreadsheets of all site IDs and positions in geographic, UTM, and local coordinate systems. On the other hand, cadastral reports are generated in the standards of SMD Ghana are all in PDF only for uniformity and easy query.

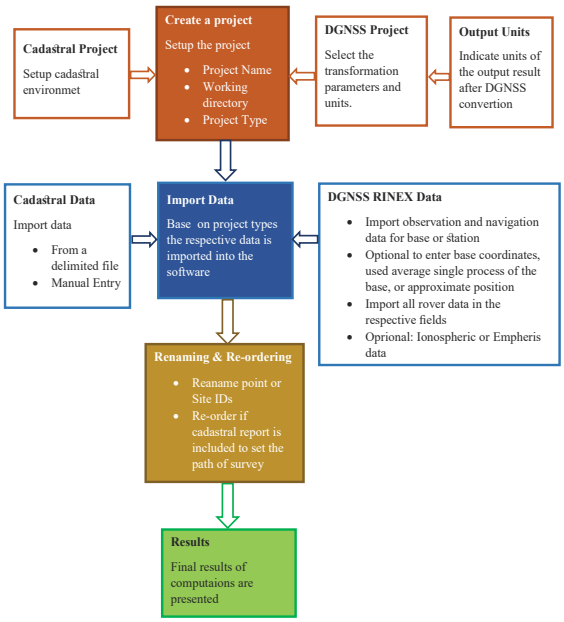


**Figure 3: General Steps in processing projects in GGS.**

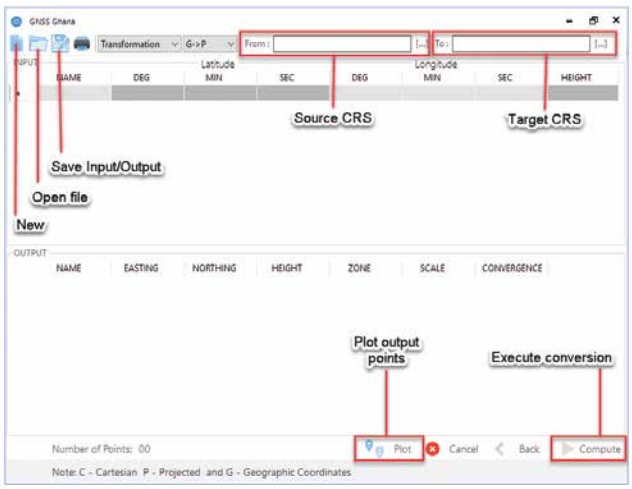


**Figure 4: GGS CRS Conversion Interface**

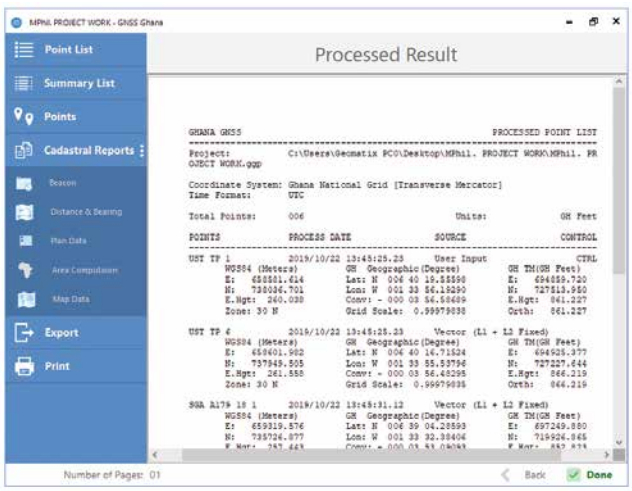


**Figure 5: GNSS Processing – Processed Solution interface.**

The concept of the kind of data reports that the Ghana SMD requires for both engineering and cadastral surveys, there are certain documents about the survey that must be included. These cadastral reports for the SMD are tabulated in Table 1. Points numbered from 1-5 are all generated from one process within the GGS but the other documents are not supported yet in the developed software.

## Data processing using GGS

The program as indicated in previous sections has a simple and straightforward GUI with short selective options to choose from and customizations based on the processing type selected. All other configurations have been done in the program and so it does not require any other files and settings to run aside from the few options given. There are detailed, but yet simple documentation and tutorials included in GGS software. Figure 3 below shows the general flow of data and results in GGS. The processing modes are three: GNSS data processing with or without cadastral reports, a standalone cadastral reports generation from points as a project, and the geodetic calculator.

The entire procedures take only four-paged steps (Creating Project, Data Importing, Renaming, and Processed results) to achieve a result or solution for both DGNSS and Cadastral report processing. All outputs can be printed directly from the GGS software.

Figure 4 shows the interface for an additional part of the developed application, the ability to perform a coordinate system conversion. Forward and Inverse projection and datum transformation processes were created in various classes to allow for easy reintegration into multiple or batch conversions and to give support to the world coordinate systems (i.e., Coordinate Reference Systems – CRS). A collection of most of the known coordinate systems in the world has been prepacked into the program. Therefore, based on the conversion type, either with simple projection with only one CRS or datum transformation with projections (which require both the source and target CRS), the user will have to select the CRS from the world CRS provided or may create a new one to perform conversions to and from either coordinate systems (i.e. Geographic, Cartesian or the Projected coordinate system).

## Results and discussion

### Generating Reports

A typical example of the output page from GNSS Data processed with cadastral computation reports is shown in Figure 5. Here, the example page looks like this because the cadastral report was checked when creating the project, and therefore an option to indicate the starting control to site points and that of the closing

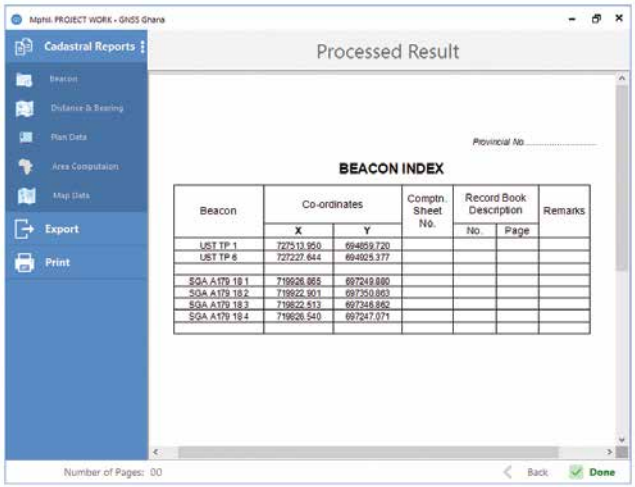


**Figure 6: Cadastral – Processed Solution interface**

**BEARING AND DISTANCE FROM COORDINATES**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| From Point | SGA A179 18 1 | (A) | | To Point | SGA A179 18 2 | (B) | |
| Xa = | 697249.880 | | | Ya = | 719926.865 | | |
| Xb = | 697350.863 | | | Yb = | 719922.901 | | |
| | -3.96 | | | | 100.98 | | |
| **Actual Bearing =** | **092** | **14** | **45** | **DISTANCE =** | **101.06** | | |
| From Point | SGA A179 18 2 | (A) | | To Point | SGA A179 18 3 | (B) | |
| Xa = | 697350.863 | | | Ya = | 719922.901 | | |
| Xb = | 697346.862 | | | Yb = | 719822.513 | | |
| | -100.39 | | | | -4.00 | | |
| **Actual Bearing =** | **182** | **16** | **54** | **DISTANCE =** | **100.47** | | |
| From Point | SGA A179 18 3 | (A) | | To Point | SGA A179 18 4 | (B) | |
| Xa = | 697346.862 | | | Ya = | 719822.513 | | |
| Xb = | 697247.071 | | | Yb = | 719826.540 | | |
| | 4.03 | | | | -99.79 | | |
| **Actual Bearing =** | **272** | **18** | **45** | **DISTANCE =** | **99.87** | | |
| From Point | SGA A179 18 4 | (A) | | To Point | SGA A179 18 1 | (B) | |
| Xa = | 697247.071 | | | Ya = | 719826.540 | | |
| Xb = | 697249.880 | | | Yb = | 719926.865 | | |
| | 100.32 | | | | 2.81 | | |
| **Actual Bearing =** | **001** | **36** | **16** | **DISTANCE =** | **100.36** | | |

**CONNECTING PILLARS**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| From Point | UST TP 1 | (A) | | To Point | SGA A179 18 1 | (B) | |
| Xa = | 694859.720 | | | Ya = | 727513.950 | | |
| Xb = | 697249.880 | | | Yb = | 719926.865 | | |
| | -7587.08 | | | | 2390.16 | | |
| **Actual Bearing =** | **162** | **30** | **50** | **DISTANCE =** | **7954.67** | | |
| From Point | SGA A179 18 4 | (A) | | To Point | UST TP 6 | (B) | |
| Xa = | 697247.071 | | | Ya = | 719826.540 | | |

**Figure 7: Sample of GGS Cadastral Bearing & Distance computation report**

**AREA COMPUTATION**

| STATION | X | Y | Y(I)*(X(I+1)-X(I)) | X(I)*(Y(I+1)-Y(I)) |
|---|---|---|---|---|
| SGA A179 18 1 | 719926.865 | 697249.880 | -2763898.52 | 72700374.61 |
| SGA A179 18 2 | 719922.901 | 697350.863 | -70005658.43 | -2880411.53 |
| SGA A179 18 3 | 719822.513 | 697346.862 | 2808215.81 | -71831808.39 |
| SGA A179 18 4 | 719826.540 | 697247.071 | 69951312.40 | 2021992.75 |
| | | | | |
| | | | -10028.75 | 10147.44 |

| | | | |
|---|---|---|---|
| DOUBLE AREA | = | **20176.19** | sq.ft |
| AREA | = | **10088.09** | sq.ft |
| AREA | = | **0.23** | acres |
| | | **0.09** | hect. |

**Figure 8: Sample of GGS Area Computation report**

control was set. It can also be changed by using the three dots on the "Cadastral Report" button to reorder the connections of the pillars even afterward. The whole sections under the cadastral report will not be there if not included during project settings.

The first three-parts (i.e., "Point List", "Summary List", and "Points") will not show if the project is for only cadastral reports from existing points in the local coordinates. Therefore, only the "Cadastral Report" button with the other two constant buttons (i.e., "Export" and "Print" buttons) are available to the user as shown in Figure 6 below. Upon clicking, the hidden buttons, including "Beacon", "Distance & Bearing", "Plan Data", "Area Computation" and "Map Data", may be used on the cadastral map for printing.

GGS also shows more capability in the accuracies of area, distance, and bearing computations like dealing with a piece of land with about 200 or more points on the boundary, and you are required to produce documents mentioned above on that land with probably others surveys you have done too. These will require separate computations for each survey's documentation manually or with several spreadsheet programs. Again, the hustle of extracting processed points for the computation is a different case altogether, but with GGS this is made with ease, and with a click of a button, unlike other propriety software which are not custom-designed to have this feature.

For a cadastral report on bearing and distance computation based on either DGNSS or direct input of coordinates, GGS creates a report on the point-to-point computations of the site pillars together with the connecting pillars as shown in Figure 7. Similarly, the area computation and the plan data for a piece of land are all prepared automatically for ready submission. These kinds of reports are not provided by the commercial software such as LGO, GSS, and SSS used in this study, since they are designed for general purpose post-processing usage as shown in Figure 8 and Figure 9.

Finally, to make it more efficient and convenient, the section designed to perform point-to-point coordinate conversions between coordinate reference systems for applications are presented in Figure 10 below and all processed points can be viewed in the map interface in the WGS 84 system using the MapWinGIS plugin as shown in Figure 11, where a converted point was plotted on it.

## Baseline Processing

Three commercial GNSS processing software packages (i.e. GNSS Solution Software (GSS), Spectrum Survey Software (SSS), and Leica Geo Office (LGO)) were used to access the accuracy of GGS software. All software were used to perform baseline processing on the same data to assess the baseline accuracies of two (2) stations. The base station used as a reference was BJCO in Benin and the other control

## PLAN DATA SHEET

| FROM | TO | BEARING | | | DISTANCE | REMARKS |
|---|---|---|---|---|---|---|
| | | deg. | min | sec | feet | |
| SGA A179 18 1 | SGA A179 18 2 | 092 | 14 | 45 | 101.06 | |
| SGA A179 18 2 | SGA A179 18 3 | 182 | 16 | 54 | 100.47 | |
| SGA A179 18 3 | SGA A179 18 4 | 272 | 18 | 45 | 99.87 | |
| SGA A179 18 4 | SGA A179 18 1 | 001 | 36 | 16 | 100.36 | |
| | | | | | | |
| CONNECTING PILLAR | | | | | | |
| UST TP 1 | SGA A179 18 1 | 162 | 30 | 50 | 7954.67 | |
| SGA A179 18 4 | UST TP 6 | 342 | 35 | 01 | 7756.71 | |
| | | | | | | |
| | | | | | | |
| AREA | = | 0.23 acres | | | | |
| | = | 0.09 hect. | | | | |
| | | | | | | |

**Figure 9: Sample of GGS Plan Data report**

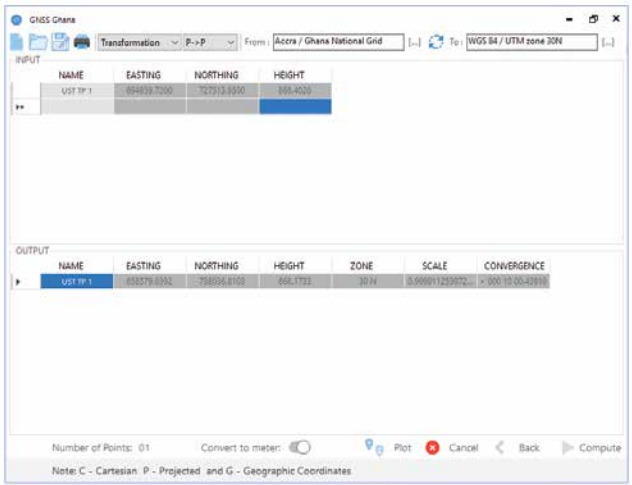


**Figure 10: GGS converts UST TP1 to UTM coordinates.**

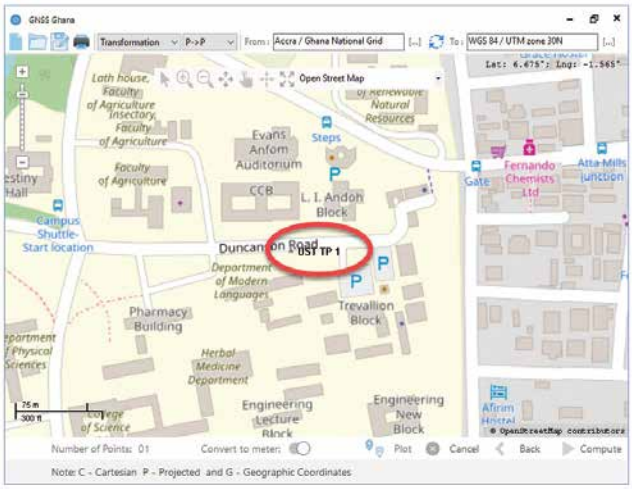


**Figure 11: GGS plot of the converted UST TP1 on the map.**

**Table 2: Coordinates of IGS station.**

| POINT ID | 3D Cartesian Coordinates | | |
|---|---|---|---|
| | X (m) | Y (m) | Z (m) |
| BJCO | 6333076.505 | 270973.437 | 704551.984 |
| YKRO | 6306439.897 | -578380.783 | 757956.481 |
| *Note: The coordinates are on the WGS84 datum* | | | |

**Table 3: Baseline results from software processed results in WGS84.**

| TOOL | 3D Cartesian Coordinates | | | UTM Zone 30 | | Baseline Distance |
|---|---|---|---|---|---|---|
| | X (m) | Y (m) | Z (m) | N (m) | E (m) | |
| GGS | 6306440.127 | -578380.727 | 757956.483 | 760018.892 | 252450.274 | 851448.198 |
| GSS | 6306440.048 | -578380.901 | 757956.414 | 760018.831 | 252450.093 | 851448.370 |
| LGO | 6306439.985 | -578380.873 | 757956.429 | 760018.854 | 252450.115 | 851448.345 |
| SSS | 6306439.906 | -578380.921 | 757956.368 | 760018.802 | 252450.060 | 851448.391 |

**Table 4: Geographical coordinates from processed results.**

| TOOL | Latitude | | | Longitude | | | Ell. Height (m) |
|---|---|---|---|---|---|---|---|
| | Deg. | Min. | Sec. | Deg. | Min. | Sec. | |
| GGS | 006 | 52 | 14.01622 | -005 | 14 | 24.33219 | 270.406 |
| GSS | 006 | 52 | 14.01422 | -005 | 14 | 24.33808 | 270.335 |
| LGO | 006 | 52 | 14.01496 | -005 | 14 | 24.33736 | 270.272 |
| SSS | 006 | 52 | 14.01328 | -005 | 14 | 24.33915 | 270.191 |

**Table 5: Comparison of the processed results against the known.**

| TOOL | 3D Cartesian Coordinates | | | UTM | | Error Distance (m) |
|---|---|---|---|---|---|---|
| | δX (m) | δY (m) | δZ (m) | δN (m) | δE (m) | |
| GGS | 0.230 | 0.056 | 0.002 | -0.024 | 0.077 | 0.080 |
| GSS | 0.151 | -0.118 | -0.067 | -0.085 | -0.104 | 0.134 |
| LGO | 0.088 | -0.090 | -0.052 | -0.062 | -0.082 | 0.103 |
| SSS | 0.009 | -0.138 | -0.113 | -0.114 | -0.137 | 0.178 |

**Table 6: GGS difference in results from other software packages.**

| COMPARISON | Software Difference | | |
|---|---|---|---|
| | δN (m) | δE (m) | δHorizontal (m) |
| GGS - LGO | 0.038 | 0.159 | 0.163 |
| GGS - GSS | 0.061 | 0.181 | 0.191 |
| GGS - SSS | 0.090 | 0.214 | 0.232 |

**Table 7: Existing WGS 84 coordinates (WGS 84 ellipsoid).**

| Point ID | Latitude | | | Longitude | | | Ell. Height [m] |
|---|---|---|---|---|---|---|---|
| | Deg. | Min. | Sec. | Deg. | Min. | Sec. | |
| CFP 109 | 05 | 27 | 36.32595 | -00 | 25 | 24.81756 | 78.341 |
| CFP 150R | 06 | 04 | 49.84387 | 00 | 03 | 00.86059 | 358.724 |
| CFP 155 | 05 | 56 | 20.52274 | -00 | 07 | 19.18038 | 524.556 |
| CFP 178 | 06 | 34 | 16.88777 | -01 | 09 | 52.78660 | 616.042 |
| CFP 179 | 06 | 22 | 19.62332 | -01 | 01 | 59.90811 | 493.174 |
| CFP 185 | 06 | 29 | 5.19173 | -01 | 55 | 30.56291 | |
| CFP 200 | 05 | 37 | 32.87363 | -00 | 33 | 33.54116 | 33.544 |
| CFP 180 | 06 | 03 | 13.64662 | -01 | 17 | 10.34588 | 437.507 |
| CFP 207 | 05 | 50 | 58.62367 | -01 | 57 | 58.14538 | 400.701 |
| CFP 217 | 05 | 56 | 35.18549 | -00 | 43 | 46.93701 | 311.009 |
| CFP 225 | 05 | 27 | 18.31345 | -01 | 30 | 03.96620 | 275.081 |
| GCS 306 | 07 | 14 | 09.09947 | -01 | 37 | 49.67440 | 536.167 |
| GCS 302 | 06 | 54 | 44.92872 | -02 | 01 | 00.32719 | 561.004 |
| GCS 304 | 06 | 59 | 31.95103 | -01 | 26 | 43.21590 | 621.058 |
| GCS 305 | 06 | 50 | 46.84308 | -01 | 44 | 36.31138 | 417.153 |
| GCS 142 | 06 | 34 | 32.86777 | -00 | 45 | 56.05383 | 782.369 |
| GCS 145 | 06 | 33 | 24.89857 | -01 | 24 | 42.82870 | 503.604 |
| GCS 213 | 06 | 07 | 41.50988 | -00 | 44 | 56.05705 | 327.169 |
| GCS 125 | 05 | 45 | 58.98277 | -00 | 03 | 54.52938 | 97.464 |
| GCS 102 | 05 | 16 | 57.87942 | -00 | 44 | 03.86026 | 83.408 |
| CFP 184 | 06 | 28 | 17.60775 | -01 | 41 | 41.39103 | 472.125 |

point processed was YKRO located in Yamoussoukro, Côte d'Ivoire. In this way, if the accuracy is less than or within a sub-meter level, then GGS can be used to process data across the country. The coordinates of the points are shown in Table 2.

The distance between these two points was computed to be about 851 km. The positional results obtained after processing were initially presented in WGS84 Cartesian coordinates in Earth-Centred Earth-Fixed (ECEF) X, Y, Z from all software and later converted to the geographic coordinate system and Universal Transverse Mercator (UTM) projected system (Northings, Eastings) using the same coordinate conversion tool. This way biases from every software are eliminated as a result of doing the conversion with their software. Post-processed results from all four software packages are presented in Table 3 and Table 4.

Table 5 below shows the differences in each software results from the known control point's coordinate. The baseline from each tool used gave relatively close values to the computed distance from the actual known coordinates taken with about 0.15m deviation.

**Table 8: Numerical comparison between transformed and existing coordinates.**

| *Point ID* | *Existing* | | *Transformed* | | *Differences* | |
|---|---|---|---|---|---|---|
| | *E (ft.)* | *N (ft.)* | *E (ft.)* | *N (ft.)* | *ΔE* | *ΔN* |
| *CFP 109* | 1109433.05 | 286868.63 | 1109433.64 | 286864.77 | -0.59 | 3.86 |
| *CFP 150R* | 1281255.21 | 512174.18 | 1281256.42 | 512177.15 | -1.21 | -2.97 |
| *CFP 155* | 1218791.85 | 460739.72 | 1218793.36 | 460741.69 | -1.51 | -1.97 |
| *CFP 178* | 840169.51 | 689861.56 | 840170.42 | 689862.51 | -0.91 | -0.95 |
| *CFP 179* | 887815.70 | 617579.48 | 887814.82 | 617581.77 | 0.87 | -2.29 |
| *CFP 185* | 564228.30 | 658750.36 | 564229.74 | 658752.06 | -1.44 | -1.70 |
| *CFP 200* | 1060041.45 | 346933.94 | 1060041.35 | 346930.69 | 0.10 | 3.25 |
| *CFP 180* | 795978.88 | 502139.98 | 795976.89 | 502141.70 | 1.99 | -1.72 |
| *CFP 207* | 548934.64 | 428353.90 | 548936.99 | 428356.60 | -2.35 | -2.70 |
| *CFP 217* | 998070.31 | 461992.40 | 998069.02 | 461990.26 | 1.29 | 2.14 |
| *CFP 225* | 717756.06 | 285019.85 | 717754.38 | 285025.31 | 1.68 | -5.46 |
| *GCS 306* | 671516.26 | 931057.32 | 671515.02 | 931053.57 | 1.24 | 3.75 |
| *GCS 302* | 531310.67 | 813987.32 | 531312.11 | 813984.44 | -1.44 | 2.88 |
| *GCS 304* | 738496.56 | 842589.26 | 738494.23 | 842588.17 | 2.33 | 1.09 |
| *GCS 305* | 630369.77 | 789811.15 | 630370.29 | 789809.50 | -0.52 | 1.65 |
| *GCS 142* | 984942.00 | 691483.15 | 984940.68 | 691482.81 | 1.32 | 0.34 |
| *GCS 145* | 750479.52 | 684673.93 | 750480.89 | 684675.54 | -1.37 | -1.61 |
| *GCS 213* | 991066.89 | 529124.19 | 991064.89 | 529125.08 | 2.00 | -0.89 |
| *GCS 125* | 1239541.76 | 398140.35 | 1239546.28 | 398142.55 | -4.52 | -2.20 |
| *GCS 102* | 996471.72 | 222464.16 | 996470.29 | 222458.07 | 1.43 | 6.09 |
| *CFP 184* | 647795.79 | 653823.60 | 647796.32 | 653823.88 | -0.53 | -0.28 |

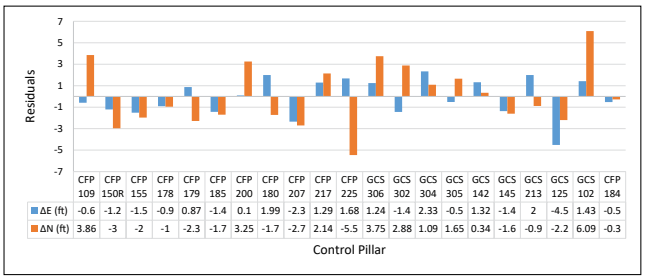


**Figure 12: Residuals in Easting and Northing Coordinates (ft.)**

It could be deduced from GGS that the results were within 0.1 from the known coordinates of YKRO. Though the deviations, per standards of different surveys and mapping divisions of different countries, may generally be accepted, the GGS's performance in terms of the deviation from the true values was better than the other software. Table 6 below shows the results of comparing the different software packages against each other.

## Coordinate Conversion

Another feature of the software is the tool for geodetic calculations which also provided promising results. There were no material errors in the results of the forward, reverse, and Cartesian projections. Table 7 shows the 21-WGS 84 geographic coordinates in Ghana used in the study.

The datum transformation of these control points to Ghana National grid coordinates using the 7- transformation parameters produced results shown in Table 8 below which were compared to the existing coordinates in Ghana's local coordinate system (feet) in the War office ellipsoid. These results did not consider the height or elevation values since the interest of the research was in the horizontal positional accuracy.

Results from transformation calculations as seen above gave the maximum values of the transformed from the existing to be [6.09 ft.] and [2.33 ft.] in the northing and easting coordinates respectively, while the minimum values of deviations are [-5.46 ft.] in northing and [-4.52 ft.] in easting. To visualize the effects, Figure 7 shows the residual plot from the existing coordinates and converted.

The mean and standard deviation of the differences respectively are [-0.10 ft. and 1.75 ft.] in easting and [0.02 ft. and 2.86 ft.] in northing. Also, the standard errors for this dataset as per the result from using GGS gave [±0.38 ft.] in the easting and [±0.62 ft.] in northing. However, the accuracy of GGS at a 99% confidence level on the points with the 7-transformation parameters for eastings was [0.10 ft. ± 0.99 ft.], and for northing [0.02 ft. ± 1.62] ft.

The general investigation in datum transformation shows that the residuals in Northings were much higher than that of the Eastings. This is a result of inhomogeneity in establishing the geodetic framework coordinates (i.e. controls pillars themselves). During the establishment of the control pillars, instead of the adjustments conducted and applied to the control pillars wholly so that the error would be evenly distributed across the board in the country, they were rather adjusted partly throughout the country. Therefore, not rendering them homogeneous. This could be the reason why the results have some high residuals in both the northings and eastings, which is also following the researches performed on the geodetic framework of Ghana by many researchers (including Ayer & Tiennah, 2007; Ayer & Fosu, 2008; Ayer, 2008; Annan et al., 2016; Ziggah et al., 2017) with Dzidefo

A GNSS processing application called "GNSS Ghana" software (GGS) was developed for GNSS data (RINEX) post-processing, Cadastral computation with reports, and an additional tool for Direct, Inverse projection and Datum transformation with a modern GUI. GNSS data can be processed using the developed application for all survey works that do not require accuracies higher than the accuracy stated for this application

(2011), who aimed at investigating and further proposing a method for transforming coordinates of points from the War Office coordinate system to the WGS 84 coordinate system and vice versa.

## Conclusions

In this paper, a GNSS processing application called "GNSS Ghana" software (GGS) was developed for GNSS data (RINEX) post-processing, Cadastral computation with reports, and an additional tool for Direct, Inverse projection and Datum transformation with a modern GUI. GNSS data can be processed using the developed application for all survey works that do not require accuracies higher than the accuracy stated for this application. The use of the software requires a few steps in the procedures involved to get a positional result. The software was tested and validated for positional accuracy with two IGS stations' data (BJCO and YKRO) in West Africa and was processed using GGS and three other commercial software. The experimental results indicated that the developed software outperformed the commercial software in this study indicating that GGS is suitable for processing GNSS data in Ghana. Additionally, the output reports from GGS has been refined and summarized, therefore recommended for both engineering and cadastral survey report submissions in Ghana. This will help structure the reporting system and minimize the discrepancies in the processed data reports from different surveyors based on the standards that are required by Ghana SMD and bring about uniformity in reports for file assessments and queries. Moreover, the datum transformation functionality of GGS was also tested and the results showed that it can be used within and outside Ghana. The functionality supports worldwide conversion of coordinates for datum transformations and projections between projected, geographic, and cartesian coordinate systems with minimal errors in the conversion with any coordinate reference system.

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## Statement of Competing Interest

The authors have no competing interests.

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The experimental results indicated that the developed software outperformed the commercial software in this study indicating that GGS is suitable for processing GNSS data in Ghana

# Energy transition in Nigeria: A technological and philosophical perspective

A theoretical based method was employed in this research to obtain simulation results from lidar scan patterns which indicate a lot of prospects of lidar laser scanners

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## Abstract

Preview measurements of the inflow by turbine-mounted lidar systems can be used to optimize wind turbine performance by increasing power production and alleviating structural loads[1] Light Detection and Ranging devices (LIDAR) allow preview information about the approaching wind to be used to improve wind turbine control thereby optimizing operational performance of the wind turbine and hence effect increase in energy yield. We employed in this research a theoretical based method to obtain simulation results from lidar scan patterns which indicate a lot of prospects of lidar laser scanners operating in the region of pico and femto seconds regime. This makes the wind energy option in Africa as a whole and Nigeria in particular a welcomed development in renewable energy discussions and the country's energy mix. Again, a generalized philosophy of energy will consider the following aspects: the inquiry into the natural phenomenon of energy; the critique of the functioning of energy in society; and the philosophy of technology within the contexts of energy transitions.

## Introduction

There has been a steady rise in energy production worldwide since 2004, with substantial actively installed capacity in Africa.

In fact, it was noted that wind energy is the "fastest growing installed alternative-energy production", with at least 20% of United States energy expected to be supplied by offshore and onshore wind farms by 2030[2] The problem that light detecting and ranging devices hope to address in the design-models and in systems that has begun to implement its feedforward system is that in such systems, information concerning the behavior of an approaching wind is provided ahead of time by a fast-scanning laser. This remote sensor device enables an automatic shift in the direction of the turbine blades to effect minimum impact and maximum energy generation respectively.

The erratic behaviour of the approaching wind in front of the turbine and the feedback method of collecting data for optimization by the traditional models has its attendant problems. The primary challenge that the feedback system presents is that the damage done to the turbine by the wind would have been completed before the signal information is received, processed and acted upon by the system units (a sort of crying when the head is already off!). This looks like a damage control mechanism that will not help technological advancements in wind energy generation and design improvements. Thus, as Eric Smiley, Holger Fürst, Florian Haizmann and David Schlipf, in the article "Optimizing Lidars for Wind Turbine Control Applications– Results from the IEA Wind Task 32 Workshop" *Remote*

*Sens*. 2018, *10, 863* noted clearly, this approach has proved to be ineffective in addressing the problem of control and design in the wind energy development[3]

From the foregoing discussions therefore, this thesis set out to contribute to the discussions on lidar systems as a remote sensor and feedforward mechanism in wind turbines designs. Our main approach was to simulate the factors that will provide a prospect for increasing the present nanosecond lidar scanners to those of pico and femto seconds regime. We further established, the correlation between wind turbines and lidar systems hence providing invaluable insights into overcoming the barriers preventing the widespread use of Lidars for wind turbine control strategies, and maximizing the effectiveness of Lidars for control applications.

From a theoretical perspective, the optimization of lidar scan patterns by minimizing the error between the measurements and the rotor effective wind speed of interest is discussed. Frequency domain methods for directly calculating measurement error using a stochastic wind field model are reviewed and applied to the optimization of several continuous wave and pulsed Doppler lidar scan patterns based on commercially-available systems. An overview of the design process for a lidar-assisted pitch controller for rotor speed regulation highlights design choices that can impact the usefulness of lidar measurements beyond scan pattern optimization. Finally, using measurements from an optimized scan pattern, it is shown that the rotor speed regulation achieved after optimizing the lidar-assisted control scenario via time domain simulations matches the performance predicted by the theoretical frequency domain model.

The significance of this research follows the main purpose of the International Energy Agency (IEA) wind task workshop-32 that was held in Boston, MA, USA in July 2016. This agrees completely with the analysis of Eric Smiley et al cited above who argued that: The workshop, 'optimizing Lidar designs for wind energy applications' was held to identify Lidar system properties that are desirable for wind turbine control applications and help foster the widespread application of Lidar-assisted control (LAC).

## Pulsed lasers in Lidar applications

By way of a simplified definition of terms, elementary physics defines wind as the flow of atmospheric gases on a very large scale. Wind flow are generally caused by uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and the rotation of the earth. However, wind flow patterns are modified by the earth's terrain features, bodies of water, and surrounding vegetation.

A wind turbine is used to harness the kinetic energy of the vast amounts of wind, and transform it into electricity. This can be expressed in a physical equation as seen by the equation [1] below. First, we need to recall that wind is an air mass moving from an area of high pressure to an area of low pressure. This movement of air implies a kinetic form of energy which for a given air of mass m, moving at a velocity v, can be expressed as:

$$(1).\ E_k = \frac{1}{} m v^2$$

Considering a certain cross-sectional area, $A$, through which the air passes at velocity $v$, the volume $V$, flowing in a certain time unit $t$, the so-called volume flow, is given by:

$$\frac{dv}{dt} = v \frac{dA}{dt} \quad (2)$$

And the mass flow with air density $\rho$ is

$$m^{\cdot} = \rho v A \quad (3)$$

This mass flow can now be substituted into the formula for kinetic energy of the moving air to give the amount of energy passing through the cross-sectional area A, per unit time. This energy is physically identical to the power P expressed as:

$$P = \frac{1}{2} \rho v^3 A \quad (4)$$

Therefore, the amount of energy in the wind is controlled by the density, surface area and velocity of the moving air. The equation [4] above shows that identifying an area of high wind velocity is the most crucial part of picking out an area to situate a wind turbine in a wind farm.

In reality however, the equation for kinetic energy of wind does not represent the amount of energy that a wind turbine is able to harness. Wind turbines like other physical machines are not 100% efficient; and are unable to convert all of the kinetic energy into wind. If a wind turbine was 100% efficient, then wind speeds would drop to 0 km/h after passing through the turbine.

The German scientist, Albert Betz, published a work in 1926 that showed that it is only possible to extract 16/27 or 59% of the energy from an approaching wind by the wind turbine. This is called Betz's law[4] Therefore, the theoretical energy model for a wind turbine is given by the expression:

$$P = \frac{16}{27} - \frac{1}{2} \rho v 3A \quad (5)$$

The lidar operation is based on the scientific theory of fluid mechanics and some elements of aerodynamics. Modern wind turbines catch the wind by turning them into or away from air flows. Wind moves the propeller mounted on a rotor and the movement turns a high-speed shaft coupled to an electric or induction generator.

The majority of wind turbines consist of three blades mounted to a tower made from tubular steel. There are less common varietieswithtwoblades,orwithconcrete orsteellatticetowers. At 100ft or more above the ground, the tower allows the turbine to take advantage of faster speeds found at higher altitudes.

### Wind modelling

Wind can be mathematically described by a set of three- dimensional wind speed vectors at each point in time and space. For aero-elastic simulations, the wind speed vectors are usually only

generated at the rotor plane to calculate the aerodynamic forces and moments. Thus, understanding the nature of a wind field over the full space in front of the turbine is necessary to simulate lidar systems, (see figure 1).

The inertial coordinate systems were used in this thesis to describe the wind models for the lidar simulations and a reduced model for wind field reconstruction.

### Wind and inertial coordinate system

The wind coordinate system is denoted in this work by the subscript *W*. It is used to describe the wind flow and is aligned with the mean wind direction regarding the inertial coordinate system, which is denoted here by the subscript *I*. The direction is defined by the horizontal inflow angle $\alpha_h$ (azimuth or rotation around the $z_I$-axis) and the vertical inflow angle $\alpha_v$ (elevation or rotation around the rotated $y_I$-axis), (see figure 2). Although all six DOFs could be used in principle, a rotation of around the $x_I$ is not considered in this work but might be useful for very complex terrain.

### Lidar and Lidar modelling systems

Generally, Lidar (LIght Detection and Ranging) is a remote sensing technology similar to radar (Radio Detection and Ranging) or sonar (SOund Navigation And Ranging). In the case of lidar, a light pulse is emitted into the atmosphere. Light from the beam is scattered in all directions from molecules and particulates in the atmosphere. A portion of the light is scattered back towards the lidar system. This light is collected by a telescope and focused upon a photo-detector that measures the amount of backscattered light as a function of distance. The lidar system uses light in the form of a pulsed laser for powerful data collection that provides 3-D information f or an area of interest. Among many things, it is useful for such tasks as surface mapping, vegetation mapping, transportation, corridor mapping, transmission route mapping, and 3-D building mapping.

According to Arthur Cracknell, over the last decades, lidar has largely contributed to our knowledge of our atmosphere. The interactions of the emitted light with the molecules and aerosols allow the observation of atmospheric parameters such as temperature, pressure, wind, humidity, and concentration of gases (ozone, methane, nitrous oxide, etc.)[5]. Lidar originated in the early 1960's, shortly after the invention of the laser. Its first applications came in meteorology where it was used to measure clouds[6]. Since then, lidar has been used not only in meteorology, but also in a wide range of other applications, such as laser range finders, altimeters, and satellite trackers.[7]The essential concept of lidar was originated by E. H Synge in 1930, who envisaged the use of powerful search lights to probe the atmosphere. Indeed, lidar has since been used extensively for atmospheric research and meteorology. Lidar instruments fitted to aircraft and satellites carry out surveying and mapping – a recent example being the U.S. Geological Survey Experimental Advance Airbone Research Lidar. NASA has identified lidar as a key technology for enabling autonomous precision safe landing of future robotic and crewed lunar-landing vehicles.

### Lidar Operating Principle

The operating principle of lidar is based on the assumption

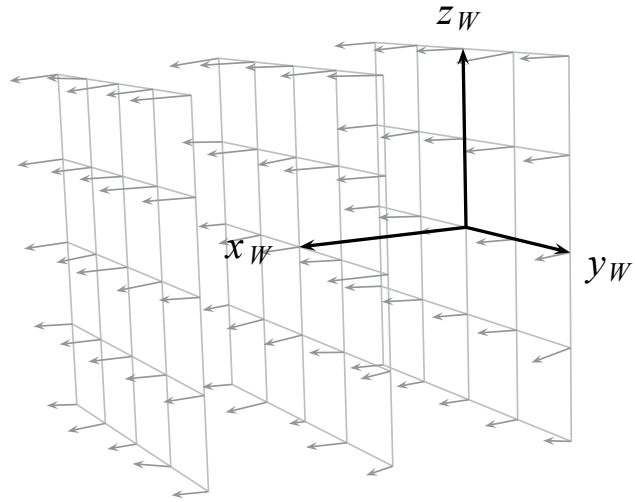


**Figure 1: Snapshot of the time variant vector field as a general description of wind.**

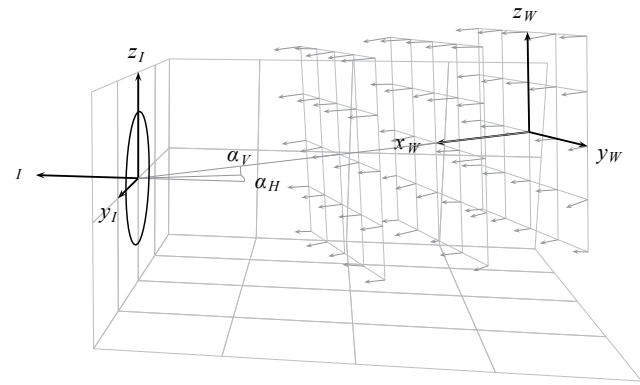


**Figure 2: Orientation of the wind coordinate system (subscript *W*) in the inertial coordinate system (subscript *I*). Rotation order is defined as azimuth → elevation ($\alpha_h \rightarrow \alpha_v$).**

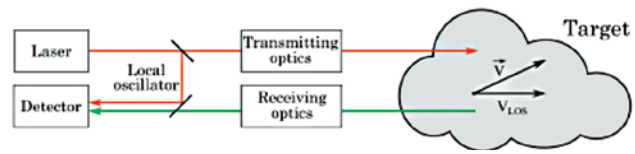


**Figure 3: Generic Doppler lidar concept where V is the mean velocity of the target, and $V_{los}$ is projected radial wind speed.**

that wind speed has the same value as the small particles in the air, called aerosols. Pollen, droplets, smoke, and particles of dust form these particles. Lidar technology relies on detecting backscattered light from moving aerosols in the atmosphere, when illuminated by laser radiation with coherent detection (best for measuring Doppler shifts, or changes in phase of the reflected light). Coherent systems generally use optical heterodyne detection[8]. This is more sensitive than direct detection and allows them to operate at much lower power, but requires more complex trans-receivers. By measuring the Doppler frequency shift of the backscattered light, the wind speed can be determined remotely. The basic concept can be illustrated as in figure 3.

### Lidar Equation

In the simplest form, the detected lidar signal can be written as

$$P(r) = KG(r)\beta(r)T(r) \quad (6)$$

where P is the power received from a distance $r$, $K$ summarizes the performance of the lidar system and is called the lidar system constant, $G(r)$ describes the range-dependent measurement geometry. The term $\beta(r)$ is the back scattered coefficient at distance $r$. It stands for the ability of the atmosphere to scatter light back into the direction from which it comes. $T(r)$ is the transmission term and describes how much light gets lost on the way from the lidar to the distance $r$ and back.

## Results from simulations

### Lidar Measurement Coherence

The quality of a wind speed measurement as influenced by evolution can be judged by the coherence between the estimate of the u component of the line-of-sight lidar system measurement and the true u component that reaches the rotor plane. Referring to figure 4, the up-wind point at which the lidar is focused is called point $j$, while the point where the evolved wind meets the rotor plane is called point $i$. Points $i$ and $j$ have the same transverse coordinates in the $yz$ plane but are separated longitudinally by the preview distance $D$.

### Components of Measurement Coherence

There are several factors that may cause a decrease in measurement coherence. In addition to wind evolution, error sources that are characteristics of lidar measurements in non- evolving wind fields, such as range weighting and directional bias, will cause a loss of coherence. Figures 5 and 6 compare the components of coherence for three different measurement geometries by showing the measurement coherence that was calculated using the appropriate physical equations with various combination of the error sources included. Figure 5 uses the spectral prop erties of the TurbSim wind field with exponential wind evolution, while figure 6 uses characteristics of the large eddy simulation (LES) wind field. The decay parameter used with the exponential model is a = 0.45. Coherence plots for both wind fields are provided to compare and contrast the simple wind evolution model and the model that is derived from the LES results. In both figures, each scenario involves a lidar that is located at the hub, measuring wind at a radial distance of $r$ = 47.25m at an azimuth angle of $\psi$ = 90°, but with different preview distances (D = 24, 58, and 130m). The curves in figure 5 and 6 do not include the effects of $uv$ or $uw$ correlation in order to highlight the other sources of coherence loss. Although the exact measurement curves differ for the two wind field models, the following trends apply to both scenarios.

When $D = 24m$, the measurement angle is large, longitudinal coherence (dashed) is relatively high, and the effects of range weighting are insignificant due to the short focal distance. Here, directional bias dominates the overall coherence, with wind evolution causing some degradation at higher frequencies.

When $D = 130m$, the measurement angle is low, longitudinal coherence is low, due to wind evolution, and range weighting is significant due to the long focal distance. Wind evolution, is the dominant component of measurement coherence, with range weighting adding a further loss of coherence.

For the $D = 58m$ scenario, all three sources of coherence loss are significant. Directional bias and wind evolution, both have very strong impacts, with range weighting causing an additional loss of coherence.

Figures 5 and 6 above reveal that the (green) coherence curves from directional bias alone are relatively constant over all frequencies and increase as the measurement angle decreases. Although not shown in figure 5 or 6, when the effects of uv and uw coherence (present in the Great Plains-Low Level Jet wind field) are included, measurement coherence, due to directional bias, changes because of the non-zero correlation between the u and $v$ as well as $u$ and $w$ components. By comparing the green and magenta curves, it can be seen that range weighting adds a significant coherence loss when wind evolution is not included, especially for larger preview distances. However, by comparing the blue and black curves, it is clear that with wind evolution included, range weighting never dominates the overall coherence loss.

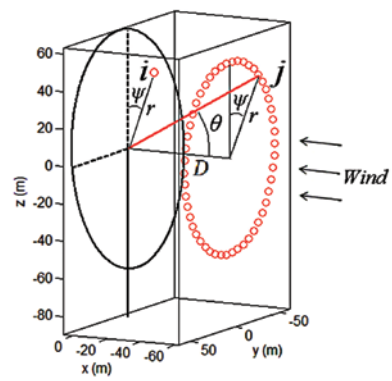


**Figure 4: Coordinate system and measurement variables used. The lidar is assumed to be mounted in the wind hub at (*xh, yh, zh*) = (0, 0, 0).**

### Lidar Measurements of Evolving Wind Fields

Two metrics are used to reveal the measurement quality for different scan geometries. The first metric is the "coherence bandwidth," defined here as the bandwidth where the measurement coherence remains above 0.5. A higher coherence bandwidth yields a better measurement, because more of the measured turbulence spectrum can be used in a wind preview-based controller. The second metric is the integral of measurement coherence, or the area under the coherence curve. The integration is only performed for a bandwidth of about 0.5 hertz (Hz), based on the Nyquist frequency of the LES wind field . A larger area under the coherence curve will yield a better measurement. Results based on the two metrics are similar, but both are provided here for comparison (Fugure 6).

The following results compare measurement quality for different scan geometries and reveal the optimal preview distances in terms of maximising the coherence bandwidth or coherence integration. For the exponential wind evolution model, the decay parameter a is varied to show the impact that wind evolution intensity has on optimal preview distance. For the LES-based model, the results reveal what typical preview distances might be in a stable wind field with physics-based wind evolution, but a wind field that is less productive from a wind energy perspective.

Separate results are provided for four different lidar azimuth angles ($\psi = 0°, 90°, 180°, -90°$) because the wind spectra and transverse coherences vary with height and direction. In addition, for the TurbSim generated wind field, the uv and uw correlations will have different impacts on measurement coherence (depending on azimuth angle).

The chosen scan geometries are based on the National Renewable Energy Lab- oratory (NREL) 5-megawatt (MW) turbine model. Scan radii of 15.75m, 31.5m, 47.25m, and 63m are investigated, which corresponds to 25%, 50%, 75%, and 100% blade span. For the Great Plains-Low Level Jet scenario, the lidar is located at a height of 90m, but for the LES wind field, the lidar is located at a height of 100m, which is the center of that wind field.

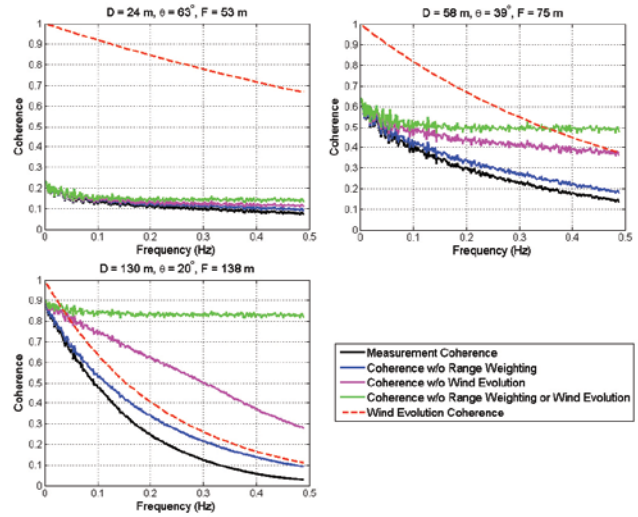


**Figure 5: A comparison of the components of measurement of coherence for a scanning LIDAR scenario, with scan radius $r$ = 47.25m using the Great Plains-Low Level Jet wind field and exponential coherence with a = 0.45**

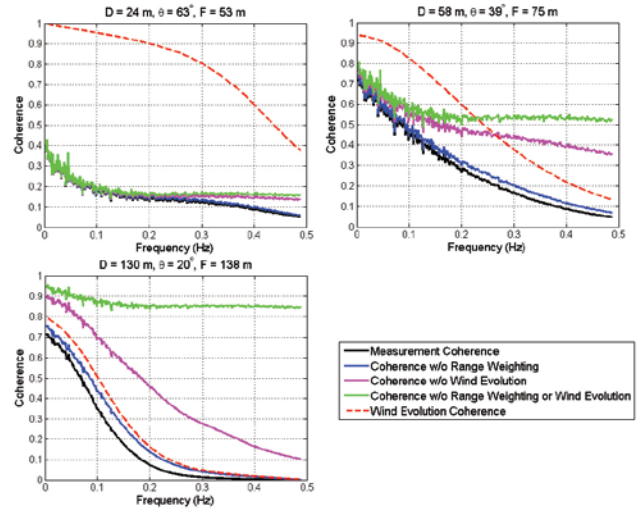


**Figure 6: A comparison of the components of measurement of coherence for a scanning LIDAR scenario, with $r$ = 47.25m using the stable Large Eddy Simulation (LES) wind field and evolution model**

## Conclusions from results of simulations

From the foregoing discussions, lidar simulation results show that for a circular scan pattern, a scan radius close to 70% rotor radius provides the strongest measurement correlation. Small scan radii, such as $r = 0.1R$ produce lower correlations because the measured winds are representative of a smaller portion of the rotor plane. For preview distances roughly equivalent to the rotor radius, the coherence drops as the preview distance increases due to wind evolution. However, preview distance must roughly double before coherence drops by more than 0.1. When knowledge of the wind speed and direction at heights other than hub height is used to determine the scan

**Figure 7: A typical wind farm with wind turbines (courtesy Reglobal analysis as in nature journal of science)**

geometry, measurement coherence can be increased, but at most by 0.1 for $r = 0.7R$ and 24m < $D$ < 130m.

The modified scan pattern (temporal attenuation) improves measurement quality more for longer preview distances. The general scan pattern optimization results show that: (i) as the number of beams increases, the measurement accuracy increases as well and (ii) additional measurement ranges afforded by pulsed lidars improve measurement.

Coherence bandwidth is maximized using shorter preview distances which prevent the coherence at higher frequencies from decaying too much from wind evolution. Measuring the wind farther away than the optimal preview distances causes wind evolution to become more severe, increasing measurement error as well. The extra preview time provided by longer preview distances are useful when attempting to detect extreme wind events and take necessary action to protect the turbine. However, using coherence bandwidth as a metric, it was revealed that, for a given scan radius, the optimal preview distance is not very sensitive to the amount of wind evolution. Optimal preview distances based on the coherence bandwidth for lidar measurements in the unstable Great plains wind field, are roughly 60m for a scan radius of $r$ = 31.5m, 80m for $r$ = 47.25m, and 120m for $r$ = 63m for decay parameters less than one. These approximate optimal preview distances are formed by averaging over all four azimuth angles.

Measuring the wind at multiple range gates with pulsed lidar offers the advantage of being able to track wind speeds as they travel towards the turbine as well as allowing measurements at different preview distances to be combined to improve the simultaneous estimation of wind shear and direction. Thus, from controls perspective, a preview measurement at 47.25m or 75% rotor radius for the 5 MW model is the most useful due to maximum power capture near this blade span. The results reveal that the bandwidth of coherent measurements at $r$ = 47.25m is roughly 0.11Hz based on $\gamma 2$ = 0.5 bandwidth definition.

When comparing results based on coherence bandwidth for different decay parameters, it can be seen that unless the intensity of evolution is very strong, the optimal preview distances are almost the same with wind evolution or without (a = 0). Using the integral of coherence as a metric, the optimal preview distances vary considerably as the decay parameter changes.

It is important to note too that wind turbine developments are long term and capital intensive; hence, the Nigerian government through the appropriate ministry must show commitment to the development of wind energy technology in a medium- and long- term mode

## Wind energy mix in Nigeria

According to the Reglobal analysis, four key modern renewable energy technologies with highest deployment potentials for Africa are modern biomass for cooking; hydropower; wind; and solar power[10]. The power sector presents significant opportunity to be transformed through the increased deployment of renewable energy technologies.

The nature journal of science news.org reports suggest that renewable energy sources such as wind and solar power will make up less than 10% of Africa's total electrical power generation by 2030, (Nature Energy Journal 25/01/ 2021).

This is a very abysmal rate compared to many first world and developing countries. This means that Africa and Nigeria in particular with her teeming population of over 200 million inhabitants needs to wake up from her slumber and begin to deploy wind energy as much as it is currently harping on solar energy as an option for renewable energy. The current scourge of epileptic electricity supplies in Nigeria makes any theoretical model discussions that have capacity to improve the current energy mix a necessity whose time is now.

It is important to note too that wind turbine developments are long term and capital intensive; hence, the Nigerian government through the appropriate ministry must show commitment to the development of wind energy technology in a medium- and long- term mode. The only existing wind farm in the country as at January 2021 is at Lambar Rimi, Katsina state. Continuing on the Lambar Rimi wind farm project, the Reglobal analysis had the caption, "Nigeria to complete 10 MW wind project in Katsina". (March 12, 2021) |

The government of Nigeria, continued the analysis, plans to commission a wind power project with a capacity of 10 MW which is located in the Lambar Rimi area of Katsina State. Katsina wind farm was set to be commissioned in March 2021. The project includes 37 GEVMP wind turbine generators with capacities of 275kW, step-up transformers for each turbine 315KVA/33KV/400V, SCADA system, installation of 2 7.5MWA transformer and accessories. The project began in 2005 under the governor of the state at the time, Umaru Musa Yar'Adua. It was then taken over by the Federal Government in 2007. It initially had a completion period of 24 months; however, the project has been met with several delays. The project commissioning was scheduled for 2012 but it never happened. This project received millions of naira

in annual budgetary allocations from the government with no expenditure details.

The above picture leaves one with no doubt that at the moment, Nigeria's implementation of the wind energy is nothing to write home about. This narrative makes it even more expedient for scientists and engineers in the field of wind energy generation to wake up to the challenge before them, viz, moving from theoretical conceptions and frameworks to the field and provide clear road map for the current energy crisis in Nigeria. The government on her part must show commitment to the blue print by partnering with several international and local organizations in turning around the matter under discussion which is providing of electricity to the people.

## The philosophy of light-energy

The philosophical conceptions of light energy in general and wind energy in particular raises once again the question of the ancient Ionian philosophers, that is, *ex qua materia constituti mundi* which means, of what material is the universe made of? The cosmologies and cosmogonies that arose from these ultimate questions became as it were less profound than the question itself. Thus, light energy with solar energy as a natural example, metamorphoses into different forms such as wind, solar radiation, etc. Wind energy is a veritable and very safe and promising part of the discussions on renewable energy and safe environment. But again, as we stated in the discussion of the energy mix in Nigeria, the 10MW Lambar Rimi wind farm is still operating at about 25% of its capacity since the entire project is conceived to generate 36MW for a nation of over 200million inhabitants!

Thus, a philosophy of energy will raise a lot of fundamental questions: what constitutes authentic existence in Nigeria with the political will and its attendant religio-ethnic drama as experienced currently in the nation? What constitutes the ultimate solution to the current energy crisis in Nigeria that has further worsened the already deteriorated economic inflation? How can authentic existence be achieved amidst the current unethical standards of politics and civil operations in Nigeria? the rising spate of insecurity, the quest for regional self-determination, the morality of banditry and kidnapping that has now become the order of the day, the whole issue of the value of human life with due regard for human dignity and freedom of choices, and several other existential questions that relate energy and the functionality of the society.

Statistics show that over 60% of the Nigerian populace are living in conditions below the authentic existence conceived by many of the 20th century existentialist philosophers. Poverty as experienced in Nigeria is fast blurring the idea of authentic existence, the frugal comfort that light (electricity) and energy provide as well as what self-actualization implies. The declining economic fortune that these debacles spell also questions the whole issue of the equitable distribution of the world resources, the current migration issues of the young talented Nigerians fleeing to Europe and America for a better life and the future of the Nigerian Nation in a medium term and long-term mode.

Robert-Jan Geerts (2014) et al in their article *Towards a Philosophy of Energy* as contained in Scientiae Studia Journal had a detailed analysis of the criteria that a good philosophy of energy should meet. According to them, "transition to a sustainable energy regime is one of the key global societal challenges for the coming decades. Many technological innovations are in the pipeline, but an uncritical appraisal of anything and everything called green innovation lacks methods for testing both the necessity and the sufficiency of these developments"[11].

Continuing this analysis, they argued that the task of the philosophy of energy is to explore and clarify the space in which the so-called energy transition is taking place. This will sketch the fundaments of such a philosophy and suggests how it might be built upon the work of twentieth century critics of the functioning of energy in society, including Mumford, Bataille, and Heidegger; through the example of flux and potentiality - two apparently opposing conceptions of energy - they proposed that a philosophy of energy allows for a broader perspective on specific problems in energy transition, and illuminates implicit and problematic assumptions behind these problems.[12]

Talking about philosophies of energy, we note that there are at least three lines of thought to be found dealing to a greater or lesser extent with aspects of energy:

1. the inquiry into the natural phenomenon of energy;
2. the critique of the functioning of energy in society;
3. the philosophy of technology.

All three lines of thought contribute the essential ingredients to a fully-fledged philosophy of energy: the first two can be seen as attempts to develop philosophies of energy in their own right, whereas the third guides us towards a more fruitful level of analysis for issues relating to the current energy transition. Some brief elucidation of these philosophies of energy may suffice here:

### Inquiry into the natural phenomenon of energy

Inquiry into the natural phenomenon of energy stretches back to Heraclitus (c.535 c.475 AD) and Aristotle (384-322 AD). Whereas the former allegedly argued that everything changes, the latter noticed that this was not exactly true: although change happens, a lot of things also stay the same. The energy historian R. Bruce Lindsay suggests that, from Aristotle onwards, an unbroken line of inquiry into the concept of energy can be drawn all the way to Albert Einstein, with as common denominator based on the assumption that "the root of the concept is the notion of invariance or constancy in the midst of change" (Lindsay, 1971, p. 383). The domain of these inquiries steadily expanded from mechanical questions on the functioning of levers and pulleys through to thermodynamic phenomena such as

combustion, electromagnetism, and the discovery of mass-energy equivalence in the early twentieth century.

We do not need to reiterate this history in any detail here; what is important here involves realizing the exceptional breadth of phenomena that are fruitfully connected with the concept of energy. Over time, these insights have led to increasingly complex technologies for converting one kind of energy into another. windmills convert the linear movement of air into a rotating movement, steam engines convert chemical energy into a rotating movement via heat and pressure, solar panels convert the energy in sunlight into electricity, and, in our homes, our appliances convert electricity back into movement, light, heat, and sound. Arguably, all our activities are understandable simply in terms of converting one kind of energy into another.

There is a specific understanding of energy underpinning all these developments: a quantitative, abstract concept of "the ability to do work" that mutually interconnects a broad range of physical phenomena. This is the first philosophy of energy that we encounter, and most present-day natural scientists subscribe to some similar form of understanding energy. Although the unification of physical phenomena via the concept of energy has been exceptionally successful, conflicting conceptions of energy do exist. These conceptions are also the result of inquiry into the natural phenomenon of energy, but, rather than relating to the scientific, quantitative paradigm, they appeal to qualitative approaches.

The scientific understanding of energy has enabled society to plug into ever increasing amounts of energy in various forms, but it fails to say much about the *effects* of these developments on society.

As changes in energy practices became increasingly visible and influential in industrial societies, in the late nineteenth century, an interest in energy emerged in the area that can broadly be described as social critique. In the twentieth century, this was picked up by a few great thinkers, and here we do find some ideas on how society relates to energy, and how this relationship developed throughout history. Thinkers like Lewis Mumford, Georges Bataille, and Martin Heidegger fall into this category.

## Critique of energy in society

In his ground breaking book *Technics and civilization*, Lewis Mumford (2010 [1934]) places energy usage squarely in the middle of his analysis of society. From his perspective, there are four steps in the functioning of energy in society: conversion, production, consumption, and creation.

Some philosophical questions on the issue of energy at the service of the society and human existence in general comes to mind: Is there a maximum creation-to-conversion ratio? Are there different levels of energy consumption at which we attain the same quality of life, by organizing society differently?

However, before plunging into such questions, we take a step back and move onto the work of Georges Bataille, who contests the instrumental conception of energy proposed by Mumford. In *The accursed share*, Bataille (1991 [1949]) suggests that our energy practices are not instrumental to satisfying our needs, but rather it is the other way around; satisfying our needs is a way of dealing with the excessive emission of energy by the sun. Our growing energy production and consumption simply represent an extension of this natural tendency of life to look for ever increasing accumulation and niches to fill, and to burn off the excess when accumulation is not possible.

Meanwhile, spokespersons for green technology appeal neither to paths of ruthless fossil fuel exploitation nor to sober frugality. Instead, they tend to sketch Bataillean visions of abundance: "the Earth receives more energy from the Sun each hour than humans use in a year", implying that we simply need to better harness this energy and thereby avoid any such thing as an energy crisis. Another question to be raised could be: Why exactly would our lives become better should we command an even greater amount of energy?

Both Mumford and Bataille develop critiques against the energy practices of their day agreeing on how energy is not guided towards its proper purpose while disagreeing sharply on just what would constitute that proper usage.

One other twentieth-century thinker needs addressing in this context. Bataille appeals to our existence as individuals with access to a certain amount of energy. This represents a rather specific perspective on just what forms the human existence, with a similar perspective playing a key role in the writing of Martin Heidegger, for whom human existence changed radically with the advent of modern technology. Heidegger argues that, in modern times, the only way of understanding the world and ourselves is as a "standing-reserve" that is ready to be put to use. Stored energy proves the purest form of this standing-reserve.

Heidegger reaches this insight in his essay *"The question concerning technology"* (1977 [1954]), in which he searches for the essence of technology. This essence can be found, he holds, in the way that, that which is comes into being. In ancient Greece, the process of coming into being was called *poiesis*, a bringing-forth. This concept served both for that which emerged of its own accord (like a flower) and whatever had a specific creator (a poem, or a tool). Bringing-forth thus represented a particular form of "unconcealing" that which was previously concealed, one in which Aristotle's four causes have play. The general process of shifting from concealed to unconcealed was called revealing, from *aletheia, veritas* in Latin, and now usually translated as truth.

What is modern technology? It too is a revealing. Only when we allow our attention to rest on this fundamental characteristic does that which is new in modern technology show itself to us.

The tendency of modern technology to store and extract energy on demand features here as a crucial moment in history. It is the central characteristic of a new way of revealing.

The very way the world presents itself to us has been changed by this new way of revealing, which Heidegger proceeds to call *enframing [Ge-stell]*. But how does humanity relate to this enframing? Because modern technology remains a human invention, one might assume we control it or can at least remain outside of its scope, but this does not prove the case. Although we might have put it in place, we have no control over the way of revealing.

The inquiry into the natural phenomenon of energy and the critique of energy in society both point to the universal applicability of the concept.

A philosophy of energy might help tackle issues in energy transition via conceptual analysis, critical reflection on argumentation, and raising the level of abstraction, while also broadening the playing field by drawing from a range of sources. It also problematizes the concept of energy neutrality as the ultimate target for energy transition by emphasizing the importance of temporality in our energy systems.

The fact that energy is understood as something storable proves essential here. Energy is here patiently waiting; this represents what we propose calling *potentiality, something static* that can be put to use at the flick of a switch Heidegger notes how this is a new phenomenon; it is the merit of modern technology to have access to energy in the form of potentiality: "but does this not hold true for the old windmill as well? No. Its sails do indeed turn in the wind; they are left entirely to the wind's blowing. But the windmill does not unlock energy from the air currents in order to store it"[13].

Energy as conveyed in the example of the traditional windmill, will be more amenable to the philosophical concept of flux. The crucial difference between flux and potentiality therefore revolves around whether or not humanity *controls* it.

## Conclusion

In conclusion then, a generalized philosophy of energy will be able to deal with developments in what is known broadly as the energy transition. A philosophy of energy would be able to explore and clarify the space in which the so-called energy transition is taking place. The philosophy of energy would help in tackling issues inherent in energy transition through conceptual analysis, critical reflection on argumentation, and raising the level of abstraction, whilst simultaneously dening the playing field by drawing on a range of sources.

'Energy transition' is not simply a technological and economic problem but also an epistemological, cultural, anthropological and even metaphysical one. What will be the consequences of our necessary departure from 'petro-modernity', that is, from the mode of living that came with fossil fuels to modern times that shape our current age of the Anthropocene? The framework of the philosophy of light-energy in general and wind energy in particular will be able to raise ultimate questions on authentic existence and frugal comfort that electricity and energy need raises in the Nigerian context.

## Endnotes

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# India's first water bodies census released by Ministry of Jal Shakti

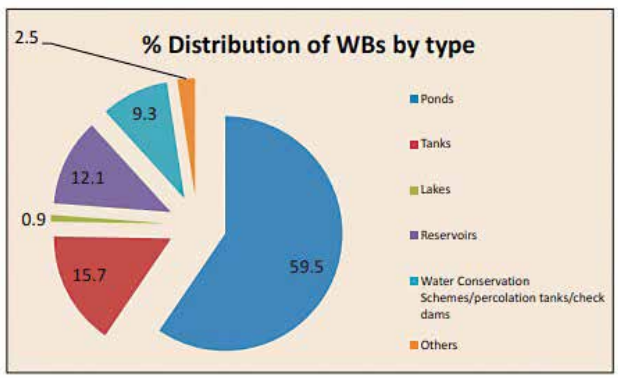
The Ministry of Jal Shakti has released the report of India's first water bodies census, a comprehensive data base of ponds, tanks, lakes, and reservoirs in the country. The census was conducted in 2018-19, and enumerated more than 2.4 million water bodies across all states and Union Territories.

In this census, water bodies are defined as follows.

All natural or man-made units bounded on all sides with some or no masonry work used for storing water for irrigation or other purposes (e.g. industrial, pisciculture, domestic/drinking, recreation, religious, ground water recharge etc.) will be treated as water bodies in this Census. These are usually of various types known by different names like tank, reservoirs, ponds etc. A structure where water from ice-melt, streams, springs, rain or drainage of water from residential or other areas is accumulated or water is stored by diversion from a stream, nala or river will also be treated as water body.

The objective of the Census of Water Bodies is to develop a national database for all water bodies by collecting information on all important aspects of the subject including their size, condition, status of encroachments, use, storage capacity, status of filling up of storage etc.

As per the report, 24,24,540 water bodies have been enumerated in the country, out of which 97.1% (23,55,055) are in rural areas and only 2.9% (69,485) are in urban areas. 59.5% (14,42,993) of water bodies are ponds, followed by tanks (15.7%, i.e 3,81,805), reservoirs (12.1%, i.e 2,92,280), Water conservation schemes/percolation tanks/check dams (9.3%, i.e 2,26,217), lakes (0.9%, i.e 22,361) and others (2.5%, i.e 58,884).

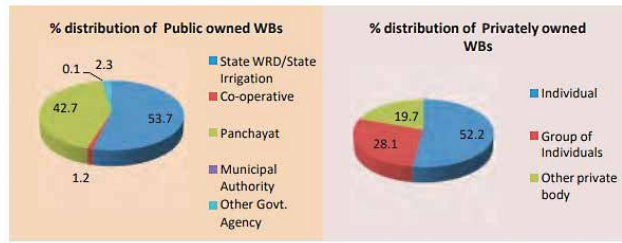



Maharashtra State is the leading state for water conservation schemes. Whereas West Bengal has highest number of ponds & reservoirs, whereas Andhra Pradesh has highest number of tanks, Tamil Nadu has highest number of lakes.

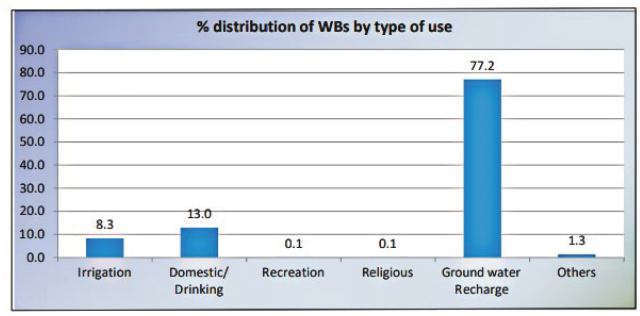
First census of water bodies was conducted with reference year 2017-18 across the country in 33 States/UTs except Daman & Diu, Dadra & Nagar Haveli and Lakshadweep. One of the many important things in this report is that Maharashtra is at the top in water conservation scheme category.

In 1st census of water bodies, 97,062 water bodies have been enumerated in the State of Maharashtra, out of which 99.3% (96,343) are in rural areas and the remaining 0.7% (719) are in urban areas. Majority of the water bodies are water conservation schemes as depicted from chart given below.

99.7% (96,767) water bodies are public owned whereas the remaining 0.3% (295) are under private ownership. This reflects the dominance of public entities in ownership of water bodies. Distribution of water bodies by type of ownership is shown in the charts given below.




Out of all water bodies in Maharashtra, 98.9% (96,033) water bodies are "in use" whereas rest 1.1% (1,029) are "not in use" on account of drying up, siltation, destroyed beyond repair and other reasons. Out of 'in use' water bodies, a major proportion of water bodies are used in ground water recharge followed by domestic/ drinking and irrigation purpose. Percentage distribution of water bodies by type of use is shown in the diagram given below.




Maharashtra's Aurangabad, Jalna and Nashik are among the top 5 Districts In Various Use Of Water Bodies.

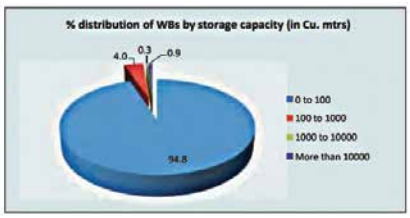
In the State of Maharashtra, there are 574 natural and 96,488 man-made water bodies. Out of 574 water bodies, 98.4% (565) are located in rural areas whereas remaining 1.6% (9) are located in urban areas. Out of 96,488 manmade water bodies, 99.3% (95,778) water bodies are located in rural areas and the remaining 0.7% (710) are located in urban areas. Most of the man-made

water bodies have original cost of construction between Rs.5 to Rs.10 Lakhs.

Based on the criteria of filling up of storage capacity during last 5 years, out of 5,403 water bodies, 63.2% (3,414) water bodies are found to be filled up every year, 35.8% (1,935) are usually filled up, 0.7% (38) are rarely filled up and 0.3% (16) are never filled up. Percentage distribution of water bodies by 'status of filling' and 'filled up storage capacity' is shown in the diagrams given below.

Out of all water bodies in Maharashtra , 60.7% (58,887) are covered in District Irrigation Plan/State Irrigation Plan. Among these 90.8% (53,449) are water conservation schemes/percolation tanks/ check dams and the remaining 9.2% (5,438) are tanks, lakes, reservoirs etc. Out of 'in use' water bodies, 82.5% (79,238) are benefitting one (01) city/ town, 17.1% (16,406) water bodies are fulfilling requirements of 2-5 cities/ towns and the remaining 0.4% (389) are benefitting more than five (05) cities/ towns. State has reported encroachment in 251 water bodies, out of which 233 are water conservation schemes/ percolation tanks/check dams.

In terms of storage capacity, 94.8% (92,026) water bodies in Maharashtra have storage capacity between 0-100 cubic meters whereas 4% (3,885) have storage capacity between 100 to 1,000 cubic meters.




Link to Download All India Report: https://jalshakti-dowr.gov.in/document/all-india-report-of-first-census-of-water-bodies-volume-1/ ;

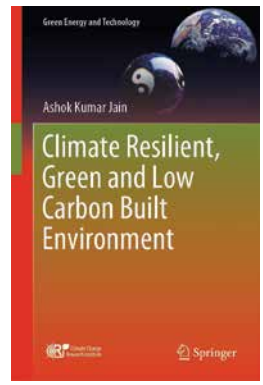
State Wise Report: https://jalshakti-dowr.gov.in/document/state-wise-report-of-first-census-of-water-bodies-volume-2

# Climate Resilient, Green and Low Carbon Built Environment

*Ashok Kumar Jain*, 2023 Springer Nature, Singapore, ISBN 978-981-99-0215-6, p xxi + 263

Climate change has become an imminent reality with a rise in temperatures, intense heat waves, and carbon emissions. The United Nations under the Paris Agreement has committed to limit global warming to 1.5 degree Celsius. This necessitates reducing the use of fossil fuels and replacing them by new sources. This also involves a paradigm shift towards urban planning which integrate the ecology, built environment, service networks, transport and heritage.

Christopher Benninger in his Foreword states: *The book Climate Resilient, Green and Low Carbon Built Environment owns up to the responsibility of fixing integrated urban systems in an organic, yet correctly technical manner. The book emerges as a "manual for urban planning and management," that every urbanist should read and understand. A.K. Jain brings into play profound personal attributes that no other urban thinker in Asia holds. He is India's most experienced urban planner and policy maker, nurtured through his years in public service. He has enriched this saga of experience, with the devoted curiosity of a true guru, with unbound intellectual energy and passion, sharing his thoughts through his years of writing."*




According to the author, the plans of built environment should adopt a circular loop integrating 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.). The breakthrough in digital technology and informatics can help in the engagement of citizens for on-line participation and services by adopting the GIS, SDI, big data analytics, ERP solutions, digital dashboard, blockchain, AI, ML DL, etc. According to the author, for a transition towards a climate resilient, net zero and low carbon urban development, digital processes Smart chips can be embedded almost in every urban services. With digital chips, cities are increasingly getting digitally scripted and coded. The urban plans should converge with the recent flagships of Government of India, viz. Sustainable Urban Networks for Dynamic and Resilient (SUNDAR) India and Lifestyles for Environment (LiFE) Missions.

A.K. Jain suggests a compact urban pattern which reduces the need to travel, a finer grid of roads and closely spaced cycle track and pedestrians' walkways. It is also necessary to digitise all the parking spaces including under stilts, adoption of single ticketing and restructuring of land uses with a compact urban pattern by transit-oriented development.

According to the author, air quality and reduction in carbon emissions are significant in minimising air pollution. For this, it is essential to identify the sources and chalk out the options to check air pollution. Airshed planning, use of cooler and light shaded surfaces/materials, prefabricated and recycled materials can help in reducing urban heat, air pollution and dust.

In conclusion, it is worth quoting Dr. Malti Goel, who states *'A. K. Jain, has a rare quality of forging his vast practical experience with academics, and his intellectual discourse draws attention to various challenges for taking climate action relating to the built environment. The book is a fantastic encounter for the planners, engineers, and developers engaged with achieving Sustainable Development Goals. It will be a valuable addition to the list of seminal books on the subject'.*

## India to set up task force for land governance in North-Eastern states

A task force will be set up for land governance in the North-Eastern states, according to the Union Rural Development Ministry. The decision was taken at the recently concluded National Conference on "Land Governance in North Eastern States" held in Guwahati, Assam. The territorial and autonomous district councils in the states of Assam, Tripura, Mizoram and Meghalaya held that digitisation and modernisation of land records is essential for development in the region. *www.ptinews.com*

## ProjectReady extends Autodesk Construction Cloud integration

ProjectReady has announced an expanded integration with Autodesk Construction Cloud, a portfolio of software and services that combines advanced technology, a builders network and predictive insights for construction teams. The platform works as an integrated data environment (IDE) to improve collaboration through the integration of systems and common data environments used by AEC industry professionals and project owners. *www.project-ready.com*

## CGI and Ordnance Survey develop water pollution predictive tool

CGI, in partnership with Ordnance Survey, has developed an initiative designed to remotely detect sewage overspill events from space.

The project will utilise a newly created artificial intelligence (AI) model that can predict with high levels of accuracy the conditions most often associated with pollution events.

This is the latest project undertaken by CGI's Sustainability Exploration Environmental Data Science (SEEDS) programme, a research initiative designed to challenge the thinking and practice around sustainability in partnership with academia, launched with the United Nations last year. *www.cgi.com*

## Sanborn pioneers the Digital Twin Base Map

Sanborn's Digital Twin Base Map is a high-resolution 3D map providing reliable mapping information. The mapping captures the full complexity of an entire city or region's infrastructure and environment in a single, integrated data set.

Sanborn creates its Digital Twin Base Maps using a combination of remote sensing data, high-quality aerial photography, and advanced machine learning algorithms that can detect and model everything from buildings and streets to vegetation and topography.

Its most recent Digital Twin Base Map delivered to a proprietary customer covers more than 400 square miles (about the area of San Antonio, Texas), and is built to a specification of 3-inch resolution with an accuracy of 2 pixels RMSE. *www.sanborn.com*

## NHAI to create around 10,000 km of digital highways by FY 2024 – 25

National Highways Authority of India (NHAI) is working towards development of around 10,000 km of Optic Fibre Cables (OFC) infrastructure across the country by FY2024-25. National Highways Logistics Management Limited (NHLML), a fully owned SPV of NHAI, will implement the network of Digital Highways by developing integrated utility corridors along the National Highways to develop OFC infrastructure. Around 1,367 km on Delhi - Mumbai Expressway and 512 km on Hyderabad - Bangalore Corridor have been identified as pilot routes for the Digital Highway development.

The OFC network will help to expedite the roll out of new age telecom technologies like 5G & 6G. Recently inaugurated, 246 km long Delhi – Dausa – Lalsot section of the Delhi - Mumbai Expressway features a three-meter-wide dedicated utility corridor used to lay Optical Fibre Cables, which will serve as the backbone for the roll out of the 5G network in the region. OFC laying work along the National Highways has started and is targeted for completion in about a year.

OFC network will allow direct plug-and-play or 'Fibre-on-demand' model for the Telecom / Internet Services. The network will be leased out on a Fixed Price Allotment mechanism on 'Open for All' basis through a web portal to eligible users. OFC allotment policy is being finalized in consultation with DoT and TRAI. *https://pib.gov.in*

## 40x reduction in real-time mapping costs

Nexar has achieved a dramatic 40x reduction in the cost of real-time mapping by leveraging cutting-edge technologies, edge AI, change detection, and crowdsourcing. Real-time mapping has become increasingly crucial, particularly as an enabler of advanced mobility services, autonomous vehicles, and smart city initiatives. However, traditional map-making methods can't keep up with the demand for real-time data due to their high costs and labor-intensive processes. Typically, mapping involves deploying fleets of dedicated vehicles and employing manual data annotation. As a result, conventional mapping techniques are prohibitively expensive and produce outdated map layers, limiting their utility in modern, data-driven applications. *nexar.com*

## Esri India launches ArcGIS Business Analyst

Esri India announced the availability of ArcGIS Business Analyst, a location intelligence solution suite designed to aid organizations in making data-driven smart decisions.

The suite for India will include a variety of location-based datasets, such as points of interest; road network; accurate boundaries at various levels like village, PIN codes, district, state, etc.; socio-economic and demographic data; and data available from Esri's Living Atlas. Live road traffic information will also be available. *www.esri.in*

## Saudi geospatial authority to align with UN framework

Geospatial studies, map production and marine surveys in Saudi Arabia will soon be on par with global standards as the Kingdom is set to align its projects with the UN framework in this pioneering field. According to the Saudi Press Agency, the General Authority for Survey and Geospatial Information participated in the inaugural meeting of the international advisory committee of its UN counterpart between April 20 and 22 in Deqing, China. The experience of the GASGI in developing a national strategy in line with global standards prescribed by the UN's Global Geospatial Knowledge and Innovation Centre Framework was highlighted during the meeting.

Mohammed bin Yahya Al Sayel, president of the GASGI, reviewed the experiences of member states and emphasized the importance of the nine strategic pathways outlined in the Integrated Geospatial Information Framework. These cover governance and institutions, legal and policy, and financial and data standards. They also take in innovation, partnerships, capacity and education, and communication and engagement. According to Al Sayel, these nine strategic pathways provide guidance for addressing challenges in the survey and geospatial information sector.

Saudi Arabia signed a deal with the UN last April to offer consultation services in the geospatial survey to boost its national capacity. *www.arabnews.com*

## NUVIEW to map the entire globe in 3D with LiDAR

NUVIEW is building the world's first commercial LiDAR satellite constellation which will map the entire land surface of the Earth in 3D for the first time ever. This revolutionary approach to data collection will transform our understanding of the Earth's surface, driving innovation and progress across numerous industries in real time. *nuview.space*

## Isro to launch navigational satellite for its constellation in May end

The Indian Space Research Organisation (ISRO), in the third launch of the year, will fly NVS-01 to augment the seven-satellite navigation constellation NavIC on May 29. Not only will it be the first launch of a navigational satellite under the new moniker NVS, but it will also beat the space agency's record during the three pandemic years. There were only two Isro launches each in 2020, 2021, and 2022.

The NVS-01 satellite will replace the navigational capabilities of another satellite IRNSS-1G in the constellation. It will retain its communication and messaging capabilities. The navigational capabilities of a couple of satellites were hampered after the atomic clocks on board malfunctioned. The location of objects for satellite-based navigation is determined by very precisely measuring the time it takes for the signals to return from the ground.

After the failure of some of the imported atomic clocks, India decided to develop its own atomic clocks as well. One of the satellites IRNSS-1A was replaced by the space agency in 2018 – the first replacement satellite launched in 2017 was lost after the heat shield containing the satellite did not open when it was supposed to. *https://indianexpress.com*

## Japan plans expansion of homegrown GPS network to 11 satellites

Japan intends to increase the number of satellites in its GPS-style system to 11 from four. Tokyo's space policy committee has set a goal to expand the Michibiki Quasi-Zenith Satellite System, a network of satellites in geosynchronous orbit above Japan and Australia.

Receiving signals from Michibiki as well as American GPS satellites allows users in the Asia-Oceania region to know their locations with an accuracy of several centimeters.

The first Michibiki satellite was launched in 2010 on a Japanese H-IIA rocket. The system has operated with four satellites since 2018. The current Michibiki system with four satellites acts in a supplementary role to GPS. With seven satellites, the system can work on its own without GPS, but the accuracy would be poor because signals cannot reach users in mountainous areas or near skyscrapers. *https://asia.nikkei.com*

## Indigenous chip for NavIC-based satellite navigation

Elena Geo Systems, a Bengaluru-based space technology firm recently unveiled a chip that could form the core of navigation, positioning and timing applications in India. The chip works using Navigation with Indian Constellation (NavIC) or the Indian Regional Navigation Satellite System (IRNSS) satellites. The chip was recently handed over to the Chief of Defence Staff General Anil Chauhan in the presence of Dr. Samir V Kamat, Chairman of Defence Research and Development Organization (DRDO) and Chief of Air Staff Air Chief Marshal Vivek Ram Chaudhari. *www.indiatoday.in*

## Carlson debuts new RTK engine

Carlson Software has announced a major advance in GNSS positioning technology with an entirely new RTK engine – Gama. It is named after famed explorer and navigator, Vasco da Gama. Developed by Carlson's navigation group, Gama is also being debuted with the Carlson RTk5 GNSS solution.It has undergone extensive testing under a wide selection of extreme trial scenarios, including under thick tree canopies, in urban and suburban environments, in close proximity to buildings and walls, and more. *https://carlsonsw.com*

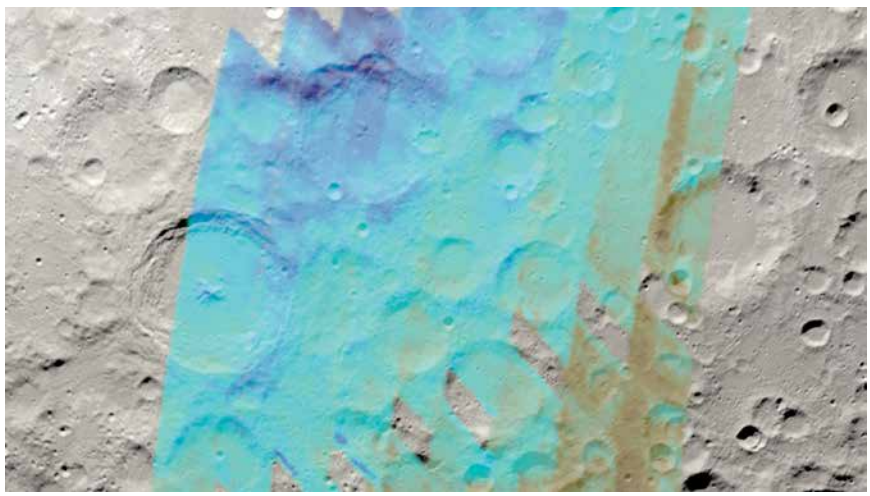
## Syntony GNSS partners with Xona Space Systems

Syntony GNSS and Xona Space Systems have partnered to integrate the low-Earth-orbit (LEO) position, navigation and timing (PNT) constellation from Xona into GNSS simulators and receiver solutions from Syntony. *https://syntony-gnss.com*

# Study reveals map of moon's water near its south pole

A new study using the now-retired Stratospheric Observatory for Infrared Astronomy (SOFIA) has pieced together the first detailed, wide-area map of water distribution on the Moon. SOFIA was a joint project of NASA and the German Space Agency at DLR. With clear, identifiable lunar features marked out by the water data, the study provides hints about how water may be moving across the Moon's surface, particularly near its South Pole - an important area for space exploration.

The new map covers about one-quarter of the Earth-facing side of the lunar surface below 60 degrees latitude and extends to the Moon's South Pole. Given the large region covered, the researchers could easily identify how water relates to surface features on the Moon, staying away from sunlight and favoring cold areas.



Credits: NASA's Goddard Space Flight Center Scientific Visualization Studio/Ernie Wright

"When looking at the water data, we can actually see crater rims, we see the individual mountains, and we can even see differences between the day and night sides of the mountains, thanks to the higher concentration of water in these places," said Bill Reach, director of the SOFIA Science Center at NASA's Ames Research Center in California's Silicon Valley and lead author on the study, which was presented at the 2023 Lunar and Planetary Science Conference.

In late 2024, NASA's Volatiles Investigating Polar Exploration Rover (VIPER) will land in the region studied by SOFIA, atop Mons Mouton, to conduct the first resource mapping mission beyond Earth. The flat-topped lunar mountain will be a region of emphasis in the next paper from the team that led the current study of SOFIA data.

This current finding, along with two previous SOFIA results about the amount and distribution of water on the Moon's sunlit surface, tracks a unique light signature of water. Other missions observing wide areas of the lunar surface have studied different wavelengths of light, which can't distinguish water from similar molecules, such as hydroxyl. The Moon's water is present in the soil and might be found as ice crystals, or as water molecules chemically bound to other materials. Instead of determining the absolute quantity of water in the region, the researchers compared the data obtained around the Moon's South Pole to a relatively dry reference region near the Moon's equator to see how its abundance changes. The water was found in greater concentrations on the shadowed sides of craters and mountains, similar to the way skiers on Earth know the slopes receiving less direct sun retain snow longer. This suggests the Moon's local geography plays an important role in the amount of water present.

As NASA prepares to send astronauts back to the Moon under Artemis, the agency has identified 13 candidate landing regions near the lunar South Pole. Through Artemis, NASA will land the first woman and the first person of color on the Moon, and lunar water could be a critical resource for establishing a long-term human presence.

"With this map of SOFIA data, and others to come, we are looking at how water is concentrated under different lunar environmental conditions," said Casey Honniball, a visiting assistant research scientist and VIPER science team member at NASA's Goddard Space Flight Center, in Greenbelt, Maryland, who was involved in the work. "This map will provide valuable information for the Artemis program on potential prospecting areas but also provides regional context for future science missions, like VIPER."

In addition to the southern region for which the new map results were created, SOFIA observations of sites relevant to other missions are in the archive and now being analyzed. NASA Artemis-related missions will target both polar and non-polar regions, including Lunar Trailblazer, which will orbit the Moon to map its hydroxyl and water.

Where the Moon's water may be coming from — whether it is ancient and exists inherently in the Moon's minerals as a result of early volcanic processes on the Moon or is contemporary and delivered by asteroids, comets, or solar wind, and whether it is migrating along the Moon's surface - is another important question left open by the SOFIA observations. VIPER will aim to better understand this distinction, which is important in determining if the water is widespread and deep within the surface, or only scattered at or near the surface. It's clear, however, that even at its lowest limit, the Moon contains much more water than we once believed.

Anashe Bandari, SOFIA Science Center, NASA's Ames Research Center. *www.nasa.gov*

## Scientific studies to monitor the changes in Himalayan glaciers

Climate change and its impact on glaciers remains a global challenge which requires global efforts and actions. Government of India is committed to protect the glaciers and has made efforts to reduce the impact through several adaptation and mitigation measures. This includes a number of programmes under National Action Plan on Climate Change. Various R&D projects are being supported for studying Himalayan Glaciers under the National Mission for Sustaining Himalayan Ecosystem and National Mission on Strategic Knowledge for Climate Change.

Several areas in the Himalayan States have also been declared as National Parks or Protected Areas, such as, Gangotri National Park, Nanda Devi Biosphere Reserve, and Great Himalayan National Park. In addition, Wadia Institute of Himalayan Geology, National Centre for Polar and Ocean Research, Geological Survey of India and Indian Space Research Organization has been carrying out regular scientific studies to monitor the changes in Himalayan glaciers.

The final outcomes at the Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) are in the form of various decisions agreed to by consensus of all the Parties following extensive negotiations, while taking into consideration the principles of Common but Differentiated Responsibilities and Respective Capabilities in the light of different national circumstances, as applicable to developing countries. *https://pib.gov.in*

## GIS data for Pradhan Mantri Gram Sadak Yojana

The Ministry of Rural Development has released Geographic Information System (GIS) data developed for the Pradhan Mantri Gram Sadak Yojana (PMGSY) scheme in public domain. Under PMGSY-III, more than 7.70 lakh rural facilities such as medical, educational and markets have been geo-tagged. Details of rural roads are available in public domain at https://geosadak-pmgsy.nic.in/opendata. The GIS data created under PMGSY National GIS guideline is not just of rural areas, but serves as a holistic national geo-spatial dataset including urban areas, National Highways, State Highways and Railway tracks, etc. GeoSadak has been developed utilizing fully indigenous GIS data layers and satellite data services. *http://pmgsy-grris.nic.in*

Pradhan Mantri Gram Sadak Yojna (PMGSY) was launched as a one-time special intervention to provide rural connectivity, by way of a single all-weather road, to the eligible unconnected habitations in the core network for uplifting the socio-economic condition of the rural population. Various impact assessment studies that have been carried out by Independent Agencies have concluded that PMGSY has helped in better access of marketplace for the rural masses and generated employment in various forms. It has also helped in improving socio-economic condition of people living around the area. Thus, it has helped in removing poverty and unemployment. The scheme has impacted agriculture, health, education, urbanization and employment generation in a big way. *www.pib.gov.in*

## Upto 100% FDI in space sector through Government route only

According to Dr Jitendra Singh, Union Minister of State (Independent Charge) Science & Technology, presently FDI in space sector is allowed up to 100% in the area of Satellites-Establishment and Operations through Government route only. In a statement laid on the table of the Rajya Sabha he said, Indian National Space Promotion and Authorization Centre (IN-SPACe) being the regulatory and promotional body for space activities was involved in revision of FDI policy which is presently under consideration of the Government. The specific role of IN-SPACe for channelizing FDI will evolve after approval of revised FDI policy by the Government. *https://pib.gov.in*

## Flood Affected Area Atlas of India

At the behest of the National Disaster Management Authority (NDMA), National Remote Sensing Centre (NRSC), ISRO has prepared the Flood Affected Area Atlas for India using the available historical satellite datasets spanning over 25 years (1998 to 2022). Flood affected area maps are one of the very important non-structural methods of flood damage mitigation. These maps are useful in planning and regulating developmental activities in flood plains, construction of relief, rescue, and health centres. Satellites provide synoptic observations of the natural disasters at regular intervals that help in disaster risk reduction in the country. Over a period of time, NRSC, ISRO has created a repository of large data pertaining to the floods & cyclones in different areas of the Country. These historical flood maps are useful for identification of flood affected areas.

Indian Remote Sensing (IRS) satellite and foreign satellite datasets (optical and microwave) during this period were acquired covering different flood magnitudes in India and used in generating the flood affected area maps after its thorough analysis. Water levels of various gauge stations during the period 1998 to 2022 has been obtained from Central Water Commission and used for the preparation of flood affected area atlas of India. These state level flood maps are validated by the state disaster management organizations of major flood-prone states.

District / State wise flood affected area statistics were presented along with the State Maps and India Map in the Atlas. Digital spatial maps are hosted on National Database for Emergency Management (NDEM) geoportal of ISRO. The Atlas would be useful as a resource of information for policy makers, planners and civil society groups and find its value towards flood risk evaluation, sustainable development and flood mitigation efforts in India. This atlas will be useful in preparing disaster management action plans at state level and in disaster risk reduction in the country. *www.nrsc.gov.in*

## Vexcel announces complimentary access to high-resolution imagery

Vexcel Data Program has announced free access to aerial imagery in Australia and New Zealand through its web-based platform, Viewer. Providing aerial data to end users at zero cost improves a user's ability to solve some of the most pressing problems of today with enhanced visualisation and analysis tools. This foundational experience with Vexcel imagery helps drive more accurate and informed decision-making, such as remote inspection of assets, monitoring change at a location, detecting surface details, and so much more. The readily accessible data is available immediately and supports multiple industries, from government to construction, landscaping to solar, roofing to utilities and beyond. *https://vexceldata.com*

## Satellite data to transform disaster response in Southeast Asia

Synspective and Thaicom will supply a joint solution to government, defense, agriculture, and finance sectors in Thailand that enhances disaster response, environmental monitoring, agricultural productivity, and infrastructure planning. The collaboration will combine Synspective's expertise in SAR technology and Thaicom's knowledge in the satellite and space technology in Thailand. *https://synspective.com*

## Dhruva Space space-qualifies 3U and 6U Satellite Orbital Deployers

Dhruva Space has announce the successful test and Space-qualification of its 3U and 6U Satellite Orbital Deployers and Orbital Link onboard Indian Space Research Organisation's PSLV-C55 mission. The launch took place at 14:20 IST on 22 April 2023, from the First Launch Pad at Satish Dhawan Space Centre (SDSC) in Sriharikota, Andhra Pradesh.

For the PSLV C55 mission, Dhruva Space utilised the PSLV Orbital Experimental Module (POEM) which allows in-orbit scientific experiments using the spent PS4 stage as an orbital platform.

Given interfacing of the Spacecraft with the Launch Vehicle is a critical component to deployment of satellites, the company has indigenously developed satellite deployment systems that are compatible with the PSLV Launch Vehicle. The 6U Satellite Orbital Deployer (DSOD-6U), designed for the storage and delayed deployment of CubeSats into Low Earth Orbit and higher orbits, rounded off a mission success with confirmation of long–duration/planned delayed deployment. *www.dhruvaspace.com*

## Planet, AXA Climate partnership

Planet Labs announced the extension of its strategic partnership with AXA Climate, a company that provides consulting services to the agri-food, industrial, financial, and public. The extension aims to offer continued satellite data-driven insights for the development of parametric insurance products, which help protect farmers against the effects of drought on their livelihoods. *planet.com*

## Inspired Flight and Phase One partnership

Inspired Flight Technologies and Phase One have jointly launched a new plug-and-play solution that combines aerial imaging and flexible operations to meet diverse surveying and inspection needs. The solution integrates the Inspired Flight IF1200A and the Phase One P3 camera, providing customers with an exceptional opportunity to increase their data quality, end-to-end productivity and operational safety using a proven UAS platform. *https://inspiredflight.com*

## Correlator3D Version 10 by SimActive

SimActive Inc. released Correlator3D Version 10. New capabilities also include adding oblique imagery to improve results, colorizing photogrammetric point clouds during their generation and advanced filtering to eliminate less accurate points. *www.simactive.com*



## Pony.ai receives permit for passenger transport in Guangzhou

Pony.ai received a permit for fully driverless autonomous vehicle passenger transport in Guangzhou, China. In an 803 square kilometer (310 square mile) area in Guangzhou's Nansha District, riders will have the opportunity to enjoy safe, convenient and comfortable fully driverless robotaxi services by placing orders through the PonyPilot+ app to locations such as high-speed rail stations, subway stops, parks, and business and residential districts. *www.pony.ai*

## Haomo.ai releases DriveGPT

Chinese autonomous driving company Haomo.AI Technology launched its large model DriveGPT. It adopts a generative pre-training Transformer, while the input is text sequence after perceptual fusion and the output is text sequence of the autopilot scene. The autopilot scene is tokenized to form a "Drive Language" for the vehicle to generate an action decision. *www.chinadaily.com.cn*

## Bosch and Plus collaborate

Bosch and Plus are collaborating to make software-defined commercial trucks a reality. Plus is offering its PlusDrive solution with the integrated steering system from Bosch featuring hardware and software to deliver driver assistance and partially automated features to commercial vehicles. The announcement was made at the Advanced Clean Transportation (ACT) Expo in Anaheim, California. *www.bosch.com*

## Porsche and Mobileye launch SuperVision collaboration

Mobileye has announced its strategic collaboration with Porsche to provide Mobileye's SuperVision™ premium advanced driver assistance systems in future Porsche production models. This new effort builds on the strategy of advancing autonomy through evolution. *www.mobileye.com*

## Seoul Robotics unveils intersection traffic solution

Seoul Robotics has announced a comprehensive end-to-end intersection traffic solution that transforms raw 3D data into actionable insights for traffic controllers. The new solution adds a layer of intelligence to 3D perception that goes beyond the capabilities of legacy traffic management systems by interpreting real-time data and driving critical roadway decisions that improve mobility and ensure pedestrian safety.

The solution collects and analyzes data through SENSR-I, the infrastructure-based version of Seoul Robotics' patented 3D perception platform, SENSR™. It uses deep learning AI to simultaneously track, detect, and identify vehicles, bicycles and pedestrians to create a digital twin of the environment. This provides traffic controllers insights for real-time decision-making to enable cities to enhance mobility and safety by accurately identifying and addressing road risks. *www.seoulrobotics.org*

## Vimaan launches new StorTRACK

Vimaan has announced the all new StorTRACK, the next generation in cycle counting technology that addresses the ongoing challenge of warehouse inventory accuracy. It conducts automated scanning of warehouse shelves and uses advanced machine learning to read labels, count inventory, reconcile against a WMS, and generate a visual and digital reconstruction of the warehouse, thus enabling 100% inventory accuracy. *vimaan.ai*

## Saudi Arabia to benefit from new satellite IoT services

iot squared, an Internet of things (IoT) technology company and a joint venture between Saudi Arabia's Public Investment Fund (PIF) and stc Group (stc), has signed a MoU with OQ Technology. Through this partnership, OQ Technology will provide satellite IoT connectivity services and products to iot squared and support the technical development of its products and services. *www.oqtec.space*

## SBG Systems unveils Ekinox Micro

SBG Systems has released Ekinox Micro, a compact and rugged high-performance inertial navigation solution designed to deliver unmatched accuracy in even the most challenging environments.

Combining high-performance MEMS tactical inertial sensor with a quad-constellation, dual-antenna GNSS receiver, Ekinox Micro is the logical choice for mission-critical applications. It meets theMIL-STD-461, MIL-STD-1275, and MIL-STD-810 standards, ensuring reliable and accurate performance even in the harshest environments.

Measuring just 4.2 x 5.7 x 6.0 cm and weighing only 165 g, Ekinox Micro is small and lightweight, yet rugged enough to handle any application. It includes pre-configured motion profiles for land, air, and marine applications, allowing the sensor and algorithms to be tuned for maximum performance in any condition. One of the features of Ekinox Micro is its dual-antenna GNSS receiver for heading. However, field-proven algorithms also allow maximum performance even in single-antenna mode for all but lowest dynamics applications. *www.sbg-systems.com*

## Autonomous mobile mapping solution by Leica

Leica Geosystems, part of Hexagon, has announced the latest addition to its Leica Pegasus TRK portfolio of mobile mapping solutions, the Leica Pegasus TRK100. The new mobile mapping system features the same modular hardware approach allowing users to add more cameras to expand the range of use cases.

It is designed to excel in GIS mapping and asset management applications, providing essential location intelligence for georeferenced visual data. Tailored for GIS professionals, it empowers them to transform their business operations. *https://hexagon.com*

## Hesai Technology partnership agreement with Inertial Labs

Hesai Technology (HSAI) announced a multi-year Technology Partnership Agreement for lidar sensors with Inertial Labs. Inertial Labs selected Hesai's sensors to provide perception and navigation capabilities for its navigation systems for autonomous marine, land, and aerial-based robotics systems.

Hesai's lidar sensor solutions enable robotics systems to operate autonomously and safely without human intervention. The sensors provide real-time 3D point cloud data for localization, obstacle detection, and path planning. Hesai's low-power sensors support autonomous mobile systems in various outdoor environmental conditions, including precipitation from rain, snow & fog. *https://inertiallabs.com*

## Trimble introduces precise positioning solution

Trimble, announced the Trimble PX-1 RTX solution for accurate and robust positioning and heading for commercial drone delivery applications. It allows drone integration companies to add precise positioning capabilities so operators can more efficiently plan and execute takeoff, navigation and landing tasks as drone delivery advances to take on more challenging operations.

The Trimble PX-1 RTX leverages Trimble's CenterPoint RTX corrections and small, high-performance GNSS-inertial hardware to provide real-time, centimeter-level positioning and highly accurate inertial derived true heading measurements. *www.trimble.com*

## Harxon releases helix antenna series

Harxon has added to its helix antenna family with a series of four devices that are suitable for unmanned system applications.

HX-CUX012A is designed with extremely low profile, making it suitable for integration into UAVs, surveying and monitoring devices. It reduces

the overall weight of applications, enables multipath mitigation and more. *https://en.harxon.com*

## Adtran and Satelles partnership

Adtran®, Inc and Satelles, Inc. announced a strategic partnership. The collaboration will enable operators of critical infrastructure to safeguard their timing networks with Satellite Time and Location (STL) technology. By integrating Satelles' STL into its Oscilloquartz network synchronization products, Adtran will provide an alternative to GNSS systems or a way to augment them with enhanced reliability and security. With the ability to deliver highly precise PNT service, even in GNSS-denied applications, STL offers a vital resource for mobile operators, power utility companies, government, scientific research and more.

STL provides augmented and secure backup for GPS or other GNSS by harnessing encrypted signals transmitted via LEO satellites. It ensures timing and location information that is highly precise, robustly secure, and accessible worldwide. *www.adtran.com*

## HC871SXF GNSS helical antenna by Tallysman

Tallysman® Wireless Inc. has released the dual-band low-profile HC871SXF to its industry-leading line of helical GNSS antennas. The dual-band GNSS antenna is designed for precise positioning, covering the GPS/QZSS-L1/L2, GLONASS-G1/G2, Galileo-E1, and BeiDou-B1 frequency bands, including the satellite-based augmentation system (SBAS) available in the region of operation [WAAS (North America), EGNOS (Europe), MSAS (Japan), or GAGAN(India)]. *www.tallysman.com*

## SingularXYZ launches NEW Sfaira One GNSS receiver

Singular XYZ has released the Sfaira One GNSS receiver. The portable size, centimeter-accurate receiver provides users with an entry-level network real time kinematic (RTK) rover. It is equipped with a GNSS module with 1,408 channels for GPS, BDS, GLONASS, Galileo and QZSS tracking — providing centimeter positioning in harsh environments. It also features advanced RTK and an anti-interference algorithm. *https://singularxyz.com*

## NavGuard solution by Asio Technologies

Asio Technologies announced the successful completion of several demonstrations of its NavGuard optical navigation system to strategic customers in the United States. The demonstrations were conducted in response to defense and civil customer requests. They involved drones performing aerial navigation activities as well as automatic door-to-door delivery of packages over urban and rural areas without relying on GNSS signals.

NavGuard is a real-time optical navigation system that enables precise, autonomous GNSS-free navigation for tactical UAS platforms, making it an ideal solution for tactical drone missions where payload capacity and flight time are limited, and continuous operation under all conditions is critical. *www.Asiotech.com*

## Final demonstration for the iMUGS European defense project

Final demonstrations for the iMUGS (Integrated Modular Unmanned Ground System) defense project took place at the San Juan del Viso military grounds in Madrid (Spain) by GMV. That project's primary objective is to increase the European Union's defensive capabilities and strategic autonomy, and its mission is to develop the standard European unmanned ground system (UGS), by integrating robotics systems into the manned technology that European defense forces already have available.

The demonstration used two THeMIS UGVs, manufactured by Milrem Robotics, Europe's leading developer of robotics and autonomous systems, and modified by other companies participating in the project. These vehicles are equipped with autonomous functions, both individually (one UGV can receive a mission and complete it in an isolated manner, with no operator involvement) and as swarms (various UGVs can be combined as a single team and given a mission, performing self-management to achieve the objective). *www.gmv.com*

## ComNav releases GNSS solution for robotic lawn mowers

Comnav Technology has released the U702 datalink module, an RX/TX data link module that supports the LoRa modulation technique. Its compact, surface-mounted design and robust electromagnetic compatibility enables easy integration into GNSS systems such as robotic lawn mowers. *www.comnavtech.com*

## Cardinal module integrated into UVify Omega drone platform

Rajant Corporation announced the integration of its latest Cardinal module with UVify's OMEGA drone platform. It is a powerful, lightweight, and notably the smallest dual-radio platform within Rajant's portfolio of industrial wireless nodes. It supports applications like drone swarms for military applications, track verification systems for rail maintenance, inventory management for smart warehousing, industrial security and mapping for large enterprise sites, and drone light shows. *https://rajant.com*

## HevenDrones partnership with RV Connex

HevenDrones and RV Connex has signed a MoU aimed at developing a national smart drone technology ecosystem in Thailand.

The MoU will span key economic sectors including defense, cyber security, IoT and logistics. It will work with HevenDrones to introduce cutting-edge advancements into Thailand's existing drones market across the public, private and military sectors, in particular, the use of hydrogen-powered drones, as well as smart IoT-connected control centers. *www.hevendrones.com*

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## MARK YOUR CALENDAR

### June 2023

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

**International Technical Symposium on Navigation and Timing (ITSNT 2023)**
28 – 30 June
Toulouse, France
**https://itsnt.fr**

### July 2023

**Esri User Conference**
10–14 July, 2023
San Diego, CA, USA
**www.esri.com**

**IUGG 2023**
11-20 July
Berlin, Germany
**www.iugg2023berlin.org**

**Surveying and Geomatics Educators' Society (SaGES) 28th biennial conference**
16-20 July
University of Calgary, Canada
**https://wpsites.ucalgary.ca/sages2023**

**IGAARS 2023**
16 - 21 July
Pasadena, CA, USA
**https://2023.ieeeigarss.org**

### September 2023

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

**ION GNSS+ 2023**
11-15 September
Denver, Colorado, USA
**www.ion.org**

**European Lidar Conference (ELC)**
13 – 15 September
Cluj-Napoca, Romania
**https://enviro.ubbcluj.ro**

### October 2023

**Asian Conference on Remote Sensing (ACRS 2023)**
30 October to 3 November
Taipei, Taiwan
**https://acrs2023.tw**

**Intergeo 2023**
10-12 October
Berlin, Germany
**www.intergeo.de**

### November 2023

**Trimble Dimensions 2023**
6-8 November
Las Vegas, USA
**www.trimble.com**

**18th International Conference on Location Based Services (LBS 2023)**
20-22 November
Ghent, Belgium
**https://lbs2023.lbsconference.org**

## Drone Nerds launches Cinematography Drone

Drone Nerds has launched cinematography drone, the DJI Inspire 3. It features the same Zenmuse X9 camera that is featured on the Ronin 4D; this camera also offers dual-native ISO to capture crystal clear images. With advanced RTK functionality, the Inspire 3 allows pilots to plan more precise flights. It can fly through industrial areas with high concentrations of metal, concrete, or magnetic interference with built-in dual antennas. *dronenerds.com*

## ROCK Robotic Introduces R3 and R3PRO LiDAR

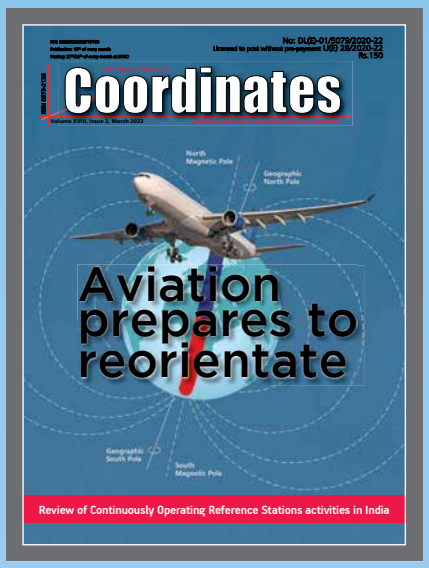
LiDAR technology company ROCK Robotic launched the R3 and R3 PRO systems. The R3 product line introduces sophisticated hardware components into a lightweight, integrated 3D point cloud collection tool. Inside the new ROCK R3, there is a cutting-edge technology, including a geodetic-grade GNSS receiver and tactical-grade IMU. The R3 PRO comes equipped with a Hesai Pandar XT32 sensor. *www.rockr3pro.com*

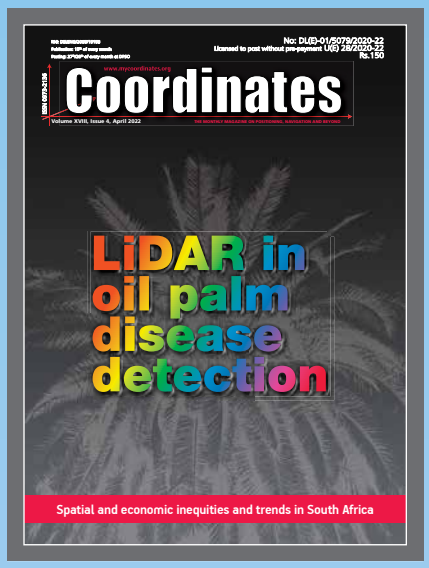
## Cesium partners with Google Maps platform

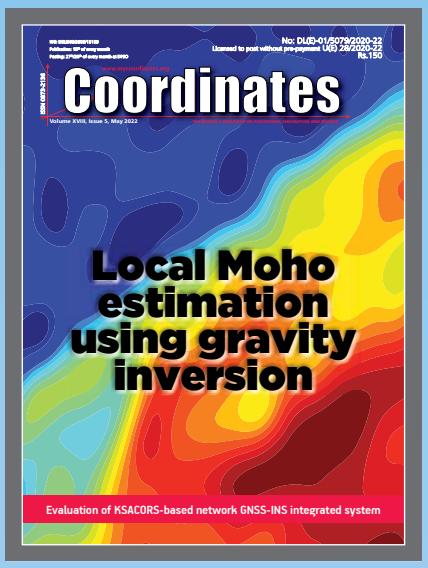
Cesium has announced a partnership with Google Maps Platform, which is launching the experimental release of Photorealistic 3D Tiles through their Map Tiles API. Photorealistic 3D Tiles use the widely-adopted Open Geospatial Consortium's 3D Tiles standard created by Cesium. Data is available for over 2,500 cities and 49 countries to an open ecosystem of 3D Tiles-enabled runtimes, including CesiumJS, Unreal, Unity, and NVIDIA Omniverse. *https://cesium.com*

## -SAS commits $1B to AI-powered industry solutions

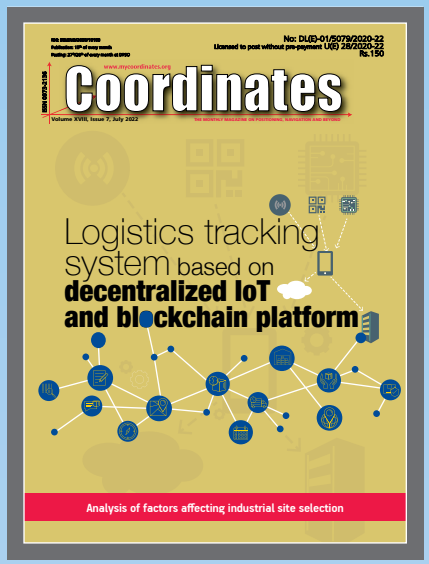
SAS will invest $1 billion over the next three years to further develop advanced analytics solutions targeted at the unique needs of specific industries. In banking, government, insurance, health care, retail, manufacturing, energy and more, SAS will build upon its decades long focus on providing tailored solutions to industry challenges. *www.sas.com*

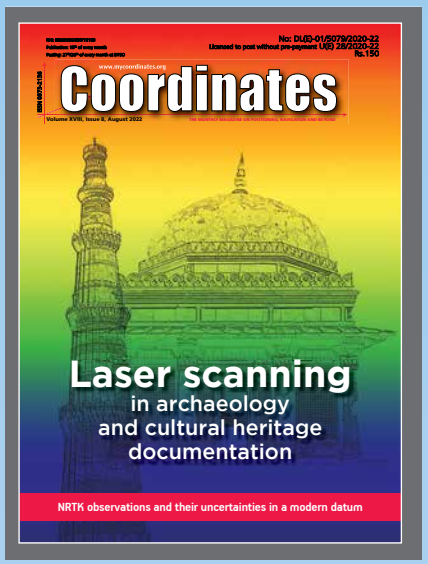


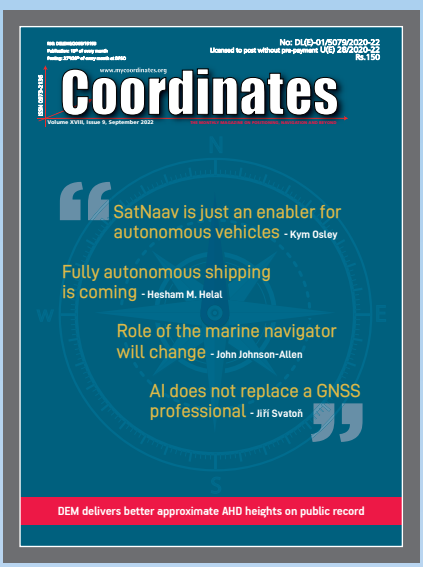



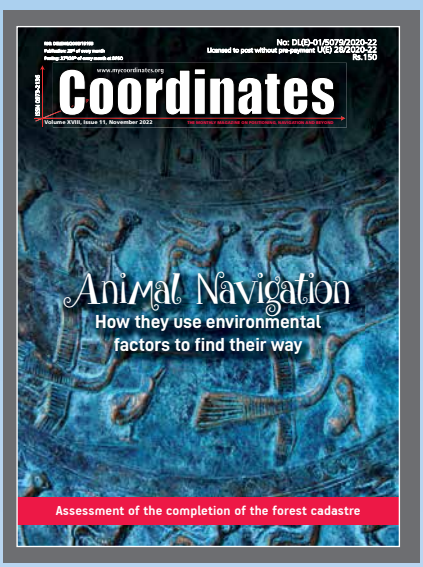






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