RNI: DELENG/2005/15153
Publication: 15th of every month
Posting: 27th/28th of every month at DPSO

No: DL(E)-01/5079/2020-22
Licensed to post without pre-payment U(E) 28/2020-22
Rs.150

ISSN 0973-2136

www.mycoordinates.org

Coordinates

Volume XVII, Issue 8, August 2021

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

MEGA EARTHQUAKE prediction method using a yearly unit periodicity

Draft Indian Satellite Navigation Policy-2021

SBG SYSTEMS

0.05°	0.02°	1 cm
ATTITUDE	HEADING	POSITION

NEW ELLIPSE-D

The Smallest Dual Frequency & Dual Antenna INS/GNSS

- RTK Centimetric Position
- Quad Constellations
- Post-processing Software

Ellipse-D
RTK Dual Antenna

Ellipse-N
RTK Single Antenna

OEM
RTK Best-in-class SWaP-C

Visit our website: **www.sbg-systems.com**

RIEGL AIRBORNE LASER SCANNERS & SYSTEMS

RIEGL WAVEFORM LIDAR TECHNOLOGY FOR TOPOGRAPHY

CHOOSE THE SCANNER EXACTLY RIGHT FOR YOUR SPECIFIC SURVEYING MISSION!

Visit us at

INTERGEO 2021 SEP. 21 – 23 HANOVER LIVE + DIGITAL

75° FOV
up to 1.5 MHz meas. rate
for UAVs and small aircraft

75° FOV
up to 1.25 MHz meas. rate
operating altitude AGL up to 3,900 ft*)
for small planes or helicopters

75° FOV
up to 1.25 MHz meas. rate
operating altitude AGL up to 4,400 ft*)
especially for snowy and icy terrain

60° FOV
up to 1.33 MHz meas. rate
operating altitude AGL up to 9,900 ft*)
for customized system configurations

NEW **VQ-780 II-S**
increased laser power for ultra-wide area mapping

58° FOV
forward/backward and nadir look
up to 2.66 MHz meas. rate
operating altitude AGL up to 12,800 ft*)
dual channel turnkey system for high altitude, large scale mapping

NEW **VQ-1560 II-S**
increased laser power for ultra-wide area mapping

VUX-240	VQ-480 II	VQ-580 II	VQ-780 II / II-S	VQ-1560 II / II-S

for surveying at low flight altitudes
e.g. powerline, rail track, and pipeline inspection, archeology

for surveying at mid flight altitudes
e.g. corridor mapping, city modeling, agriculture and forestry

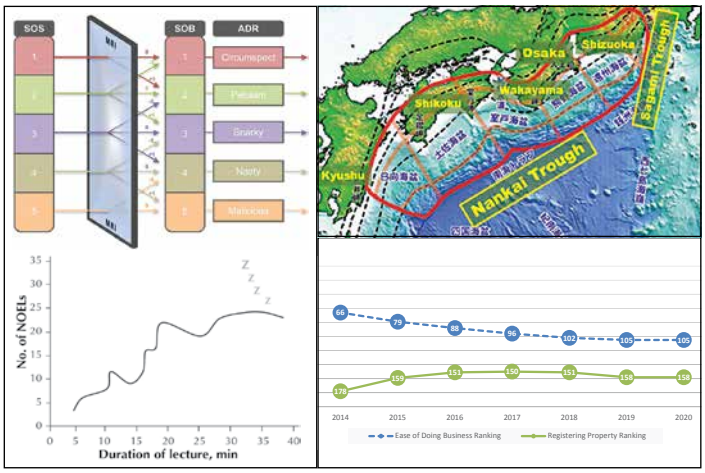
for surveying at high flight altitudes
e.g. wide area mapping of complex environments

*) operating altitudes AGL given for target reflectivity in excess of 20%

Also explore RIEGL's proven LiDAR sensors for UAVs and for BATHYMETRY www.riegl.com

RIEGL®

Austria | USA | Japan | China | **RIEGL WORLDWIDE** | Australia | Canada | United Kingdom



In this issue

Coordinates Volume 17, Issue 8, August 2021

Articles

MEGA earthquake prediction method using a yearly unit periodicity Guangmeng Guo and Shunji Murai 6
Deeds and titles in harmony: Trinidad and Tobago property business registration system Mark A Griffin, Carol Roffer, Karen Bridgewater, Nicole Moonan and Aurélie Milledrogues 10 **Humorous science: An introduction** Volker Janssen 19 **Draft Indian Satellite Navigation Policy – 2021** 25

Columns

My Coordinates Editorial 5 **Old Coordinates** 18 **News** Imaging 30 GNSS 33 UAV 34 GIS 35 LBS 36 Industry 36
Mark Your Calendar 38

This issue has been made possible by the support and good wishes of the following individuals and companies
Aurélie Milledrogues, Carol Roffer, Guangmeng Guo, Karen Bridgewater, Mark A Griffin, Nicole Moonan, Shunji Murai and Volker Janssen; Labsat, Riegl, SBG System and many others.

Mailing Address
A 002, Mansara Apartments
C 9, Vasundhara Enclave
Delhi 110 096, India.
Phones +91 11 42153861, 98102 33422, 98107 24567

Email
[information] talktous@mycoordinates.org
[editorial] bal@mycoordinates.org
[advertising] sam@mycoordinates.org
[subscriptions] iwant@mycoordinates.org
Web www.mycoordinates.org

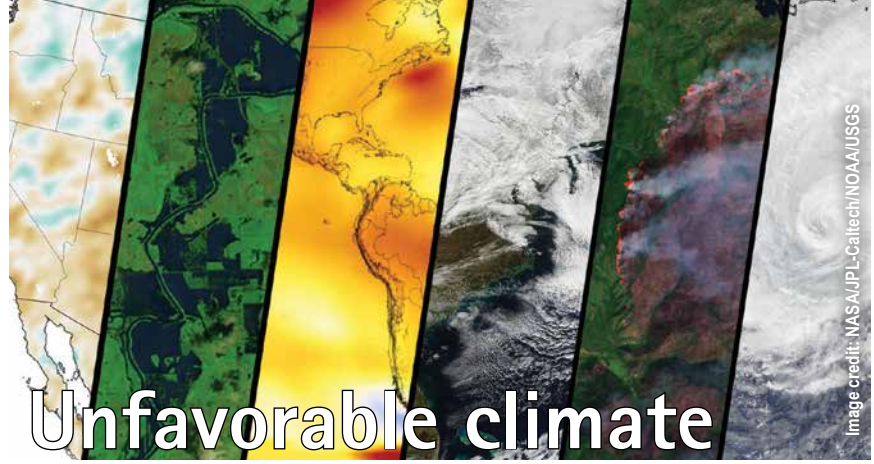
Coordinates is an initiative of CMPL that aims to broaden the scope of positioning, navigation and related technologies. CMPL does not neccesarily subscribe to the views expressed by the authors in this magazine and may not be held liable for any losses caused directly or indirectly due to the information provided herein. © CMPL, 2021. Reprinting with permission is encouraged; contact the editor for details.

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

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

Editor Bal Krishna
Owner Coordinates Media Pvt Ltd (CMPL)

This issue of Coordinates is of 40 pages, including cover.



Unfavorable climate

In this year itself, there have been many worrying events of extreme weathers.

In Greenland, for the first time rain fell at the highest point of its ice sheet.

If there are extreme level of flooding in Germany, China and Australia,

Then the Western US is facing one of the worst droughts.

Unprecedented heat waves in part of Europe and North America.

The temperature in Moscow soared to 38 degree Celsius.

There are incidents of fires in Greece, Turkey, and California.

Hurricanes have become deadlier.

The Intergovernmental Panel on Climate Change report warns against the worsening situation in coming years.

Climate change is a global phenomenon. It deserves urgent remedies.

It needs to be a priority – a political priority at the global level.

Signs are showing,…it is getting late!

Bal Krishna, Editor
bal@mycoordinates.org

ADVISORS Naser El-Sheimy PEng, CRC Professor, Department of Geomatics Engineering, The University of Calgary Canada, George Cho Professor in GIS and the Law, University of Canberra, Australia, Professor Abbas Rajabifard Director, Centre for SDI and Land Administration, University of Melbourne, Australia, Luiz Paulo Souto Fortes PhD Associate Professor, University of State of Rio Janeiro (UERJ), Brazil, John Hannah Professor, School of Surveying, University of Otago, New Zealand

MEGA earthquake prediction method using a yearly unit periodicity

The method is based on newly developed multiple year interval analyses between combinations of past MEGA earthquakes in each region derived from historical records

Dr Guangmeng Guo PhD
Institute of Geographic Science and Natural Resource, Chinese Academy of Science, 2008-2020 Professor, Nanyang Normal University, 2020- Chief Researcher, Japan Earthquake Science Exploration Agency Co. Ltd.

Dr Murai Shunji
Professor Emeritus, University of Tokyo. Chairman, Asian Association of Remote Sensing, Honorary Member, International Society for Photogrammetry and Remote Sensing (ISPRS), Chief Technical Officer, Japan Earthquake Science Exploration Agency Co. Ltd.

Abstract

The objective of this research is to develop a long-term MEGA earthquake prediction method using a yearly unit periodicity for past MEGA earthquakes for supporting clearly targeting preparedness against earthquake disaster. Hereinafter MEGA earthquake means large earthquakes with human casualties. The method is based on newly developed multiple year interval analyses between combinations of past MEGA earthquakes in each region derived from historical records. Three case studies shown in the paper include East Japan, Tokyo Metropolitan Area and Nankai Pacific Area where seriously damaging MEGA earthquakes and/or Tsunamis have occurred in the past. The results demonstrate, based on long-term prediction of yearly units, that the year of 2026 for both East Japan and Tokyo Metropolitan Area, and the year of 2053 for Nankai Pacific Area, are the most likely repeatable MEGA earthquakes with magnitudes similar to those that occurred in the past.

Introduction

The earthquake investigation committee of the Japanese Government has

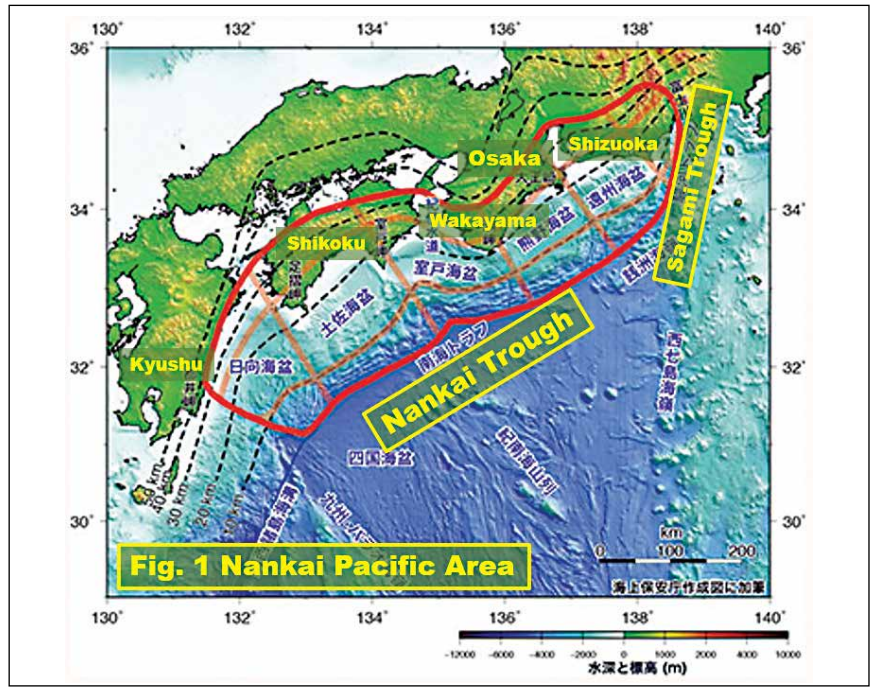


Fig. 1 Nankai Pacific Area

presented the 2020 version of seismic hazard map for the public which includes color coded probability percentages indicating the risk of M7 class earthquake occurrence in the next 30 years[1]. However, it is difficult to understand how to promote preparedness against upcoming MEGA earthquakes in the next 30 years from this hazard map. It would be unclear how to understand for example, 70% probability risk over the next 30 years in the Tokyo Metropolitan Area. The Japanese nation expects to receive long-term predictions with clear targets when the most serious earthquakes ate likely to occur, regardless of the correctness. Moreover, another problem is that the committee has not shown how to compute the probability percentage based on scientific rigor. No one can verify the hazard map with the corresponding probabilities for individual residential areas.

One of the largest worries for the Japanese nation will be future occurrence of MEGA earthquake in the Nankai Pacific Area (see Fig. 1) which, in the past is estimated to have caused about 300,000 casualties, if a similar MEGA earthquake and Tsunami occur as in the past, in 100 to150 year cycles. Many people living in the 700 km along the Nankai Trough in the west to Sagami Trough in the east, would be anxious about their future, but not able to prepare specific emergencies measures when the probability for the next 30 years is only 80%.

The paper in "Nature' by the American scientist Bakun and his colleagues (Bakum et al 1985) predicted that a M6 class earthquake may occur ±5 years from 1988 with 90% probability derived from the average cycle between the past earthquakes along San Andreas Faults in California, USA in 1857, 1881, 1901, 1922, 1934 and 1966 [2]. However, the prediction was not correct as the M6.0 earthquake occurred in 2004.

The authors of this paper have re-considered the existing earthquake probability analysis methods using the mean and standard deviation based normal distribution of earthquake occurrences. As a result of this re-consideration, a prediction method based on yearly unit periodicity analysis with multiple combinations between past MEGA earthquakes has been developed as described in this paper.

> Although the long-term prediction method introduced in this paper is not verified on a scientific basis, this approach could persuade the Japanese people to be prepared for MEGA earthquake disasters because the method can show the risky years. It is much better and clearer than the Japanese Government's long-term prediction in the form of xx% in 30 years in the future

Long-term prediction method using a yearly periodicity analysis

Step 1: Select past records of MEGA earthquakes from the website such as for example, USGS site (https://earthquake.usgs.gov) based on a yearly unit. Let n be the number of the earthquakes selected.

Step 2: Prepare a matrix table with i line and j column (i=1, n; j=1, n). Let the years of MEGA earthquakes be Y(i) and Y(j).

Step 3: Calculate the multiple intervals T (i, j) between the year of MEGA earthquakes as follows.

$$T(i, j)=Y(i)-Y(i - j) \quad (i>j: i=1,n+1; j=1,n)$$

Step 4: The year to be predicted for the next predicted MEGA earthquake is Y (n + 1).

Step 5: Apply a similar procedure as Step 3 and search the most likely risky year with maximum number of multiple yearly intervals.

Step 6: Check the same or multiple year intervals of more than 10 years at the Y(n+1) line and change the number to red color. Change the common periodical year number to blue color for years other than Y(n+1).

The results of cases studies in Japan

Case study 1: East Japan

Table 1 shows the past records of MEGA earthquakes in East Japan including Kanto Area of Tokyo, Tohoku Area and Hokkaido.

Table 2 shows the result of a yearly unit periodicity analysis in East Japan.

The 14th line of 2026 in Table 2 lists eight periodical cycle years including multiple cycle years of 15, 32, 58, 66, 74, 88, 95 and 171,

> The authors of this paper have re-considered the existing earthquake probability analysis methods using the mean and standard deviation based normal distribution of earthquake occurrences

which corresponds to the years 2011, 1994, 1968, 1960, 1952, 1938, 1931 and 1855.

We use different colors to show the numbers which have multiple relations.

- light yellow color for 15, 30, 45, 105 and 300
- medium yellow color for 22, 66, 88 and 220
- dark yellow color for 37, 74 and 148
- pink color for 19, 76, 95, 152, 171 and 228
- dark pink for 16, 32 and 80
- blue color for 29 and 58

We can also see that 43, 51 and 80 appear in both 2003 and 2011, and 58, 73 and 88 appear in both 2011 and 2026.

It is concluded that the year of 2026 should be the most likely risky year for the next MEGA earthquake in East Japan, as the number of common periodical cycle years is a maximum. It should be noted that there are seven periodical cyclic years including multiple cyclic years, part of which are shown in blue. The numbers 43, 51, 78, 80, 88 and158 in red color, correspond to 1968, 1960, 1933, 1931, 1923 and 1853. If the long-term prediction method had been applied before 2011, we could have predicted that 2011 would be the most likely risky year, and we would

Table 1 Past earthquakes in East Japan

Year	Name of Eq.	M	Dead	Injured
1703	Gen-roku	8.2	6,700	Many
1855	An-sei Edo	7.8	~10,000	Many
1923	Great Kanto	7.9	142,807	103,733
1931	Sanriku Offshore	7.2	???	???
1933	Showa Sanriku	8.4	3,064	Many
1938	Fukushima Offshore	7.5	???	???
1952	Tokachi Offshore	8.1	33	???
1953	Boso Offshore	7.9	???	???
1960	Sanriku Offshore	7.2	???	???
1968	Tokachi Offshore	7.9	52	???
1994	Sanriku Haruka	7.8	3	???
2003	Tokachi Offshore	8.2	2	23
2011	Great asy Japan	9.1	22,000	6,242

Table 2 A year unit periodicity analysis in East Japan

Y(i/j)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1703	1855	1923	1931	1933	1938	1952	1953	1960	1968	1994	2003	2011	2026
2	1855	152												
3	1923	68	220											
4	1931	8	76	228										
5	1933	2	10	78	230			T(i,j)=Y(i)-Y(i-j)			i>j; i=1,...n+1, j=1,....n			
6	1938	5	7	15	83	235								
7	1952	14	19	21	29	97	249							
8	1953	1	15	20	22	30	98	250						
9	1960	7	8	22	27	29	37	105	257					
10	1968	8	15	16	30	35	37	45	113	265				
11	1994	26	34	41	42	56	61	63	71	139	291			
12	2003	9	35	43	50	51	65	70	72	80	148	300		
13	2011	8	17	43	51	58	59	73	78	80	88	156	308	
14	2026	15	23	32	58	66	73	74	88	93	95	103	171	323

Table 3 Past earthquakes in Tokyo Metroplitan Area

Year	Name of Eq.	M	Dead	Injured
1633	Kan-ei Odawara	7.0	150	Many
1697	Genroku Kamakura	6.5	???	???
1703	Genroku	8.2	10,000	Many
1782	Tenmei Odawara	7.0	Some	Some
1853	Ka-ei Odawara	7.0	100	Many
1855	Ansei Edo	6.9	10,000	Many
1894	Meiji Tokyo	7.0	31	197
1895	South Ibaraki	7.2	9	68
1915	Boso Penisula	6.0	0	5
1921	South Ibaraki	7.0	0	0
1922	Uraga Cahnnel	6.8	2	23
1923	Great Kanto	7.9	142,807	103,733
1956	Central Chiba	6.3	0	4
1987	Chiba Offshore	6.7	2	161
1992	South Tokyo Bay	5.9	0	34
2005	North West Chiba	6.0	0	38

Table 4 A year unit periodicity analysis in Tokyo Metropolitan Area

Year														
1633														
1697	64													
1703	6	70												
1782	79	85	149											
1853	71	150	156	220										
1855	2	73	152	158	222									
1894	39	41	112	191	197	261								
1915	21	60	62	133	212	218	282							
1921	6	27	66	68	139	218	224	288						
1922	1	7	28	67	69	140	219	225	289					
1923	1	2	8	29	68	70	141	220	226	290				
1956	33	34	35	41	62	101	103	174	253	259	323			
1987	31	64	65	66	72	93	132	134	205	284	290	354		
1992	5	36	69	70	71	77	98	137	139	210	289	295	359	
2005	13	18	49	82	83	84	90	111	150	152	223	302	308	372
2026	21	34	39	70	103	104	105	111	132	171	173	244	323	329	393

Table 5 MEGA earthquakes in Nankai Pacific Area

Year	Name of Eq.	M	Dead
684	Haku-ho	8.0~9.0	Many
887	Nin-na	8.0~8.5	Many
1096	Ei-cho	8.0~8.5	???
1099	Ko-wa Nankai	8.5	???
1361	Sho-hei Tonankai	8.3	Many
1498	Meio-ou	8.2~8.6	26,000
1605	Kei-cho	8.0	3,000?
1707	Ho-ei	8.4~8.6	20,000
1854	An-sei Tonankai	8.4	3,000~6,000
1944	Showa Tonankai	8.2	1,223
1946	Showa Nankai	8.0	1,443
	Tsunami occurred together with Eq.		

Table 6 A year unit periodicity analysis in Nankai Pacific Area

Year											
684											
887	203										
1096	209	412									
1099	3	212	415								
1361	262	265	474	677							
1498	137	399	402	611	814						
1605	107	244	506	509	718	921					
1707	102	209	346	608	611	820	1023				
1854	147	249	356	493	755	758	967	1170			
1944	90	237	339	446	583	845	848	1057	1260		
1946	2	92	239	341	448	585	847	850	1059	1262	
2053	107	109	199	346	448	555	692	954	957	1166	1369

The results obtained from three case studies in this paper seems reasonable for individuals to execute preparedness for their own risk of MEGA earthquakes. Otherwise, people have no other options than to believe the Government's probability prediction without scientific evidence

have been able to reduce the impact of the 2011 Great East Japan Earthquake disaster which caused 22,000 casualties.

Case study 2: Tokyo Metropolitan Area

Table 3 shows the past record of MEGA earthquakes in Tokyo Metropolitan Area including Yokohama, Chiba and Saitama, while Table 4 shows the result for a yearly unit periodicity analysis in Tokyo Metropolitan Area.

The 16th line of 2026 in Table 4 shows nine periodical yearly cycles including multiple year cycles which are listed in red color. They are 21, 34, 39, 70, 105, 111, 132 and 328, which correspond to the years 2005, 1992, 1987, 1966, 1923, 1921, 1894 and 1703. It is concluded that the year of 2026 should be the most likely risky year for the next MEGA earthquake in Tokyo Metropolitan Area, as the number of common periodical cycle years is a maximum.

Case study 3: Nankai Pacific Area

Table 5 shows the list of the past record of MEGA earthquakes in Nankai Pacific Area including Kyushu. Shikoku, Wakayama and Shizuoka. Table 6 shows the result of a yearly unit periodicity analysis in Nankai Pacific Area.

In the 12th line of 2053 in Table 6, five periodical yearly cycles including multiple yearly cycles are listed in red color. They are 107, 346, 39, 448, 692 and 1166, which correspond to the years 1994, 1707, 1605, 1361 and 887. It is concluded that the year of 2053 should be the most likely risky year for the next MEGA earthquake in Nankai Area, as the number of common periodical cycle years is the maximum.

Considerations for the result

Although the long-term prediction method introduced in this paper is not verified on a scientific basis, this approach could persuade the Japanese people to be prepared for MEGA earthquake disasters because the method can show the risky years. It is much better and clearer than the Japanese Government's long-term prediction in the form of xx% in 30 years in the future. Another benefit is that the proposed method will be available for anybody to calculate simply if the past MEGA earthquake record in the relevant area can be searched.

At least it can be said that the results obtained from three case studies in this paper seems reasonable for individuals to execute preparedness for their own risk of MEGA earthquakes. Otherwise, people have no other options than to believe the Government's probability prediction without scientific evidence.

It may be surprising to know that there is a yearly periodicity for MEGA earthquakes as shown in this paper, which seems to be a strange coincidence. However, the cyclic anomalies occurring on Earth including earthquakes, volcanic eruptions or global change such as global warning may have been strongly influenced by the solar cycle such as sunspot 11years cycle, as well as planetary orbital cycles of 12 years for Jupiter and 29 years for Saturn. In Table 2, the cycle of 58 corresponds to multiple cycles of the Saturn planetary cycle, 66 and 88 corresponds to multiple solar cycle[4].

Conclusions

1. A new MEGA earthquake prediction method using a yearly unit periodicity has been developed by the authors.

2. The validation results of three case studies reveal that the most likely risky years for the next MEGA earthquakes are clearly based on a yearly unit, which will be helpful for preparedness against earthquake disasters in Japan.

3. The advantage of the long-term prediction method developed by the authors is very clear and simple for individuals to calculate the most likely risky years from past earthquake records. It would give individuals a free hand to believe or not their own risk.

4. The new method will be verified in future when case studies are accumulated in various areas.

Acknowledgement

We would like to extend appreciation to Prof. Emeritus Dr. John Trinder for his kind reviewing the contents as well as editing English. We also appreciate Mr. Toshihiro Kitta, President of JESEA for his kind supporting our research.

References

1. https://www.jishin.go.jp/evaluation/seismic_hazard_map/shin_report/shin_report_2020/

2. Bakun, W.H., Aagaard, B., Dost, B. *et al.* (2005) Implications for Prediction and Hazard Assessment from the 2004 Parkfield Earthquake. *Nature*, 437, 969-974. https://doi.org/10.1038/nature04067

3. https://jishin.go.jp/regional_seismicity_rs_kaiko/k_nankai

4. Gribbin, J. Relation of sunspot and earthquake activity. Science, 173, 558 (1971).

Deeds and titles in harmony: Trinidad and Tobago property business registration system

This paper outlines the innovative Property Business Registration System (PBRS) project to migrate separate deeds and titles registers into a single land information system and discuss some of the practical aspects

Mark A Griffin
IGN FI, Trinidad and Tobago

Carol Roffer
IGN FI, Trinidad and Tobago

Karen Bridgewater
Ministry of the Attorney General and Legal Affairs, Trinidad and Tobago

Nicole Moonan
Ministry of the Attorney General and Legal Affairs, Trinidad and Tobago

Aurélie Milledrogues
IGN FI, Trinidad and Tobago

Abstract

The Property Business Registration System (PBRS) project is an initiative of the Ministry of the Attorney General and Legal Affairs in Trinidad and Tobago to develop a land information system. The project will bring separate deeds and titles registers into a single harmonized, Land Administration Domain Model compliant, system.

This paper will present some background to the dual systems of land registration administered by the Registrar General's Department and the legal frameworks that govern them. It will consider the legal reforms necessary to improve efficiency of the systems and examine the difficulty in developing a land information system that complies with and enforces existing laws and regulations while supporting new laws that have been assented to but are awaiting proclamation. This paper will outline the innovative PBRS project to migrate separate deeds and titles registers into a single land information system and discuss some of the practical aspects.

Introduction

The Property Business Registration System (PBRS) project is an initiative of the Ministry of the Attorney General and Legal Affairs (MAGLA) of the Government of the Republic of Trinidad and Tobago (GORTT) to develop a land information system that will provide a highly available secure application to govern, capture and manage all aspects of the real and personal property registration process including the separate deeds and titles registration systems and ancillary documents. The project will bring separate deeds and titles registers into a single harmonized, Land Administration Domain Model (LADM) compliant, system.

PBRS is financed under the Strengthened Information Management at the Registrar General's Department (SIMRGD) project through an Inter-American Development Bank (IDB) loan which commenced in January 2014. The SIMRGD project is part of the Public Sector Investment Programme (Ministry of Planning and Development, 2019a) and falls under the Improving Productivity Through Quality Infrastructure and Transportation development theme of the National Development Strategy 2016-2030 (Ministry of Planning and Development, 2019b). Known as Vision 2030, the strategy provides a pathway for attaining developed country status by the year 2030 and includes the United Nations Sustainable Development Goals.

The Vision 2030 national vision, development themes, and goals were crafted against a background of declining performance in selected global indices over the period 2006 to 2016. Trinidad and Tobago's Global Competitiveness

Index ranking had decreased from 67 to 92. The Ease of Doing Business ranking had declined from 55 in 2006 to 97 in 2011, improved to 66 in 2014 and declined to 88 in 2016. The Index of Economic Freedom ranking had declined from 42 to 73. The Networked Readiness Index had fluctuated but ultimately changed little as the ranking moved from 68 in 2006 to 67 in 2016. The Corruption Perception Index ranking began as 79 in 2006, declined to 91 in 2011, improved to 72 in 2015, and declined again to 101 in 2016 (Ministry of Planning and Development, 2019b).

The SIMRGD project primarily aims to improve conditions for investment in Trinidad and Tobago (TT) by streamlining the property registration process. Two components are financed under the project, namely: Institutional Capacity Strengthening of the Registrar General's Department (RGD); and Support to Strengthening Identification of Parcels and Persons in Property Registration. A secondary aim is to help detect and prevent land fraud, land corruption, and money laundering. Vision 2030 stresses the need to monitor and evaluate performance, project success will be partially measured against global indices such as those mentioned earlier.

In Trinidad and Tobago, the RGD Land Registry is responsible for property registration and the Survey and Mapping Division (SMD) of the Ministry of Agriculture, Land and Fisheries, is responsible for cadastral surveys and the cadastre.

The main activities of the PBRS project are to:

- Design, develop, and implement a single land information system to administer both deeds and titles registration
- Migrate and integrate data from the existing deeds registration Property Information Management System (PIMS) to the new unified land information system
- Migrate and integrate data from a contemporaneous external project to digitize title registration instruments

MAGLA engaged a consortium led by IGN FI (and including GEOFIT and the University of the West Indies) to execute the high-velocity PBRS project over an ambitious schedule of 17 months beginning in December 2018, going live in February 2020, and completing the warranty period in May 2020.

This paper will present some background to the dual systems of land registration administered by the RGD and the legal frameworks that govern them. It will consider the legal reforms necessary to improve efficiency of the systems and examine the difficulty in developing a land information system that complies with and enforces existing laws and regulations while supporting new laws that have been assented to but are awaiting proclamation. This paper will outline the innovative PBRS project to migrate separate deeds and titles registers into a single land information system and discuss some of the practical aspects of doing this.

Context

The twin island Republic of Trinidad and Tobago is an archipelago at approximately 11° North and 61° West lying between the Caribbean Sea and the North Atlantic Ocean, the southernmost nation of the Windward Islands of the Lesser Antilles. The islands are 130 km south of Grenada and 11 km off the coast of Venezuela. Experiencing a tropical climate, the islands usually escape the path of hurricanes but lie in a seismically active area and were rocked by a 6.9 magnitude earthquake in August 2018.

Trinidad and Tobago have a total land area of 5,130 km^2 and total population (in 2018) of 1.39 million (World Bank, 2019a). This land area is about the same size as the second smallest state of the United States, Delaware. Trinidad and Tobago's population is about one and a half times that of Delaware.

Trinidad and Tobago gained independence from the United Kingdom in 1962 and is a member of the United Nations and CARICOM. Recognised by the United Nations as one of the group of small island developing states (SIDS) that have their own peculiar vulnerabilities and characteristics, Trinidad and Tobago like other SIDS has limited ability to benefit from economies of scale and is vulnerable to a large range of impacts from climate change (United Nations, 2019). Unlike many Caribbean SIDS, Trinidad and Tobago's economy is less reliant on tourism. It is one of the most prosperous countries in the Caribbean largely due to petroleum and natural gas production and processing.

Two legal frameworks for land registration have existed side-by-side in Trinidad and Tobago since the late nineteenth-century resulting in today's dual systems of land registration. The Common Law (or Old Law) system is a deeds registration system and the RPA (Real Property (TT) Act of 1945) or Torrens system, is a titles registration system. The legal frameworks for these systems are discussed below.

The Parliament of the Republic of Trinidad and Tobago comprises the President and two houses, the Senate, and the House of Representatives. A proposal for a new law or for amendments to an existing law, when introduced into a House of Parliament becomes known as a bill. After a bill has passed both houses, it is presented to the President for assent or approval. The grant of ascent converts the bill into an Act. An Act, although assented to, does not necessarily come into immediate operation. The commencement provision specifies when the Act is to come into effect. This may be the date of assent by the President, a date to be fixed by proclamation, a nominated date, or some combination of these to provide for different sections or parts to come into effect at different times.

The frequent delay between the assent and when the Act comes into force is often for the purpose of gathering the necessary resources to administer the law. Development of the PBRS of necessity, was based on existing laws but simultaneously had to support

new laws that had been assented to but were awaiting proclamation.

Legal frameworks

British rule of Trinidad and Tobago began in 1802 and brought with it the British common law and statutory legal system. Later, as Britain began modernizing its statutes regarding land tenure and conveyancing in the mid-nineteenth century, so too did Trinidad and Tobago. Statutory modifications to common law conveyancing practices that were introduced from time to time to simplify and clarify conveyancing practice, were codified as the Conveyancing and Law of Property (TT) Act of 1939.

A deeds registration system covering common law conveyancing practices was introduced with records maintained by the Registrar General as set out in the Registration of Deeds (TT) Act of 1884. Similarly, a titles registration system for administering documents and titles pertaining to land was introduced by the Real Property (TT) Ordinance of 1889 that was revised as the Real Property (TT) Act of 1945. Land in Trinidad and Tobago is regulated by the foregoing laws and by the Registrar General (TT) Act of 1921 (all as amended) as well as The Constitution of the Republic of Trinidad and Tobago of 1976.

The deeds system requires that the original title deeds of a land parcel be deposited in the Land Registry, as evidence of the land transaction. The law requires a twenty-year title search as evidence of good title to a land parcel and offers a would-be purchaser a record of evidence of the transactions on the land. Registration is voluntary except when required by lending institutions and there is no guarantee of the accuracy of the content in the documents registered. A cadastral plan of the land is not mandated. The deeds system is favored over the titles system for its relative simplicity of procedure and low cost of registration.

The titles system was introduced with the aim of removing perceived defects of the deeds system. For this system, a certificate of title is issued for every land parcel registered. Registration is voluntary except in the case of granted state land and the state guarantees the title to the land, but not the parcel boundaries. An approved cadastral plan of the land parcel is required for registration. Provisions are made for the transfer of lands already registered under the deeds system to the titles system. The titles system is viewed as including expensive, long, and tedious procedures.

Legal reform

By the 1950s, there were many complaints about undue delays in completing land transactions and about the deplorable condition of some of the land records maintained by the Registrar General (Land Tenure Center, 1992b). A system which was adequate for the needs of a plantocracy for recording a few hundred instruments each year had long ago been overwhelmed and by the 1980s, change was urgently needed.

Done and Robertson (1988) summarized the recommendations of a feasibility study carried out by Statskonsult in 1980 as follows:

1. Create a special administrative unit for land registration.
2. Establish an effective base-register system for land registration which should comprise:
   a. An unambiguous parcel definition;
   b. A descriptive land record register;
   c. A map system showing the position of land as part of the register.

Done and Robertson (1988) also noted that the Land Registration (TT) Act of 1981 "made provision for the extension of registered title to compulsory registration areas and for the establishment of a Land Commission to be responsible for adjudication of title and adjustment of boundaries."

Reporting on the Property Law Reform package of 1981, the Land Tenure Center (1992b) noted that it comprised seven acts including the Land Registration (TT) Act of 1981 and the Condominium (TT) Act of 1981 and that they "were intended to replace more than twenty existing enactments that govern property dealings and inheritance in Trinidad and Tobago" and that the entire reform package was based on "certain significant departures from the existing law", introduced through the Land Law and Conveyancing (TT) Act of 1981 as follows: Reduction to two of the number of estates capable of subsisting at law

- Limitation of the possibility of the creation of legal tenancies in common
- Creation of the statutory trust

The Land Tenure Center (1992b) criticized that "A case for this attempt at multiple, major organ replacement surgery on the statute book has never been satisfactorily made out." The Land Tenure Center argued that the problems affecting operation of the system of land registration in Trinidad and Tobago were mainly related to the recording and retrieval of land transaction information and the consequential proliferation of informal arrangements for gaining access to land. The package was never proclaimed.

In 1992, a ten-month GORTT comprehensive land use rationalization study was carried out by the Land Tenure Center with support from the IDB as part of the Land Rationalization and Development Programme (LRDP). The programme sought greater realization of the agriculture sector potential in Trinidad and Tobago based on a stable and secure system defining the rights of access and use of the land with a view to attract investment (Land Tenure Center, 1992a). Objectives included: to study farmers in irregular possession of state land, to review legislation and institutional capabilities for processing and recording land transactions, and to develop options to improve the security of those acquiring rights to land and to reduce costs of these transactions involving both public and private land. An action plan was developed that proposed several projects.

The study recommended that the 1981 Property Law Reform Package not be implemented and that a new Land

Registration Act be prepared drawing on the provisions of the Land Registration (TT) Act of 1981 but expressed in a more readable style. In summary, the following legislation was recommended:

- **Land registration.** To make titles registration compulsory and unambiguously referenced to a map and a unique parcel number. Reliance on Judges and the High Court to be reduced through alternative methods of dispute resolution.
- **Land adjudication.** To provide for systematic adjudication of all claims affecting land to achieve economies of scale and facilitate prompt compilation of the titles register while removing routine title registration matters and boundary disputes from the High Court.
- **Land tribunal.** To establish a specialized, lay, Land Tribunal to resolve disputes concerning land-related issues speedily and inexpensively.
- **Land surveying.** To provide for registration of land surveyors and regulation of their practice.
- **Condominium.** To provide for multiple ownership of property based on a company law model.
- **Town and country planning.** To provide greater clarity about the nature of the powers and the manner of their exercise by the Minister and officers of the Ministry.

Based on the study's recommendations, the "Land Package" of the Land Adjudication (TT) Act of 2000, Land Tribunal (TT) Act of 2000, and Registration of Titles to Land (TT) Act of 2000 were all debated together and then assented in 2000 (Parliament of the Republic of Trinidad and Tobago, 2018). The Land Registration (TT) Act of 1981 was repealed.

Although the three Acts are awaiting proclamation, they have all been significantly revised through the Land Adjudication (Amendment) (TT) Act of 2018, Land Tribunal (Amendment) (TT) Act of 2018, and Registration of Titles to Land (Amendment) (TT) Act of 2018. These amendments are all awaiting proclamation.

PBRS data model

The LADM, the ISO 19152:2012 international standard (Lemmen, Van Oosterom, & Bennett, 2015), was used as the starting point for the PBRS database design. The third-party software underlying PBRS, Innola, extends and adapts the conceptual LADM to develop a Trinidad and Tobago country profile with due regard for project requirements and international good practice. The PBRS re-engineered workflows, transactions, and database must be flexible enough to support both existing Common Law and RPA legislation. Furthermore, they must support some new laws that have been proposed but are awaiting assent and/or proclamation. For example, the adjudication of all land provided in the Land Package resulted in the PBRS being modified to introduce additional attributes on land parcel data which allow identification of which parcels are under adjudication or have completed adjudication. These designations will support future transactions and business rules to be introduced to manage these lands appropriately within PBRS.

However, anticipating new laws in software development brings with it the risk of rework. The software framework is designed to be able to support new laws or amendments to existing laws as and when they are proposed, assented, and proclaimed.

Table 1 shows the key LADM objects as implemented in the PBRS to support the unified land register. All instruments are registered as a deed interest type under Common Law. It is important to emphasize that there are not separate tables to manage these key objects for deeds and titles data. The single set of person table(s) support the unified register thus allowing a search on a unique person which results in all interests or transactions for which that person is party to regardless if related to deeds or titles. This may be enhanced by a proposed new requirement to use the birth personal identification number assigned by the RGD Civil Registry on the birth certificate. A unique identifier for foreign-born persons is still under consideration.

To simplify database searches for end users, objects are attributed appropriately to filter searches for a deeds or titles relationship. Document/Instrument names are harmonized to better support searches; that is a *Deed of Mortgage* and a *Memorandum of Mortgage* are both referred to as a *Mortgage* in PBRS but are attributed such that searches can distinguish between those which are deeds or which are title instruments, and provide this information back to the user. Another example is that spatial units are attributed as derived either from Common Law or RPA.

CL = Common Law, RPA
= Real Property Act

The Doing Business report measures business regulations and their enforcement across 190 economies (World Bank, 2019b). The report provides quantitative indicators for several regulatory environments as it applies to local firms

Table 1. Key LADM objects as implemented in the PBRS to support the unified land register.

LADM	PBRS	Trinidad & Tobago Examples
LA_SpatialUnit	Spatial Unit	Land Parcel, Building, Unit
LA_BAUnit	CL: Real Property RPA: Title	Freehold, Leasehold
LA_BAUnit	CL: Chattel	Vehicle, Machinery, Boat
LA_RRR	Interest	CL: Deed of any kind RPA: Freehold, Mortgage, Caveat, Lease, Sublease, Easement
LA_Party	Person	Proprietor, Lessor, Purchaser, Mortgagee
LA_Source	Document	CL: Deed of Conveyance, Deed of Mortgage RPA: Certificate of Title, Memorandum of Transfer, State Grant

***Source*: PBRS project CL = Common Law, RPA = Real Property Act**

Implementation of PBRS has provided a window of opportunity for the Land Registry and SMD to collaborate to realise the full benefits of this unique identifier as the vital key to enable critical linkages between the register and cadastral data and to other land management data and systems to facilitate cross-government decision-making

and encourages economies to compete towards more effective regulation and offers measurable benchmarks for reform. Perhaps the most relevant indicator to implementation of PBRS is known as *registering property*. This indicator examines four component indicators: *procedures*, *time*, *cost*, and the *quality of land administration* in each economy.

The reliability and objectivity of the report's measurements has been questioned and caution should be used when comparing between regions and between countries as the methodology may vary. Rankings should be interpreted with care. The name of several indicators overstates what they measure. For example, registering property measures the procedures to transfer the property title of land and a building between two businesses, and not the procedures to obtain a title for the property for the first time. The World Bank Group recognises the limitations of the measurements (see also Acemoglu, Collier, Johnson, Klein, & Wheeler, 2013) but asserts that "The report measures complex regulatory processes by zeroing in on their quantifiable components, which can be contested, compared– over time and across economies– and, ultimately reformed" and offers "policy makers a tool to identify good practices that can be adopted within their economies" (World Bank, 2019b).

Doing Business 2019: Trinidad and Tobago (World Bank, 2019c) gives detailed results for the five indices that make up the quality of land administration index: *reliability of infrastructure*, *transparency of information*, *geographic coverage*, *land dispute resolution*, and *equal access to property rights*.

As mentioned above, the Land Registry is responsible for property registration and SMD is responsible for cadastral surveys. Trinidad and Tobago scores 4.0 out of 8.0 for reliability of infrastructure. Most topical title or deed records are kept as scanned images. Most maps of land plots are kept as scanned images and there is an electronic database for recording boundaries, checking plans, and providing cadastral information. However, title or deed records and maps of land plots are not yet fully digital, and information recorded by the Land Registry and SMD is kept in separate (unlinked) databases. The Land Registry and SMD do not use the same identification number for properties.

The need for a unique property identifier for Trinidad and Tobago has been recognised since at least 1980 (Done & Robertson, 1988) and the Registration of Titles to Land (TT) Act of 2000 establishes the use of a unique parcel reference number (UPRN) as the legal description of the parcel. Although this Act is awaiting proclamation, SMD anticipated the UPRN requirement by implementing a unique parcel identification number (UPIN) in their Cadastral Management Information System (CMIS). The Land Registry included provision for a UPRN in the PIMS deed registration system but never implemented it. Although the PBRS does not manage the spatial data related to land parcel spatial units, the database has been designed to support the UPIN assigned and managed by the SMD.

Implementation of PBRS has provided a window of opportunity for the Land Registry and SMD to collaborate to realise the full benefits of this unique identifier as the vital key to enable critical linkages between the register and cadastral data and to other land management data and systems to facilitate cross-government decision-making. At the very least, it will allow PBRS to integrate a display of a land parcel map for which SMD is the owner. Implementation of PBRS may encourage proclamation of all or part of the Land Package.

Other standardization proposed for the PBRS, but not yet finalized, is the adoption of the Trinidad and Tobago Postal Corporation (TTPost) addressing standard. TTPost, together with the Ministry of Public Utilities, the Ministry of Local Government along with its Municipal Corporations and the Tobago House of Assembly, is implementing the internationally recognised Universal Postal Union's S-42 Addressing Standard, with postal codes throughout Trinidad and Tobago (TTPost, 2020). Although property addressing responsibilities and requirements are not legislated, adoption of the TTPost addressing standard will help to accurately identify persons and spatial units.

PBRS transactions and processes

Although the database is unified, the workflows and transactions for deeds registration and subsequent registrations on titles are separate and unique. The workflow and number of tasks for subsequent registrations on titles (e.g. mortgage, easement, lease) reflect the rigor required for review and approval of these registrations versus a deeds registration workflow which has fewer tasks to achieve a completed legal recordation.

The implementation of the PBRS transactions and the unified land register is complicated by the fact that Common Law still governs many prerequisite transactions for subsequent actions on a title under the RPA. The PBRS business rules and data entry are therefore configured to establish any required relationships. For example, a *Substitution of Name* (change of person name not due to marriage) transaction under RPA requires that the name change first be registered as a deed poll, and the instrument number of the registered deed is linked to the *Substitution of Name*. In addition, since a title registration applies to the land only, the registration of rights on dwellings (units, condominiums) constructed on that land are executed as a lease or sublease and registered as a deed, while also referring to the titled property in the titles register. For the lessor of that unit to have rights to common land areas on the titled land, an easement lease is registered against the title and linked to the registered lease deed. If a mortgage is registered against the lease interest, a collateral mortgage is also registered against the easement interest. There is no condominium legislation in force.

There are many other examples in current practice and in proposed law, which bind the registration of deeds to subsequent registrations on titled land. Further there are land policies, which apply to both deeded property and titled property in the same manner but must be implemented in PBRS as separate workflows and transactions in order to manage the interests and relationships properly. An example is the requirement to receive approval from the Attorney General for the late registration (after 12 months) for the conveyance of land as a gift.

PBRS legacy data verification and cleansing

The value of the unified land register database will not be fully realized until the deeds register data from the PIMS and the recently digitized titles, are thoroughly verified and cleansed after migration to the PBRS. There are two specific data objects which will require cleansing over time: the "person" data and the "spatial unit" data. Current data sources have many duplicates for the same person (natural or legal) and for the same spatial unit. Without cleansing, automated business rules cannot be implemented as desired, and searches are much more time consuming for both staff and public users. Ideally, there will be one active record for a person and one active record for a spatial unit. Verification and cleansing will be complex and tedious since there is no unique identifier for persons or parcels. The PBRS will support data verification and cleansing through various configured transactions. However, in order to maintain the accuracy of person data, submitting attorneys must change their practices and be required to use birth personal identification number for certain parties of transactions, and ideally use standard spatial identifiers (UPIN and TTPOST assigned address) as specified by the RGD for land parcels in their prepared instruments.

Performance

Six years after the start of the SIMRGD project, it is worthwhile to briefly examine performance against two of the global indices that prompted change: The Ease of Doing Business and the Global Competitiveness Index. Figure 1 shows that Trinidad and Tobago's Ease of Doing Business ranking has continued to decline from 2014. Figure 1 also shows that during the same period, although the *registering property* indicator ranking was much lower than the Ease of Doing Business ranking, there was considerable (uneven) improvement.

The analysis presented in the Global Competitiveness Report produced by the World Economic Forum "is based on a methodology integrating the latest

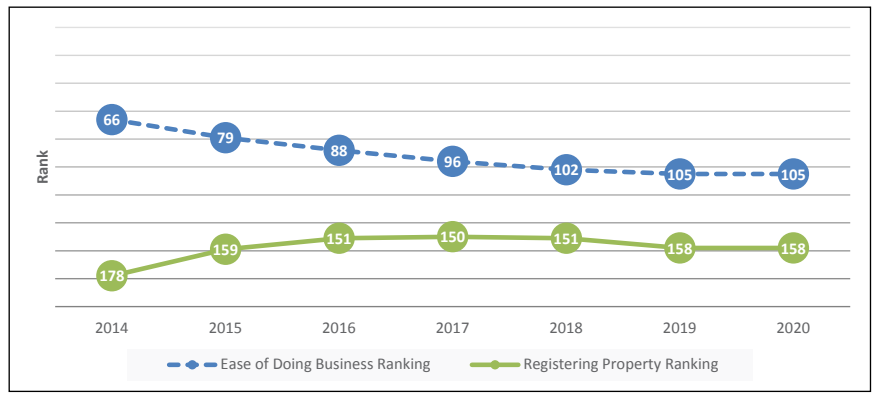


Figure 1. Trinidad and Tobago global ranking for Ease of Doing Business and registering property by year. Data from World Bank (2014, 2015, 2016, 2017, 2018, 2019b, 2020).

Figure 2. Trinidad and Tobago ranking for Global Competitiveness Index and Institutions by year. Data from World Economic Forum (2014, 2015, 2016, 2017, 2018, 2019).

Most maps of land plots are kept as scanned images and there is an electronic database for recording boundaries, checking plans, and providing cadastral information

statistics from international organisations and a survey of executives." The report is "designed to help policy-makers, business leaders and other stakeholders shape their economic strategies in the era of the Fourth Industrial Revolution." The main ranking is known as the *Global Competitiveness Index* and measures national competitiveness defined as the set of institutions, policies and factors that determine the level of productivity. The index is organized into 12 pillars: *Institutions*, *Infrastructure*, *ICT adoption*, *Macroeconomic stability*, *Health*, *Skills*, *Product Market*, *Labour Market*, *Financial system*, *Market size*, *Business dynamism*, and *Innovation capability* (World Economic Forum, 2019).

Perhaps the most relevant pillar to implementation of PBRS is *Institutions*. This pillar includes components such as *Efficiency of legal framework in settling disputes*, *Property rights*, and *Quality of land administration*. Figure 2 shows that Trinidad and Tobago's Global Competitiveness Index ranking has improved since 2014. Figure 2 also shows that during the same period, the *Institutions* pillar ranking was lower than the Global Competitiveness Index ranking and that overall there has been a decline since 2014.

Trinidad and Tobago ranks 79th overall, down one place from 2018. Its score has improved (58.3, +0.4 points) but dropped one place due to the addition of Barbados (58.9, 77th) to the ranking. Trinidad and Tobago's performance is below the High-income group average for all pillars but its relative strengths include ICT adoption (60.4, 61st), Macroeconomic stability (88.9, 58th), and Financial system (67.9, 45th), all with a positive trend. Trinidad and Tobago's three main weaknesses are Institutions (47.9, 102nd), Product market (46.4, 122nd), and Market size (40.5, 106th). Institutions and Product market also show a negative trend.

Conclusion

The two global indices examined in this paper show some reasons to be optimistic about the success of the SIMRGD. Over the six years, the registering property indicator ranking, and the Global Competitiveness Index ranking have both improved. The Institutions ranking was improving but suffered a setback in 2019 that requires further investigation to determine the cause.

There are other reasons to be optimistic. Implementation of the PBRS will bring separate deeds and titles registers into a single harmonized, LADM compliant, system, thus achieving the goal of strengthening identification of parcels and persons in property registration. It will also contribute to detection and prevention of land fraud, land corruption, and money laundering. Successful implementation of the UPIN in the PBRS will make it possible to link the Land Registry and SMD databases for the first time thus improving the Doing Business reliability of infrastructure indicator, the quality of land administration index, and the registering property indicator. Once the PBRS is operational, land transactions will become faster and this, together with the proclamation of assented laws, is likely to boost the global indices. In the longer term Trinidad and Tobago may attract more investment.

References

Acemoglu, D., Collier, P., Johnson, S., Klein, M., & Wheeler, G. (2013). "A Review of Doing Business." Retrieved from https://www.doingbusiness.org/content/dam/doingBusiness/media/Methodology/Open-Letter-Review-of-the-Arguments-on-DB.pdf.

Condominium (TT) Act of 1981. Retrieved from http://laws.gov.tt/ttdll-web/revision/byunprocliamed

Conveyancing and Law of Property (TT) Act of 1939, Chapter 56:01. Retrieved from http://rgd.legalaffairs.gov.tt/laws2/alphabetical_list/lawspdfs/56.01.pdf

Done, P. & Robertson, M. M. (1988). A Northern Hemisphere Post-Colonial Cadastral System: Trinidad. *Australian Surveyor* 34(1). Available from https://www.tandfonline.com

Land Adjudication (TT) Act of 2000. Retrieved from http://laws.gov.tt/ttdll-web/revision/byunprocliamed

Land Adjudication (Amendment) (TT) Act of 2018. Retrieved from http://laws.gov.tt/ttdll-web/revision/byyear

Land Law and Conveyancing (TT) Act of 1981. Retrieved from http://laws.gov.tt/ttdll-web/revision/byunprocliamed

Land Registration (TT) Act of 1981. Retrieved from http://laws.gov.tt/ttdll-web/revision/byunprocliamed

Land Tenure Center. (1992a). *Land Rationalization and Development Programme: Final Report*. (Volume 1). Trinidad and Tobago Ministry of Agriculture, Land, and Marine Resources. Retrieved from https://books.google.com

Land Tenure Center. (1992b). *Land Rationalization and Development Programme: Annexes*. (Volume 1). Trinidad and Tobago Ministry of Agriculture, Land, and Marine Resources. Retrieved from https://books.google.com

Land Tribunal (TT) Act of 2000. Retrieved from http://laws.gov.tt/ttdll-web/revision/byunprocliamed

Land Tribunal (Amendment) (TT) Act of 2018. Retrieved from http://laws.gov.tt/ttdll-web/revision/byyear

Lemmen, C., Van Oosterom, P., & Bennett, R. (2015). Land Administration Domain Model. *Land Use Policy, 49,* 535-545. Retrieved from http://www.gdmc.nl/publications/2015/Land_Administration_Domain_Model.pdf

Ministry of Planning and Development. (2019a). *Public Sector Investment Programme*. Retrieved from https://www.finance.gov.tt/wp-content/uploads/2019/10/PUBLIC-SECTOR-INVESTMENT-PROGRAMME-2020.pdf.

Ministry of Planning and Development. (2019b). *The National Development Strategy of Trinidad and Tobago 2016-2030*. Retrieved from https://www.planning.gov.tt/content/vision-2030.

Parliament of the Republic of Trinidad and Tobago. (2018). *Bill Essentials: The Land Adjudication (Amendment) (No.2) Bill, 2017; The Land Tribunal (Amendment) (No.2) Bill, 2017; The Registration of Titles to Land (Amendment) (No.2) Bill, 2017*. Retrieved from http://www.ttparliament.org/documents/2649.pdf

Real Property (TT) Act of 1945, Chapter 56:02. Retrieved from https://rgd.legalaffairs.gov.tt/laws2/alphabetical_list/lawspdfs/56.02.pdf

Real Property (TT) Ordinance of 1889. Not available.

Registrar General (TT) Act of 1921, Chapter 19:03. Retrieved from https://rgd.legalaffairs.gov.tt/laws2/Alphabetical_List/lawspdfs/19.03.pdf

Registration of Deeds (TT) Act of 1884, Chapter 19:06. Retrieved from https://rgd.legalaffairs.gov.tt/laws2/Alphabetical_List/lawspdfs/19.06.pdf

Registration of Titles to Land (TT) Act of 2000. Retrieved from http://laws.gov.tt/ttdll-web/revision/byunprocliamed

Registration of Titles to Land (Amendment) (TT) Act of 2018. Retrieved from http://laws.gov.tt/ttdll-web/revision/byyear

The Constitution of The Republic of Trinidad and Tobago of 1976. Retrieved from http://rgd.legalaffairs.gov.tt/Laws2/Constitution.pdf

TTPost. (2020). Postal Code Implementation. Retrieved from https://ttpost.net/index.php/news/postal-code/

United Nations. (2019). "Small Island Developing States." Retrieved from https://sustainabledevelopment.un.org/topics/sids/list

World Bank. (2014). Doing Business 2014: Understanding Regulations for Small and Medium-Size Enterprises. World Bank Group. Retrieved from http://www.doingbusiness.org/en/reports/global-reports/doing-business-2014.

World Bank. (2015). Doing Business 2015: Going Beyond Efficiency. World Bank Group. Retrieved from http://www.doingbusiness.org/en/reports/global-reports/doing-business-2015.

World Bank. (2016). Doing Business 2016: Measuring Regulatory Quality and Efficiency. World Bank Group. Retrieved from http://www.doingbusiness.org/en/reports/global-reports/doing-business-2016.

World Bank. (2017). Doing Business 2017: Equal Opportunities for All. World Bank Group. Retrieved from http://www.doingbusiness.org/en/reports/global-reports/doing-business-2017.

World Bank. (2018). Doing Business 2018: Reforming to Create Jobs. World Bank Group. Retrieved from http://www.doingbusiness.org/en/reports/global-reports/doing-business-2018.

World Bank. (2019a). "World Development Indicators." Retrieved from https://datacatalog.worldbank.org/dataset/world-development-indicators.

World Bank. (2019b). Doing Business 2019: Training for Reform. World Bank Group. Retrieved from http://www.doingbusiness.org/en/reports/global-reports/doing-business-2019.

World Bank. (2019C). Doing Business 2019: Trinidad and Tobago. World Bank Group. Retrieved from http://www.doingbusiness.org/content/dam/doingBusiness/country/t/trinidad-and-tobago/TTO.pdf.

World Bank. (2020). Doing Business 2020. World Bank Group. Retrieved from http://www.doingbusiness.org/en/reports/global-reports/doing-business-2020.

World Economic Forum. (2014). The Global Competitiveness Report 2014-2015. Retrieved from http://reports.weforum.org/global-competitiveness-report-2014-2015/.

World Economic Forum. (2015). The Global Competitiveness Report 2015-2016. Retrieved from http://reports.weforum.org/global-competitiveness-report-2015-2016/.

World Economic Forum. (2016). The Global Competitiveness Report 2016-2017. Retrieved from https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1

World Economic Forum. (2017). The Global Competitiveness Report 2017-2018. Retrieved from https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018.

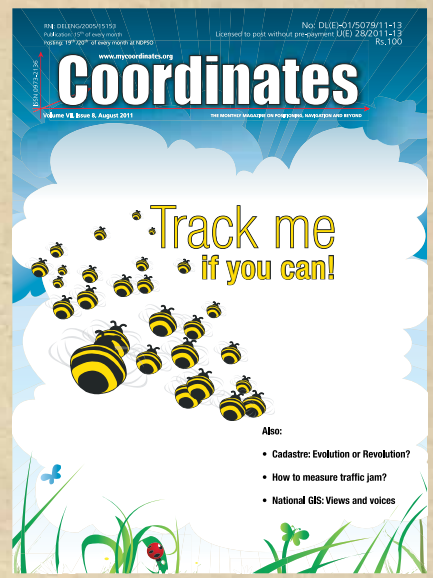
World Economic Forum. (2018). The Global Competitiveness Report 2018. Retrieved from http://reports.weforum.org/global-competitiveness-report-2018/.

World Economic Forum. (2019). The Global Competitiveness Report 2019. Retrieved from http://reports.weforum.org/global-competitiveness-report-2019/.

The paper was prepared for presentation at the "2020 World Bank Conference On Land And Poverty" The World Bank - Washington DC, March 16-20, 2020. *Copyright 2020 by author(s).*

In Coordinates

10 years before...



mycoordinates.org/vol-7-issue-8-August-2011

Evolution or Revolution?

Kees de Zeeuw
Director, Kadaster International, part of the Cadastre, Land Registry and Mapping Agency The Netherlands

Martin Salzmann
Director, Strategy and policy with the Cadastre, Land Registry and Mapping Agency The Netherlands

Based on the environment and developments as delineated in this paper, it is concluded that innovation is not an option a but a prerequisite. Society goes on, whether we like it or not. This innovation concerns our information strategy, systems, services, organisation, way of working and business models. The pace of innovation is becoming so fast that solving user demands alone with existing systems is not possible any longer. We have to adopt to the concept of 'open innovation' and be open to new technological developments. The increasing pace of innovation demands can no longer be tackled by a single-party strategy.

Track me if you can!

Pei-Hung Jau, Zuo-Min Tsai, Fan-Ren Chang and Huei Wang

The specialized positioning system used for the tiny insects, such as bees, has been proposed in this article. In order to achieve the purpose of positioning the target accurately instead of only tracking the target in a rough area, the ranging techniques of the pulse radar system are improved by using the spread spectrum technology which is inspired from the GPS and the other communication system. The autocorrelation properties of the PRN code help us to overcome the weak signal problems and increase the ranging accuracy.

How to measure traffic jam?

Martin Grzebellus
Managing Director NavCert GmbH, Germany

We have now identified KPIs which reflect the achieved quality and based on ISO/EN 17025 a proper methodology for measurements has been identified. However an optimum way to measure cost effectively ground truth does not exist. A way forward is to perform an audit of the service provider offering traffic information.

National GIS: Views and Voices

"A well defined concept of NGIS is needed"

K R Sridhara Murthi
Senior Expert, Office of Adviser to Prime Minister on Public Information Infrastructure and Innovation

"Academic research should focus on modeling"

Prof NL Sarda
Professor, IIT-Bombay

"The mandate of INGO needs to be carefully drafted"

Dr Vandana Sharma
Deputy Director General, National Informatics Centre

NSDI and National GIS go hand in hand

Swarna Subba Rao
Surveyor General of India

Humorous science: An introduction

As the world continuous to struggle with the COVID-19 pandemic, this paper provides an introduction to the use of humour in the scientific literature and highlights several examples

Volker Janssen
Publications Officer, Association of Public Authority Surveyors (APAS), New South Wales, Australia

This is the first in a series of papers celebrating some of the weird and wonderful research findings hidden amongst the scientific literature. It aims to ensure that we remember the funnier side of science and provides answers to questions we may have been too afraid to ask. This study was conducted entirely in the author's spare time and is in no way related to his employer. To get started, we explore some general issues about publishing research and the difficulties associated with it.

Humorous papers can improve student learning and have the potential to convey scientific information to a much wider and much more general and diverse audience. Often, they have a more serious message that is hidden between the lines or disguised by tackling a ridiculous topic. In an age of increasing importance of high-quality, peer-reviewed research output by academics ('publish or perish'), it would be a shame to lose the funny side of science as it is also a crucial part of academic freedom. Thankfully, some journals continue to support the publication of the occasional humorous paper, sometimes with unexpected results. For example, several years ago, a study on the indirect tracking of drop bears using Global Navigation Satellite System (GNSS) technology was published in the *Australian Geographer* (Janssen, 2012) and quickly became the most downloaded paper in the journal's online history.

To honour unusual and imaginative research, the science humour magazine *Annals of Improbable Research* introduced the Ig Nobel Prizes in 1991. The aim is to make people laugh and then think, and along the way spur their interest in the various sciences. The prizes are presented to the winners by genuine Nobel laureates during an annual gala ceremony held at Harvard University. Indeed, several of the studies mentioned in this series of papers on humorous science received the Ig Nobel Prize.

The *Journal of Irreproducible Results*, founded in 1955, is another science humour magazine worth mentioning. These magazines often include shorter communications addressing intriguing research questions such as: Which came first, the chicken or the egg? Does it rain more often on weekends? Can you compare apples and oranges? How do cats react to bearded men? Is an eye for an eye worth more than an arm and a leg? What is the dead-grandmother exam syndrome?

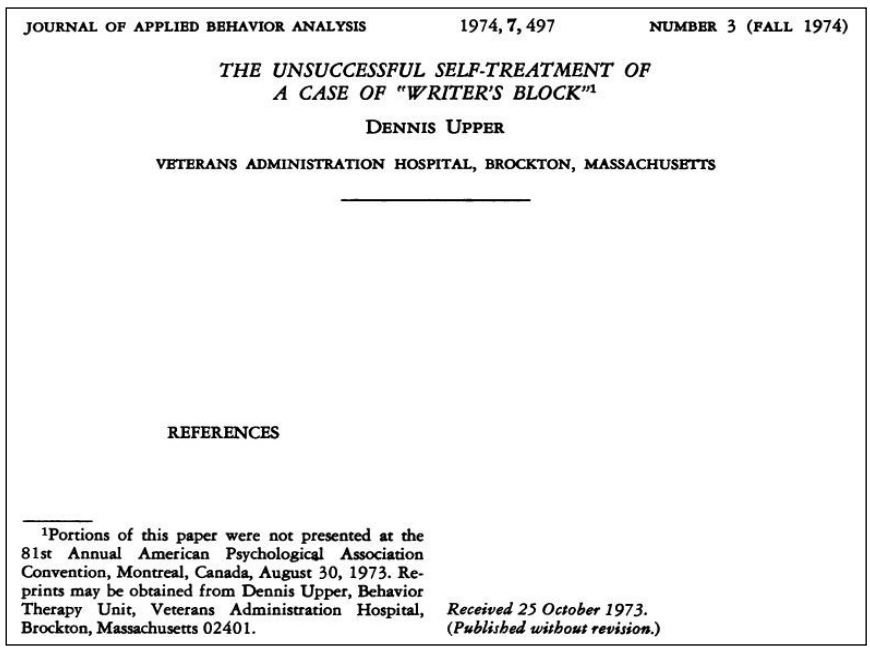
To set the reader's mind at ease, here are brief answers to these questions: The chicken came first, proven experimentally using a chicken, an egg and the US Postal Service (but conflicting with a later theoretical answer collaboratively provided by a geneticist, philosopher and chicken farmer). Yes, certain locations exhibit more rain on weekends than weekdays (and vice versa), proven by analysing precipitation data from nearly 200 stations across the US over 40 years. Apples and oranges can indeed be compared and are actually very similar, proven experimentally via infrared spectra of apple and orange extracts, and later confirmed by Barone (2000) who identified a significant difference only in the categories of colour and seeds. Female cats dislike men with long dark beards, proven by analysing the reactions of 214 cats to photographs of bearded men, measuring changes

Humorous papers can improve student learning and have the potential to convey scientific information to a much wider and much more general and diverse audience. Often, they have a more serious message that is hidden between the lines or disguised by tackling a ridiculous topic. In an age of increasing importance of high-quality, peer-reviewed research output by academics ('publish or perish'), it would be a shame to lose the funny side of science as it is also a crucial part of academic freedom

in pulse rate, respiration, eye dilation, fur shed rate and qualitative behaviour. An arm and a leg are worth less than two eyes, proven by determining the psychological worth people attribute to various parts of the human body.

The dead-grandmother exam syndrome implies that a student's grandmother is far more likely to die suddenly just before the student takes an exam than at any other time of year (particularly if the student's current grade is poor), proven based on 20 years of data collected and analysed by Adams (1999). A student who is about to fail a class and has a final exam coming up was found to be more than 50 times more likely to lose a family member than an excellent student not facing any exams. This clearly showed that family members literally worry themselves to death over the outcome of their relatives' exam performance.

Another valuable source of science humour is arXiv (https://arxiv.org/), a free open-access archive for scholarly articles in various fields of science, many of these denoted as submitted or in print. Materials on this site are not peer-reviewed by arXiv and include contributions that may never have been intended for submission elsewhere or had their titles de-humorised for publication. An intriguingly large number of papers are uploaded to this archive around April Fool's Day each year.



JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1974, 7, 497 NUMBER 3 (FALL 1974)

THE UNSUCCESSFUL SELF-TREATMENT OF A CASE OF "WRITER'S BLOCK"[1]

DENNIS UPPER

VETERANS ADMINISTRATION HOSPITAL, BROCKTON, MASSACHUSETTS

REFERENCES

[1]Portions of this paper were not presented at the 81st Annual American Psychological Association Convention, Montreal, Canada, August 30, 1973. Reprints may be obtained from Dennis Upper, Behavior Therapy Unit, Veterans Administration Hospital, Brockton, Massachusetts 02401.

Received 25 October 1973.
(Published without revision.)

Figure 1: Unsuccessful self-treatment of writer's block (Upper, 1974).

Getting published

Starting with the difficulty to write an academic paper, Upper (1974) famously reported on the unsuccessful self-treatment of a case of writer's block (Figure 1). The reviewer mentioned at the time: "I have studied this manuscript very carefully with lemon juice and X-rays and have not detected a single flaw in either design or writing style. I suggest it be published without revision. Clearly it is the most concise manuscript I have ever seen – yet it contains sufficient detail to allow other investigators to replicate Dr Upper's failure." Decades later, this indeed spawned a multi-site cross-cultural replication of the study, showing a remarkable agreement of results between the two (Didden et al., 2007).

The feedback received from reviewers during the rigorous peer-review process is usually constructive and helpful in improving the submitted paper, but sometimes it can be incomprehensible or plain silly. In order to help emerging academics to appropriately navigate the peer-review process in these cases, Rosenfield and Hoffman (2009) developed an innovative, evidence-based framework for providing "snappy answers to stupid questions". The received (inadequate) feedback is given a score on the five-tiered Scale of Silliness (SOS), which can be adjusted by ±1 through the Mood Reflective Index (MRI) depending on the author's personal disposition at the time, to obtain the Scale of Belligerence (SOB), which determines the Appropriate Degree of Response (ADR). The ADR ranges from timid circumspection (caution) all the way to extreme maliciousness, with mild petulance, moderate snarkiness and severe nastiness in between (Figure 2).

It was noted that applying this framework to its full extent may have negative consequences, such as loss of promotion or research funding, but its therapeutic value cannot be understated. Also, it should only be used in conjunction with high-quality submissions that reviewers either did not understand or did not give sufficient attention to, as poorly written and under-researched submissions probably deserve the feedback received.

In a quest to provide recommendations for writing good paper titles, Subotic and Mukherjee (2014) investigated title characteristics (length, type, amusement and pleasantness) and title markers (colons and attention-grabbing words) in relation to subsequent paper downloads and citations in the field of psychology. Examples of titles classified as highly amusing included 'How extraverted is honey.bunny77@hotmail.de? Inferring personality from e-mail addresses' and 'Taking a new look at looking at nothing'.

They determined that title length and title amusement (humour) were the most important characteristics, with shorter titles being associated with more citations. However, it was noted that this result may be an artefact caused by the naturally higher citation rate of higher-impact journals. Papers with more humorous titles showed slightly more downloads but were not correlated with citations, and more amusing titles tended to be shorter. Noting that more research is required to understand how relevant title characteristics relate to each other, they recommended to keep the title short and amusing, within common sense and good taste, and that colon usage probably does not matter.

Research findings are often presented at conferences and seminars. Rockwood et al. (2004) explored how often attendees nod off during scientific meetings and examined risk factors for this behaviour. After counting the number of heads falling forward during a 2-day lecture series attended by 120 people (this method was chosen because counting is scientific), they calculated incidence density curves for nodding-off events per lecture (NOELs) and assessed risk factors using logistic regression analysis. The quality of the lectures varied from entertaining and informative to monotonous and repetitive, to rushed and surreal. The incidence density curve ranged from 3 to 24 NOELs, with a median of 16 NOELs per 100 attendees (Figure 3).

Identified risk factors for nodding off included environmental factors (dim lighting, warm room temperature, comfortable seating), audio-visual factors (poor slides, failure to speak into the microphone) and circadian factors (early morning, post meal), but speaker-related behaviour (monotonous tone, tweed jacket, getting lost in the lecture) provided the strongest risk. A questionnaire administered to those who nodded off revealed that most were comforted to know they were not alone and that it was predominantly the speaker's fault. Most had no enthusiasm to attend boring presentations but were influenced by continuing professional development (CPD) credits, guilt or obsessiveness.

Since this paper generated considerably more interest than the authors' more conventional publications, they decided to write a follow-up (Rockwood et al., 2005). Here, they performed a comprehensive, international systematic review of nodding off and napping during medical presentations, spanning more than 100 years (but only three papers during that time, including their own). The results suggested that tranquillising lectures are common, annoying and persistent, with low lighting and boring (and badly presented) contents being the main risk factors for nodding off. The authors also provided a few tips on how to help increase the attention a paper may receive after publication through ingested keywords, citations and tweaking the methodology to exclude unwanted references.

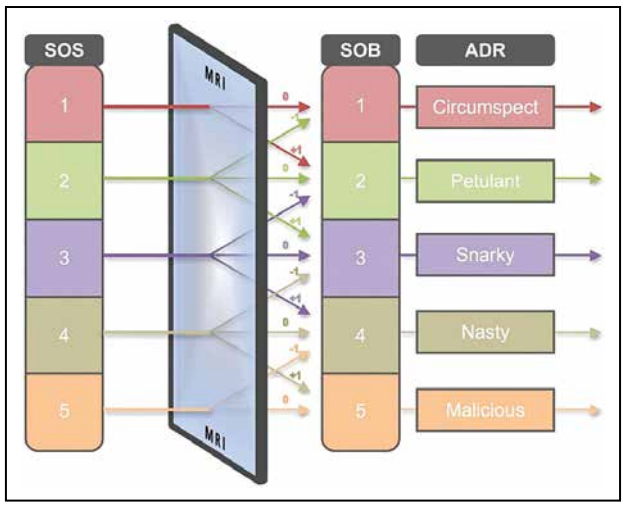


Figure 2: Evidence-based framework for responding to silly peer-review feedback, using the Scale of Silliness (SOS), Mood Reflective Index (MRI) and Scale of Belligerence (SOB) to arrive at the Appropriate Degree of Response (ADR) (Rosenfield and Hoffman, 2009).

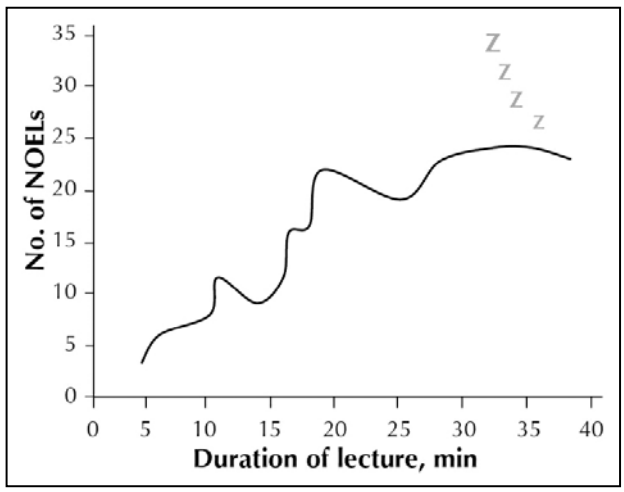


Figure 3: Special incidence density curve, showing the number of nodding-off events per lecture (NOELs) per 100 attendees as a function of presentation time (Rockwood et al., 2004).

Noting that comedy can tell us something important about the human condition, Watson (2015) encouraged the use of humour as a methodology for carrying out research and presenting its findings in the social sciences. She concluded that academics should take seriously their responsibilities as producers of research to entertain and as consumers to read for fun

Humorous publications

Noting that comedy can tell us something important about the human condition, Watson (2015) encouraged the use of humour as a methodology for carrying out research and presenting its findings in the social sciences. She concluded that academics should take seriously their responsibilities as producers of research to entertain and as consumers to read for fun. This is not an easy task, considering the danger of having a humorous paper rejected by the targeted publication or, once published, potentially losing credibility amongst peers and thereby jeopardising one's professional career. Focussing on the field of physics and astronomy, Scott (2021) reiterated the need to see the funny side of science, while taking the reader through history and many entertaining examples. In a world still suffering from the effects of the COVID-19 pandemic, maybe this is now more important than ever.

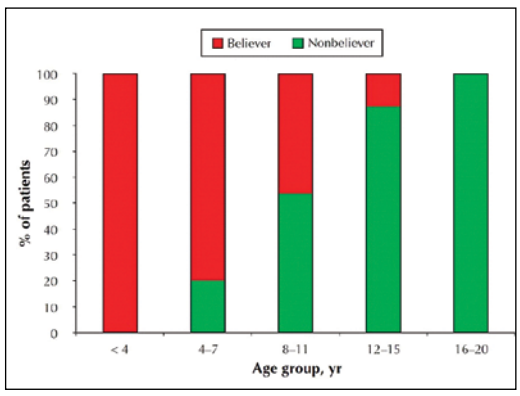


Figure 4: Belief in Santa Claus by age group based on 45 participants (Cyr, 2002).

However, it should be noted that opposing views on humour exist. For example, Bentall (1992) proposed classifying happiness as a psychiatric disorder, arguing that it is statistically abnormal, consists of a discrete cluster of symptoms, reflects the abnormal functioning of the central nervous system and is associated with various cognitive abnormalities (in particular, a lack of contact with reality). He suggested to replace the ordinary language term 'happiness' with the more formal description 'major affective disorder, pleasant type' in the interest of scientific precision and the hope of reducing any possible diagnostic ambiguities. He concluded that once the debilitating consequences of happiness become widely recognised, it is likely that psychiatrists will begin to devise treatments for the condition, soon leading to the emergence of happiness clinics and anti-happiness medications.

Fortunately, over the years, researchers in many areas of science have taken on the challenge of being entertaining. While often hidden among more serious research results, fruits of these endeavours have been compiled in several lists of funny papers, generally focussing on a particular discipline (e.g. Martin, 2001; McCrory, 2006; Scott, 2021).

Here are only a few examples of papers included on these lists:

•Audoly B. and Neukirch S. (2005) Fragmentation of rods by cascading cracks: Why spaghetti does not break in half, *Physical Review Letters*, 95(9), 095505.

- Barss P. (1984) Injuries due to falling coconuts, *Journal of Trauma*, 24(11), 990-991.
- Bowman R. and Sutherland N.S. (1969) Discrimination of 'W' and 'V' shapes by goldfish, *Quarterly Journal of Experimental Psychology*, 21(1), 69-76.
- Forrest J.B. and Gillenwater J.Y. (1982) The hand vacuum cleaner: Friend or foe? *Journal of Urology*, 128(4), 829.
- Georget D.M.R., Parker R. and Smith A.C. (1994) A study of the effects of water content on the compaction behaviour of breakfast cereal flakes, *Powder Technology*, 81(2), 189-195.
- Hatta T. and Kawakami A. (1999) Are nonproper chopstick holders clumsier than proper chopstick holders in their manual movements? *Perceptual and Motor Skills*, 88(3), 809-818.
- Sidoli M. (1996) Farting as a defence against unspeakable dread, *Journal of Analytical Psychology*, 41(2), 165-178.
- Sreekumar K.P. and Nirmalan G. (1990) Estimation of the total surface area in Indian elephants (Elephas maximus indicus), *Veterinary Research Communications*, 14(1), 5-17.
- Verhulst J. (1999) Nonuniform distribution of the elliptical longitudes of sun and moon at the birthdays of top scientists, *Psychological Reports*, 85(1), 35-40.
- Ward W.D. and Holmberg C.J. (1969) Effects of high-speed drill noise and gunfire on dentists' hearing, *Journal of the American Dental Association*, 79(6), 1383-1387.

Other amusing papers include Blackler et al. (2016) confirming that users of various products and interfaces generally find life is too short to RTFM (read the fricking manual), which may be of particular concern to spatial professionals regularly employing sophisticated equipment. Using a series of questionnaires administered to 170 people over 7 years and two 6-month studies based on diaries and interviews with a total of 15 participants, they found that most people do not read the documentation and do not use all

features of the products they own and utilise regularly. Men are more likely to do both than women, younger people are less likely to use manuals than middle-aged and older ones, and more educated people are also less likely to read manuals. Furthermore, it appears that over-featuring and being forced to consult manuals causes negative emotional reactions in users. The findings therefore suggest that people do not read manuals because they find it a negative experience, overly complicated and feel that the interface itself should tell them all they need to know.

The application of human saliva to clean dirty surfaces has been an intuitive practice for many generations (and caused many children to protest in disgust when their parents used this technique on them). Apparently, conservators have been cleaning old paintings and statues with their own spit for years because they discovered that it can clean an artefact without breaking it down. Romao et al. (1990) finally established the scientific basis for this practice, performing tests on five gilded and polychromed sculptures dating from the 18th century and applying chromatographic techniques to separate and investigate the components of saliva. Compared to other cleaning agents tested, saliva was confirmed as the best cleaner. However, it was noted that it slightly attacked red and blue matte surfaces.

Blinder (1974) presented a new model for brushing teeth, arguing that the existing bad-taste-in-your-mouth and mother-told-me-so models were not sufficiently rigorous to describe this phenomenon. Applying an assumption common to all human capital theory (individuals seek to maximise their income), his model is firmly grounded in economic theory and considered the toothbrushing decisions of chefs and waiters working in the same restaurant. On the benefits side, chefs are rarely seen by customers and work on a consistent salary. Waiters, on the other hand, constantly interact with the public and rely on tips for most of their income, i.e. bad breath and/or yellow teeth could have damaging effects on their earnings. On the cost side, since wages for chefs are higher, the opportunity cost of brushing is correspondingly higher. Therefore, the theory predicts that chefs brush their teeth less often than waiters.

The model predictions were empirically confirmed through the analysis of data obtained from a cross-sectional study of American adults in the civilian labour force, conducted by the Federal Brushing Institute (FBI), which included denture wearers but excluded people with no teeth at all. Thus, the study demonstrated the usefulness of human capital concepts in understanding dental hygiene. Furthermore, it was noted that the model could also be applied to other problems such as combing hair, washing hands or cutting fingernails.

Staying with economics, McAfee (1983) applied counterfactual analysis to examine American economic growth if Columbus had fallen off the edge of the world rather than stumbled across the American continents. He constructed a theoretical model of the Earth in which implications of Columbus falling off the edge could be tested and used a novel analytical procedure (Fractured Reconstructive Autoerotic Projection Package with Econometrisation, FRAPPE) to detail the properties of the counterfactual world.

This revealed that the US would be relatively unchanged and therefore unaffected by tinkering with history. However, the rest of the world would be drastically different, which was illustrated by presenting a rough chronology of events following Columbus' demise. For example, in a daring exploit, Australia was unfastened from the Pacific rim by a team of Welsh divers and sneaked past India and Africa to be fastened near the edge of the world about 1,000 miles off Britain. While travelling around the Cape, Australia was accidently inverted, causing this new continent of America to look remarkably like today's US. It was first used as a penal colony for former British Lords and French royalty who eventually revolted, and the rest is history. It was also speculated that if the Earth had more than one moon, the space race would have turned out differently, representing an *m* nation *n* moon problem.

Cyr (2002) investigated the level of belief in Santa Claus among 45 inpatients at a children's hospital. The answers obtained during a structured interview, which also included questions about the Tooth Fairy and Easter bunny, along with separate questions for parents were combined into

It is known that only female vinegar flies produce a particular pheromone for communication and mate-finding. A pheromone is basically a hormone working outside the body, i.e. a chemical produced by an animal that changes the behaviour of another animal of the same species (perhaps comparable to a human wearing perfume). Becher et al. (2018) discovered that they could distinguish male from female flies just by sniffing them, so they devised a series of experiments to investigate whether a panel of eight wine connoisseurs could do the same

a final score (HOHO score) of family fantasy predisposition. Statistical analysis demonstrated that belief in Santa Claus was inversely proportional to a child's age and directly proportional to the age at which their parents stopped believing. In other words, as expected, belief in Santa diminished with increasing age (Figure 4). It was noted that a multivariate analysis failed to relate the HOHO score to belief in Santa, which may be due to the HOHO score reflecting an assimilation of cultural folklore rather than independent fantasy predisposition.

Finally, it is known that only female vinegar flies produce a particular pheromone for communication and mate-finding. A pheromone is basically a hormone working outside the body, i.e. a chemical produced by an animal that changes the behaviour of another animal of the same species (perhaps comparable to a human wearing perfume). Becher et al. (2018) discovered that they could distinguish male from female flies just by sniffing them, so they devised a series of experiments to investigate whether a panel of eight wine connoisseurs could do the same. This included asking panel members to smell empty wine tasting glasses, which had previously contained a male or female fly for 5 minutes. Then, a female fly was added to a glass of water or wine (and removed before testing), and additional tests were conducted using a synthetic chemical corresponding to the female fly scent. Statistical data analysis revealed that the scent of a single female fly was stronger and qualitatively clearly different from a male fly and that even a small amount of the female fly scent was perceptible, spoiling a glass of wine.

Conclusion

This paper has only been able to provide a brief introduction into the fascinating world of amusing research, which generally applies serious science to weird and wonderful research questions but also includes the occasional spoof paper. Upcoming papers in this series on humorous science will highlight selected examples of entertaining research for particular areas of interest, often including a considerable spatial component. This includes typical problems encountered in the workplace office environment, analysing the coexistence of humans and vampires or zombies, animal mapping and behaviour, grappling with applied physics in our everyday lives, as well as studies related to work health and safety and our physical and mental wellbeing.

References

Adams M. (1999) The dead grandmother/exam syndrome, *Annals of Improbable Research*, 5(6), 3-6.

Barone J.E. (2000) Comparing apples and oranges: A randomised prospective study, *BMJ*, 321(7276), 1569-1570.

Becher P.G., Lebreton S., Wallin E.A., Hedenström E., Borrero F., Bengtsson M., Joerger V. and Witzgall P. (2018) The scent of the fly, *Journal of Chemical Ecology*, 44(5), 431-435.

Bentall R.P. (1992) A proposal to classify happiness as a psychiatric disorder, *Journal of Medical Ethics*, 18(2), 94-98.

Blackler A.L., Gomez R., Popovic V. and Thompson M.H. (2016) Life is too short to RTFM: How users relate to documentation and excess features in consumer products, *Interacting with Computers*, 28(1), 27-46.

Blinder A.S. (1974) The economics of brushing teeth, *Journal of Political Economy*, 82(4), 887-891.

Cyr C. (2002) Do reindeer and children know something that we don't? Pediatric inpatients' belief in Santa Claus, *CMAJ*, 167(12), 1325-1327.

Didden R., Sigafoos J., O'Reilly M.F., Lancioni G.E. and Sturmey P. (2007) A multisite cross-cultural replication of Upper's (1974) unsuccessful self-treatment of writer's block, *Journal of Applied Behavior Analysis*, 40(4), 773.

Janssen V. (2012) Indirect tracking of drop bears using GNSS technology, *Australian Geographer*, 43(4), 445-452.

Martin N. (2001) Weird and wonderful, *The Psychologist*, 14(9), 484-485.

McAfee R.P. (1983) American economic growth and the voyage of Columbus, *American Economic Review*, 73(4), 735-740.

McCrory P. (2006) Who says you cannot get published? *British Journal of Sports Medicine*, 40(2), 95.

Rockwood K., Hogan D.B. and Patterson C.J. (2004) Incidence of and risk factors for nodding off at scientific sessions, *CMAJ*, 171(12), 1443-1445.

Rockwood K., Patterson C.J. and Hogan D.B. (2005) Nodding and napping in medical lectures: An instructive systematic review, *CMAJ*, 173(12), 1502-1503.

Romao P.M.S., Alarcao A.M. and Viana C.A.N. (1990) Human saliva as a cleaning agent for dirty surfaces, *Studies in Conservation*, 35(3), 153-155.

Rosenfield D. and Hoffman S.J. (2009) Snappy answers to stupid questions: An evidence-based framework for responding to peer-review feedback, *CMAJ*, 181(12), E301-E305.

Scott D. (2021) Science spoofs, physics pranks and astronomical antics, https://arxiv.org/abs/2103.17057 (accessed Aug 2021).

Subotic S. and Mukherjee B. (2014) Short and amusing: The relationship between title characteristics, downloads, and citations in psychology articles, *Journal of Information Science*, 40(1), 115-124.

Upper D. (1974) The unsuccessful self-treatment of a case of "writer's block", *Journal of Applied Behavior Analysis*, 7(3), 497.

Watson C. (2015) A sociologist walks into a bar (and other academic challenges): Towards a methodology of humour, *Sociology*, 49(3), 407-421.

Draft Indian Satellite Navigation Policy-2021

The draft "Indian Satellite Navigation Policy-2021 (SATNAV Policy-2021)" is hosted in website for public consultation. Comments on the draft policy, if any, shall be forwarded to this Department to the email id :- dir.proj ects@isro.gov.in at the earliest, but not later than 29.08.2021. Here are the excerpts of the policy

Department of Space being the administrative Ministry/Department in respect of space activities in India as per the allocation of Business Rules of Government of India, shall issue appropriate norms, guidelines and procedures including approval-mechanism from time to time for the services in satellite navigation and augmentation system along with possibility of promoting & fostering participation of Indian entities to carry out research and development activities in the field of satellite navigation. Accordingly, the draft "Indian Satellite Navigation Policy-2021 (SATNAV Policy-2021)" is hosted in website for public consultation. Comments on the draft policy, if any, shall be forwarded to this Department to the email id :- *dir.proj ects@isro.gov.in* at the earliest, but not later than 29.08.2021. We present here the excerpts of the policy.

The Indian Satellite Navigation Policy - 2021 (SATNAV Policy - 2021) has been formulated towards effective development, operation and maintenance of satellite based navigation system and is stated hereunder.

The Indian Satellite Navigation Policy-2021 has been formulated with an aim to address and meet the growing demands of space based navigation and timing applications and advancements in the relevant technologies

1 Introduction

1.1 Over the last few decades, there has been a phenomenal growth in the number of applications that rely on Position, Velocity and Time (PVT) services provided by space based navigation systems. With the advent of information and mobile phone technology, crores of users across India rely heavily on PVT based applications in virtually every walk of life.

1.2 Global Navigation Satellite Systems (GNSS) are space based navigation systems that provide navigation signals across the globe. Currently, there are four GNSS viz., GPS from USA; GLONASS from Russia; Galileo from European Union & BeiDou from China; offering PVT solution globally. In addition, there are two regional navigation satellite systems viz., NavIC from India and QZSS from Japan offering navigation signals for the defined coverage area.

1.3 The navigation signals are offered free-to-air for a variety of applications ranging from air, space, maritime and land applications covering tracking, telematics, location based services (using cell phone and mobile devices), automotive, survey, mapping & GIS and timing.

1.4 GNSS also offer secured navigation signals exclusively for strategic applications of their respective countries as the free-to-air signals are susceptible to adversaries. There is a need for such secured services exclusively for the Indian strategic community also. The Government

of India has therefore, established a resilient and independent system -Navigation with Indian Constellation (NavIC). This system is totally under the control of Government of India.

1.5 Satellite based augmentation systems (SBAS) augment navigation satellite constellations by providing integrity and correction information via geostationary sat ellit es. WAAS of USA, EGNOS of European Union, SDCM of Russia, SNAS/BDSSBAS of China offer these services in their defined coverage area. Government of India has also established a similar SSAS system viz., GPS Aided Geo Augmented Navigation-(GAGAN) for the Indian airspace.

1.6 Space based navigation / augmentation system is essentially a public good which has to be accessible to all users. Such a national infrastructure can only be provided by the Government. Further, to strengthen Government's initiative of *Atmanirbhar Bharat*, it is essential to ensure continuity of NavIC and GAGAN services, upgrade the system considering the exponential technological advancements and also continue having the capability to operate in conjunction with other GNSS/ SBAS.

1.7 The Indian Satellite Navigation Policy-2021 (SATNAV Policy - 2021) has been formulated with an aim to address and meet the growing demands of space based navigation and timing applications and advancements in the relevant technologies for self-sustenance in areas of commercial, strategic and societal applications to maximise the socio-economic benefits.

2 Policy Statement

"Achieve self-reliance in satellite based navigation and augmentation services with emphasis on assuring availability & quality, enhancing usage, working towards progressive evolution of the services and promoting research & development"

3 Objectives

3.1 Ensure guaranteed and continuous availability of free-to-air navigation signals for civilian uses and secured navigation signals for strategic uses in the defined coverage area.

3.2 Ensure guaranteed and continuous availability of Satellite Based Augmentation System (SBAS) for aviation safety in the defined coverage area.

3.3 Ensure judicious dissemination of Signal-In-Space (SIS) interface definition and system performance reports for the intended use.

3.4 Work towards progressive evolution of navigation signals and expansion of coverage for enhanced use.

3.5 Focus on technology development for enhancing the navigation satellite systems.

3.6 Work towards compatibility and interoperability of Indian satellite navigation and augmentation signals with other GNSS/ SBAS signals.

3.7 Promote Indian Industry and academia to carry out research and development activities in the field of satellite navigation based applications with emphasis on societal benefits.

3.8 Work towards facilitating global usage of Indian satellite navigation and augmentation systems.

Department of Space, being the administrative Ministry for space activities under Government of India, shall issue appropriate norms and guidelines from time to time for the services rendered using Satellite Navigation.

The objectives are elaborated in the following sections.

4 Satellite based Navigation System

"Ensureguaranteed and continuous availability of free-to-air navigation signalsf or civilian uses and secured navigation signalsf or strategic uses in the defined coverage area"

4.1 ISRO/ DOS shall ensure nominal operation and maintenance of existing NavICspace segment and also ensure adequate measure in place to realise sufficient spare satellites to meet the nominal end-of-life replacement and/ or any exigency arising due to unforeseen failure in the in-orbit satellites. (ISRO/ DOS has established a regional navigation satellite system viz., NavIC which is described in §1 of Annexure.)

4.2 ISRO/ DOS shall ensure flexibility of incorporating new navigation signals/ services in the space segment in addition to the broadcast of legacy navigation signals and to cater to national needs as deemed necessary.

4.3 ISRO/ DOS shall diligently plan towards upgradation / replacement / augmentation of ground segment without affecting the services being rendered.

4.4 ISRO/ DOS shall ensure protection for the frequency allocated towards operation of space and ground segment, including the broadcasted navigation signals.

4.5 ISRO/DOS shall restrict access to space and ground infrastructure only to authorized personnel. A risk mitigation plan shall be devised and implemented to protect the infrastructure from any security threats.

4.6 ISRO/ DOS shall devise a mechanism to assist strategic users in development of specific techniques to ensure protection against and to mitigate the possible threats on usage of secured navigation signals of NavIC.

5. Satellite Based Augmentation System (SBAS)

"Ensure guaranteed and continuous availability of Satellite based Augmentation System (SBAS) f or aviation safety in the defined coverage area"

5.1 ISRO/ DOS shall ensure nominal operation and maintenance of existing GAGAN space segment. In order to ensure seamless continuity of GAGAN service, ISRO/ DOS shall have adequate measures in place to realise a GAGAN payload on a suitable satellite to meet the nominal end-of-life replacement and/ or any exigency arising due to unforeseen failure in the in-orbit GAGAN payload/ satellite. (ISRO/ DOS and Airport Authority of India have jointly established a Satellite Based Augmentation System (SBAS) viz., GAGAN which is described in §2 of Annexure.)

5.2 GAGAN services are currently being rendered from three GEO satellites. Considering possible scope of enhancement in terms of wide area (continental level) coverage, ISRO/ DOS shall assess the number of GAGAN payloads that are required to be operational simultaneously either from different GEO satellites or from non-GEO satellites as deemed necessary.

5.3 ISRO/DOS shall develop a mechanism of along with the GAGAN augmentation signals shall evolve to support dual-frequency signals from multiple GNSS.

5.4 ISRO/ DOS shall develop a mechanism involving the concerned stakeholders for extending the utility of GAGAN for non-aviation related applications.

5.5 ISRO/ DOS and the concerned stakeholder(s) shall evolve a mechanism for strict control of the critical information regarding the operation of the space and ground segment to protect the augmentation system.

5.6 ISRO/ DOS and the concerned stakeholder(s) shall restrict the access to space and ground infrastructure only to authorized personnel. A risk mitigation plan shall be devised and implemented to protect the infrastructure from any security threats.

6 Dissemination of Signal-In-Space (SIS) interface definition

"Ensure judicious dissemination of Signal-In-Space (SIS) interface definition and system performance reports for the intended use".

6.1 ISRO/DOS shall continue to ensure that SIS interface definition of free-to-air navigation signals and information related to performance of free-to-air signal transmission is available in public domain to enable development of civil application. (ISRO/ DOS currently provides the above information in public domain, which is described in §3 of Annexure.)

6.2 ISRO/ DOS shall release in public domain the performance parameters of free-to-air navigation signals periodically and the navigation satellite system operational advisories, if any, as and when it occurs.

6.3 ISRO/ DOS along with the identified agency/ agencies shall devise a mechanism for dissemination of secured signals' SIS interface definition to protect the confidentiality during development, production and operational phase of the receivers.

7 Progressive Evolution of Navigation Signals and Expansion of Coverage

"Work towards progressive evolution of navigation signals and expansion of coveragef or enhanced use."

7.1 ISRO/DOS shall devise a mechanism to adopt advanced techniques in the realisation of navigation signals considering the technological trends and ensure compatible with legacy systems.

7.2 ISRO/ DOS, in addition to the PVT services, shall plan for having signals to support allied services, such as, search &rescue, emergency warning system, high accuracy services, etc...

7.3 The current navigation signals primarily cater to the users within the defined coverage area on Earth. ISRO/ DOS shall also work towards making the navigation signals capable for supporting space service volume.

7.4 ISRO/ DOS shall work towards expanding the coverage from regional to global to ensure availability o_f NavIC standalone signal in any part of the world without relying on other GNSS and aid in wide utilisation of Indian navigation system across the globe.

8 Technology Development in the space based navigation system of India

"Focus on technology development for enhancing the navigation satellite systems"

8.1 While many of the space and ground based systems used for navigation and augmentation system are indigenously developed, ISRO/ DOS shall put best efforts towards reduction of dependence on foreign imports.

8.2 ISRO/ DOS share ensure that the ground systems are periodically augmented with state-of-the-art systems.

8.3 ISRO/DOS shall work .towards harnessing the emerging technological advancements such as, highly stable clocks, artificial intelligence, machine learning, inter-satellite links, on-orbit re-programming of navigation signals, quantum communication, etc. in space segment

9 Compatibility and Interoperability

"Work towards compatibility and interoperability of Indian satellite navigation and augmentation signals with other GNSS/ SBAS signals."

9.1 ISRO/ DOS shall continue to work towards necessary coordination with ITU for frequency allocation for broadcasting navigation and augmentation signals. (The

current practices of frequency coordination are described in §6 of Annexure.)

9.2 ISRO/ DOS shall put continuous efforts towards ensuring the Indian navigation and augmentation signals compatible with other free-to-air navigation and augmentation signals. (The current practices of ensuring compatibility are described in §6 of Annexure.)

9.3 ISRO/ DOS shall put continuous efforts towards ensuring the Indian navigation and augmentation signals are interoperable with other free-to-air navigation and augmentation signals. (The current practices of ensuring interoperability are described in §6 of Annexure.)

9.4 ISRO/ DOS shall engage in interactions with multilateral forums such as ITU, ICG, UNCOPUOS, ICAO, IMO, etc. and in bilateral forums to safeguard and to further the interests of Indian navigation and augmentation signals. (Some of the major bi-lateral/ multi-lateral forums are described in §6 of Annexure.)

10 Role of Indian Industry and Academia in Satellite Navigation Services and Applications

"Promote Indian Industry and academia to carry out research and development activities in thefield of satellite navigation based applications with emphasis on societal benefits."

10.1 ISRO/ DOS shall put in place mechanisms to promote the participation of NGPEs, state government bodies, non-government bodies and academia towards creating ecosystem built using Indian satellite navigation system which are socially and economically beneficial.

10.2 ISRO/ DOS, in consultation with the Central / State ministries, shall identify applications for societal benefits using Indian satellite navigation system, shall execute proof of concept demonstration/ pilot projects and shall eventually enable Indian industry for productionisation.

10.3 ISRO/DOS shall provide technical support for academic institutions in the field of GNSS research and applications.

10.4 ISRO/ DOS shall constantly endeavour to encourage all the concerned Central/State Ministries towards utilisation of NavIC applications with a view to promote the Indian industry engaged in developing indigenous NavICbased solutions.

10.5 ISRO/DOS shall organise regular interactions among users, industry and academia to synergise their research & development activities and end use deployment.

10.6 ISRO/ DOS shall organise / aid in organising outreach events such as, exhibitions, webinars, trainings etc. create awareness of Indian satellite navigation systems and capabilities. ISRO/DOS shall organise hackathons towards innovative problem solving and new applications using satellite navigation.

10.7 ISRO/ DOS shall work with concerned ministries/ departments to introduce specialisation courses on satellite navigation in academic institutions so as to develop indigenous expertise in the field of satellite navigation.

10.8 ISRO/DOS shall explore possibilities of international collaboration to evolve satellite navigation based applications for societal benefits and aide in promoting Indian Industry / academia to support these endeavours.

11 Facilitating Global Usage of NavIC & GAGAN

"Work towardsfacilitating global usage of Indian satellite navigation and augmentation systems"

11 .1 ISRO/ DOS shall continue to work with Indian Standard Development Organisations (SDO) such as, Bureau of Indian Standards (BIS) and relevant international SDOs such as ISO, ICAO, IMO, IEC, 3GPP, RTCM, RTCA, NMEA, etc. to develop Indian and Global standards to enable Indian satellite navigation and augmentation based applications.

11.2 ISRO/DOS shall ensure representation of Indian satellite navigation and augmentation system in the relevant National and International Standard Development Organisation/ committees to safeguard the interests of Indian navigation and augmentation systems.

11.3 ISRO/DOS shall jointly work with concerned stakeholders from India towards the recognition of Indian satellite navigation and certification of augmentation system from International organisations like IMO, ICAO etc. where ever necessary.

Annexure

1 Satellite based Navigation System

Government of India has developed a Regional Navigation Satellite System, viz., NavIC (Navigation with Indian Constellation), an all-weather space based navigation system operating within the specified coverage area. NavIC provides signals which can be used to accurately determine position, velocity, and time in a common reference frame on a 24x7 basis.

The NavIC system consists of Space Segment and Ground Segment

The space segment operates in conjunction with ground segment to enable the navigation services for the end user. ISRO/DOS is responsible for establishment and maintenance of both the space segment and ground segment;

The end use for satellite based navigation system is broadly classified as civilian and strategic.

1.1 Space Segment

NavIC space segment has been established by ISRO/ DOS.

It comprises of a constellation of seven satellites located in various gee-synchronous orbits and is scalable to meet enhanced coverage requirements.

The use of orbital slots for the specific satellite mission is governed by International Telecommunication Union (ITU) Radio Regulation (RR). The orbital slots for NavIC satellites are informed, coordinated, notified and registered at ITU. Indian orbital resources are under the exclusive control of Government of India.

The Radio Frequencies currently being used by NavIC for broadcasting the navigation signals are filed a priori in the ITU and necessary approvals are in place.

1.2 Ground Segment

NavIC system comprises of the following ground systems established by ISRO.

1. Range and Integrity Monitoring Stations
2. Two-way Ranging Stations
3. Network Time Facility
4. Navigation Control Centre
5. Data Communication Network
6. Spacecraft Control Centre

These ground systems, established across India as well as beyond the Indian Mainland, are interconnected through terrestrial/satellite link to generate the navigation parameters and uplink them to NavIC space segment. The user receiver acquires these parameters from NavIC space segment for computing its own position.

The ground segment is operated on a 24x7 basis with sufficient redundancies supporting the satellite constellation.

2 Satellite Based Augmentation System (SBAS)

Government of India has developed a Satellite Based Augmentation System, viz., GAGAN (GPS Aided Geo Augmented Navigation) - an all-weather space based augmentation system operating within the specified coverage area.

The objective of GAGAN is to establish and deploy a certified satellite based augmentation system primarily for safety-of-life civil aviation applications catering to the Indian airspace.

GAGAN has been declared operational for safety-of-life application in civil aviation and a seamless operation of GAGAN system is being ensured. Efforts towards utilisation of GAGAN for non-aviation sector related applications are also being carried out.

The GAGAN system consists of space and ground segment. The space segment works in conjunction with ground segment to enable the augmentation services for the end use.

2.1 Space Segment

ISRO/DOS has established the space segment for GAGAN and is responsible for its operations and maintenance.

The space segment comprises of GAGAN payload accommodated on three satellites located in geo-stationary orbit.

The Radio Frequencies currently being used by GAGAN for space as well as ground segment for providing the augmentation services are filed in the ITU and necessary approvals are in place.

2.2 Ground Segment

Airports Authority of India (AAI) has established ground segment of GAGAN and is responsible for its operation and maintenance. Directorate General of Civil Aviation (DGCA) is the certifying authority for aviation use of the GAGAN system.

GAGAN system comprises of following ground systems established by Airport Authority of India.

1. Reference Stations 2. MasterControlStation

1. Data communication network
2. Uplink Station

These stations collect and process navigation data from GPS to generate the correction messages and integrity information which are subsequently uplinked to the GAGAN satellites and transmitted by the satellites in Ll and LS-bands.

Currently, GAGAN is augmenting the navigation signals received from single frequency of GPS.

The GAGAN signal-in-space format complies with ICAO standards and recommended practices for satellite-based augmentation systems.

3 Dissemination of Signal-In-Space (SIS) interface definition

The satellite navigation and augmentation systems publish the detailed Signal-in-Space characteristics on their respective websites in the form of Interface Control Document (ICD) to enable industry in developing products and academia in pursuing Research & Development.

The performance parameters of free-to-air navigation signals are periodically shared in public domain to provide confidence in the satellite navigation system.

The Signal-in-Space Interface Control Document and performance report of NavIC are made available on ISROwebsite.

4 Progressive Evolution of Navigation Signals and Expansion of Coverage

In the past few decades, satellite navigation has been revolutionised in terms of coverage and accuracy. The emergence of multiple global constellations has significantly penetrated into various sectors working on PVT solutions.

In order to meet the demand for enhanced positioning performance arising due to continuous expansion of satellite navigation applications, GNSS systems worldwide are adopting latest techniques to improve the navigation signals.

The Indian satellite navigation system, NavICis also continuously evolving by introducing new signals, capabilities and expansion of coverage area.

5 Technology Development in the space based navigation system of India

The technologies being used for space and ground segments of navigation and augmentation systems are developing continuously in terms of improved performance, reliability, efficiency etc...

The technology development in Indian satellite navigation and augmentation system is focussed on indigenisation, miniaturisation and improvement in performance of space and ground segments.

6 Compatibility and Interoperability

Navigation and augmentation satellite systems share the same radio frequency bands for broadcasting the navigation signals. The International Telecommunication Union (ITU) regulates the radio frequency allocation.

The navigation and augmentation satellite systems are being used separately or together without causing unacceptable interference and/ or other harm to each other.

The interoperability of the signals broadcast from multiple GNSS constellations will result in improved signal availability, end-user accuracy in the environments where visibility satellites from a single constellation may be partly or wholly obscured. Therefore, the user receiver systems are now being designed for a multi-constellation system.

International Committee on GNSS (ICG) under United Nations Office for Outer Space Affairs (UNOOSA) provides a framework towards coordination among providers of satellite navigation and augmentation systems for ensuring compatibility and interoperability. In addition, International Civil Aviation Organization (ICAO) provides the forum to assure common understanding among the augmentation systems' service providers for implementation in aviation services

NavIC and GAGAN systems comply with the standards, practices, guidelines and regulations of ITU, ICGand ICAO.

7 Role of Indian Industry and Academia in Satellite Navigation Services and Applications

Over the years, ISRO/DOS has fostered a network with industry and academia to meet the needs of various fields of space technology/applications through inclusive and supportive efforts.

ISRO/DOS is also interacting with other user departments within Government for ensuring optimal utilisation of Indian space assets.

Government's initiatives like digital India, smart city, Make in India and other key flagship programmes has created opportunities for Indian Industry, start-ups and academia to work towards innovation in the field of satellite based navigation services.

8 Facilitating Global Usage of NavIC& GAGAN Standards provide systematic guidelines so as to ensure uniformity in the products thereby facilitating better adoption, interchangeability, efficiency and cost effectiveness.

NavIC is now a part of some key international standards such as RINEX, NMEA, RTCM and 3GPP and national standards such as AIS-140. NavIC has also been accorded recognition by the International Maritime Organisation (IMO).

GAGAN system has been recognised by International Civil Aviation Organisation (ICAO) and certified by the Directorate General of Civil Aviation (DGCA).

Exploring the limits of spectral remote sensing imaging systems

The National Geospatial-Intelligence Agency, USA is funding a team of Rochester Institute of Technology imaging scientists to study the limits of spectral remote sensing imaging systems. Led by principal investigator John Kerekes, a professor in the Chester F. Carlson Center for Imaging Science, the team received a grant of up to $1 million to conduct fundamental research on imaging systems over the next two to five years. Spectral remote sensing imaging systems use instruments capable of detecting bands of light far beyond what the human eye can see mounted on aircraft or satellites to study the Earth below. *www.rit.edu*

Tackling modern slavery in Greek strawberry fields using satellite technology

A consortium of modern slavery experts, led by the University of Nottingham, have assisted the Greek government to tackle a humanitarian crisis unfolding in the strawberry fields of southern Greece.

Using satellite technology to identify migrant settlements - a technique pioneered by the university's Rights Lab - and working with the Greek authorities, the experts then developed a decision model for which they could prioritise victims that were at highest risk.

Leading the study, the Rights Lab combined different data sources and methods to build a set of criteria measuring the extent of labour exploitation in a settlement. The academics then validated these criteria with a government agency and a Non-Governmental Organisation (NGO) involved in fighting labour exploitation. By combining earth observation data with operations management techniques, this method has been successfully used to address labour exploitation in areas where strawberries are harvested. This approach is a world-first in the humanitarian sector, with the study, funded by the Economic and Social Research Council (ESRC) *www.nottingham.ac.uk*

Q-CTRL to manufacture remote sensing technology for space

Q-CTRL, a University of Sydney spin-off quantum technology company, will develop quantum technology solutions to be used for near earth observation and remote sensing. As Australia's first venture-capital-backed quantum technology company, Q-CTRL was awarded $4.5 million by the federal government to expand the manufacture of novel remote sensing payloads for space deployment. *www.manmonthly.com*

Private companies to boost space activity in India

Twenty seven new proposals have been received by the Indian government from private companies for various space-related activities, according to the Minister of State for Science and Technology, Dr Jitendra Singh. The proposals cover the ambit of building and operating launch vehicles, satellites; providing satellite-based services; establishing ground segments; research partnerships and providing mission services. The Cabinet recently approved the participation of the private sector in the entire range of space activities including planetary exploration missions. *https://pib.gov.in*

Indian start-up Pixxel targets satellite launch

Indian start-up Pixxel, which has developed an Earth observation satellite, will target an October launch with the Indian Space Research Organisation (ISRO) mission. The satellite was to be launched aboard the PSLV-C51 mission in February this year, but due to the last minute technical glitch in the software, the company had to back out.

"There was a problem with the GPS acquisition and logging in the satellite which we were able to resolve in a couple of days. But we had missed the window to ship the satellite to ISRO launch site. The satellite is completely ready and we used the time to do another round of testing. We were waiting for the next opportunity that ISRO mission would go to the orbit we need. We will be launching the satellite in October," Awais Ahmed, Founder and CEO of the company, was quoted as saying.

The company aims at completing the constellation of hyperspectral satellites by 2023. This would be the first satellite by an Indian start-up, barring the satellite of the non-profit SpaceKidz India that was launched as per a non-commercial agreement by ISRO on PSLV C51 mission in February.

Pixxel is designing the world's highest resolution hyperspectral imaging satellites that can provide 10 to 50 times more detailed information. *www.pixxel.space/*

NSSL to undertake launch services for SDA satellites

The National Security Space Launch (NSSL) program will undertake the launch services for Space Development Agency (SDA) satellites. The NSSL program is being run by the US Space Force.

SDA is a Defense Department agency that is building a large constellation of small communications satellites in low Earth orbit known as the Transport Layer. The agency previously awarded SpaceX a $150.4 million contract to launch its first 28 satellites in 2022 and 2023. But future launches will be procured from either the United Launch Alliance or SpaceX under the National Security Space Launch program (NSSL). *www.sda.mil*

OHB and ESA Φ-lab cooperation

Φ-lab, the division in the Future Systems Department of the EO (Earth Observation) Programmes Directorate of ESA, and OHB Italia agreed to examine together "transformational technologies" to benefit the end-users of the commercial EO market. The collaboration, might be extended to a joint research program in the future. It aims to characterize and advance transformative commercial services and technologies powered by space-based data. *https://philab.phi.esa.int*

New RealityCapture release

Capturing Reality is an Epic Games Studio based in Slovakia developing photogrammetry software RealityCapture (also known as RC) which creates textured 3D meshes, orthographic projections, geo-referenced maps from (aerial, terrestrial) images and/or laser scans completely automatically. New software release aims for field working professionals requiring the highest precision and speed. *www.realitycapture-training.com*

GeoOptics orbiting observatory to scan evolving Earth

GeoOptics Inc., a trailblazer in Earth remote sensing, announced a major improvement to its CICERO constellation of satellites to observe our changing planet. With launches scheduled to begin next year, it will form a unified Earth observatory allowing governments, industry, and individual stakeholders to monitor and prepare for the many impacts of climate change.

The first CICERO-2 launches will realize several key milestones in small satellite Earth observation, including Global Precipitation Watch, Advanced GNSS Reflectometry (GNSS-R), and Triple RO. *http://geooptics.com*

JAXA and UNOOSA open 7th round of KiboCUBE program

Japan Aerospace Exploration Agency (JAXA) and the United Nations Office for Outer Space Affairs (UNOOSA) is pleased to announce the opening of the 7th round of KiboCUBE program. This program offers an opportunity for the selected entity located in developing countries to deploy 1U CubeSat (10cm^3-sized small satellite) from the Japanese Experiment Module "Kibo" of the International Space Station (ISS). So far, 6 winners have been selected in this program, out of which 3 winners have successfully deployed their CubeSats from the Kibo.

An increasing number of CubeSats have been developed in recent years for its

cost-effectiveness, educational value, and as a testbed for new technology. *https://humans-in-space.jaxa.*

SpaceX to launch KAI's future EOS

Korea Aerospace Industries (KAI) reported signing an agreement with SpaceX for the launch and orbital dispatch of its medium weight Earth observation satellite scheduled for 2023.

According to the KAI statement, the selection of SpaceX was not only guided by the high success rate and low relative costs of the company, but also by analysis of strategic cooperation options for the regional market.

KAI was the first private company in Korea to be responsible for the development and launch of a new next-generation standard medium weight (500 kg) satellite platform. It is also the only Korean company capable of mastering all satellite production processes, from design, component manufacturing, assembly, as well as testing and certification. *www.koreaaero.com*

Farmbot launches next generation satellite monitor

Farmbot, provider of remote monitoring solutions for Australian agriculture, has launched its next generation satellite monitor which enables two-way communication between farm infrastructure and farmers via satellite connectivity. The Farmbot Duplex Satellite Monitor is the central unit, which will support the camera device and in the near future provide the ability for farmers to control pumps and gates.

Powered by Inmarsat's IsatData Pro (IDP) service, the new generation monitor provides farmers with two-way messaging via satellite, elevating the Farmbot platform from a monitoring solution, to a management solution. Not only will farmers be able to monitor data collected by sensors, they will also be able to direct a course of action depending on the connected asset. *www.farmbot.com*

Aeronautic remote-sensing system by China

China's new aeronautic system for conducting detailed observations and monitoring of Earth's surface passed its final acceptance stage recently and is now formally in operation.

The Chinese Aeronautic Remote Sensing System (CARSS), which consists of two medium-sized manned aircraft together with a range of remote-sensing technologies, was developed by the Aerospace Information Research Institute of the Chinese Academy of Sciences. According to Ding Chibiao, vice president of the institute, aeronautic remote-sensing images are needed to assess road damage, landslides and collapsed houses when people suffer from severe earthquakes or floods. Remote sensing is widely used in disaster prevention and alleviation, agriculture, forestry and fishery, water conservancy, surveying and mapping.

Compared with space-based remote sensing, aeronautic remote sensing offers higher resolution and precision. It can take pictures of the ground continuously, all day long, producing clearer images. *www.xinhuanet.com*

Planet Data to all US Federal Civilian agencies

Planet has expanded its contract with the NASA Commercial SmallSat Data Acquisition (CSDA) Program to provide access to PlanetScope imagery for scientific research use for all US Federal Civilian researchers and National Science Foundation funded researchers, including their contractors and grantees — roughly 280,000 eligible users.

This expands access on the existing contract that currently supports NASA and NASA-funded researchers. Since Planet's first contract with NASA in 2019, scientists have leveraged Planet imagery for a variety of research projects focused on climate change, biodiversity loss, and complex sustainability problems. Planet is eager to see what projects this expanded pool of researchers will pursue, as it will enable more strategic information sharing across research groups and facilitate greater scientific use. *www.planet.com*

NASA, ESA partnership

NASA and ESA (European Space Agency) have formed a first-of-its-kind strategic partnership to observe Earth and its changing environment. The global climate is rapidly changing and the demand for accurate, timely, and actionable knowledge is more pressing than ever. Recognizing that climate change is an urgent global challenge, the timing is right for NASA and ESA, as partners in space, to join forces to lead and support a global response to climate change. The partnership is an effort to help address and mitigate climate change through monitoring Earth with combined efforts of both agencies in Earth science observations, research, and applications. *www.nasa.gov*

Spire awarded contract for Earth observation data

Spire Global, Inc. has announced the continuation of its participation in NASA's Commercial Smallsat Data Acquisition (CSDA) Program with a six-million-dollar contract extension. The contract continuation, Task Order 6 (TO6), is a subscription data solution that includes radio occultation (RO) data, grazing angle GNSS-RO, total electron content (TEC) data, precise orbit determination (POD) data, soil moisture and ocean surface wind speed GNSS-Reflectometry data, and magnetometer data. This data will be available to all federal agencies, NASA-funded researchers and to all the US Government-funded researchers.

Under CSDA Program TO6, Spire will deliver a comprehensive catalog of data, associated metadata, and ancillary information from its Earth-orbiting small-satellite constellation. The Company operates its constellation in low Earth and collects upwards of 10,000 radio occultations per day with consistent global coverage. *Spire.com*

Galileo Second Generation proof-of-concept testing begins

The first Galileo Second Generation hardware has begun testing, with test versions of the satellites' navigation payloads undergoing evaluation by Airbus Defence and Space at their Ottobrunn facility in Germany and by Thales Alenia Space at ESA's ESTEC technical centre in the Netherlands.

These testbed versions of these new navigation payloads designed by the two companies are undergoing testing of their respective navigation antennas to check whether they meet the ambitious performance levels set for the coming generation of Europe's satellite navigation system. *www.esa.int*

New tool limits disruptions caused by Space operations: FAA

The Federal Aviation Administration (FAA), USA said it has got a new tool — Space Data Integrator — which will help them track rocket launches and Space vehicles returning to Earth in a better way. The tool will replace a system in which much of the work of giving telemetry data about Space vehicles to air traffic control managers is done manually.

According to the FAA, Elon Musk's SpaceX was the first company to share flight telemetry data with the FAA, and others, including Jeff Bezos's Blue Origin, have also joined the program.

The FAA said the new technology was first used on June 30 for the launch of SpaceX's Transporter 2, which lifted off from Cape Canaveral, Florida, carrying dozens of satellites into orbit. It will be used again with the pending return of a SpaceX cargo ship from the International Space Station.

During Space operations, the FAA shuts a huge section of airspace for hours in case the rocket or the Space vehicle breaks apart. Airlines must reroute flights, which causes them to burn more fuel and fall behind schedule. A single launch can affect hundreds of flights. *www.faa.gov*

Inhofe, Duckworth, Rounds introduce RETAIN GPS Act

U.S. Sens. Jim Inhofe (R-Okla.), ranking member of the Senate Armed Services Committee, Tammy Duckworth (D-Ill.) and Mike Rounds (R-S.D.) introduced S. 2166, the Recognizing and Ensuring Taxpayer Access to Infrastructure Necessary for GPS and Satellite Communications Act or RETAIN GPS and Satellite Communications Act. The April 2020 Ligado Order from the FCC recognized the likelihood of interference to GPS signals and requires Ligado to pay the federal government the costs for repairs. However, 99 percent of the more than 900 million GPS devices found in the United States are used by the private sector, consumers, as well as state and local governments; under the current Order, they—or their consumers—would have to bear the costs.

"GPS and satellite communications don't only impact our military—we rely on it for so much of our day to day lives, which is why we need to take steps to protect not just the federal government from the harmful decision, but all state and local governments, private entities and consumers too," Inhofe said. "Our nation has an integrated public and private sector infrastructure to support the reliability and use of GPS and satellite communications to navigate our cars and boats for recreation and commerce, to plow our fields, to manage equipment for transportation construction projects, to track our exercise and to predict weather patterns – the list goes on. When Ligado's effort to repurpose spectrum causes interference in the infrastructure of those systems, as tests have shown it will, consumers and taxpayers shouldn't bear the burden of updating countless systems. That cost should only be borne by the responsible party: Ligado."

"As a founding co-chair of the Congressional GPS Caucus, I'm proud to help Senator Inhofe introduce bipartisan legislation that will help make sure Ligado Networks is accountable for covering the costs of addressing any harmful interference that results from deployment of its proposed wireless network," said Duckworth. "Given the continued concerns regarding Ligado's efforts from stakeholders like the Department of Defense, Department of Transportation, NTIA and countless industries that rely on GPS and satellite communications, Congress should establish clear pre-conditions that Ligado must meet before the FCC Order may go into effect." *www.inhofe.senate.gov*

Ligado Networks statement on the RETAIN GPS Act

Ligado Networks issued the following statement from Chief Communications Officer and Head of Congressional Affairs Ashley Durmer regarding the RETAIN GPS Act:

"This legislation is unnecessary, as the FCC's bipartisan, unanimous, and science-backed order fully protects GPS devices – whether they're used by the government or the private sector – as well as satellite communications devices. This bill does not address any safety issues; instead, it presents a false notion that consumers are at risk – when the FCC determined they are not – and then requires one company to assume a cost burden that is not based on actual harm.

Years of data, testing and congressional testimony make it clear that – just like government GPS users – consumer devices like smartphones and safety-of-life equipment, like certified aviation receivers, are not at risk from Ligado operations. To suggest otherwise implies that technical experts and career public servants at the FCC would knowingly put Americans in harm's way. That is not only false, but also illustrates a lack of seriousness on this topic.

We stand ready to work in good faith to implement the FCC's order and are moving full-steam ahead on the important work of developing and deploying 5G services that will keep the U.S. globally competitive and help modernize the critical infrastructure companies that keep America running." *https://ligado.com*

UAV LiDAR to inform carbon emission reduction policy making

A specialist team at the University of Wiconscin-Madison (UW-Madison) used the Routescene UAV LiDAR system to detect and visualize forests in Northern Wisconsin, USA as part of the CHEESEHEAD project. The objective of this wider project is to improve weather forecasting by understanding further how vegetation and forests influence the atmosphere.

The aim of the CHEESEHEAD project (The Chequamegon Heterogeneous Ecosystem Energy-balance Study Enabled by a High density Extensive Array of Detectors) is to study interactions and feedbacks between the land surface and atmosphere and how these results can be used to improve weather and climate models. Ultimately the results will enable better carbon emission reduction policy making.

The UW-Madison team collected high density 3D point cloud data of the prominent tree species in the Chequamegon-Nicolet National Forest, USA. This survey was part of a wider project to understand how water, heat and carbon interact across a variety of landscapes like forests. *www.routescene.com*

Shield AI to acquire Martin UAV

Shield AI, that develops AI and self-driving car technologies for the defense industry has signed a final agreement to acquire Martin UAV, an aerospace company best known for its industry-leading vertical takeoff and landing (VTOL) unmanned aircraft, V-BAT. Shield AI will integrate its combat-proven autonomy software, Hivemind®, into the V-BAT, bolstering Shield AI's leadership position in defense-focused edge autonomy.

Shield AI's Hivemind uses cutting edge path-planning, mapping, state-estimation, and computer vision algorithms, along with reinforcement learning and simulations, to train unmanned systems to execute a variety of missions — from infantry clearance operations to breaching integrated air defense systems with unmanned aircraft. The V-BAT, with its innovative, near-zero footprint VTOL and long-endurance capabilities, is different from any UAS on the market. *www.shield.ai*

ACSL, Japan ties up with Arc Ventures, India

Autonomous Control Systems Laboratory (ACSL), Japan is making a move into the Indian market through a partnership with Delhi-based Arc Ventures to establish a joint venture called ACSL India, at an initial investment of $3.5 million.

ACSL develops industrial drones that are used in logistics, infrastructure inspection, disasters etc. It has also developed its own flight controller to manage its drones, which serves as an extra layer of security. The joint venture is planning to build several manufacturing plants in the country, with the first one stated to open in October in Coimbatore, Tamil Nadu. *www.acsl.co.jp*

Meituan unveils self-developed drone model

China's leading e-commerce platform for services, has introduced a new, self-developed drone model and announced plans for a drone logistics network pilot program in Shanghai. The announcement was made at the 2021 World Artificial Intelligence Conference (WAIC) in Shanghai, where Meituan demonstrated how drones and delivery riders could conceivably work together to deliver orders.

In a partnership with local government, Meituan will explore opportunities for the construction of a demonstration center in Shanghai's southwestern district of Jinshan; this center will run pilot operations for an urban low-altitude logistics network, the first of its kind to be established in China. The three-pronged network of drones, ground support infrastructure (landing ports, battery changing stations), and cloud-based dispatching systems will aim to achieve 15-minute delivery time for destinations within a three kilometer radius.

Riders would pick up orders from merchants and take them to drone launching pads for last-mile delivery. Drones would then deliver them to special drone drop-off lockers, after which users could scan QR codes to pick up the orders. In June, Meituan also used drones to deliver vital supplies to residents in Shenzhen's Nanshan district, who were isolated by a COVID-induced quarantine. *https://about.meituan.com*

Drone delivery test for smart city infrastructure system

Airspace Link will team up with drone delivery services provider DroneUp and the City of Ontario to showcase the digital infrastructure between the New Haven neighborhood, located within the Ontario Ranch development. This digital infrastructure will enable safe, advanced and scalable drone delivery options for a variety of products.

Airspace Link will work in collaboration with DroneUp to enable drone delivery missions for this technology showcase. Drones will deliver ribbon cutting scissors and microbrew beverages to commemorate the ceremonial grand opening of the New Haven Marketplace, various community resources and the highly anticipated Brew Haven brewery. *https://airspacelink.com*

Upskilling UAV pilots conducting electric grid inspections

PrecisionHawk, Inc. is collaborating with the National Rural Electric Cooperative Association (NRECA) to bring a new wave of UAV instruction to electric co-ops across the United States. The course and skills assessment are designed to increase unmanned aircraft systems (UAS) pilots' knowledge and confidence to inspect electricity transmission and distribution assets more safely and efficiently.

The program includes approximately 10 hours of flight time in the field where pilots will learn the dos and don'ts of flying, safety tips for navigating hazardous environments and emergency situations, and UAS industry best practices for maintaining equipment and increasing its lifespan. The full skills assessment will ultimately test pilots on skill competencies regarding drone-led energy inspections and how to efficiently run a single pilot operation. *precisionhawk.com*

Aerodrome acquires FlyTech

Israeli unmanned aerial systems operator Aerodrome Group Ltd. has acquired FlyTech, which specializes in providing advanced aviation services and solutions in the commercial market. It operates in the commercial field and Aerodrome plans concentrating all its commercial activities in the acquired company. The acquisition will help Aerodrome enter the US commercial market.

FlyTech is Aerodrome's first acquisition. Aerodrome has bought a company that is an operator and thus works mainly in the commercial sector where the rate of growth in Israel and worldwide is increasing significantly. *www.aerodrome-ops.com*

Drone-based inspection for wildfire mitigation

iHawk by Cyberhawk, is a cloud-based asset visualization software platform, has launched more than 22,000 drone flights to inspect nearly 25,000 electric utility structures in the Western U.S. through the first six months of 2021 as part of utilities critical wildfire prevention and reliability campaigns. Through a proactive approach to inspection, the company's services have been successfully deployed globally.

The U.S. power grid is one of the oldest in the world, with 70 percent of transmission lines more than 25 years old. Inspecting and maintaining these aging power grids are incredibly important, especially when it comes to mitigating the risk of wildfires. *https://thecyberhawk.com*

West Bengal, India begins GIS survey for MSMEs

The state of West Bengal in India, which has the second most number of MSMEs (Micro, Small and Medium Enterprises) in the country, has initiated a GIS survey of the existing 570 MSME clusters, viewing them as a key component of the state's economy.

The outcome of the survey is expected to benefit the sector in different ways. First of all the state government will develop more technologically advanced infrastructure as the survey will provide detailed data on the kind of technology that is in use at present in each of the clusters. Secondly, the survey will provide the exact location of every cluster, details of which will be made available in a portal, which will act as an interface between investors from any part of the world and clusters' entrepreneurs or artisans. *https://auto.economictimes.indiatimes.com*

New features for ArcFM Editor XI by Schneider Electric

Schneider Electric announced the release of ArcFM Editor 11.3, the latest update to ArcFM Editor XI built specifically in ArcGIS Pro and for Esri's Utility Network. This latest release provides new ways for an overall efficient and better editing experience, most notably with the addition of Conduit Manager XI for the Utility Network. *www.se.com*

Open access to key federal geospatial data by Esri

Esri has announced that in collaboration with federal agencies, it is opening up access to dozens of high-priority, high-demand national data layers, referred to by government users as National Geospatial Data Assets (NGDA). This development is critical for decision-making in areas of national concern like infrastructure development and disaster response.

The information being made available includes cartographic boundary files and demographic data from the US Census Bureau; National Agriculture Imagery Program (NAIP) data from the US Department of Agriculture (USDA); and the National Inventory of Dams (NID) database, managed by the US Army Corps of Engineers. *www.esri.com*

1Integrate 3D rules engine

1Spatial are increasing the capability of their patented rules engine, 1Integrate, with added support for 3D data. 1Integrate 3.0 now supports full 3D data in its data stores, rules and actions. The updated data visualizer allows you to explore your data efficiently and freely in 3D, and validation and transformation capabilities process 3D data just as easily as 2D and 2.5D (2D data with heights). This means 2D & 3D integrated solutions can easily be created for asset, infrastructure, and facility management. *https://1spatial.com*

GEDO GX50 Laser Scanning System

Trimble GEDO GX50 is a flexible laser scanning system designed to operate with Trimble GEDO track measurement systems for clearance analysis and asset data collection, further enhancing the modular track survey and scanning solutions portfolio. It features new Trimble-designed profiling lasers for high-accuracy data collection. It is available in a Single Head configuration with one laser scanner and a Dual Head configuration with two laser scanners, and the scan heads can be flexibly adjusted depending on project requirements. *www.trimble.com*

Trimble MX50 LiDAR System

Trimble MX50 is a mobile mapping system for asset management and mapping. This vehicle-mounted mobile LiDAR system is a mid-range option for first-time mobile mapping users and experienced providers to expand their equipment fleet with precise, high-volume data capture technology that works in conjunction with Trimble's geospatial software solutions.The system produces dense point clouds and immersive imagery for surveying and mapping accuracy, and works with Applanix POSPac, Trimble Business Center and the Trimble MX software suite. *www.trimble.com*

Ultra-wideband micro-location technology gains traction

From AR games to automatic car locks, pinpointing the location of devices is becoming increasingly important in modern life. The difference being that the precision we demand is far beyond the reach of GPS or Bluetooth. With Ultra-Wideband (UWB) micro-location technology from imec, the location of objects in a space can be pinpointed in minute detail.

Imec is a research and innovation center in nanoelectronics and digital technology. It is part of the FiRa consortium, which is committed to the development and application of user experiences with UWB technologies. Among other things, imec developed a UWB radio chip that can be mass-produced at low cost. *www.imec-int.com*

New deployment ready LiDAR perception system

Seoul Robotics has announced the commercial launch of Voyage, a plug-and-play LiDAR perception system. This all-in-one deployment kit — equipped with the company's proprietary software SENSR2, LiDAR sensors, and a computer— allows customers to simply unbox the product, plug it in, and instantaneously start seeing real-time results. The company's sensor-agnostic perception software is available worldwide and is currently deployed by top-tier organizations such as BMW, Mercedes-Benz, Chattanooga Department of Transportation, Emart, among many others. *www.seoulrobotics.org*

VHB's DataTripper tool

VHB has announced that the development of their latest transportation technology-enabled tool, DataTripper, will provide transit agencies with a user-friendly web application for analyzing and utilizing data. The need stems from the desire to create a faster, easier way to interpret transportation data that has traditionally been cumbersome and fragmented, requiring more time and resources to make connections and find trends.

DataTripper takes a fraction of the time associated with traditional travel data analysis methods and allows users to explore the spatial dimensions of data with the click of a button. This customizable web-based tool uses interactive maps and empowers agencies to make data-informed decisions about future transportation projects, ridership safety, and where to prioritize funding moving forward. *www.vhb.com*

Integrating long-range LiDAR tech into autonomous solution

Continental is integrating the long-range LiDAR technology into its full sensor stack solution to create the first full stack automotive-grade system for Level 2+ up to Level 4 automated and autonomous driving applications. The solution based on AEye's LiDAR technology is a substantial part of the sensor setup for high level automation systems. It complements the radar, camera and ultrasonic technologies in Continental's sensor system, and enables a reliable and redundant Automated Driving platform that can handle complex, diverse traffic scenarios and adverse weather conditions. *www.continental.com*

AI-based auto insurance

TomTom and Loop has announced a new multiyear agreement in which TomTom will provide Loop with its speed profiles, traffic stats and maps to help Loop customers make safer driving choices and receive insurance rates that are based on fair, bias-free criteria.

Loop will use TomTom's maps and traffic data to better understand driver behavior and road risk. Rather than rely on a driver's credit and other financial proxies such as homeownership and educational attainment, this AI-driven approach will enable Loop to establish fairer and more transparent auto insurance prices. *www.tomtom.com*

Oceaneering and DDK Positioning sign service agreement

Oceaneering International, Inc., and DDK Positioning Limited have entered into an agreement for the provision of GNSS (Global Navigation Satellite System) augmentation service and all associated software and hardware supporting Oceaneering's C-Nav Positioning Solutions group offerings.

DDK Positioning's services are delivered exclusively through the Iridium satellite communications network coupled with hardware developed by partner Topcon. It will provide its MAX service to Oceaneering clients, which can achieve accuracy to less than 10 cm (2 Sigma). The MAX service use both GPS, Galileo, and GLONASS constellations with further systems to be added within a year. *www.oceaneering.com*

AsteRx SB3 GNSS receiver

Septentrio has launched the AsteRx SB3 receiver family, enclosed in an IP68 housing. This receiver offers superior availability of RTK high-accuracy positioning due to its ability to track a wide variety of signals from all currently operating GNSS, including not only GPS and GLONASS but also Galileo and BeiDou. *septentrio.com*

Sonardyne navigation for Kawasaki Heavy Industries' SPICE AUV

Kawasaki Heavy Industries' (KHI) has chosen a suite of subsea navigation, positioning and communications technologies from Sonardyne to navigate, track and control its first commercial SPICE autonomous underwater vehicles (AUVs).

The SPICE (Subsea Precise Inspector with Close Eyes) AUV, complete with a submerged docking system and unique robotic arm for non-destructive testing, has been designed and built by KHI for intelligent and low-logistic pipeline and subsea asset inspection operations down to 3,000 m water depth. *sonardyne.com*

Swift Navigation and KDDI announce partnership

Swift Navigation announced a partnership with Tokyo-based KDDI Corporation. This partnership will be key in bringing Swift's precise positioning technology to the Japan market and adds KDDI as a key partner in the global expansion of Skylark precise positioning service—currently available across the continental U.S. and Europe in partnership with Deutsche Telekom. *swiftnav.com*

Fugro's Spacestar satellite positioning service heads into space

Loft Orbital, which flies and operates customer payloads on its YAM series of small satellites, launched their YAM-2 satellite, the first in space to be equipped with Fugro's SpaceStar next-generation positioning technology, on 30 June into a 525 km sun-synchronous orbit from Cape Canaveral in Florida onboard a SpaceX Falcon 9 rocket.

SpaceStar is using PPP to deliver high-accuracy sub-decimetre onboard positioning in real time during YAM-2's low earth orbit (LEO) operations. Fugro's proprietary positioning software is integrated into YAM-2 and employs state-of-the-art technology to receive precise GNSS real-time orbit and clock corrections from geostationary satellites. *Fugro.com*

Dual-output automotive dead reckoning module

ublox is introducing a series of automotive-grade positioning modules that are operational up to 105 °C. The NEO-M9L modules and the M9140-KA-DR chip are built on the robust ublox M9 GNSS platform and use dead reckoning techniques to provide accurate position data when satellite signals are compromised or unavailable. Both are specially designed for first-mount automotive solutions. The modules and the chip are all automotive grade. *www.ublox.com*

New eXtended filtering to Accutenna precision antennas

Tallysman Wireless has announced new eXtended Filtering (XF) features to the TW3900 series of Accutenna precision antennas. It has designed the XF feature to mitigate interference from all near-band signals and ensure that the antenna provides the purest GNSS signals.

Worldwide, the radio frequency spectrum has become congested as many new LTE bands have been activated, and their signals or harmonic frequencies can affect GNSS antennas and receivers. In North America, the planned Ligado service, which will broadcast in the frequency range of 1526 to 1536 MHz, can affect GNSS antennas that receive space-based L-band correction service signals (1539 – 1559 MHz). New LTE signals in Europe [Band 32 (1452 – 1496 MHz)] and Japan [Bands 11 and 21 (1476 – 1511 MHz)] have also affected GNSS signals. Lastly, the Inmarsat satellite communication uplink (1626.5 – 1660.5 MHz) commonly used on maritime vessels can also affect nearby GNSS antennas.

Tallysman's custom XF filtering has been tested to mitigate new (Europe and Japan) and existing LTE signals, enabling the XF antennas to produce clean and pure GNSS radio frequency data. *www.tallysman.com*

GPSdome 2 anti jamming solution

infiniDome, the Israel-based GPS Security Company, announced GPSdome 2 Duo, its newest product line delivering GNSS protection for small-medium Class 2-3 UAV/UAS, ground UGV fleets and other critical manned and unmanned platforms. GNSS signal is the basis of all unmanned platforms whether operating in the air or on the ground.

infiniDome utilizes electronic warfare principles into a tiny package, enabling high-end GNSS anti-jamming protection for the unmanned small to medium platform. Offering dual frequency protection GPS L1 + GPS L2 or GPS L1 + GLONASS G1, it protects any GNSS-based system from multiple interfering signals. *www.infinidome.com*

UrsaNav trials eLoran

ADVA has announced that UrsaNav and ADVA have conducted an enhanced long-range navigation (eLoran) field trial using UrsaNav's eLoran receiver and ADVA's Oscilloquartz grandmaster clock technology. The successful demo shows that eLoran offers a robust and reliable backup for GPS and other GNSS and could be used to provide an assured position, navigation, and timing (PNT) service. The trial follows US federal executive order 13905 aimed at strengthening national resilience through PNT services, including protecting critical infrastructure such as electrical power grid and communication networks from rising cyber threats. By harnessing ADVA's flexible OSA 5420 Series, designed with assured PNT (aPNT) technology, UrsaNav has shown that eLoran can provide a new layer of protection and significantly boost timing resilience and security.

Across the globe, essential services and entire industries are increasingly reliant on GNSS for PNT information. But these satellite systems are inherently susceptible to interference, which could have disastrous consequences. A major disruption may result in billions of dollars of economic damage as well as a serious risk of loss of life. eLoran is one of the key technologies that could provide protection, with governments including the US exploring its potential as an alternative PNT source. *www.adva.com*

neXat navigates new route to maritime prosperity

neXat is now available to the maritime sector, opening the door for maritime connectivity services providers to new markets and the monetization of payment and management services.

SUBSCRIPTION FORM

YES! I want my Coordinates

I would like to subscribe for (tick one)

☐ 1 year	☐ 2 years	☐ 3 years
12 issues	24 issues	36 issues
Rs.1800/US$100	Rs.3000/US$170	Rs.4300/US$240
		SUPER saver

First name .....

Last name .....

Designation .....

Organization .....

Address .....

.....

City ..... Pincode .....

State ..... Country .....

Phone .....

Fax .....

Email .....

I enclose cheque no. .....

drawn on .....

date ..... towards subscription

charges for Coordinates magazine

in favour of **'Coordinates Media Pvt. Ltd.'**

Sign ..... Date .....

Mail this form with payment to:

Coordinates
A 002, Mansara Apartments
C 9, Vasundhara Enclave
Delhi 110 096, India.

If you'd like an invoice before sending your payment, you may either send us this completed subscription form or send us a request for an invoice at iwant@mycoordinates.org

neXat is a cloud-based, virtual OSS/BSS that also operates as a satellite aggregation platform, acting as a connectivity broker connecting teleports with regional services providers that operate in the maritime sector. The new services from SatADSL's flagship platform will serve both the commercial shipping industry as well as the leisure boating sector. *www.satadsl.net*

Ubihere launches crowdfunding campaign

Ubihere has launched an equity crowdfunding campaign on StartEngine. Its solutions use next-generation location systems to keep track of items in GPS-deprived environments such as remote, mountainous regions; or in office and hospital corridors. By unlocking this data, Ubihere provides its customers with the intelligence needed to make valuable real-time business decisions. Ubihere arose when NASA needed to know how future colonies of astronauts and autonomous rovers could navigate accurately on extraterrestrial planets without GPS. The space agency turned to The Ohio State University and Dr. Alper Yilmaz, head of the nationally renowned Photogrammetric Computer Vision Lab. *ubihere.com*

BAE Systems chooses Spirent Federal Systems

BAE Systems has selected Spirent Federal Systems to provide a CRPA Test System to support M-Code military GPS technology development. BAE Systems is developing an advanced military GPS receiver and improving the capabilities of size-constrained and power-constrained military GPS applications, including precision-guided munitions and handheld devices. Spirent Federal is uniquely qualified to provide essential test equipment and support in the pursuit of resilient, accurate PNT data in GPS-degraded Navigation Warfare (NAVWAR) situations. CRPAs provide proven and effective protection against jamming in high-interference environments. The Spirent CRPA Test System can simulate 16+ individual elements with a separate RF output per antenna element. *spirentfederal.com*

Orolia introduces EdgeSync network timing platform

Orolia has introduced EdgeSync, a new cost-effective network timing platform that provides Network Time Protocol (NTP) and Precision Time Protocol (PTP) Grandmaster and Boundary Clock functionality for real-time edge applications. It uses a multi-GNSS receiver (GPS, Galileo, GLONASS, Beidou and QZSS), PTP and Synchronous Ethernet (SyncE) as input references and generates PTP, SyncE, NTP and timing signals (10 MHz, 1 PPS and Time of Day message) as outputs. It features dual 1 GbE ports for both copper RJ45 and optical network timing connections. *www.orolia.com*

MARK YOUR CALENDAR

September 2021

Commercial UAV Expo Americas
7-9, September
Las Vegas USA
www.expouav.com

ION GNSS+ 2021
20-22 September
St. Louis, Missouri, USA
www.ion.org/gnss/index.cfm

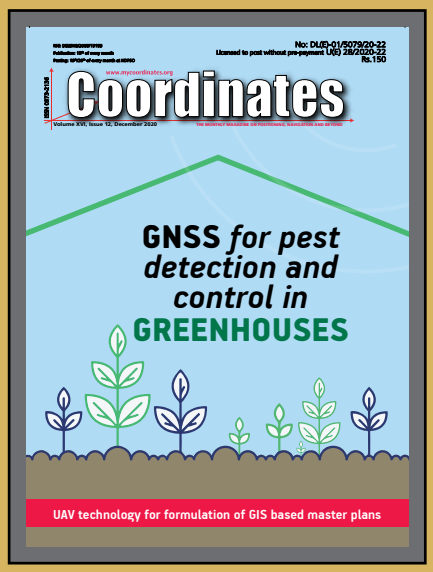
INTERGEO 2021 Live+Digital
21 - 23 September
Hannover, Germany
https://www.intergeo.de

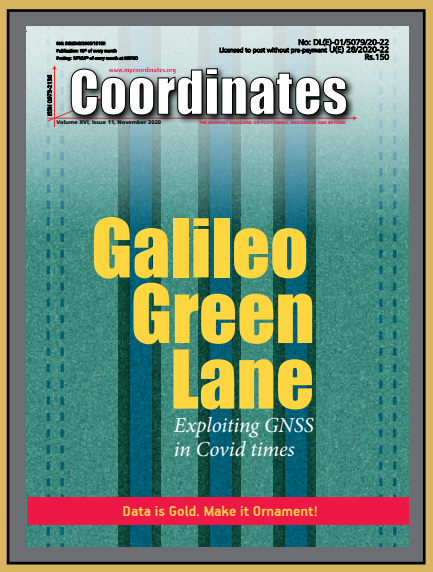
Mapping The Future Of Land Administration & CSDILA's 20 Years Celebration Event
20-23 September, 2021
Melbourne, Australia
https://www.csdila20-fig.org

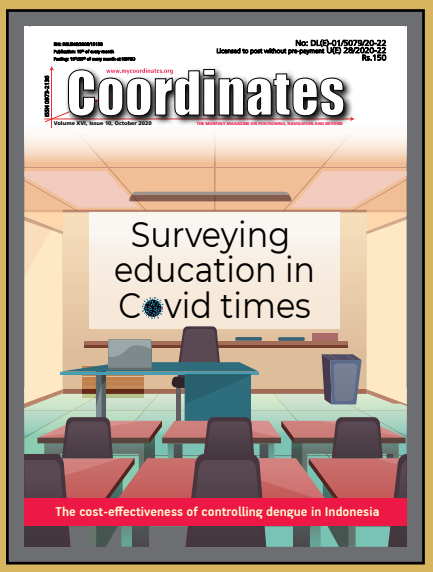
November 2021

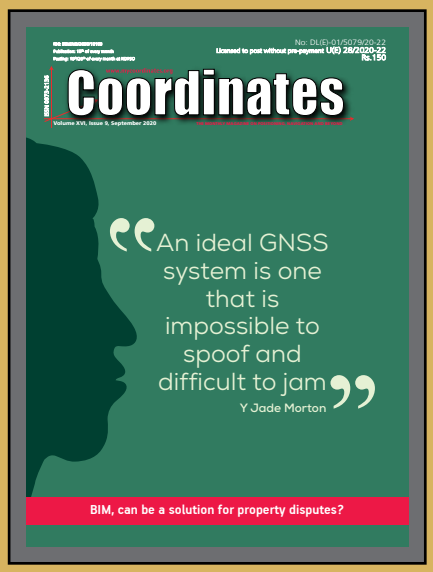
Digital Construction Week
24-25, November
London, UK
www.digitalconstructionweek.com

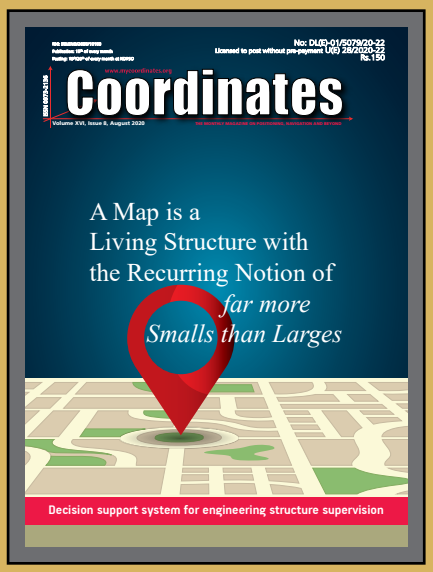
GEO Business
24-25 November
London, UK
www.geobusinessshow.com

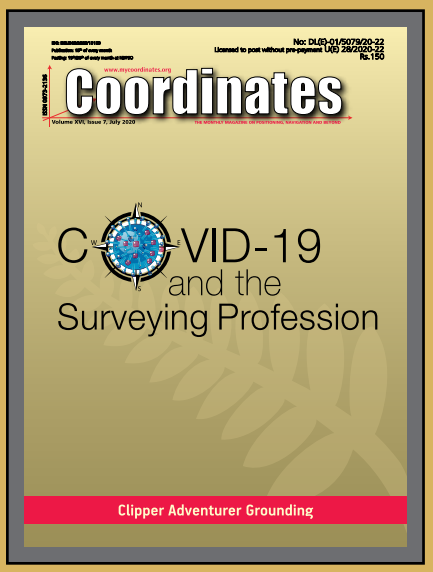


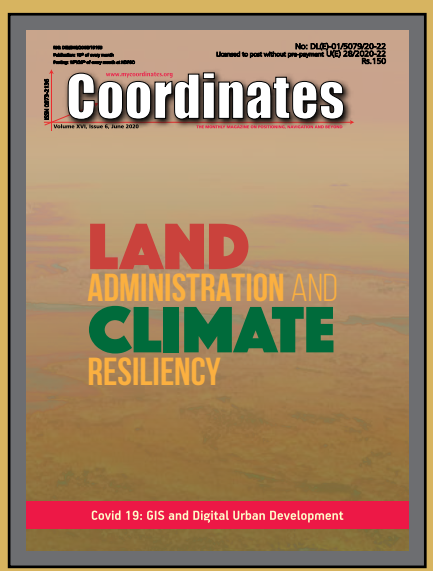


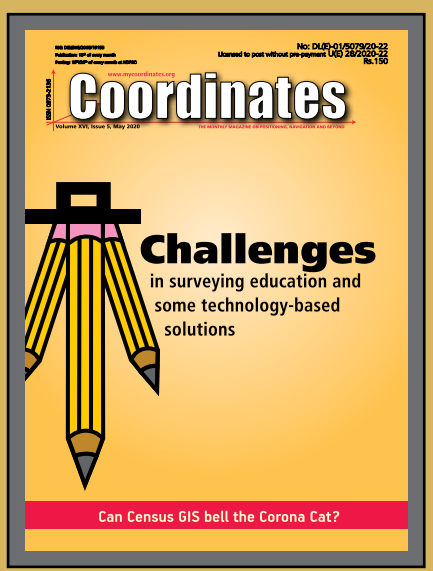












"The monthly magazine on Positioning, Navigation and Beyond"

Download your copy of Coordinates at www.mycoordinates.org

Need to create custom GNSS test scenarios?
Simulate anywhere with **SatGen**

SatGen simulation software generates bespoke GNSS test scenarios at the time, date and location of your choice:

- Compatible with all LabSat simulators
- Multi-Constellation
- Multi-Frequency
- Static or high-dynamic scenarios (including space simulations)
- Real-time simulations (only available with LabSat Real-Time simulator)

LabSat GNSS simulators – **Test Anywhere**

labsat.co.uk