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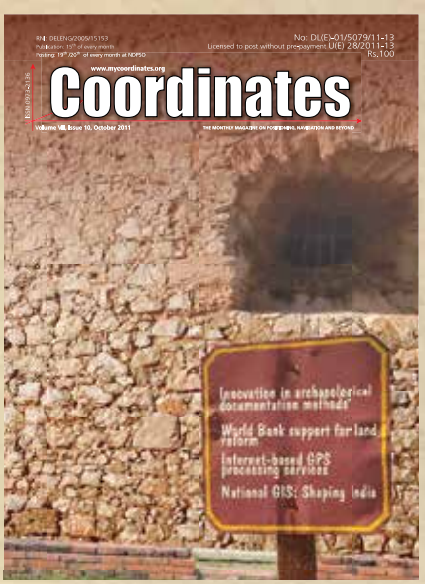

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Experiences from World Bank development support for land reform

Keith Clifford Bell
World Bank, East Asia Pacific Region Washington DC, USA

This paper discusses the World Bank support for sustainable land reform, focusing on the East Asia Region, with particular emphases on initiatives in land governance, land development investment, tenure security, NSDI, e-government, land tax, spatial planning, disaster response and mitigation

Analysis of Internet-based GPS processing service

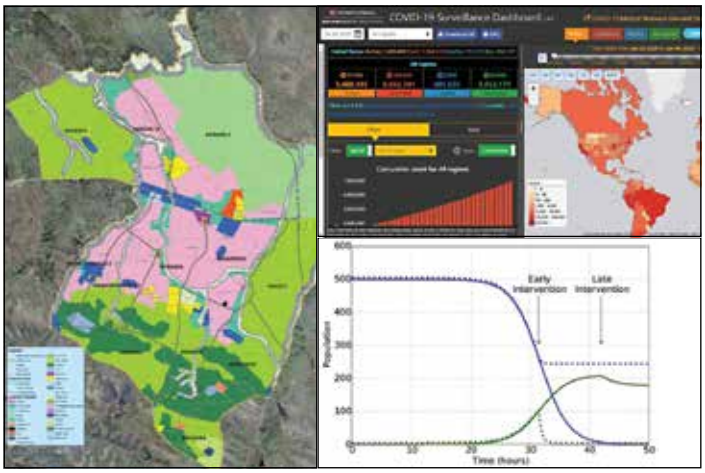
Harun Kenan Subasi and Reha Metin Alkan
Istanbul Technical University, Department of Geomatics Engineering, Istanbul, Turkey

In this study, the accuracy performance of internet-based online GPS processing service is analyzed. The results show that, coordinates are estimated between 1 cm and 22 cm accuracy level in position from all services. To get sub-decimeter accuracy at least 2 hour data span is required. The results show that these services can be used for surveying applications with a cost-effective manner and very easily without knowledge of any GPS processing software.

Innovation in archaeological documentation methods

Nurul Shahida Binti Sulaiman, Zulkepli Bin Majid and Halim Bin Setan
Universiti Teknologi Malaysia

Recent decades of archaeological research, conventional method was used to manually record and document all the contrivances. Prompt by the highly demand for faster and precise documentation of archaeological finds, archaeologist started to shift from using pencils and paper to digital 3D model and digital database for the heritage sites. Several researches have proved that the used of photogrammetry and laser scanning for archaeology data collection is a practical method compare to the previous method. Instead of giving 3D model as final output, it allows archaeologist to integrate the model with its spatial and attribute data in a system called archaeology database system.



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Articles

Columns

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Editor Bal Krishna
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This issue of Coordinates is of 40 pages, including cover.

Vaccination gaps

In this divided world, emerges an additional fault line

Vaccinated vs. un-vaccinated.

If in high-income countries around 60% have been vaccinated with at least one dose, the percentage remains abysmally low at around 3% in low-income countries.

The priority to vaccinate ones own first is understandable and justifiable to some extent,

But the concerns towards a large unvaccinated population

Have to be followed by concrete actions.

The euphoria around the vaccination drive

And the signs of revival towards normalcy in certain parts of the world

Will remain short lived unless each one of us is vaccinated.

Bal Krishna, Editor
bal@mycoordinates.org

Modernization of land administration services in Uganda

The geospatial information in digital format generated under the projects were inputs to other land administration processes which significantly improved the delivery of services, access and transparency while contributing to a more reliable, efficient and effective land administration and management system

Richard Oput
Land Administration/
Geomatics Consultant,
Uganda

Abstract

Uganda got a new Constitution in 1995 which had fundamental provisions for Land Administration and Management which were aimed at creating a favorable working policy, legal and regulatory environment. A long term Land Sector Strategic Plan was developed to guide implementation of the various Land Sector reforms. The Strategy had major provisions for modernization of Land Administration services which were driven by reforms promoted by Projects which aimed at modernizing delivery of land services through implementation of various activities with major components which involved digitization of geospatial information and the associated processes.

The geospatial information in digital format generated under the projects were inputs to other land administration processes which significantly improved the delivery of services, access and transparency while contributing to a more reliable, efficient and effective land administration and management system.

Finally the paper discusses the achievements realized and challenges experienced in modernization of land administration services.

Background

Uganda got a new Constitution in 1995 which had fundamental provisions for land administration and management which were aimed at creating a favorable working policy, legal and regulatory environment. It was also hoped that improvement in efficiency and effectiveness of delivery of land services would naturally follow. Furthermore, there was a provision to put in place the Land Act within two years of coming into force of the new Constitution. However, after enactment of the Land Act in 1998, there were quite a number of challenges which were faced during implementation of the new Act. One of the major bottlenecks identified during implementation was the large unfordable implementation structure, the spirit of which was to take services closer to the people, which were also meant to be much cheaper and therefore more affordable for the majority of the people. A Land Act Implementation Study (LAIS) which was carried out in 1999, that is one year after enactment of the Land Act, identified the challenges which were faced during implementation of the Act and made a number of recommendations which included among other things, streamlining the implementation structure for the Land Act. After reviewing the recommendations which were made in the Land Act Implementation Study, Cabinet directed the Ministry of Lands to develop a Strategic Action Plan for implementation of Land Sector reforms including implementation of the Land Act. Following the Cabinet directive, the Ministry developed the 10 year Land Sector Strategic Plan (LSSP I), which was approved by Cabinet in 2002. The LSSP I was designed to provide the operational, institutional and financial framework for the implementation of sector wide reforms and land management

including the implementation of the Land Act. The LSSP I had major provisions for modernization of land administration services which were driven by reforms introduced during implementation of the Land Tenure Reform Project (LTRP), followed by the Second Private Sector Competitiveness Project (PSCP II) and later by the Competitiveness and Enterprise Development Project (CEDP), which last two projects were funded by the World Bank. These Projects aimed at modernizing delivery of land services through implementation of various activities with major components which involved digitization of geospatial information and the associated processes, resulted in improvement of delivery of land services which were much faster and cheaper and proved to be more efficient and effective, as well. The LSSP II (2013 – 2023) has strategies aimed at scaling up the programs initiated under the LSSP I, refocuses and strengthens the efforts aimed at modernizing delivery of land services with the major objective of provision of much more efficient and effective land services buttressed by digitization of geospatial and other land related information and automation of previously manually based processes.

Introduction

Implementation of the LSSP started in earnest in mid-2005 when a World Bank-funded project was initiated, which enabled Government to start addressing the inefficient administration and poor security of the country's land registration system, while also updating and strengthening the policy and regulatory framework for land administration and management. The Land Component of the Second Private Sector Competitiveness Project (PSCP II) supported the rehabilitation/ construction of 13 zonal land offices (including the provision of equipment); the re-engineering and computerizing of the land registration system and records in six zonal land offices covering about 70 percent of the formal land market transactions; and rehabilitating the Institute of Surveying and Land Management, and training and equipping staff to run the systems and institutions. The Project achieved significant progress in the areas of decentralizing and computerizing the land registration system. In particular, the intervention resulted in a reduction in the number of days to transfer property from 227 in 2006 to 52 in 2012. In addition, the initiative also rehabilitated the geodetic reference network and produced multi-purpose base maps for the areas covered by the six zonal land offices.

The PSCP II together with Government support under the LTRP, also supported the preparation and adoption of the overarching policy framework for land administration and management, which was essential for addressing the first three objectives of LSSP I, which dealt with equitable and secure access to land and its productive use and pilot activities. Notable achievements were the support for the National Land Policy, which was approved by the Cabinet in February 2013; the National Land Use Policy, which was adopted in 2007, followed by enactment of the Physical Planning Act 2010; the Mortgage Act 2009; and the Land (Amendment) Act 2010 to reduce illegal evictions. In addition, support was given to the preparation and drafting of nine bills, including the Registration of Titles Bill, the Survey Bill, the Surveyors Registration (Amendment) Bill, the Real Estate Agents Bill, the Condominium Property (Amendment) Bill, the Land Acquisition Bill, the Government Land Bill and the Uganda Land Information Systems Bill.

The piloting supported by the PSCP II together with Government support under the LTRP included systematic titling of high-value rural land in Ntungamo, Iganga, and Mbale districts using best practice, low-cost, and transparent approaches. The data capture was carried out using affordable GPS equipment and the associated data processing was mainly carried out in digital format.

It should be noted that additional interventions were needed to support implementation of the LSSP's strategic objectives, which had been grossly underfunded and this was made possible under the CEDP.

The CEDP addresses those issues which were highlighted as priority areas for action in the second LSSP (2013-2022) and required a major boost, but had remained unfunded due to financing constraints. Such key areas include: registration/certification of communal lands in the North and East; registration of individual land parcels all over the country; piloting and scaling up improved land use planning models in strategic areas; and strengthening land dispute resolution.

Enhancement of delivery of land services buttressed by digitization of geospatial information

Modernization of land administration and management services supported by digitization of geospatial information and automation of some associated processes was carried out mainly under 5 Sub-Projects under the Land Component of the Competiveness and Enterprise Development Project (CEDP). These included Development of the National Physical Development Plan; Modernization of the National Geodetic Network and Establishment of Continuously Operating Reference Stations (CORS); Production of Basemaps for Land Administration; Systematic Adjudication, Demarcation and Certification/Registration of Individual and Communally Owned Land; and Development and Implementation of the National Land Information System.

Development of the National Hhysical Development Plan (NPDP)

Uganda's long-awaited first National Physical Development Plan (NPDP), comes from a background of its modern Physical Planning systems, which originated in the construction of trading

and administrative centers during the pre-independence period, but which work was based on paper based manual operations.

A central objective of the NPDP is to give the physical aspect of planning development a more central role within Government policy-making. It will help to coordinate and align national projects in urbanization, infrastructure, transportation, and wealth creating sectors.

The National Physical Development Plan provides the analytical parameters for the planned allocation, use and management of the country's land and other physical resources, as well as the most efficient location of infrastructure, towns and cities, and how they link to the surrounding rural areas. It is intended to serve as a framework through which the spatial location of investments, as well as planning and management of resources are guided at the national level.

The Physical Planning system, as defined in the Physical Planning Act 2010, works at different levels from the national down to the detailed local level, and covers the whole country. By being integrated with Economic Development Planning, it will assist with the dissemination of the NDPs down to Local Government levels. The NPDP therefore also contains an overall plan and program for capacitating the Physical Planning System to be effective across the whole country, as it develops.

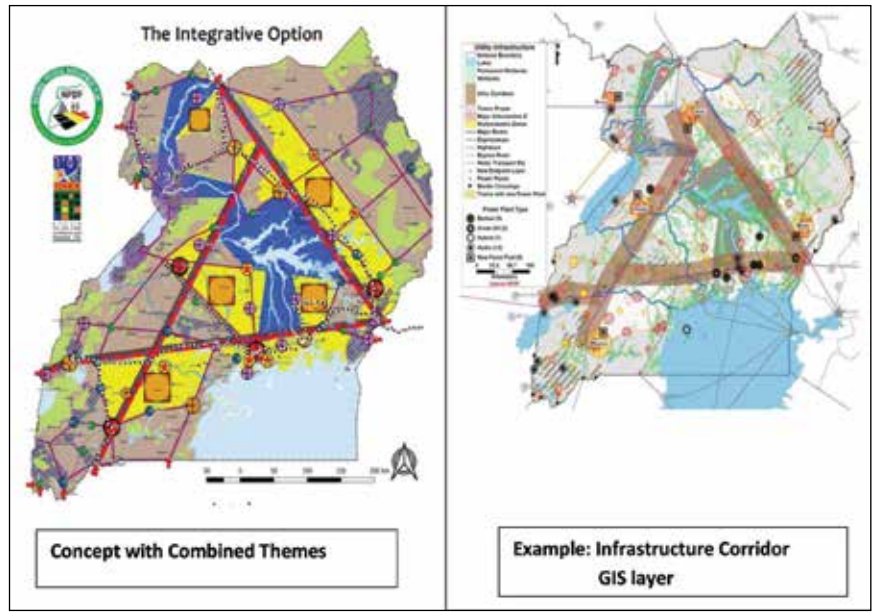
Much more efficient Physical Planning processes have been made possible with the arrival of (digital) Geographical Information Systems (GIS). The process of updating and sharing data will be greatly facilitated by the Uganda Spatial Development Framework (UGSDF), which will ensure that core data sets are freely available and that a common frame of reference for GIS data is used.

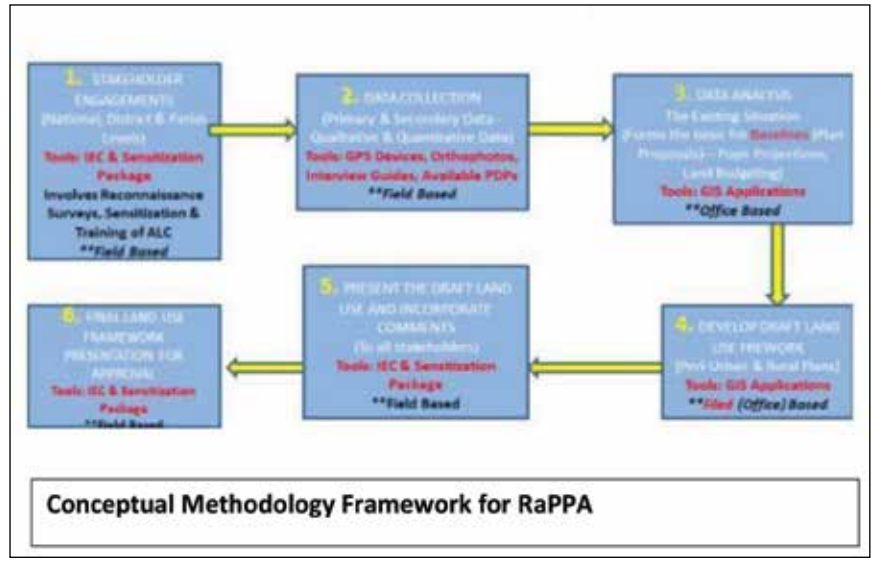
Digital spatial data systems will play a key role in implementing the NPDP as pillars/sub pillars have GIS layers which are the same as the NSDI core layers, besides the NSDI will enable some ongoing self-coordination by its users. Using the PPUMIS, the DPPUD will be able to check if individual MDA project proposals conform to NPDP – 5,10,15,20 year strategies, guidelines and principles.

Physical Planning and Urban Management Information System (PPUMIS)

The overall aim of the Physical Planning and Urban Management Information System (PPUMIS) was to set up Geographical Information and related systems in the Ministry of Lands and in 14 Municipalities in order to store, validate and coordinate spatial data, prepare and implement Physical Development Plans and manage Urban Development faster, more effectively and efficiently.

The PPUMIS will enhance planning, preparation, implementation and monitoring of the urban processes. The system will include a database to facilitate data collection, storage, display and spatial analysis and it is based on a comprehensive Geographical Information System with the abilities to synchronize data between the Ministry and the 14

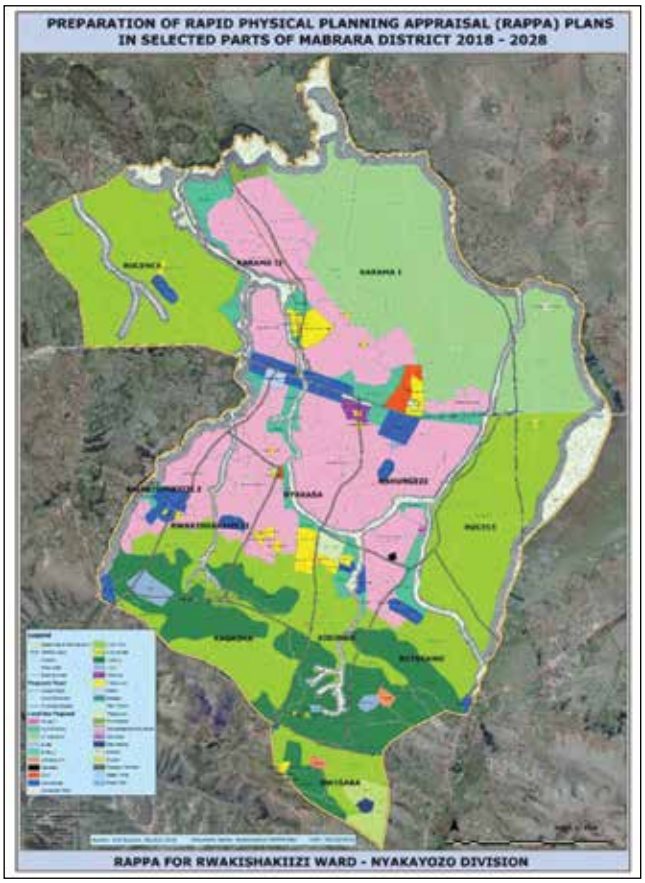




municipalities; import, enhance and display Physical Development Plans for intelligible use; provide analysis and update capabilities for urban data, in particular, Street Naming and Building Numbering Process and Monitoring of Urban Indicators. With regard to implementation of the NDP, PPUMIS is linked with the LIS and Local Governments and Plans can be transmitted and incorporated thereby in Plans at lower levels, furthermore LIS Physical Planning checks at MZOs as part of land management and administration system, will also then assist with NDP implementation.

Rapid Physical Planning Appraisal (RaPPA)

RaPPA is a guide to the development direction of a given area in a systematic procedure based on the analysis and triangulation of data acquired through a consultative and qualitative manner.



The Physical Planning Act 2010 declares the whole country a planning area, this implies that as part of procedures for registration of land titles, there will be a requirement for Physical Planning approvals to be given as part of the process for titling. Therefore the system of "Rapid Physical Planning Assessment" was devised in order to do the necessary planning for the SLAAC process.

The Ministry adopted RaPPA to precede the SLAAC process and developed internal capacity and is able to develop RaPPA plans for the Physical Development Frameworks for the Districts, Sub Counties and Parishes. At the Parish level, planning is done in detail to map out the public facilities, access roads, environmental sensitive areas, cultural and tourism sites for preservation. At this level, the development path for a Division/ Ward/Parish is determined and planning instructions issued to guide SLAAC.

The activities involved in RaPPA include Processing/Preparation of Base Maps, Conducting Reconnaissance Surveys, Training of Land Management Institutions (LMIs), Sensitization of Local Communities, Developing of RaPPA Framework Plan, and Presenting Draft RaPPA Framework to Stakeholders.

Outputs of RaPPAs which are mainly in digital format are direct inputs to the Systematic Land Adjudication and Certification (SLAAC) Project and together with all the processes handled in a digital environment, have significantly contributed to improvement in the efficiency and effectiveness of implementation of the land administration and management processes.

It should be noted that the volume of work involved requires that highly effective database management and automated systems based on digital geospatial data, will be needed to achieve the outputs in time.

Updating and implementing of the National Geodetic Reference Framework for land administration

The objective of the Uganda Geodetic Reference Framework (UGRF) Project, initiated by the Government of Uganda with the assistance of the World Bank, was to establish a modern, reliable and accurate geodetic reference frame for the entire country to support land administration, physical planning, land development, construction industry, environment protection and other spatial data activities in different sectors of economy. The UGRF consists of a three level architecture network including a Zero Order sub network of active CORS, a First Order sub network and a Second Order sub network of passive geodetic points.

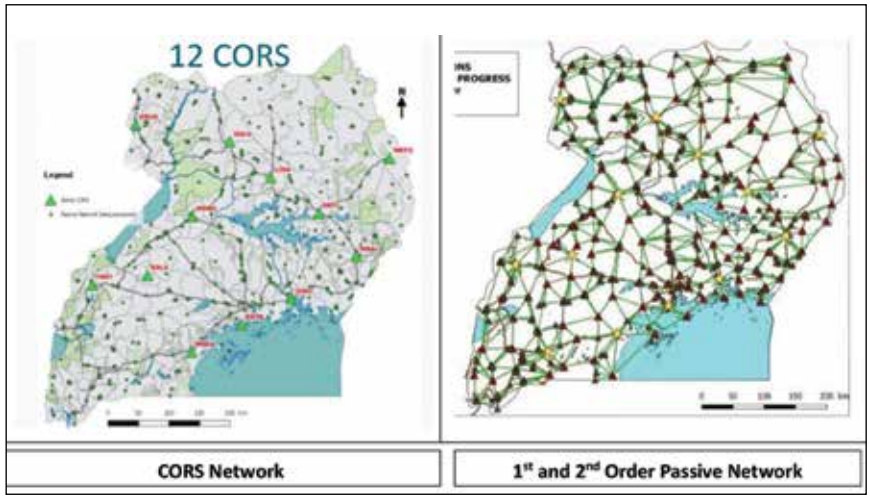
The CEDP funded modernization of land administration by establishment of a geodetic reference framework and Continuously Operating Reference Stations. This has contributed to the enhancement of land administration services, improvement of their reliability and will increase public confidence in the land administration sector.

Uganda Geodetic Reference Network (UGRN)

The UGRN is composed of two types of geodetic control networks. These are the Active Control Network (Continuously Operating Reference stations) and the Passive Control Network (Terrestrial Reference Stations); Transformation Parameters – The Surveys and Mapping

Department (SMD) had been working to determine transformation parameters between the old datum "New Arc 1960" and the ITRF05. The UGRN has also generated better parameters

CORS - These are also referred to as the Active Control Network, there are currently composed of 12 CORS with a plan to increase them to 28 CORS exclusive of the private sector which will be included to improve on the robustness of the network. The CORS are installed in mainly Ministry premises and other Government facilities and these transmit data to the National Computing Centre (NCC) at the National Land Information Centre (NLIC).



Passive Control Network (Terrestrial Reference Stations) - These are made up of 14 Zero Order points known as Uganda Geodetic Network (UGN), 129 1st Order points and 297 2nd Order Points, making a total of 440 Passive points.

Major changes have been brought about by the use of Internet:

- Products have changed – They are Internet based (data, real time corrections) - Online processing - Online transformation and geoid software; the paper description card is no longer a product
- Products update – It is easy to update coordinates and description cards - Improvements and maintenance can be handled easily
- Information sharing - People want up-to-date information - Users can easily give feedback (social networks but also and more interestingly feedbacks on existence of points)

It has been made possible to practice Modern Geodesy:

- CORS network website (rinex files, data QC, etc) http://ugrf.go.ug/SBC
- On line post processing http://ugrf.go.ug/SBC/User/Xpos/
- Description cards (no need for login) http://ugrf.go.ug/carto
- Transformation parameters and interim geoid software (to be downloaded for free, no need for login): http://ugrf.go.ug/download

It is now possible for users to follow online data availability, data quality and to process their own data online using the website which has been put in place.

Real Time data is now available on NTRIP Caster for any user who simply needs to register online and RTK corrections and processed coordinates are provided in the official UGRN reference framework.

This project has made it much faster, cheaper and more efficient to carry out a typical survey exercise as a result of data capture and processing of geospatial information in digital format

Production of basemaps for land administration

The main objective of this Project is to establish high resolution and accurate Digital Ortho-rectified Imagery (DOI) for the whole country to support the National Land Information System Infrastructure, land registration and cadastral procedures, land valuation, physical planning as well as decision making for land management and protection of the environment.

The Project also aimed at contributing to the enhancement of land administration services in the country, improvement of their reliability and increasing public confidence in the land administration sector and enhancement of social economic development in the country.

The outputs include Aerial Photography, Digital Elevation Models, Digital Orthorectified Images (15 cm resolution for urban areas and 40 cm resolution for the whole country), all produced in digital format. The Digital Orthorectified Images and associated data are used directly in the UgNLIS, SLAAC, Physical Planning and as a base for revision of the Topographic Maps, at all scales and engineering works involving planning way leaves, power lines; water lines.

Because of the relative ease of handling and storage in digital format, the DOI have been shared with many institutions requiring use of this data – which has been made easier compared to previous cases when most map data was paper based.

The main objective of this Project is to establish high resolution and accurate Digital Ortho-rectified Imagery (DOI) for the whole country to support the National Land Information System Infrastructure, land registration and cadastral procedures, land valuation, physical planning as well as decision making for land management and protection of the environment

Display and verification by beneficiaries

Systematic Land Adjudication And Certification (SLAAC)

This involves demarcation and registration of individual lands in rural and peri-urban areas (including issuance of titles to said individuals) ensuring application of fit-for-purpose approaches that are cost effective and that will ensure fast expansion of coverage of registered land; establishing Communal Land Associations (CLAs) in priority areas; demarcation and registration of communal lands in the priority areas and issuance of certificates or titles to said CLAs.

The systematic demarcation activities initiated and piloted during LSSP I (2001-2011) were rolled out under the CEDP. These activities included:

- Systematic registration of individual and communally owned land through establishing Communal Land Associations (CLAs) in priority areas including the Northern and Eastern Regions;
- Demarcation and registration of communal lands in priority areas and issuance of titles to Communal Land Associations; and
- Demarcation and registration of individual lands in rural and peri-urban areas including issuance of titles

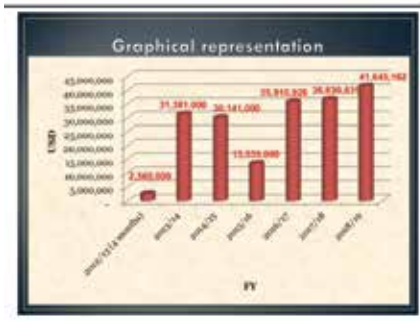
The use of the Systematic Land Adjudication and Certification (SLAAC) application supports issuance of Certificates of Customary Ownership,

Communal Land Associations and Freehold Titles. It is a collection of tools, procedures and infrastructure which assist the Ministry of Lands, Housing and Urban Development in the data collection, mapping, and processing of spatial and other land related data, which is carried out in digital format.

The objective of the use of the SLAAC application is to increase the rate of land registration and certification, secure land rights for vulnerable groups, increase productivity and use of the documented rights to contribute to improvement of social economic development in the Country.

Average Number of Days Taken to Transact

Transaction Type	FY 2013/14	FY 2014/15	FY 2015/16
Search	23	21	27
Mortgage charge	39	32	25
Conversions	50	33	20
Sales			
Transfer Freehold	34	29	19
Transfer Leasehold	36	28	21
Transfer Mailo	44	39	28
Av. Sales	43	38	27
Overall total	39	34	23



The application is based on mobile tablets installed with Windows operating system and now being upgraded to Android operating system and is based on open source software running on a Postgres/ PostGIS database, Alfresco and QGIS software for mapping. Digital Ortho-rectified Imagery or orthophotos are used as a base while carrying out the demarcation of boundaries and other data capture procedures. The application is also used in the data processing and the associated quality control processes in the Data Processing Centre (DPC) including monitoring and evaluation, production of reports and final outputs including maps and information required in the titling process.

Currently, the SLAAC tool is being used in Mbarara, Oyam, Ibanda and Kiruhura Districts and the titling process is ongoing.

Overall, the procedures followed supported by availability of data in digital form are much more reliable, efficient and promotes transparency compared the paper based manual processes which are cumbersome, inefficient and prone to mistakes and interference in the processes.

Development and Implementation of the National Land Information System (NLIS)

Development and implementation of the NLIS incorporates cadastral, registration, valuation and physical development planning functions in all zonal land offices (including conversion of associated land records) and moreover there will be significant improvement of monitoring of performance of various aspects involved in land transactions; Furthermore the land information system will be linked to the tax authority, courts, land use, financial institutions, national identification

registration authority, company registry and administrator general to ensure reliable and authentic land transactions.

The following improvements in the new NLIS have been supported by the availability of geospatial and other land related data in digital form: The new system is based on Open Source components; Web architecture; Improved data model (LADM compliant, simplified); A unified data model used for registry and cadaster in order to assure database consistency; Handling of land transactions submitted - Queuing based on First Come, First Served; Integration with other Government systems; Customer Call Centre for the Public; Staff, Public and Corporate Web Portals; Physical File Tracking System; Administrative dashboard for Managers; SMS Notification for all land transactions; Improved operations and modules to reflect user experience in the pilot phase - Simplified transactions and workflows.

The National Land Information System has been installed and is operational in 22 Ministry Zonal Offices of Wakiso-(Busiro and Kyadondo), Mukono, Masaka, Kampala (KCCA), Masindi, Kibaale, Kabarole, Mbarara, Arua, Gulu, Lira, Mbale and Jinja. Others are Mpigi, Luwero, Mityana, Kabale, Rukungiri, Tororo, Moroto and Soroti respectively.

The objective of establishing Ministry Zonal Offices (MZOs) and development of the National Land Information System is:

a. To bring the Ministry's services closer to people who had to bear all inconveniences and indirect costs of moving frequently to the Capital City (Kampala) to access Ministry's services.
b. To digitally store and archive land Information for easy and timely access of information by both the service provider and the public for quick decision making.
c. To detect and eliminate any possibilities of fraudulent practices in the land transaction process such as double titling, overlapping surveys among others.
d. To improve the internal efficiency of Land Administration operations, provision of prompt, efficient, reliable and wide range of land services to clients.
e. To efficiently and effectively disseminate land information to the public.
f. To capture all the land tenure systems in the Land Information System.
g. To increase revenue generation by the Lands Sector.
h. To provide more time for land administrators and managers to offer specialized consultation, sensitization and technical guidance both to clients and Land Management Institutions.

The benefits, some of which have so far been realised from establishing Ministry Zonal Offices and implementation of the National Land Information System include:

a. Reduced cost of doing business as a result of quick retrieval of information and speedy land transactions;
b. Reduced turnaround time for producing land title from 52 days to 10 days;
c. Increased revenue generation;
d. Reduced land transaction malpractices such as forgery and fraud;
e. Elimination of unprocessed land registration transactions, since the NLIS is premised on the principle of first in first out;
f. Safe storage of records and space saving, which has led to better security of records by reducing possibilities of manipulation;
g. g) Elimination of manual system and problems associated to it, thus leading to efficiency and effectiveness in land transactions which is essential for economic competiveness;
h. Improved surveys and mapping as issues of overlapping surveys and double plotting have been dealt with;
i. Reduced land litigation cases as a result of improved security of land ownership;
j. Availability and quick retrieval of various land related statistical data and reports on the types of land, area and ownership as and when required;
k. Restoration of trust and confidence in the land registration system;
l. Established two portals: one public portal for the general public and the other is a corporate portal for financial institutions, professionals i.e. lawyers and surveyors among others. These portals will be operational by end of April 2020 and both the public and professionals will be able to access land related information online.

It should be noted that approximately US$ 193 million has been generated from land related transactions since its launch in February 2013 to June 2019. This is revenue generated from land related activities and includes both the Taxable revenue and Non-taxable revenue.

The cumulative generation of US$ 192 million in revenue near completion of the project represents an enormous of over 166% percent return on the US$72 million investment provided as a World Bank loan that includes the construction of buildings.

Summary of project contributions to modernization of land administration services

All the projects mentioned above promoted use of land related geospatial and other land information in digital format. The digitized geospatial information generated under the projects were inputs to other land administration processes which significantly improved the delivery of services and at the same time improved access and transparency while contributing to a more reliable, efficient and effective land administration and management system. System security is a key concern that ensures issues regarding data protection are well addressed

while data ownership will be handled under the spatial data infrastructure.

Overall the projects mentioned contributed to modernization of land administration services through the use of modern applications and tools including adoption of practices that promoted digitization of geospatial information and associated processes.

Project achievements in modernization of land administration services

The major achievements realized in modernization of land administration services supported by digitization of geospatial information and associated processes in Uganda, included the following:

- Improvement in delivery of land administration services
- Improvement of the quality of records and their management
- Effective decentralization of cadastral and registration services (22 zonal offices)
- Securing of land related records and maps
- Establishment of audit trail
- Security of land transactions has been enhanced
- Instant retrieval of information
- Improvement of decision-making intelligence
- Enhancement of quality control, monitoring and evaluation

Challenges in the projects involve in modernization of land administration services

The major challenges experienced in modernization of land administration services supported by digitization of geospatial information and associated processes in Uganda, included the following:

- Poor state and quality of the records (maps) – mismatch between the final scanned maps and what exists on the ground
- Maintenance challenges : basic infrastructure, power and connectivity
- Slow adaptation of the Ministry structure to the new working environment requiring new or differently skilled personnel, staff structure
- Reluctance to adopt new business processes
- Sensitization: The public is not well informed about the new changes in land administration and management across the country.
- Limited continuous capacity building for the MZO and Ministry staff
- Legal and regulatory framework was not fully consistent with flexible development framework driven by modernization of land administration services

References

1. Government of Uganda and Private Sector Foundation Uganda (PSFU) (2016) About the Competitiveness and Enterprise Development Project: Enhancing Uganda's Competitiveness, Competitiveness and Enterprise Development Project (CEDP), March [https://www.cedp.go.ug/wp-content/uploads/publications/CEDP-Brulletin-March-2016.pdf] accessed 20 January 2018.
2. Migereko, Daudi (2013) "The national land policy will strengthen existing land laws," The Monitor, 13 February.
3. Migereko, Daudi (2016) How Uganda is addressing land issues in the country, Speech presented at the World Bank Round Table Conference on Land Policy Process in Africa on the topic, Good Land Governance: Lessons from Uganda New Vision, 24th March, [https://www.newvision.co.ug/new_vision/news/1420403/uganda-addressing-land-issues-country] accessed 18 January 2018.
4. Oput Richard; Aurélie Milledrogues; Patrick Stimpson; Sergiy Lizenko; Carol Roffer and Christopher Burke (2017) "Scaling Up a Pilot Land Management Initiative in Uganda to a National Land Information System (NLIS)" Republic of Uganda Ministry of Lands, Housing and Urban Development (MLHUD), and French National Institute of Geographical and Forestry Information-France International, Paper presented at the Annual World Bank Conference on Land and Poverty, World Bank Headquarters, Washington DC, 20-24 March 2017.
5. Oput Richard; Aurélie Milledrogues and Christopher Burke (2018) "Implementation of the National Land Information System (NLIS) in Uganda: Strengthening Land Governance" Republic of Uganda Ministry of Lands, Housing and Urban Development (MLHUD), and French National Institute of Geographical and Forestry Information-France International, Paper presented at the Annual World Bank Conference on Land and Poverty, World Bank Headquarters, Washington DC, 19-23 March 2018.
6. Republic of Uganda (1995) Constitution 1995, Chapter 15, Article 237, Section 3 (a, b, c, d).
7. Republic of Uganda (2013a) Land Sector Strategy Plan 2013 - 2023 Ministry of Lands, Housing and Urban Development Republic of Uganda, 20 December 2013.
8. Republic of Uganda (2013b) Uganda National Land Policy, Ministry of Lands, Housing and Urban Development (MLHUD), February.
9. Republic of Uganda (2019) National Physical Development Plan, Ministry of Lands, Housing and Urban Development (MLHUD), September.
10. Republic of Uganda (2019) Reports on Physical Planning, Surveys and Mapping, UgNLIS, Ministry of Lands, Housing and Urban Development (MLHUD), December.
11. The World Bank Group (2017) Doing Business 2018, Reforming to Create Jobs, Economy Profile: Uganda, The World Bank Group: Washington, D.C..

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COVID-19 and the role of digital technology based on the ten global trends identified by the World Economic Forum

This paper reviews how technology could play a crucial role in a global pandemic for timely dissemination of information and operational decision-making

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With the COVID-19 pandemic spreading rapidly across the world, one of the important aspects that came to the forefront is the role of information and communications technology. While the twenty first century has already shown the dependence on technology but the COVID-19 pandemic has proved that technology can demonstrate a crucial role at the time of crisis and disasters. Be it digital technology or drones or social media or infusion of technology as part of work from home modality, technology has played a very critical role not only for monitoring but also for addressing the daily needs of people. While digital technology such as satellite has played an important role in observing the earth's environment and mapping of COVID hotspots, drones have been able to provide critical information on lockdown procedures. Similarly, web platforms such as Zoom, Google Meetings, WebEx, Skype, etc. have kept the communications channels open for everyone whether working from home or being a medical practitioner or a news broadcaster to disseminate up-to-date information on the pandemic situation around the world. COVID-19 dashboards developed by different countries have been the most successful application of information technology providing real-time information on COVID from around the world. This review paper would therefore, try to review how technology could play a crucial role in a global pandemic for timely dissemination of information and operational decision-making.

Introduction

The year 2020, started with the COVID-19 pandemic affecting global economies, restricting movement of people and locking down countries for a prolong period of time. With a crisis which is likely to continue for a prolong period, getting into a new normal mode of life has become important. Since the beginning of the pandemic, COVID-19 distancing policies are accelerating the digital transition. As the world reacts to the pandemic, countries have become increasingly reliant on technology to support their citizens and workforce to self-isolate or quarantine themselves to mitigate the spread of the virus. Therefore, remote working or the "Work From Home (WFH)" modality as it is called in collaboration with information and communication technology (ICT) have become essential systems, with new demands placed on networks and data center infrastructure to keep the system of communication running while also ensuring that such systems are not breached and appropriate data and information security measures are put in place. Access to the internet and digital public services are now being

seen as essential for dignified living, leaving no one behind (UNOCHA, 2020). Cities are at the forefront to balance the equality of services, performance, accessibility, choice, security and rights of all citizens. The live streaming of sessions or the day-to-day communications through WFH modality on digital technologies highlighted the role of new technologies during the pandemic and beyond. Moreover, it is also realized that governments need to make full use of digital technologies to confront the COVID-19 pandemic and address a wide range of pandemic-related issues. According to the UN, the pandemic is compelling governments and societies to turn toward digital technologies to respond to the crisis and, increasingly, is requiring governments to adopt an open government approach and to use digital communication channels to provide reliable information on global and national COVID-19 developments.

With the new social distancing norms and continued lockdowns in many countries, governments are forced to deploy digital technologies to contain the pandemic outbreak. A review of the national portals of the 193 United Nations Member States showed that by 25 March 2020, 57 per cent (110 countries) had posted some kind of information on COVID-19, while around 43 per cent (83 countries) had not. But by 8 April 2020, around 86 per cent (167 countries) have included information and guidance about COVID-19 in their portals (UNDESA, 2020).

From designing new apps to monitor COVID-19 to facilitate services such as delivering food and other essential items to those most in need government has been optimizing the entire supply chain via digital government services. According to the World Health Organization (WHO), it has received overwhelming support from technology-based companies to fight the COVID-19 pandemic as a result of which on April 2, 2020, some of the experts from the world's leading digital technology gathered through a virtual roundtable discussion to help in WHO's collaborative response to COVID-19. WHO has further mentioned that the pandemic has triggered an unprecedented demand for digital health technology solutions and has revealed successful solutions such as for population screening, infection tracking, allocation of resources on priority basis and designing targeted responses.

The European Union Strategy for Alpine Region (EUSALP), intends to reaffirm the importance of a robust digital infrastructure and widespread digitization of services, especially for disadvantaged areas such as rural or mountain areas realizing the need for digital technologies during crisis situation. However, digitalization should not only infrastructure focus but it should include technologies and digital skills. With every people taking to work from home or work remotely, the pandemic has made us realized that our future way of living and working has gone through fundamental changes that will have a long-term impact on our society and economy even upon return of normality, some of those new transformations will continue to stay.

Considering the several factors mentioned above, this present paper reviews how technology could play a crucial role in a global pandemic like COVID-19 for timely dissemination of information and operational decision-making.

Digital access

According to the UN, COVID-19 has made universal digital access and cooperation essential with technology proving to be a very useful and necessary tool to help governments dealing in COVID-19 related emergencies to provide essential public services as required. For instance, several tools, apps and dashboards have been deployed at the global, regional and national levels to provide up-to-date information on the pandemic situation. While this information has effectively helped in monitoring, detection and prevention of COVID-19, it has also been able to enhance the opportunities of performing modeling studies helping countries policy-makers to enhance their preparation for the pandemic outbreaks including identifying containment zones and enhancing public-health education and communication. While this has brought us to the realization of the opportunities of big data and internet of things (IoT) in the long-run, it has also enabled us to understand how technology could help governments and societies to accelerate their response to the pandemic.

The International Telecommunications Union (ITU) has reported that the internet traffic has tripled during the pandemic with demands growing at a very rapid pace including the massive shift in broadband usage toward suburbs and rural areas instead of urban office buildings, where people are now telecommuting or working from their homes. However, with access to internet still limited in many parts of the world, it is now becoming important that efforts should be made where new technologies can help provide coverage at affordable prices to underserved communities and for this to happen both satellite and terrestrial technologies could play a critical role in providing access to broadband connections to the rural and remote areas.

As part of the effort to provide global digital access, the World Economic Forum (WEF) has identified ten technology trends that has evolved during COVID-19 pandemic which includes:

i. **Online shopping and robot deliveries:** With the lockdowns in place in most countries, the need for online shopping and contactless deliveries have become crucial. Many countries have already started launching contactless delivery services where goods are picked up and dropped off at a designated location instead of from or into the hands of a person. For example, Chinese e-commerce giants have been using robot deliveries as part of their contactless efforts.
ii. **Digital and contactless payments:** With the instances of cash getting infested with virus, countries like China, US and South Korea

have been implementing various measures to ensure banknotes are clean before they go into circulation. Now a more secure mode of payments have been recognized that is the contactless digital payments either in the form of cards or e-wallets as a measure to prevent the spread of COVID-19. Numerous apps have also been introduced by the governments to help people carry out online purchases and utility payments such as electricity bills, phone bills, water bills, etc. However, one of the challenges of using contactless payments is that the availability of digital payments relies heavily on internet availability, devices and a network to convert cash into a digitalized format. But a recent study in 2017 by the World Bank has shown that nearly 1.7 billion adults have no access to banking which means that they are still dependent on hard cash transactions.

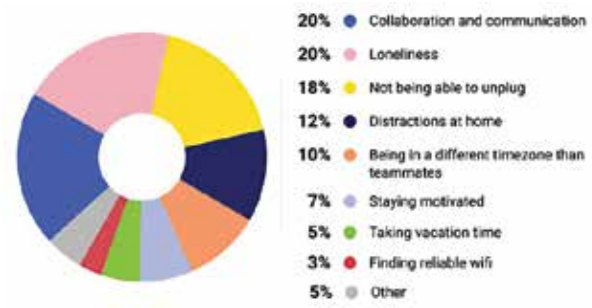

Figure 1: Biggest struggle working remotely (Source: State of Report 2020)

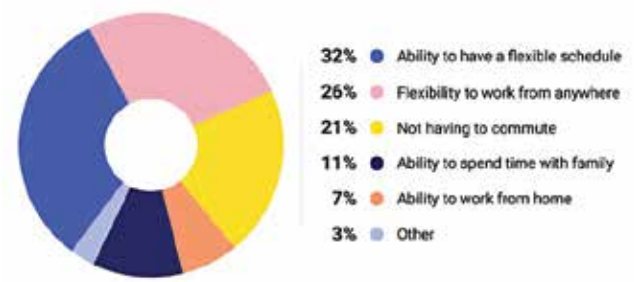

Figure 2: Benefits of working remotely (Source: State of Report 2020)

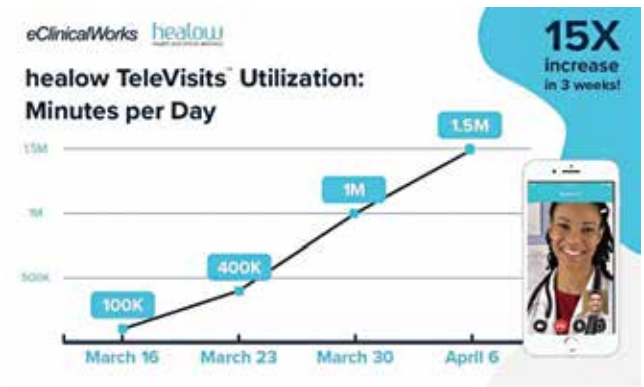

Figure 3: Telehealth utilization has grown during the COVID-19 pandemic (Source: World Economic Forum)

iii. **Remote work:** With the lockdowns being enforced globally, it is realized that remote work is enabled by technologies such as virtual private networks (VPNs), voice over internet protocols (VoIPs), virtual meetings, cloud technology, work collaboration tools and even facial recognition technologies that enable a person to appear before a virtual background to preserve the privacy of the home. Yet, it is found that there do exist challenges between employers and employees when it comes to data privacy and security. For instance, the recent incidences of Zoom Bombing as it is called has brought to the forefront the technological challenges that may trigger when it comes to data security issues. Although work from home modality is good in terms of preventing spread of COVID-19, it does have indirect psychological issues such as loneliness, boredom, mental stress and other health issues (Figure 1).

However, a survey conducted by the State of Report 2020, also shows that the work from home modality also has some direct benefits that includes work-life-balance (Figure 2).

iv. **Distance learning:** As of mid-April 2020, 191 countries have announced or implemented school or university closures, impacting 1.57 billion students. Many educational institutions started offering courses online to ensure that education is not disrupted by the quarantine measures. For example, Thailand has recently rolled out Distance Learning Television (DLTV) and online classrooms. Similarly, in Ukraine, UNICEF[1] has been supporting the Ministry of Education and Science with distance learning options for students to ensure continuity and help parents, caregivers and teachers access to remote education resources and support during quarantine. Infact, Ukraine is one of the first countries since the COVID-19 pandemic to roll out its online curriculum through the Learning Passport, a global learning platform launched by UNICEF and Microsoft that ensures that education of children and youth are not affected by COVID-19 and they can continue their studies from home. Timor-Leste has also rolled out its curriculum on the Learning Passport platform after schools in the country closed in March 2020 to prevent the spread of COVID-19. The course contents include online books, videos and additional support for parents of children who have learning disabilities. As part of its efforts to help reach hearing-impaired children, UNICEF Viet Nam has introduced a video on how to prevent transmission of COVID-19 and pledged to include sign language in more of its online assets. The Ministry of Education and Training has also been supported by UNICEF in developing online and offline learning materials, including for physical exercise, to help improve children's physical strength, health and mental wellbeing during the school closures. Similarly, Government of Malawi has been developing learning programmes with support from UNICEF Malawi to be delivered on radio, television and online.

v. **Telehealth:** Telemedicine has become essential during COVID-19 pandemic accelerating the transition to a new model of remotely delivered health care that embraces the benefits of digital and data technologies. Telemedicine over the years have become a mainstream form of patient interaction as it defies the time-honored custom of the physical visit. With the current pandemic, many hospitals are encouraging patients to use virtual urgent care for a consultation before heading to a clinic or require any hospitalization. Virtual consultations allow doctors to treat their patients without exposing them to the risk of spreading the virus while also providing quick treatment to patients for their symptoms. It was seen that during the COVID-19 pandemic there has been an increasing utilization of telehealth (Figure 3).

vi. **Online entertainment:** Although quarantine measures have reduced in-person interactions significantly, human creativity has brought them to the online platforms. Cloud raves and online streaming of concerts and release of movies have gain traction around the world. Film production companies also released films online while museums and international heritage sites offer virtual tours. According to Forbes preliminary statistics, total internet hits have surged by between 50 percent and 70 percent while live streaming has also jumped by at least 12 percent. One of the most prominent online entertainment has been the rise of TikTok. It has made mainstream news during the current COVID-19 crisis starting from a Vietnamese handwashing dance to Britain's biggest TikTokers raving together in lockdown to a remix of the BBC news theme. TikTok users have been creating videos of themselves dancing, acting and exercising to audio clips and sharing it with their friends. With TikTok becoming more popular, making its influence across different age and regional demographics, it has become a new way of entertaining oneself during lockdown while also being used for connecting with others. According to Music Business Worldwide, the week of March 16th, the video app was downloaded 2 million times (an 18 percent increase in downloads from the previous week). The app also saw a 27 percent increase in the first 23 days of March compared to February with 6.2 million downloads[2]. According to Netflix[3], the streaming giant has announced recently that it added 15.77 million new paid subscribers globally which is well above the 7 million it had expected, as people worldwide sought ways to entertain themselves during the lockdowns.

vii. **Supply chain 4.0:** The COVID-19 pandemic has created disruptions to the global supply chain. With social distancing and quarantine orders, some factories have been shut down completely. While demand for food and personal protective equipment soar, some countries have implemented different levels of export bans on those items. Heavy reliance on paper-based records, a lack of visibility on data and lack of diversity and flexibility have made existing supply chain system vulnerable to any pandemic. Core technologies such as blockchain, cloud computing, Big Data and Internet-of-Things ("IoT") are building a more resilient supply chain management system for the future by enhancing data accuracy and data sharing. A very recent study by Rio-Chanona et al., 2020 shows that demand and supply shocks would threaten around 22 percent of the US economy's GDP, jeopardise 24 percent jobs and reduce the total income wage by 17 percent. However, at the industry level, sectors such as transport are likely to have output constrained by demand shocks while sectors relating to manufacturing, mining and services are more likely to be constrained by supply shocks. Entertainment, restaurants and tourism will face huge supply and demand shocks.

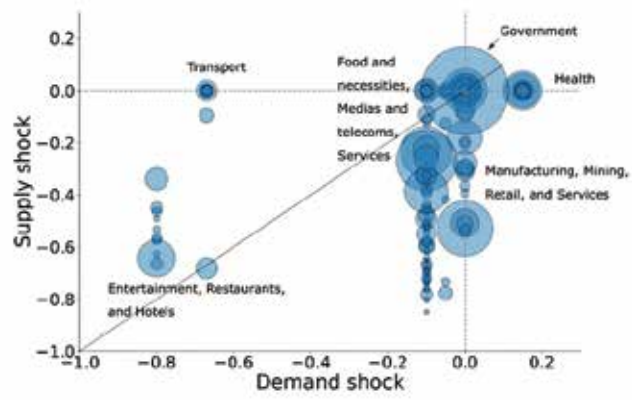

Figure 4: Supply and demand shocks for industry. Each circle is an industry, with radius proportional to growth output. many industries experience exactly the same shock, hence the superimposition of some of the circles. Labels correspond to broad classifications of industry (Rio-Chanona et al., 2020)

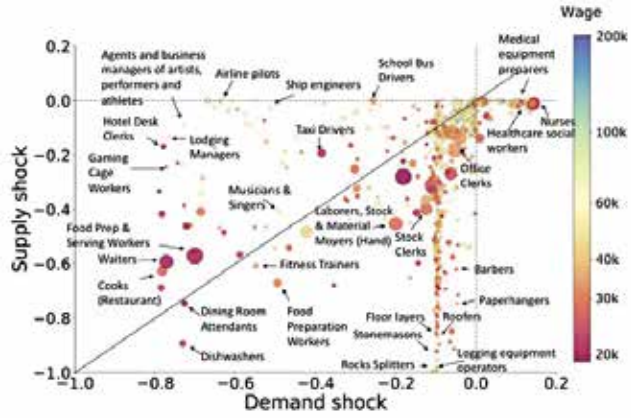

Figure 5: Supply and demand shock for occupation. Each circle is an occupation with radius proportional to employment. Circles are color coded by the log median wage of the occupation. The correlation between wages and demand shocks is 0.26 (p-value = 0.26 x 10^{-13}) and between wages and supply shocks is 0.40 (p-value = 3.9 x 10^{-29})

With the public recalibrating its relationships with technology, the COVID-19 pandemic has further accelerated the speed of technology change with people suddenly becoming highly dependent on Zoom, Google Meetings, Google Classroom, Microsoft Teams, WebEx, Skype, YouTube and so on. The pandemic has greatly increased our dependency on technology while also making the people to realize the efficient use of data and information for one's day-to-day work

At the occupation level, however, the study shows that high-wage occupation is relatively immune from adverse supply and demand shocks while low-wage occupation will remain highly vulnerable (Figure 4 and 5).

viii. **3D printing:** 3D printing technology (World Economic Forum 2020) has been deployed to mitigate shocks to the supply chain and export bans on personal protective equipment (PPE). 3D printing offers flexibility in production as the same printer can produce different products based on different design files and materials, and simple parts can be made onsite quickly without having to wait long for the shipment to arrive. However, massive production using 3D printing faces a few challenges. First, there could be issues related to intellectual property involving producing parts that maybe patented. Second, production of certain goods, such as surgical masks, will require regulatory approvals that may need appropriate procedures to be followed. There could also be other unsolved issues that may include protecting design files under patent regimes, its place of origin and its impact on trade volumes including product liabilities associated with 3D printed products.

    The European Association for Additive Manufacturing (CECIMO) has been responding to a request from the European Commission where members are been asked on whether they are able to aid in producing medical equipment such as valves and ventilators for hospitals tackling the COVID-19 outbreak. CECIMO has already invited the private companies to take part in the process to help countries get adequate supplies of their required equipments through 3D printing. Many companies from the European 3D printing industry have come forward voluntarily to aid hospitals and health centers by proposing the use of their machines and technology. There are already some good examples of how 3D printing has enabled hospitals in getting their required demands at the shortest possible time. One such example was a hospital in Italy where a Brescia-based engineering firm, used 3D printing to meet the hospital's demands and saved patients' lives. Materialise, a global provider of 3D printing services, has released files for a 3D printed hands-free door handle attachment to alleviate Coronavirus transmission via one of the most common mediums that is the door handles. Similarly, 3D printed hand sanitizer holder was designed by an engineer specializing in surgical 3D printing in Saudi Arabia where a 3D printable wrist clasp holds a bottle of sanitizer for easy access.

ix. **Robotics and drones:** COVID-19 makes the world realize how heavily we rely on human interactions to make things work. Labor intensive businesses, such as retail, food, manufacturing and logistics are the worst hit. COVID-19 provided a strong focus on robotic research and usage of robots. In recent months, robots have been used to disinfect areas and to deliver food to those in quarantine. Drones have walked dogs and delivered items.

    A recent study by Yang et al., 2020, published in the Science Robotics said that robots have the potential to be used for disinfection, medications and food delivery purposes, monitoring and measuring vital signs, and assisting border controls. With the pandemic, the realization in the potential roles of robotics have become very clear. The study further states that for disease prevention, robot-controlled non-contact ultraviolet (UV) surface disinfection should be used as COVID-19 spreads not only from person to person via close contact respiratory droplet transfer but also via contaminated surfaces.

    Some good case examples (Dasgupta, 2020) of robots being used during COVID-19 includes Providence Regional Medical Center in Washington using robots equipped with a microphone, stethoscope and camera to treat COVID-19 patients in a contactless manner. In China, a large number of hospitals have ordered the Disinfection Robot UVD manufactured by Denmark's Blue Ocean Robotics that have played a key role in controlling the virus in Wuhan. In the UK efforts have been made by the robotic experts to build

a healthcare robot that can talk with more than one patient at the same time.

According to a recent assessment, it was found that long-endurance drones or Unmanned Aerial Vehicles (UAVs) proved their value against COVID-19 (Cozzens, 2020). Public and private organizations are racing against time to develop experimental treatments and vaccines to fight COVID-19. At the same time, many private companies are thinking out of the box to find ways to minimize the effects. One such effort has been the deployment of drones to contain the spread of the pandemic. Drones can be used for a wide variety of purposes that includes distributing public information like voice messages for following social distancing norms, delivering medical supplies as well as spraying disinfectants in COVID-19 areas or containment zones. As of now several startups in Europe such as Quaternium, Drone Tools and Manna Aero, and in the U.S. and Canada, companies such as Zipline and Draganfly are exploring ways of how they can help in their regions and neighboring countries to decrease the aftermaths of the pandemic and save more lives.

x. **5G and Information and Communications Technology (ICT):** All the aforementioned technology trends rely on a stable, high-speed and affordable internet. While 5G has demonstrated its importance in remote monitoring and healthcare consultation, the adoption of 5G will increase the cost of compatible devices and the cost of data plans. According to IoT World, 5G may take a hit in the short and medium term given the spread of COVID-19 globally and resulting supply chain disruption including 5G hardware delays and general effects of the economic downturn. But in the longer term, the burgeoning needs for home connectivity, digital health and even economic stimulus measures may give 5G buildout a boost. 5G, or fifth-generation wireless connectivity, has already fasten the speeds up to 100 times compared to 4G connectivity and gives greater network reliability. According to an article published by Ericsson[4], it makes it very clear that connectivity matters in a time of crisis. The article further states that mobile networks across Europe are proving a critical backbone amid this pandemic with cellular, broadband and wireless technologies helping businesses run remotely and smoothly. Many telecoms providers have recognized that their services are proving to be an essential lifeline now more than ever, with operators across Europe providing free data to their customers during this moment of crisis.

Monitoring, detection and prevention

One of the most important aspects of COVID-19 is to monitor, detect and prevent the spread of the pandemic. In order for this to be achieved, involvement of technology and innovation is a pressing need. Within a few months of the outbreak of COVID-19, it was felt the need for a real-time COVID-19 dashboard that would tend to provide up-to-date information on the pandemic both at the global and country scale. Based on this understanding efforts were made to explore the potential application of four inter-related digital technologies that includes internet of things (IoT), big data analytics, artificial intelligence (AI) and blockchain to augment the traditional public health strategies of COVID-19 that is monitoring, detection and prevention and mitigation of

Figure 6: COVID-19 dashboard by John Hopkins University's Center for System Science and Engineering

Figure 7: Worldometer dashboard

the impact of healthcare indirectly related to COVID-19 (Ting et al., 2020). This has resulted in developing dashboards that are today providing real-time and up-to-date COVID-19 information not only at the global level but also at the country level.

COVID-19 Dashboard by John Hopkins University's Center for System Science and Engineering

John Hopkins University's Center for System Science and Engineering developed a real-time tracking map (https://coronavirus.jhu.edu/map.html) following the cases of COVID-19 throughout the world using the data collected from the US Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), the European Center for Disease Prevention and Control, the Chinese Center for Disease Control and Prevention (China CDC) and the Chinese Website DXY which aggregates data from China's National Health Commission and the China CDC (Ting et al., 2020) (Figure 6).

Worldometer

The Worldometer (https://www.worldometers.info/) provides a real-time update on the actual number of people infected by COVID-19 worldwide including daily new cases, virus distribution by countries and the severity of the pandemic (Figure 7).

Climate Data Store: Monthly Climate Explorer for COVID-19

This dashboard (https://cds.climate.copernicus.eu/apps/c3s/app-c3s-monthly-climate-covid-19-explorer) developed by Copernicus Climate Change Service, enables user to explore that air temperature and humidity could alter the spread of COVID-19 by plotting the average air temperature and humidity of the most recent months, alongside climatological air pollution levels from the Copernicus Atmosphere Monitoring Service and the mortality data obtained from Johns Hopkins University (Figure 8).

Novel Coronavirus (COVID-19) Infection Map

This online interactive map (https://hgis.uw.edu/virus/) enables users to track both the global and local trends of Novel Coronavirus infection since January 2020. The supporting dataset is timely collected from multiple official sources and then plotted onto this map.

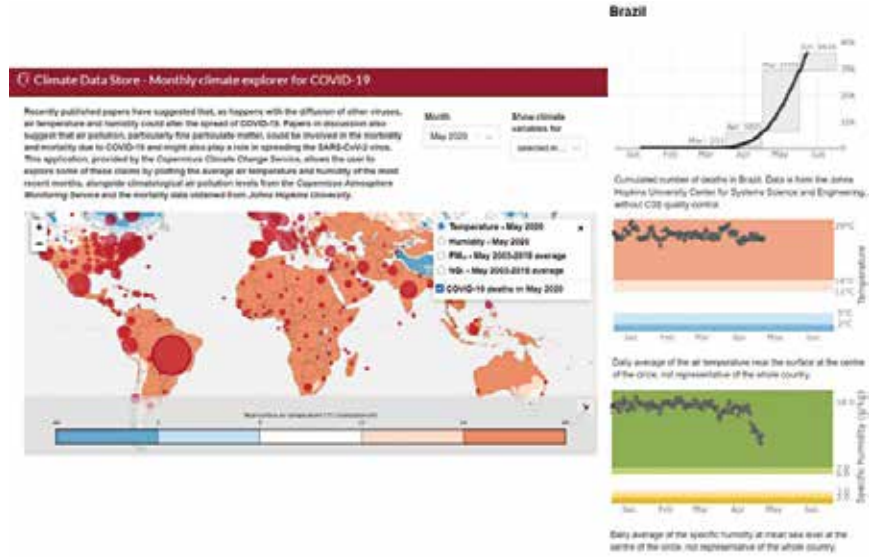

Figure 8: Climate Data Store: Monthly Climate Explorer for COVID-19

Figure 9: Novel Coronavirus Infection Map

Figure 10: COVID-19 Surveillance Dashboard by University of Virginia

The data are mainly collected from 1. National Health Commission (NHC) of the People's Republic of China 2. China's Provincial & Municipal Health Commission, China's Provincial & Municipal government database 3. Public data that are published from Hong Kong, Macau, and Taiwan through official channels 4. World Health Organization (WHO) 5. Centers for Disease Control and Prevention (CDC) 6. Public Health Agency of Canada (PHAC) 7. Baidu. 8. the state officials of different states in the U.S. 9. NBC News. The dataset can be downloaded and viewed in the CSV format. To make a timely data and map updates, data is collected every 4 hours, and the data quality is verified per day. In addition, the dashboard also provide finer-scale data from China (at the county level), U.S. (at the state level) and Canada (at the province level) in its next updated version (Figure 9).

Figure 11: WHO Coronavirus Disease (COVID-19) Dashboard

Figure 12: Bhuvan COVID-19 Dashboard

Figure 13: COVID-19 Dashboard of Thailand

COVID-19 surveillance dashboard

The Network Systems Science and Advanced Computing (NSSAC) division of the Biocomplexity Institute and Initiative at the University of Virginia has developed a visualization tool (https://nssac.bii.virginia.edu/covid-19/dashboard/) to support the planning and response efforts for the COVID-19 pandemic by providing a unique way of examining data curated by NSSAC (Figure 10).

WHO Coronavirus Disease (COVID-19) dashboard

WHO has developed a COVID-19 Dashboard (https://covid19.who.int/) that presents COVID-19 cases and deaths reported by countries, territories and areas to the World Health Organization (WHO). While the WHO COVID-19 Situation Reports present official daily counts, this dashboard is intended to serve as a frequently updated data visualization, data dissemination and data exploration resource (Figure 11).

Bhuvan COVID-19 dashboard

The Indian Space Research Organization (ISRO) is supporting State Governments in India by providing Geo-spatial tools and location-based solutions to fight against COVID-19, including national level Corona virus tracker. The Bhuvan geoportal has the capability to provide day-wise COVID-19 spread in India, State-wise spread trends, pan India scenarios and deceased statistics (Figure 12).

The geoportal provides graphical presentation at national level as part of its effort in sensitizing common man on

the Covid-19 situation on a regular basis, based on the data being made available by the Ministry of Health and Family Welfare of the Government of India. The link to the dashboard can be accessed at Bhuvan COVID-19 Dashboard. https://bhuvan-app3.nrsc.gov.in/corona/corona_dashboard/dashboard/dashboard.php?type=citizen

Outbreak India COVID-19 dashboard

The outbreak India COVID-19 dashboard too is a customized COVID-19 dashboard that is developed as a means of creating awareness about COVID-19 and its spread in India with a live tracker, analysis and breakdown of cases, up to the state level so that accurate and up-to-date information about COVID-19 cases are available to everyone. (Figure 13).

The dashboard uses data from the Ministry of Health and Family Welfare, Government of India and the data related to COVID-19 test are updated based on the bulletins issued by the State Governments and the Indian Council of Medical Research (ICMR). The dashboard also provides up-to-date information on vaccination trends (Figure 14). The Outbreak India COVID-19 dashboard can be accessed at https://outbreakindia.com/india-dashboard

COVID-19 risk assessment tool of India

The COVID-19 Risk Assessment Tool (https://www.covid19risk.net/) for India has been developed by a group of Disaster Management professionals from RIKA India (Figure 15).

The tool collects geotagged data once the responder permits it on his/her device. The State, District and pin code is important for identifying locational/spatial risk. The survey does not collect any data linked to mobile number or other details of the respondent. The tool can be used generically in any country condition by translating the questions to local language for deeper community penetration. The tool can also be disseminated by national and local disaster management authorities, embedded in various government websites, UN agencies, NGOs, and also by retail sites of amazon India.

Sahyog COVID-19 India

India's national mapping agency, the Survey of India (SoI), has developed an e-platform called Sahyog COVID-19 India (https://indiamaps.gov.in/covid/) that collect geotagged information on the nation's critical infrastructure in order to help the Government and public health agencies take critical decisions in response to the COVID-19 pandemic (Figure 16).

Figure 14: Vaccination Trends in India

Figure 15: COVID-19 Risk Assessment Tool

Figure 16: Sahyog COVID-19 Dashboard of India

Figure 17: Corona Live Database Dashboard of Bangladesh

Figure 18: Aarogya Setu App (Government of India)

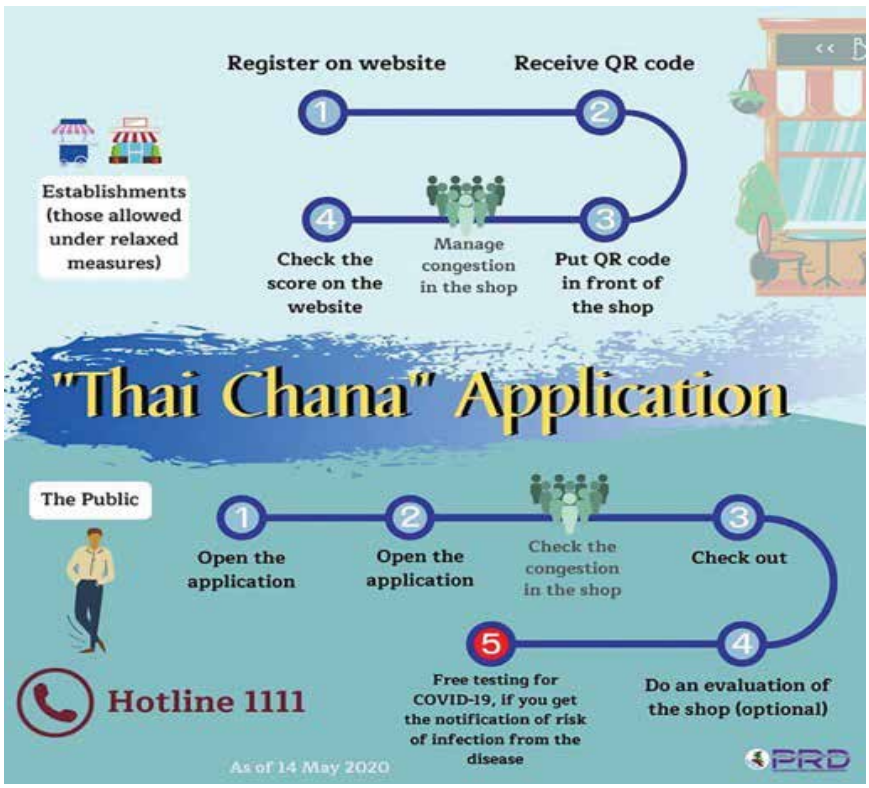

Figure 19: Thai Chana App of Thailand (Source: Public Relations Department)

The platform contains geo-location-based information of hospitals, testing labs, quarantine camps, containment and buffer zones as well as information on biomedical waste disposal sites. The platform is supported through a mobile based application, called SAHYOG, which works as a key tool in helping community workers carry out the Government's objectives of door-to-door surveys, contact tracing, essential items delivery and also used for public awareness campaigns. This platform and app help to enhance efforts of Government towards improving its response mechanisms to COVID-19 at crucial time. The platform is expected to strengthen the public health delivery system of the State and Central Governments and subsequently provide the necessary geospatial information support to citizens and agencies in dealing with the challenges related to health, livelihoods and socio-economic distress.

Corona live database of Bangladesh

Bangladesh Institute of Planners (BIP) has customized COVID-19 Dashboard developed by John Hopkins University (Corona-Live-Database-Bangladesh) for monitoring the COVID-19 cases in the country on a daily basis and providing the situational report to the Department of Disaster Management (DDM) and also the local government (Figure 17).

Although so many dashboards have been made available during the COVID-19 pandemic, it however requires to be understood that there is an enormous effort involved in designing these dashboards. One need to make sure that the data representations are consistent and accurate, while also considering people's concerns and fears by strictly maintaining data privacy and security. These dashboards help simplify large-scale, complex and often disorganized data in a way that users can easily process the data, assess the situation and form an informed decision.

Mitigation of COVID-19

The challenge of sharing best practices for risk mitigation during the COVID-19 pandemic is high (Koonin, 2020) and it will require mechanisms that can build

upon knowing how to evaluate, plan, implement and maintain risk mitigation measures, together with appropriately identifying the right people to be engaged (Renn, 2008; Di Nucci et al., 2017). Further, it should also identify the chain of command who is responsible for decision-making, communication and information dissemination. These mechanisms of communications are especially important to bring together different regions around the world in discussing and preparing for the different phases of a pandemic, quickly understanding lessons learned and applying them in the regions that are going through the earlier steps of the process (Bruinen et al., 2020). Risk mitigation is an interdisciplinary decision-making process based on information from risk and exposure assessment (Bruinen de Bruin et al., 2007) taking into consideration political, socioeconomic, epidemiological, (mental) health and engineering data to compile regulatory mechanisms and select the appropriate regulatory response to COVID-19. With COVID-19 spreading rapidly throughout the world, countries have already initiated risk mitigation measures and are trying to prepare for the future by looking at countries that are ahead in tackling the pandemic and learning from their experiences (Wu and McGoogan, 2020). Some of the measures includes mobility restrictions, socio-economic restrictions, physical distancing, communications and international support mechanisms. While timely first response during pandemics benefit from globally harmonized risk mitigation options, at the same time, citizens' awareness addressing individual and group roles creates obedience of imposed measures. Moreover, global acceptance, preparedness and alignment are also key aspects of a local outbreak.

Risk mitigation should also include maintaining a core and critical clinical services. Healthcare systems should ensure the integration of digital technology that would allow the functioning of virtual clinics using telemedicine consultations including imaging data like X-rays, CT scans, etc. that could be interpreted remotely. This in turn would ensure that patients continue to receive standard clinical care while maintaining physical distance including avoiding crowding at hospitals.

Another mitigation measure that is becoming increasingly important is the use of mobile applications (apps) to monitor COVID-19 hotspots. Many countries have already deployed such apps to increase its surveillance to prevent spread of the virus. The Aarogya Setu app for instance is an Indian open-source cross-platform COVID-19 contact tracing, syndromic mapping and self-assessment digital service or mobile app, developed by the National Informatics Centre under the Ministry of Electronics and Information Technology of the Government of India (Figure 18). The app has reached over 100 million installs in 40 days from the day it was launched. The stated purpose of this app is to spread awareness of COVID-19 and to connect essential COVID-19 related health services to the people of India by sharing best practices and advisories as initiated by the Department of Health to contain COVID-19. The app uses the smartphone's GPS and Bluetooth features to track the coronavirus infection. Using the Bluetooth, it determines the risk of a person if he/she has been

near (within six feet) to a COVID-19 infected person, by scanning through the database of known cases across India. Using location information, it determines whether the location belongs to one of the infected areas based on the data available.

The Ministry of Digital Economy and Society of the Royal Government of Thailand have launched a COVID-19 monitoring app named "Thai Chana". Thai Chana is a smartphone application that helps to facilitate contact tracing for safety of both customers and establishments during the Covid-19 pandemic. As of 18 May 2020, more than 2.6 million shoppers have downloaded the app. The application helps the government to quickly track people infected with COVID-19 and those who got in close contact with them (Figure 19).

Similarly, many countries have started using contact tracing mobile apps that not only helps government to monitor but quickly trace any person who comes in contact with an infected person and who should self-isolate themselves as and when being traced.

Conclusions

While the COVID-19 pandemic is showing no signs of declining, it is well understood that coronavirus is likely to continue for a prolong period of time. As a result, dependence on digital technology is also likely to continue both in terms of demand and supply. The global lockdown has already imploded data demand globally as more people are working from home than ever before resulting in triggering an increase in the consumption of online content resulting in increased use of mobile applications that were earlier considered suitable only for preteens. With the public recalibrating its relationships with technology, the COVID-19 pandemic has further accelerated the speed of technology change with people suddenly becoming highly dependent on Zoom, Google Meetings, Google Classroom, Microsoft Teams, WebEx, Skype, YouTube and so on. The pandemic has greatly increased our dependency on technology while also making the people to realize the efficient use of data and information for one's day-to-day work. However, in the midst of all these, it is well acknowledged that the pandemic and the subsequent lockdown has brought the digital future forward through the heightened levels of digital activity taking place. This has also made us to further rethink how during a crisis like COVID-19 will help us integrate digital and real world of works over an extended period of time. While technology will continue to evolve, the government will also have to go hand-in-hand towards implementing regulatory requirements and mandates including measures related to data security and privacy.

End notes

[1] https://www.unicef.org/press-releases/unicef-and-microsoft-launch-global-learning-platform-help-address-covid-19-education

[2] https://www.newsweek.com/tiktok-users-soar-viral-videos-coronavirus-covid-19-1494229

[3] https://www.theguardian.com/media/2020/apr/21/netflix-new-subscribers-covid-19-lockdown

[4] https://www.ericsson.com/en/patents/articles/lessons-from-covid-19-connectivity-matters

References

De Bruin, Y.B., Lequarre, A.S., McCourt, J., Clevestig, P., Pigazzani, F., Jeddi, M. Z., Colosio, C. and Goulart, M. (2020). "Initial Impacts of Global Risk Mitigation Measures Taken during the Combatting of the COVID-19 Pandemic", *Safety Science*, 128, pp. 1 – 8.

Bruinen de Bruin, Y., Lahaniatis, M., Papameletiou, D., Del Pozo, C., Reina, V., Van Engelen, J., Heinemeyer, G., Viso, A.C., Rodriguez, C. and Jantunen, M. (2007). "Risk management measures for chemicals in consumer products: documentation, assessment, and communication across the supply chain", *Journal of Exposure Science and Environmental Epidemiology*, 17 (1) (2007), pp. S55-S66.

Cozzens, T. (2020). "Long-endurance Drones Prove their Value Against COVID-19", *GPS World*, 6 May 2020.

Dasgupta, S. S. (2020). "How Robots are Helping in Fight Against COVID-19?" *Geospatial World, 17 April 2020*.

Maria Del Rio-Chanona, R., Mealy, P., Pichler, A., Lafond, F. and Farmer, J. D. (2020). "Supply and Demand Shocks in the COVID-19 Pandemic: An Industry and Occupation Perspective", *CEPR Covid Economics*, Issue: 6, pp. 65 – 103. *arXiv:2004.06759v1 [econ.GN] 17 April 2020*

Yang, G.Z, Nelson, B.J., Murphy, R.R, Choset, H., Christensen, H., Collins, S.H., Dario, P., Goldberg, K., Ikuta, K., Jacobstein, N., Kragic, D., Taylor, R.H. and McNutt, M. (2020). "Combating COVID-19 – The Role of Robotics in Managing Public Health and Infectious Diseases", *Science Robotics*, 5 (40).

Koonin, L. M. (2020). "Novel Coronavirus Disease (COVID-19) Outbreak: Now is the Time to Refresh Pandemic Plans", *Journal of Business Continuity Emergency Planning*, 13 (4) (2020 Jan 1), pp. 1 – 5.

Di Nucci, M. R., Brunnengräber, A., Isodoro Losada, A. M. (2017). "From the "Right to Know" to the "Right to Object" and "Decide": A Comparative Perspective on Participation in Siting Procedures for High Level Radioactive Waste Repositories", *Progress Nuclear Energy*, 100.

Renn, O. (2008). "Risk Governance: Coping with Uncertainty in a Complex World", Earthscan, Oxon, UK/New York (2008).

Wu, Z. and McGoogan, J. M. (2020). "Characteristics of and Important Lessons from the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72,314 Cases from the Chinese Center for Disease Control and Prevention", *Jama*.

Humorous science: Vampires and zombies

As the world continues to struggle with the COVID-19 pandemic, this paper highlights humorous research showcasing the considerable contribution of vampires and zombies to science

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This is the third 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. Here, we explore the fascinating world of vampires and zombies, and their contribution to solving scientific problems.

Vampires

Humans have been interested in vampirology for a long time, presumably caused in part by the fear of potentially not being on top of the food chain. Representing the use of serious analysis of an imaginary topic, several papers studied the coexistence of humans and vampires based on common predator-prey interactions but as a special case because the prey is turned into predator. Hartl and Mehlmann (1982) investigated a typical problem of renewable resources, using mathematical optimisation and control theory to model a dynamic confrontation between humans and vampires. Most interestingly, this was done from the vampires' point of view.

It was assumed that every living person who had their blood sucked by a vampire would (after their immediate death) turn into a vampire and deal with other persons in the same manner. Considering vampire attrition due to contact with sunlight, crucifixes, garlic and vampire hunters, bloodsucking strategies were mathematically derived for the asymptotically satisfied vampire, the blood maximising vampire and the unsatiable vampire. This represented a typical consumption-resource trade-off: The vampire population derives utility from consumption of human blood, and by turning each victim into a vampire the human resource is reduced while the vampire population increases. The authors basically provided operations-research advice to vampires, indicating how vampires could manage their human resources to keep the human race (and thus their own) in existence. The results made it obvious that humans required a defensive strategy against optimally behaving vampires.

Snower (1982) was rather shocked by these efforts and developed a macroeconomic optimal strategy for the destruction of vampires. Intuitively, vampires are like an infectious disease and should be eliminated swiftly and without mercy to avoid a world pandemic. He provided humans with a decision rule of optimally splitting their economy's output between consumption and production of defensive weapons against vampires. However, by standard application of the maximum principle, he surprisingly concluded that it is socially undesirable to drive the vampire population to extinction.

Revisiting the problem, Hartl et al. (1992) improved their model by assuming that changing bloodsucking behaviour induces costs and vampires also derive benefit from possessing humans, not only from consuming them. They mathematically showed that optimal bloodsucking rates change periodically, being modulated over time to achieve a stable trade-off and net utility according to the so-

called cycles of fear, which is more concurrent with empirical evidence in popular literature where the appearance of vampires typically follows a cyclical behaviour. Moving around the cycle of fear (Figure 1) in anti-clockwise direction, the bloodsucking rate increases with the availability of humans per vampire until the resource becomes scarce due to the increasing vampire population, causing a sudden fall in the bloodsucking rate (and the number of vampires) until the human population has recovered sufficiently to sustain an increasing vampire population again.

Using a different approach, Strielkowski et al. (2012, 2013) modelled the human-vampire problem based on popular fiction literature, comic books, movies and TV series in order to determine whether peaceful coexistence of humans and vampires would be scientifically possible.

They identified and investigated four types of scenarios:

- Stoker-King model (based on Bram Stoker's *Dracula* and Stephen King's *Salem's Lot*): The vampire requires to be invited by the victim to enter the premises, unless it attacks a sleeping victim. The vampire bites the victim and drinks its blood, then returns to feed for 4-5 consecutive days, at which point the victim dies, is buried and rises to become another vampire (unless a wooden stake is put through its heart). Vampires generally need to feed every day, and there are no organised groups of vampire slayers. This model is very similar to an epidemic outbreak caused by a deadly virus.
- Rice model (based on Anne Rice's *Vampire Chronicles*): Vampires act more discreetly, being able to feed on a victim but leaving it to live. Turning a human into a vampire takes time and effort (the victim needs to give permission, drink some of the vampire's blood, and the process is painful for both). Vampires do not need to feed every day, only requiring some blood once a week or so to survive. There are no organised groups of vampire slayers.
- Harris-Meyer-Kostova model (based on Stephenie Meyer's *Twilight* saga, Charlaine Harris' *Sookie Stockhouse (Southern Vampire)* book series that inspired the *True Blood* TV series, and Elizabeth Kostova's *The Historian*): Both species coexist and may be aware of each other. Vampires can tolerate the sunlight, drink animal blood to survive or buy bottled synthetic blood. Turning a human into a vampire takes time and effort. Some humans capture and kill vampires to use their blood as a hallucinogenic drug.
- Whedon model (based on the TV series *Buffy the Vampire Slayer*): Vampires bite the victim, quickly turning it into another vampire. Luckily for humans, there are organised groups of vampire slayers with higher effectiveness than in the Harris-Meyer-Kostova model.

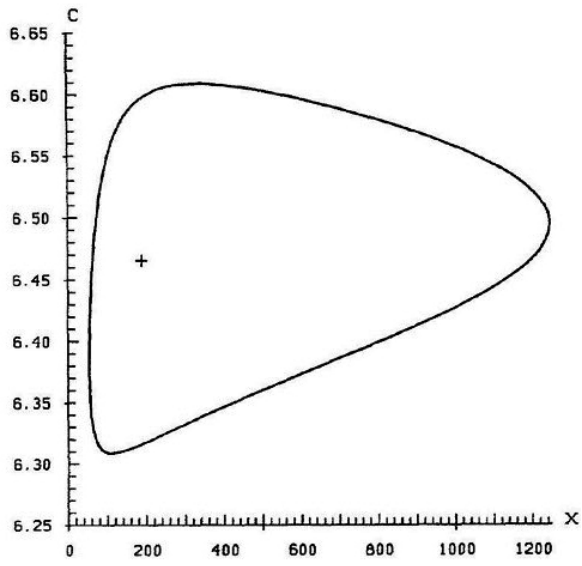

Figure 1: Cycle of fear, where *c* is the bloodsucking rate (number of consumed humans per vampire) and *x* is the available resource (number of humans per vampire) (Hartl et al., 1992).

Mathematical modelling showed the Stoker-King model to be highly unrealistic as vampires would need only 6 months to deplete all human resources, thereby causing their own demise. The Rice model merely delayed human extinction to almost 50 years, allowing coexistence only while the vampire population is small. Under certain conditions, the Harris-Meyer-Kostova model appeared to be plausible but very fragile, breaking down when the human population growth slows, the blood thirst of vampires accelerates or the small group of vampire slayers becomes too greedy. The Whedon model was deemed too unstable to be realistic, allowing coexistence only for a short time before vampire slayers exterminate all vampires.

Rather than basing his analysis on the attributes and decisions of representative agents to capture the important characteristics of the economy from the top down as applied in the previously mentioned studies, Farhat (2013) analysed human-vampire interaction from the bottom up. He constructed a computational model in which diverse, artificially intelligent human and vampire individuals (agents) engage in one-on-one interaction according to pre-determined behavioural rules within a virtual landscape.

This revealed that in virtual societies where vampires are highly visible, the human population suffers terribly for a short time (building up defences, which results in starvation) until the vampire population is driven to extinction. In virtual societies where vampires are observable but somewhat hidden, they may flourish provided they are easily destroyed in a confrontation. Cycles of fear then emerge. Otherwise, they increase in numbers, over-exploit the human herd and then starve. In virtual societies where vampires are unobservable, their existence persists. Whether they flourish or stagnate depends on their hunger for blood and the speed of human reproduction. If vampires live on the brink of starvation, both populations continually grow despite mild cycles of fear. If humans reproduce easily, both communities languish with extreme cycles of fear to keep both populations

in check. Given our persistent population growth and vampires being rarely encountered today, the former appeared more likely.

Menuet and Villieu (2015) applied the human-vampire problem to the world of finance via a macroeconomic system based on the evolution of public debt and private capital. The debt burden acts as a vampire bite, which reduces available resources for productive public spending in the government budget constraint and lowers both the output and rate of capital accumulation. Simultaneously, the collection of income tax vanishes, generating further increases in public debt. Therefore, the public-debt vampire transforms private-capital humans into its own kind, sucking the productive flow of public expenditure and regenerating by weakening the government's fiscal stance. The optimal rate of depletion of non-infected capital (the consumption of goods or harvesting of humans) was then obtained from a standard optimal control problem. In agreement with Snower (1982), it was shown that the extinction of the public-debt vampire is sub-optimal because this would involve fixing the tax rate at such a level that economic growth would deteriorate too much.

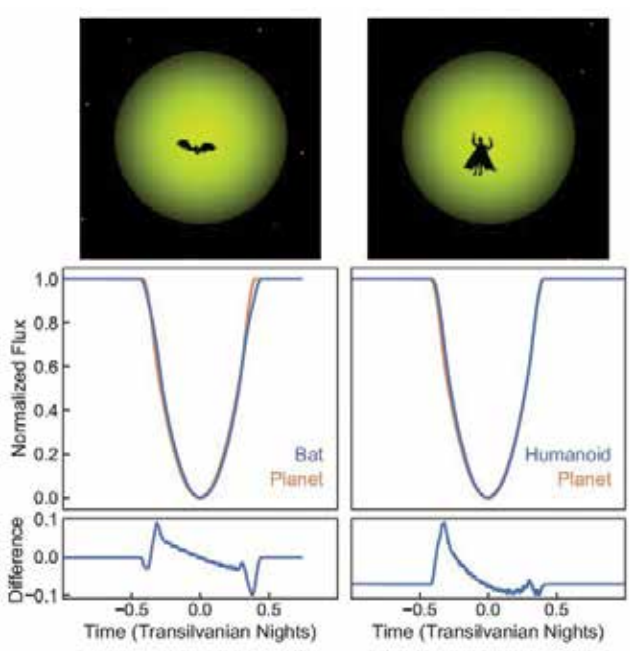

Figure 2: Transit shapes for a bat (left column) and humanoid vampire (right column) in comparison to a planet, showing the distinction between the three transit shapes (Günther and Berardo, 2020).

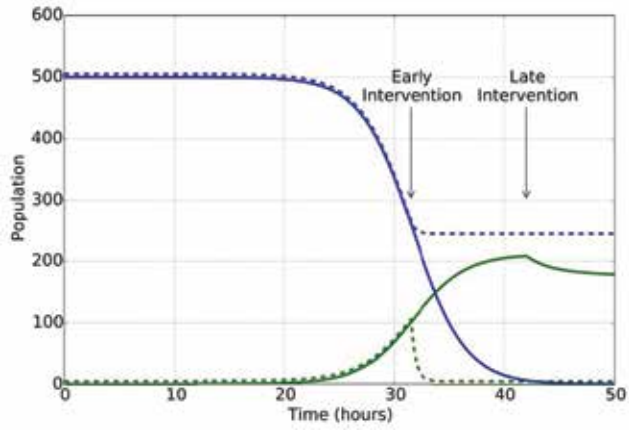

Figure 3: Effect the timing of military intervention has on the human (blue) and zombie (green) populations, showing early intervention is key to human survival (Witkowski and Blais, 2013).

Looking further afield and moving on to astronomy, Günther and Berardo (2020) reported on the search for transit signatures of space vampires trapped in the gravitational pull of cool dwarf stars. This research supports the theory that vampires may have originated in outer space, settled down and domesticated asteroids, and then fell onto Earth through meteor crashes. The authors generated models representing two potential space vampire populations (i.e. bat shape and humanoid shape) and searched light curves from the Transiting Exo-Vampire Survey Satellite (TE_VSS) using a template matching algorithm. This clearly showed the distinction between the transit shapes of bats and humanoid space vampires compared to planets void of these creatures (Figure 2).

Analysis of the TE_VSS data provided a short list of between 0 and 394,400,933 potential space vampire transits. Using Bayesian evidence, they determined that two of these most likely originated from bats (or noise) and one from a humanoid shape (or noise), while the remainder could be due to either shape (or noise). Adding the information gained from TE_VSS data constrained the space vampire occurrence rate to between 0% and 100%. It was noted that such precise analyses will be crucial in optimising future observing schedules for space-vampire characterisation with the James Webb Space-Vampire Telescope (JWS_VT) and the Extremely-Large-Vampire Telescopes (EL_VTs).

Zombies

Zombies move in small, irregular steps and show signs of physical decomposition such as rotting flesh, discoloured eyes and open wounds. Due to their inferior intelligence and sophistication, zombies may not be as attractive to the science community as vampires. However, their insatiable hunger for living human flesh and ability to turn humans into zombies by inflicting a bite is very similar to the Stoker-King vampire model and an ideal setting to investigate scenarios of an infectious disease outbreak.

Munz et al. (2009) were the first to apply mathematical modelling to the analysis of a zombie outbreak by using an epidemiological model to investigate the dynamics of a zombie apocalypse. In this case, zombies are created either by infection of a living human or resurrection of recently deceased humans. The latter was acknowledged to

be an unlikely scenario if taken literally, but possible real-life applications may include allegiance to political parties or diseases with a dormant infection. Zombification can be avoided by defeating the zombie during a confrontation, e.g. by destroying its brain, decapitation or cremation.

The analysis included a latent period of zombification, whereby humans are infected but not infectious before becoming undead. It was shown that quarantine of infected and zombified individuals would only delay the inevitable doomsday scenario, i.e. the collapse of society as zombies take over the planet. A cure, allowing zombies to return to their human form but not providing immunity to repeated infection, would result in a small human population surviving the outbreak while still coexisting with zombies. Only sufficiently frequent attacks, with increasing force, would result in the eradication of zombies, assuming the available resources can be mustered in time.

Several others extended this work. For example, Witkowski and Blais (2013) introduced tools of Bayesian statistics, removed zombification via resurrection and used quantitative data (zombie population estimates taken from depictions of zombies in popular movies) to estimate the dynamic model

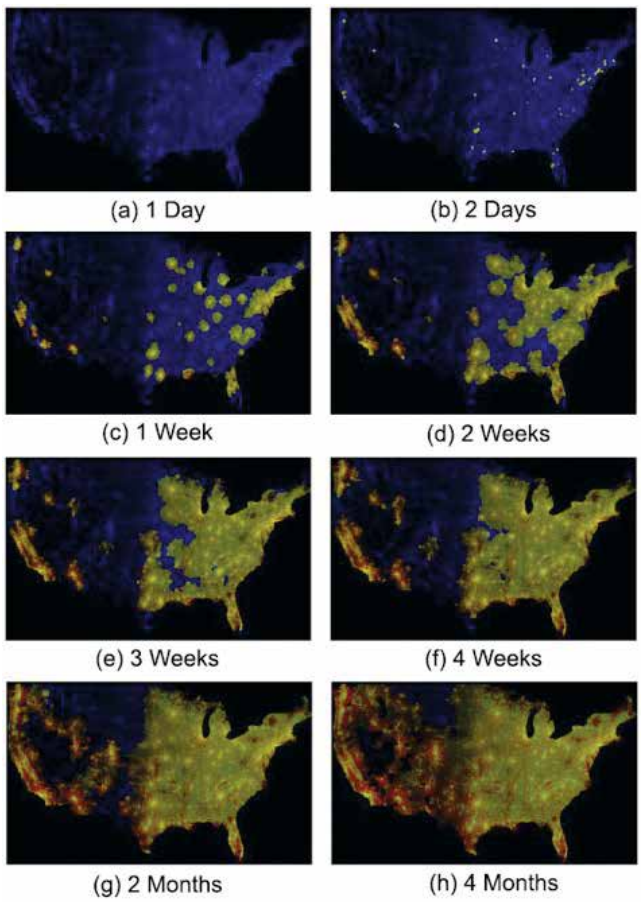

Figure 4: Simulation of a zombie outbreak in the continental United States over time, showing the uninfected human population (blue), active zombies (red) and the permanently dead (green) (Alemi et al., 2015).

parameters. The same model was then applied to actual data on influenza to establish infection and recovery rates, thus making the methods more applicable to real-world disease dynamics. The popular movies *Night of the Living Dead* and *Shaun of the Dead* were analysed in detail, both including a military intervention that saves human civilisation. It was shown that the strength and timing of the attack are crucial for its success. If the intervention happens quickly, the zombie population is effectively eliminated. However, if it happens later, intervention of any magnitude may be in vain (Figure 3).

Considering several model variants and employing spatial parameters, Alemi et al. (2015) provided a full-scale stochastic dynamic simulation of a zombie outbreak in the continental United States (Figure 4). The simulation started with one in every million individuals being infected at random. By the first week, most of the population had been turned into zombies, although the map does not appear that compelling. In the early stages, the outbreak spread in roughly uniform circles, with the speed of infection tied to the local population density. Infections on the coasts (higher population density) reached further than those near the centre of the country. After several weeks, the map shows stronger diversity in the directional spread, now over larger geographical areas and influenced by large changes in population density. After 4 weeks, much of the country had been overrun, but remote areas remained zombie-free even after 4 months.

Zombie danger maps were also produced, showing the probability of being infected at a certain location and point in time during an epidemic originating from a single zombie. As expected, after 7 days, high-population metropolitan areas are most at risk because many individuals could potentially serve as patient zero and zombies rapidly spread in these areas. After 28 days, it is not the largest metropolitan areas that suffer the greatest risk of being overrun but the regions located between them.

Using a far more general approach based on elementary physics and mathematics, Efthimiou and Gandhi (2007) attempted to prove that these creatures do not exist, promptly attracting criticism regarding the simplicity of the argumentation used (Sejdinovic, 2008). However, their intent was to provoke critical thinking and encourage probability-based assessments of various claims using reason, reminding readers that pseudo-scientific and paranormal ideas generally make no sense when elementary logic and science is applied and that any element of truth is usually distorted and hidden behind elaborate myths.

To this end, sudden drops in temperature when sensing a ghostly presence in an old building were explained by the draught of air through concealed doors, causing columns of cold air to emerge. Newton's laws of motion were then used to highlight the paradox that ghosts can apparently walk around (and therefore must be material) but pass through walls and are unable to pick up

These selected studies have demonstrated the flexibility of mathematical modelling and how it can respond to a wide range of challenges for different areas of science, tongue in cheek or not. They have also highlighted that modelling output is heavily reliant on the assumptions made and the input parameters chosen

objects (and therefore must be immaterial). The existence of vampires was disproved by basic calculations showing that humanity would become extinct about 2.5 years after the first vampire appears. The same argument was applied to zombies in popular literature and movies. A documented case of voodoo zombification (where zombies are created by a sorcerer's spell) was explained by the use of a puffer fish toxin, which suspends the victim's bodily functions and causes them to appear dead. After being buried alive, oxygen deprivation damages the brain. If the person is unburied (or manages to escape the grave) before really dying from suffocation, they appear as a soulless creature (zombie) because they have lost the thinking process of their brain.

Conclusion

These selected studies have demonstrated the flexibility of mathematical modelling and how it can respond to a wide range of challenges for different areas of science, tongue in cheek or not. They have also highlighted that modelling output is heavily reliant on the assumptions made and the input parameters chosen. Amusing examples can improve student learning of a topic and make it more accessible to an outside audience, thereby contributing to a better understanding of science in the general public.

Entertaining outreach programs can help attract potential students into Science, Technology, Engineering and Maths (STEM) and related disciplines. For example, Curtin University's Team Zombie is a multi-disciplinary response team that investigates a zombie outbreak, models the spread and potential interventions, works towards cures or vaccines, and provides options for detection and monitoring. Engaging students from primary school through to university level, it is raising awareness of the many approaches to problem solving through models and simulations (Maxville and Sandford, 2020).

References

Alemi A.A., Bierbaum M., Myers C.R. and Sethna J.P. (2015) You can run, you can hide: The epidemiology and statistical mechanics of zombies, *Physical Review E*, 92(5), 052801.

Efthimiou C.J. and Gandhi S. (2007) Cinema fiction vs. physics reality: Ghosts, vampires and zombies, *Skeptical Inquirer*, 31(4), 27-34.

Farhat D. (2013) The economics of vampires: An agent-based perspective, Economics Discussion Papers No. 1301, University of Otago, New Zealand, 23pp.

Günther M.N. and Berardo D.A. (2020) Searching for space vampires with TE_VSS, https://arxiv.org/abs/2003.14345 (accessed Oct 2021).

Hartl R. and Mehlmann A. (1982) The Transylvanian problem of renewable resources, *Operations Research*, 16(4), 379-390.

Hartl R.F., Mehlmann A. and Novak A. (1992) Cycles of fear: Periodic bloodsucking rates for vampires, *Journal of Optimization Theory and Applications*, 75(3), 559-568.

Maxville V. and Sandford B. (2020) Computational science vs. zombies, in Krzhizhanovskaya V.V. et al. (eds.) *Computational science – ICCS 2020*, Lecture Notes in Computer Science, vol. 12143, Springer, Cham, 622-633.

Menuet M. and Villieu P. (2015) Is government debt a vamp? Public finance in a Transylvanian growth model, https://hal.inria.fr/halshs-01199770/ (accessed Oct 2021).

Munz P., Hudea I., Imad J. and Smith? R.J. (2009) When zombies attack!: Mathematical modelling of an outbreak of zombie infection, in Tchuenche J.M. and Chiyaka C. (eds.) *Infectious disease modelling research progress*, Nova Science Publishers, Hauppauge, 133-150.

Sejdinovic D. (2008) Mathematics of the human-vampire conflict, *Math Horizons*, 16(2), 14-15.

Snower D.J. (1982) Macroeconomic policy and the optimal destruction of vampires, *Journal of Political Economy*, 90(3), 647-655.

Strielkowski W., Lisin E. and Welkins E. (2012) Intertemporal model of co-existence of two rival species: A case of vampires and humans co-habitation, *Modern Economy*, 3(7), 826-831.

Strielkowski W., Lisin E. and Welkins E. (2013) Mathematical models of interactions between species: Peaceful co-existence of vampires and humans based on the models derived from fiction literature and films, *Applied Mathematical Sciences*, 7(10), 453-470.

Witkowski C. and Blais B. (2013) Bayesian analysis of epidemics – Zombies, influenza, and other diseases, http://arxiv.org/abs/1311.6376 (accessed Oct 2021).

Bentley Systems announces Seequent's acquisition of Minalytix

Bentley Systems has announced that its Seequent business unit has acquired Canadian software company Minalytix, the developer of MX Deposit. The acquisition extends Seequent's cloud capabilities and solutions for mining, including greenfield exploration, resource development, and mining production. .

MX Deposit simplifies and controls how drill hole and other field data is collected, managed, and shared throughout the lifecycle of a deposit. Mining exploration teams can configure the solution for various activities, including diamond and percussive drilling, grade control, underground face sampling, metallurgical sampling, stockpile sampling, and sampling mill circuits. *bentley.com*

GeoCloud selected for Google for Startups Black Founders Fund

GeoCloud was selected to join the second cohort of the Google for Startups Black Founders Fund, a $10 million initiative designed for Black founders who are building great companies yet are often locked out of access to the funding that is critical to their success. GeoCloud is one of a select few high-potential startups that the Google for Startups team has selected for this year's nationwide cohort. *geocloud.co*

UN-GGIM marks a decade of global cooperation

Globally adopted frameworks developed in the first decade of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) are enabling Member States to unlock the true power of location-based data. At its eleventh session, the Committee focussed on consolidating these achievements to meet future challenges, such as the on-going pandemic and the 2030 Agenda for Sustainable Development, to ensure that no one is left behind. UN-GGIM convened its eleventh session in a scaled-down virtual format consisting of three two-hour meetings on 23, 24 and 27 August 2021. It was successfully concluded through a modality that allowed the Committee of Experts to collectively consider, consult and agree decisions that set the agenda and work programme for the period ahead.

In his opening statement of the eleventh session, Mr. Liu Zhenmin, UN Under-Secretary-General for Economic and Social Affairs said: "This important annual gathering – now being convened virtually for the second time – underpins the ongoing global stress arising from the COVID-19 pandemic."

"Impacting the entire world, the pandemic has reinforced that – as with the UN Sustainable Development Goals (SDGs) themselves – the most vulnerable countries continue to face the greatest challenges in collecting, analysing, maintaining, and using timely and reliable data, including geospatial and other disaggregated location-based data."

Noting that adversity can also bring new opportunities, Mr. Liu added that Member States can "achieve a more comprehensive and integrated data approach through the implementation of the frameworks and methods that have been developed by this Committee of Experts, during its first decade of work. The United Nations Integrated Geospatial Information Framework, or UN IGIF, is one such globally adopted framework"

Described by Stefan Schweinfest, Director, UN Statistics Division, as the 'creme de la creme' of the complex architecture and achievements in the past ten years of UN-GGIM, the UN IGIF is the globally agreed paradigm for Member States to achieve a comprehensive and integrated approach to data. The Committee's endorsement of the Strategic Plan of the High-Level Group on the Integrated Geospatial Information Framework (HLG-IGIF) will sustain the considerable progress towards implementation made by countries, by providing strategic leadership and oversight for its continued development and improvement.

In addition to the HLG-IGIF Strategic Plan, the Committee also endorsed the third edition of the Guide to the Role of Standards in Geospatial Information Management (Standards Guide). The Guide is a living online resource aligned with the UN IGIF to promote the use of standards for geospatial information management.

UN-GGIM also noted the SDGs Geospatial Roadmap and its role in recognizing location-based data as official data for the SDGs and their global indicators. The Roadmap will directly bring the global geospatial and statistical communities closer and foster greater geospatial-statistical integration in advancing the 2030 Agenda. The 'Position Paper on Sustaining the Global Geodetic Reference Frame' and the 'Concept Paper on Establishing a Global Geodetic Centre of Excellence' was adopted by UN-GGIM and will serve as key guidance to ensure the sustainability and enhancement of the Global Geodetic Reference Frame for Member States. *http://ggim.un.org.*

Lemur release enhances enterprise mobile GIS capabilities

Critigen released its mobile GIS solution Lemur. It delivers enterprise mapping capabilities that complement field service apps used in utilities, oil and gas, transportation, local and federal government, and other large organizations. The latest release provides expanded support for the enterprise, with enhancements to data synchronization, security, and more. *www.critigen.com*

Experimenting satellite-based positioning on the lunar surface

The project NEIL (Navigation Early Investigation on Lunar surface) will experiment satellite-based positioning on the lunar surface. The project is at the center of an agreement between the Italian Space Agency (ASI) and NASA, linked to the CLPS 19-D mission (NASA's Commercial Lunar Payload Service, Task Order 19) in which the US Space Agency is planning to land to the "Mare Crisium" basin of the Moon in 2023. The NEIL payload, subject matter of the contract signed between ASI and Qascom Srl, will be integrated into the experimentation called Lunar GNSS Receiver Experiment (LuGRE), an ASI/NASA cooperation framework with the objective to develop activities in lunar and cislunar environments.

For the first time in history, the positioning based on GPS and Galileo signals will be tested at almost 400.000 km distance from Earth. This is the first experiment of its kind considering that the previous limit was experimented by NASA at a distance of approximately 200.000 km. The mission, in addition to the NEIL payload, will also bring to the Moon other 9 scientific experiments. Planned in 2023, it is foreseen to be launched with Falcon 9 of Space X.

Under this contract, Qascom will develop and provide to ASI a dual-frequency and double constellation GNSS receiver, as well as the entire radiofrequency chain (antenna, LNA, filters), capable to support the extreme environmental conditions of the Moon. NEIL will be integrated on the NASA's Blue Ghost lunar lander in 2022. The GPS and Galileo signals received from NEIL will be extremely weak due to the distance from Earth, and therefore will be processed with specific algorithms allowing to calculate position and time, even if with reduced accuracy, both during the Moon transfer orbit and on its surface.

NEIL provides also an important technical and scientific contribution to study how GPS and Galileo could be used for positioning and timing in future Moon missions, including for example the deployment of lunar satellite constellations, lunar rovers, the lunar space station Gateway and the infrastructures that are going to be developed in the frame of Artemis programs. The raw measurement collected will be used by the research community to study the lunar and cislunar environment and evaluate the future use of GNSS to support permanent missions.*www.asi.it*

Dr Mark Psiaki receives Kepler award

The Institute of Navigation's (ION) Satellite Division presented Dr. Mark Psiaki with its Johannes Kepler Award September 24, 2021 during the ION GNSS+ Conference.

Dr. Psiaki was recognized for setting a standard of rigor, clarity, and thoroughness in addressing key estimation and signal processing problems in PNT. He originated the technique of bit-wise parallel RF signal processing for use in general-purpose processors. This enabler of software-defined GNSS led to the first space deployment of a fully software-defined GNSS receiver on a general-purpose DSP and to the widespread adoption of software-defined GNSS across the aerospace industry.

Additionally, Dr. Psiaki's real-time software radio expertise enabled the development of a spoofer cultivated in his research group. He subsequently led the development of spoofing detection algorithms based on cross-correlation of unknown P(Y) codes and based on direction-of-arrival sensing. He was the lead signal processing designer/analyst for the iGPS program that combined Iridium L-band downlink signals, GPS signals, and INS data to enhance GPS anti-jam capabilities.

Dr Lakshay Narula receives Parkinson award

The Institute of Navigation's (ION) Satellite Division presented Dr. Lakshay Narula with its prestigious Bradford W. Parkinson Award September 24, 2021 during the ION GNSS+ 2021 conference. Dr. Narula was recognized for his thesis, "Towards Secure & Robust PNT for Automated Systems".

The Bradford W. Parkinson Award is awarded annually to an outstanding graduate student in the field of Global Navigation Satellite Systems (GNSS). This award, which honors Dr. Parkinson for his leadership in establishing both the U.S. Global Positioning System and the Satellite Division of the ION, includes a personalized plaque and a $2,500 honorarium.

Galileo Ground Control Segment ready

In early July the European Union Agency for the Space Programme (EUSPA) announced the upcoming upgrades of the Galileo GCS infrastructure in preparation for the next launch.

Recently, the new GCS V3.0 infrastructure has been completely deployed in the Galileo Ground Control Centres in Oberpfaffenhofen (Germany) and Fucino (Italy) and is being used to operate the Galileo Satellite Constellation since early August.

The new GCS release includes upgradings to increase system capabilities, enhance virtualization and obsolescence resolution as well as operational improvements. It represents a major step forward towards the Galileo FOC (Full Operational Capability), boosting the management capacity to 38 satellites. *www.gmv.com*

GLONASS monitoring stations in five countries

The Precision Instrument-Making Systems research and production corporation (part of the state space corporation Roscosmos) plans to place non-request measuring stations of the SM-Glonass satellite navigation system in Brazil, China, Indonesia, India and Angola. The equipment from Precision Instrument-Making Systems is meant for enhancing the accuracy and improving other parameters of the system GLONASS. *https://tass.com*

Wipro and HERE partnership

Wipro Limited and HERE Technologies are partnering to offer location-based services, to customers from Energy & Utilities, Manufacturing, Transport & Logistics, Telecom and Automotive industry verticals. Both will be jointly developing solutions in the areas of asset tracking, logistics, supply chain, smart-metering and analytics, field workforce management, and private mapping-as-a-service for indoor and outdoor real-time asset tracking. *https://here.com*

Deployment of 20,000 smart building IoT sensors using LoRaWAN

Beyond Eyes, a brand initiated by Heijmans N.V., a major Dutch construction-services business, with CSU Cleaning Services BV, deployed over 20,000 LoRaWAN-connected IoT sensors for Heijmans' clients in the Netherlands, as part of their innovative Smart Building concept. Beyond Eyes uses wireless sensors from CLICKEY to collect anonymous data on a building's utilization, occupation, usage, and indoor environment. Sensors are then connected through the private LoRaWAN® IoT network managed on Actility's ThingPark® Enterprise IoT platform, where data is aggregated and then forwarded to Microsoft Azure IoT Hub using using ThingPark Enterprise Azure connector. *www.beyondeyes.com*

TRX awarded NIST funding

TRX Systems was awarded funding through the National Institute of Standards and Technology (NIST) Public Safety Innovation Accelerator Program (PSIAP) to test, validate and harden the TRX NEON Personnel Tracker solution to support wide-scale public safety deployment. TRX is partnering with the Arlington County Fire Department (ACFD) to conduct extended testing during which the TRX 3D location technology will be used by all personnel at Station 5, serving Pentagon City and Crystal City, to validate usability and performance and to better align the solution with first responder needs. *www.trxsystems.com*

Open-source wireless GPS/ GNSS hardware

Septentrio has announced the open-source resources for their GPS/ GNSS module receivers: mosaicTM wireless orsimply mowi. It combines the Septentrio mosaic-X5 or mosaic-H module receiver with a dual-mode Bluetooth and integrated Wi-Fi from the ESP32- WRover programmable module by Espressif Systems. It is an addition to the already existing mosaicHAT board, designed on the Raspberry Pi platform.

The mowi project facilitates GNSS positioning for robotic and autonomous devices, on a hardware level. *septentrio.com*

Development of fully autonomous multi-purpose vehicle

Oxbotica and AppliedEV have announced a collaboration to develop a fully autonomous, multi-purpose electric vehicle capable of being deployed in a wide range of environments for a variety of commercial applications. The project will see Oxbotica integrate its autonomous vehicle software with AppliedEV's programmable and configurable EV platform. The vehicle will be driverless, marking a huge step on the journey towards commercial autonomy. *www.oxbotica.com*

Lowest power GNSS receiver for mobile by Broadcom

Broadcom Inc. has launched the BCM4778, its lowest power L1/L5 GNSS receiver chip optimized for mobile and wearable applications. Equipped with the latest GNSS innovations, the third-generation chip is 35% smaller and consumes five times less power than the previous generation. *www.broadcom.com*

First UAE Spectral library website for public use

The Hyperspectral Remote Sensing Centre at the College of Natural and Health Sciences at Zayed University has earned a commendable badge by presenting the first UAE Spectral Library website for public use.

The library will allow users to interact and access spectral information derived using hyperspectral camera and Field Portable Spectroradiometers, as well as remote sensing images from space and airborne platforms for remote spectroscopic sensing. The centre is considered the first of its kind in the UAE to carry out planetary studies, environmental studies, training and consultancy in the remote sensing sector. *https://wam.ae*

USGS and Peru sign an agreement for RS operations

The United States and the Republic of Peru formalized a partnership that will facilitate cooperative research in Earth Observations and technology development, which has numerous applications for national priority research areas. This agreement, facilitated through the intergovernmental organization of the Group on Earth Observations, is an example of the lasting commitment of the United States and the Republic of Peru for "a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive, and sustained Earth Observations". *www.usgs.gov*

Indian Space Association launched by the Prime Minister

Prime Minister of India, Mr. Narendra Modi has expressed the hope that with the active engagement of stakeholders, and with suggestions from industrialists, a better space and remote sensing policy will be developed.

The 20th-century tendency of trying to rule space and the space sector divided the countries of the world. But now, in the 21st century, India will have to

ensure that space plays an important role in uniting and connecting the world, he said. Speaking at the launch of the Indian Space Association (ISpA) on 11th October 2021, he stressed that to develop a strong start-up ecosystem, a platform approach is very important. Citing the platform of UPI, which became the basis for a strong fintech network, he said similar platforms are being encouraged in space, geospatial fields and for use of drones in various areas

Among its early members include Bharti Airtel, Larsen & Toubro, Nelco (Tata Group), OneWeb, Mapmyindia, Walchandnagar Industries and Ananth Technology Limited.

Pawan Goenka appointed as chairman of IN-SPACe

The Government of India (GOI) has proposed the name of Pawan Goenka, former Managing Director, Mahindra & Mahindra, as the chairman of the Indian National Space Promotion and Authorization Center (IN-SPACe). On September 7, the Department of Personnel and Training (DoPT) issued an executive order to this effect.

The announcement to launch IN-SPACe under the Department of Space was made in June 2020 to serve as the bridge between the Indian Space Research Organisation (ISRO) and other government agencies and the private sector to develop a commercially viable and vibrant space ecosystem in India. Its mandate is to regulate and promote the building of routine satellites, rockets, and commercial launch services through Indian companies. *www.timesofindia.com*

China launches hyperspectral EOS

China launched the Gaofen 5 (02) hyperspectral Earth observation satellite. A Long March 4C rocket lifted off from Taiyuan Satellite Launch Center at 11:01 p.m. EDT Sept. 6 (0301 GMT or 11:01 a.m. local time Sept. 7). The China Aerospace Science and Technology Corporation (CASC), announced the success of the launch once the satellite had entered its planned orbit. *www.space.com*

Trial run of delivering vaccines by drones

The Telangana government in India holds a trial run of delivering medicines and vaccines using drones. It is a part of state government's ambitious 'Medicine From The Sky' project.

On the first two days, the drones will be flying in the visual line of sight - between 500 and 700 metres from the base - and people present in the area will be able to see them with the naked eye.

From September 11 onwards, drone flights will take place Beyond Visual Line of Sight (BVLOS) - for 9-10 km distances. These flights will be with consignments of vaccines, medical samples and other healthcare items, the statement further said.

BVLOS drone flights are those that go beyond 500-700 metres from the eye's vision or beyond the visual line of sight. This will make Telangana the first state in the country to start trials of Beyond Visual Line of Sight (BVLOS) drone flights for delivery of Covid-19 vaccines. *www.hindustantimes.com*

Draganfly and Alabama State University partnership

Draganfly Inc. has announced that it is expanding its partnership with Alabama State University (ASU) in a move to upgrade its Vital Intelligence Smart Vital Assessment Stations, and delivering its patented drone technology Varigard sanitizing spray for ASU's annual Labor Day Classic football game.

ASU made history last year by becoming the first university in the United States to implement Draganfly's safety system as part of the Safely Opening Schools Program, which provides an integrated health and screening protocol to be used campus-wide to screen, detect, assess, protect, and provide continuous action against the potential threat of infectious diseases, including COVID-19. The

Smart Vital system monitors, with voluntary consent, vital signs including but not limited to temperature, heart rate, breathing rate and blood oxygen content (SpO2). *draganfly.com*

Delta Drone International acquire Arvista

Delta Drone International has formally completed the acquisition of 60% of the shares in Perth-based provider of aerial and terrestrial surveying services, Arvista Pty Ltd (Arvista) as announced on 16 August 2021. The merger is a key milestone in DLT's growth strategy and immediately provides the Group with a blue-chip Australian client base and access to a team of highly skilled professionals with the expertise to expand their skillset beyond surveying to include the full range of drone-as-a-service operations Delta Drone International provides. *www.dlti.com.au*

Altitude Angel selected as UTM provider for Blue Dart India BVLOS

Altitude Angel announced that it has been selected by India-based air and integrated transportation & distribution company Blue Dart, to provide its services to Beyond Visual Line of Sight (BVLOS) operations supported by Directorate General of Civil Aviation (DGCA).

In May of this year the India Ministry of Civil Aviation (MoCA) granted conditional exemption from Unmanned Aircraft System (UAS) Rules to the Government of Telangana for its 'Medicine from the Sky Project'. Blue Dart Express is a part of the this initiative and has been selected as one of the consortiums to carry out vaccine delivery trials.

The project would include conducting trials over a period of six days with the findings helping the Govt. of Telangana to develop a framework for commercial deliveries by drone to be enabled in Waves 2 & 3 of the project. *www.altitudeangel.com*

Collins Aerospace launches Military Underwater Navigation System

Collins Aerospace has launched the world's first Military Underwater Navigation System with M-Code (MUNS-M), a handheld diver navigation system that provides the diver with precise position and includes secure anti-jamming capabilities during deep sea missions. M-CODE is the military GPS signal required by the U.S. DOD for military operations, and is designed to enhance position, navigation and timing (PNT) capabilities and improve resistance to existing and emerging threats to GPS, such as jamming and spoofing. *CollinsAerospace.com*

Eos Positioning Systems becomes Esri partner network gold partner

Eos Positioning Systems, Inc. has announced its participation in the Esri Partner Network Gold Program. This recognizes a new level of commitment from both Eos and Esri toward furthering field location technology used among GIS professionals worldwide. *www.eos-gnss.com*

All-new Outback Guidance MaveriX by Hemisphere GNSS

Hemisphere GNSS announces its all- new Outback Guidance MaveriX Precision Ag Solution. The new solution, built around the new MaveriX agriculture application software platform, provides state-of-the-art guidance, steering and application control. The software includes a new user interface that provides an innovative tablet-like user experience with improved 3-D graphics. The included adjustable widgets give users the freedom to customize their UI experience. *www.OutbackMaveriX.com*

SE150A4 smart module by Telit

Telit has launched the SE150A4 "system on module" series for retail and POS devices, home automation and security, law enforcement and other applications that need high data rates, advanced human-machine interfaces and edge computing functionality. Featuring Android OS and the Qualcomm QCM2150 solution, the new SE150A4 module marks another new product line introduction to better serve IoT device makers and customers.

Wi-Fi (802.11a/b/g/n) and Bluetooth Low Energy (BLE) 4.2 provide additional connection flexibility, along with an embedded multi-constellation GNSS (GPS, BeiDou, GLONASS and Galileo) receiver for high-performance positioning and navigation. *www.telit.com*

Orolia wins 70M euros in atomic clock contracts for Galileo

Orolia has been awarded 70 million euros in two contracts to provide atomic clocks for the first 12 satellites of the Galileo Second Generation System (G2S). The first was from the European Space Agency (ESA) and the second from Leonardo. Each of the new G2S satellites, will contain three Orolia Rubidium Atomic Frequency Standards (RAFS) and two Orolia atomic clock physics packages integrated with Leonardo's Passive Hydrogen Masers (PHM).

NAUTIZ X6 ultra-rugged Android phablet

Handheld Group has launched a new version of the popular NAUTIZ X6 ultra-rugged phablet, a handheld computer that combines the big-screen functionality of a tablet with the go-anywhere performance of a rugged phone. It runs Android 11 and is Android Enterprise Recommended (AER). It is ideal for industrial and field applications with the reliability to perform in the most challenging outdoor and industrial environments. *www.handheldgroup.com*

Spirent charts the way forward for autonomous systems

Spirent Communications plc has announced the launch of Spirent GNSS Foresight, an innovative cloud-based solution that lets operators know in advance where and when GPS or GNSS positioning is reliable for unmanned and autonomous journeys. It accurately predicts where and when unmanned vehicles, air taxis, and drones can operate safely and dependably beyond visual line of sight (BVLOS), especially in urban areas where buildings frequently obstruct GNSS signals. *www.spirent.com*

New Trimble DA2 receiver

Trimble has launched the Trimble® DA2 GNSS receiver for the Trimble Catalyst™ positioning service. It now includes the Trimble ProPoint™ GNSS engine for enhanced performance. Unique to the latest Trimble GNSS solutions, ProPoint technology reduces convergence times and improves positioning accuracy when operating near trees and buildings. In addition, the Bluetooth®-enabled DA2 adds iOS support to the Catalyst service, greatly increasing the range of devices, workflows and apps that can be used with the Catalyst solution. *www.trimble.com*

Safe navigation in Middle East

The International Foundation for Aids to Navigation (IFAN) has announced a near $1.2 million investment to promote safe navigation in the Middle East Gulf, including significant recapitalization of the Differential Global Positioning System (DGPS) sites it operates in the region. The investment will also provide for the construction of a new workboat to help strengthen its capabilities when it comes to maintaining Aids to Navigation (AtoNs) in the Middle East Gulf.

The Ras Al Khaymah DGPS site will be relocated 5km away from the previous location, and only a few meters away from shore. It will have a range of more than 250 nautical miles covering the entire southern part of the Arabian Gulf and part of Gulf of Oman. The DGPS capability will boost positioning accuracy for less than 1 meter compared to 10+ meters promised by traditional GPS systems.

The workboat, which is being built in the United Arab Emirates, should be operational by the beginning of October and will have a range of more than 40 nautical miles, enabling it to reach offshore waters in the Gulf. *https://gcaptain.com*

NX510 Pro Auto Steer by CHC Navigation

CHC Navigation (CHCNAV) has released the NX510 Pro, a high-accuracy automated steering system designed for tillage, seeding, fertilization, pesticide application, and harvesting. With a steering controller and full GNSS RTK capability, it can be quickly and easily mounted to various types of tractors and other farming vehicles to achieve ±2.5 cm pass-to-pass accuracy.

The intuitive AgNav software controls operations. It supports multiple guidance patterns to fit field layouts, including Straight AB line, A+ line, circle line, irregular curve and headland turn. It eliminates steering errors and overlapping passes on the field. The AgNav software also features real-time remote technical support from the local dealer's help desk. *www.chcnav.com*

Hi-Target launches GNSS/IMU RTK receiver for the field

Hi-Target has introduced a new GNSS receiver, the V200. It is a GNSS RTK receiver with an integrated nine-axis inertial measurement unit (IMU). The advanced RTK engine and new-generation nine-axis IMU guarantees a 25% performance improvement over the company's previous V100 model, even in demanding environments. It is designed to be easy to use and carry. A smart Hi-Fix function supports the receiver to increase stability. Hi-Fix enables continuous connectivity and quality results even if the signal is lost while using an RTK base station or VRS network under extreme circumstances. *https://en.hi-target.com.*

Survey receiver based on Triumph-3 chip by Javad GNSS

Javad GNSS has launched a new field receiver based on the technology implemented in its Triumph-3 chip. The MCAnt-3S receiver hosts 874 GNSS signal channels, allowing it to track all current and future GNSS signals. It can be mounted on flat surfaces with four screws or mounted on standard poles. MCAnt-3S combines the receiver with a high-performance GNSS antenna in a compact and robust housing that is easy to mount, making it suitable for machine control applications. Communication is provided via CAN 2.0, USB 2.0 and RS-232/RS-422 interface.

NovAtel GNSS SMART Antenna

NovAtel announced that Fendt machines in North America, Europe and the Middle East equipped with Fendt GuideTM guidance systems powered by Fuse Smart Farming now come with NovAtel's SMART7 GNSS receiver as the default configuration choice. Precision guidance systems are integral to advancing precision agriculture globally, and the SMART7 from NovAtel is future-ready and offers the performance and reliability that farmers require.

The SMART7 uses multi L-Band tracking to access TerraStar Correction Services globally – bringing repeatable centimetre-level accuracy to any application, anywhere in the world. Access to multi-frequency GPS, GLONASS, BeiDou, Galileo and QZSS signals provides better satellite availability, fuelling the positioning solution - even in challenging environments. Resiliency to radio frequency interference is engrained in NovAtel's hardware designs and the Interference Toolkit firmware suite provides detection and additional protection from any potential intentional or unintentional interference. *hexagon.com*

Spirent and Qascom Collaboration

Spirent Communications plc and Qascom have announced the industry's first simulation test solution for the Galileo Open Service Navigation Message Authentication (OSNMA) mechanism. SimOSNMA is designed to work with Spirent's GNSS simulation platforms to test OSNMA signal conformance, which will bring new levels of robustness for both civilian and commercial GNSS uses.

SimOSNMA provides developers with vital new simulation tools to test for OSNMA, the security protocol which enables GNSS receivers to verify the authenticity of signals distributed from the Galileo satellite constellation. Designed to combat signal falsification or "spoofing", OSNMA ensures the data received is authentic and has not been modified in any way. *www.spirent.com*

SBG Systems partnership with Septentrio

SBG Systems' popular INS/GNSS PPK software called Qinertia is now available to users of Septentrio AsteRx-i3 D Pro+, AsteRx-i3 S Pro+ and AsteRx SBi3 Pro+ receivers.

"As a result of our cooperation with SBG Systems, Septentrio's mapping customers who use GNSS/INS now have access to both real-time accuracy as well as quick and reliable post-processing workflow." said Danilo Sabatini, product manager at Septentrio.

In case of GNSS outage or correction link failure, post-processing recovers accuracy for recorded positioning and inertial data. Who said post-processing needs to be complicated? Qinertia is the easiest, fastest, full-featured post-processing software highly appreciated by geospatial professionals for its modern and intuitive interface. After the mission, Qinertia gives access to RTK corrections from more than 8,000 base stations to deliver centimeter level accuracy to all your projects. Trajectory and orientation are greatly improved by post processing GNSS and IMU data in forward and backward directions. *www.sbg-systems.com*

GeoMax launches Zenith60 GNSS smart antenna

GeoMax has announced a new GNSS smart antenna, the Zenith60. It is a calibration-free tilt compensating GNSS smart antenna that incorporates state-of-the-art technology. The antenna's tilt capability makes surveys faster and more convenient, hence more productive and efficient. *https://geomax-positioning.com*

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Leica BLK ARC and Leica BLK2FLY

The Leica BLK ARC is a laser scanning sensor purposely built to improve the autonomous navigation of robots and other carrier platforms to deliver fully autonomous mobile laser scanning. It addresses the growing demand for autonomous solutions that can safely and repeatedly capture accurate 3D point clouds and panoramic images of changing environments with minimal user intervention.

The Leica BLK2FLY is the world's first fully integrated, autonomous flying laser scanning sensor. With a few simple taps on a tablet, users can quickly and easily scan structures and environments accurately and entirely from the air. The airborne scanning provides value across multiple industries in need of accurate data of inaccessible or hard-to-reach areas (e.g., façade projections, rooftops), ensuring complete capture of a structure's exterior features and dimensions. *www.blk2021.com*

The UltraCam Condor 4.1 is released

Vexcel Imaging has announced the next camera release based on Vexcel Imaging's 4th generation camera architecture, the UltraCam Condor 4.1. More than just a 'facelift' to the Condor M1, the UltraCam Condor 4.1 boasts multiple significant advancements to make it the gold standard for wide-area aerial mapping.

The unique camera design consists of a very wide, high-resolution RGB array that delivers the utmost resolution and flying efficiency due to its impressive across track footprint of 48,462 pixels. The system also features a lower resolution rectangular NIR for classification projects and a lower resolution rectangular PAN for producing highly accurate DSMs and DTMs through dense matching. Due to the rectangular image footprint, frontlap of 85% is obtained for maximum dense matching quality. This breadth of functionality eliminates the need for additional flights by other sensors, given that all necessary data sets can be derived from a single UltraCam Condor 4.1 flight.

A revolutionary feature, exclusive to all UltraCam 4th camera generations, is the Adaptive Motion Compensation (AMC). AMC is an innovative motion compensation approach that, in addition to correcting image blur in the direction of flight as provided by traditional Forward Motion Compensation (FMC) technology, also addresses blur caused by multi-directional camera movements during flight. *www.vexcel-imaging.com*

Corrigendum: There was an inadvertent mention of *Asst Secretary of the Air Force and retired CEO, MITRE Corporation* in the intro line of Guy Buesnel paper on page 6 of Coordinates September'21 print edition. The error is regretted.

MARK YOUR CALENDAR

November 2021

Navigation 2021
15-18 November
https://rin.org.uk

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

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

December 2021

SIRGAS2021 (virtual)
Nov 29 to Dec 1
www.sirgas.org/en/sirgas-symposia/symp_2021
www.geobusinessshow.com

February 2022

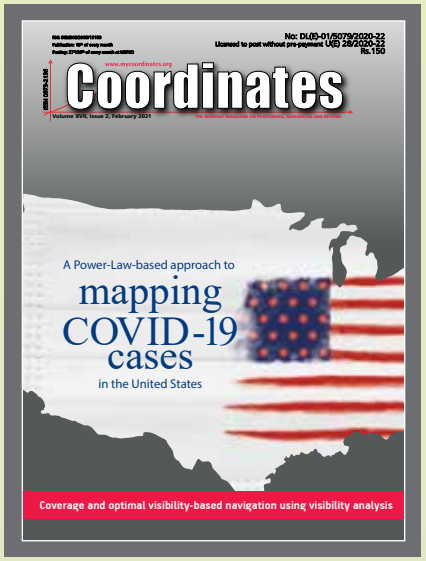
Geo Week
6-8 February, 2022
Denver, CO, USA
www.geo-week.com

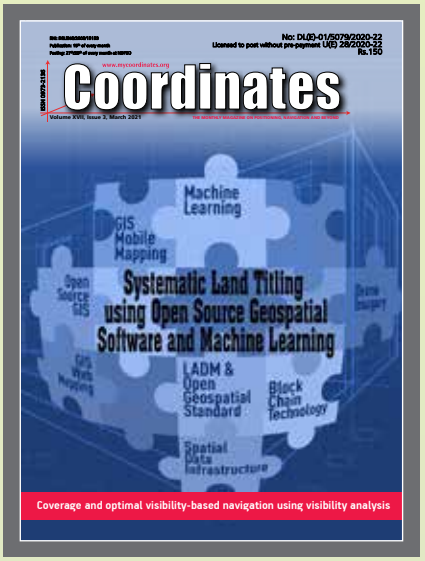
DGI Geospatial Intelligence for National Security 2022.
London on 08-09 February 2022.
https://dgi.wbresearch.com

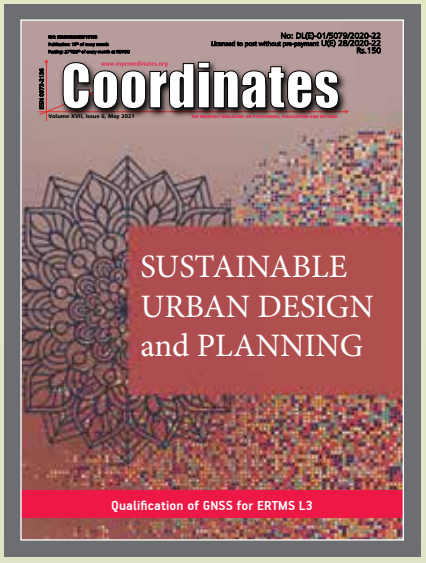
March 2022

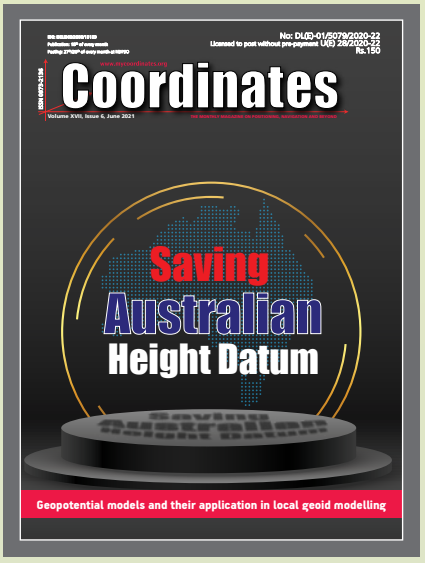
Munich Satellite Navigation Summit 2022
7-9 March
Munich, Germany
munich-satellite-navigation-summit.org

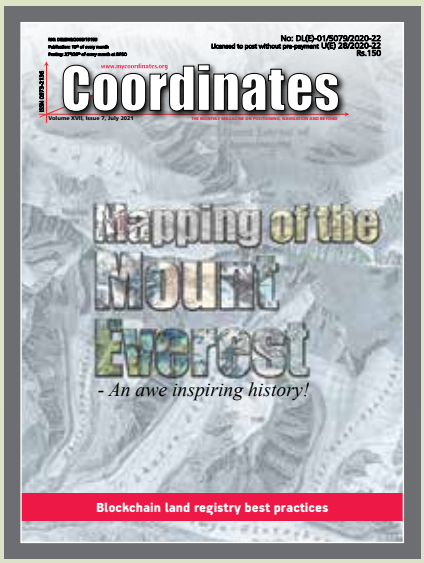
IGRSM 2022
8-9 March
Virtual Conference
Kuala Lumpur Malaysia
www.igrsm.org

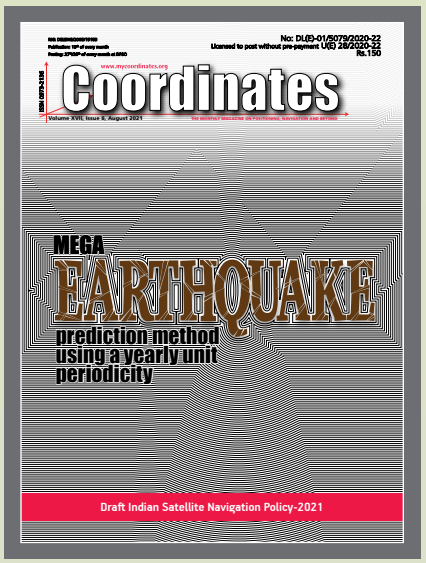


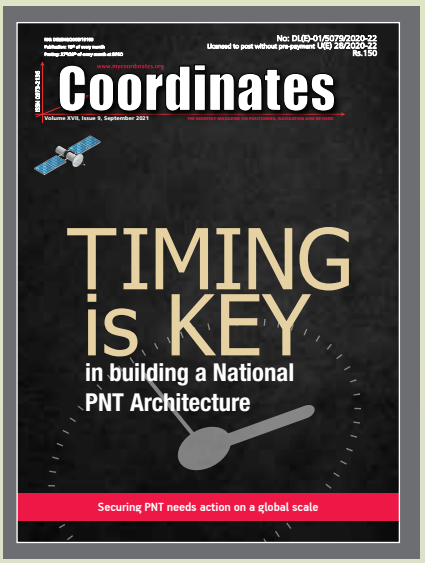












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