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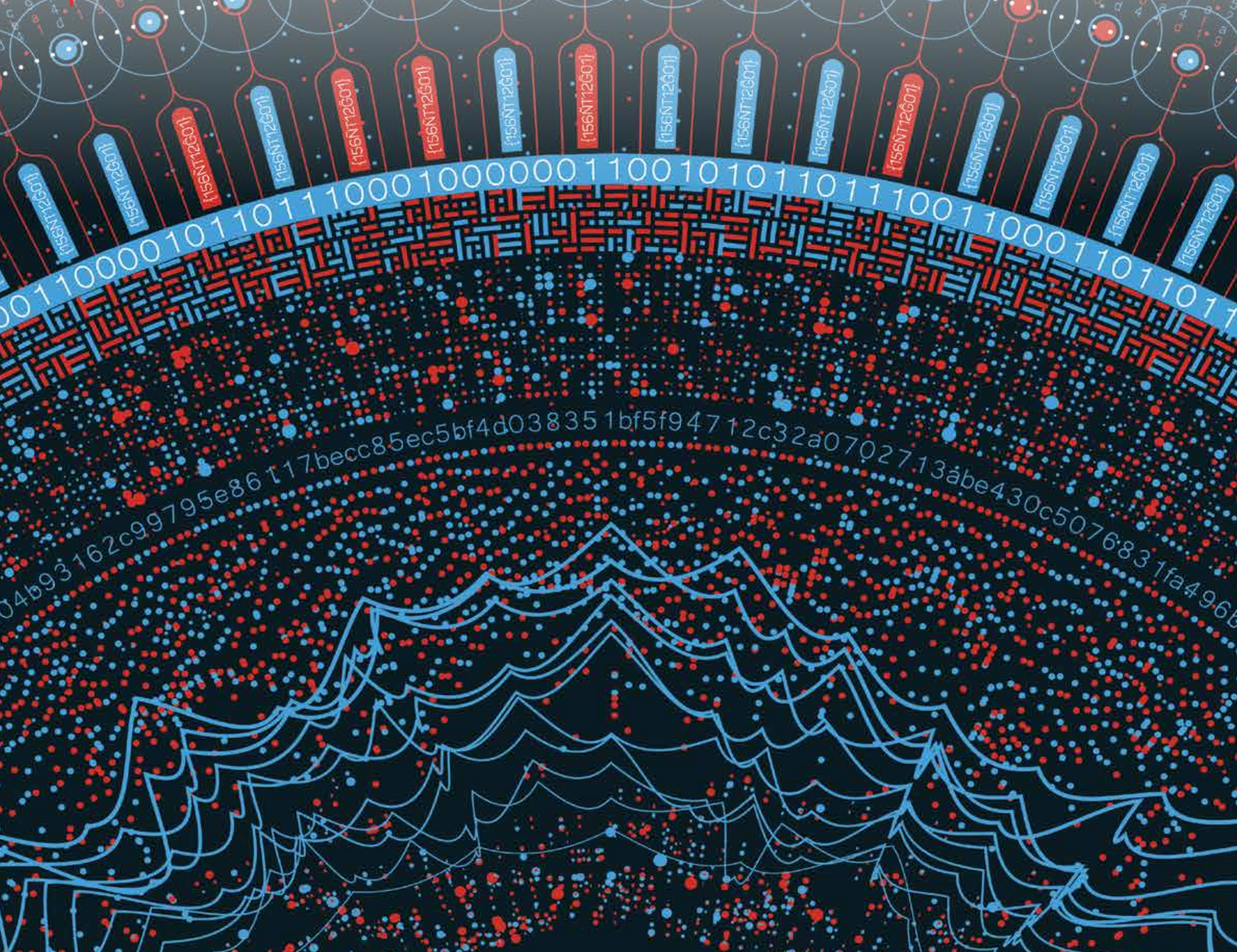

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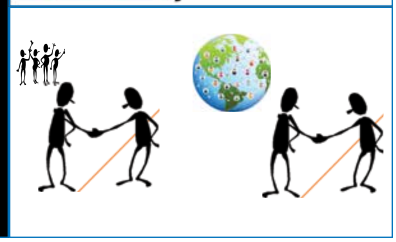

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Columns

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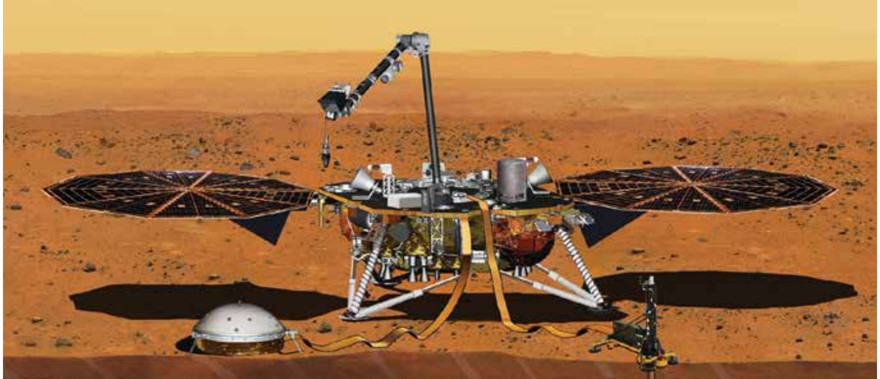

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The reverberation of these sounds

May further lead the humanity deeper into the space…

On this high note,

Coordinates team wishes a happy and healthy new year 2019

To all our esteemed readers, authors, advertisers and well-wishers.

Bal Krishna, Editor
bal@mycoordinates.org

From oral agreement to distributed agreement: digital ledgers in land registration

This article conceptualises the application of digital ledgers in land administration by addressing some fundamental questions. The article first discusses what digital ledgers are and how they are relevant to land administration. It then expands on how digital ledgers could improve land administration. It concludes with elaborating on some technical challenges in adopting digital ledgers in land administration

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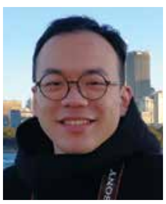

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What are digital ledgers?

A digital ledger is a geographically distributed database that is shared and synchronized across a network by consensus of the network participants. Digital ledgers can be designed in various ways one of which is the popular Blockchain. A blockchain is a chain-like data structure with an unceasingly growing chain of records. Any change or update of the data will be stored in blocks, linked and secured by cryptography. Blockchain was first developed for cryptocurrency and now is being used in handling identities, contracts, assets and various types of records.

The blockchain is as a peer-to-peer electronic transactions system. In this context, the transactions are referred to the exchange of something of value. It can involve exchanging money, valuable documents such as shares or documented agreements such as contracts. The premise of blockchain is that the transactions can happen between two parties and the role of the trusted intermediary party that witnesses and endorses the transaction is removed. In the blockchain process, the trusted intermediary party is replaced by a cryptographic signature.

The cryptographic signature is based on a hash algorithm that converts data of a random size into data of the string of a predefined and fixed length which is called hash. The principle here is that a hash should be easy to compute from the data but it should be complicated to compute the data from the hash.

There are three types of blockchain: public blockchain, consortium blockchain and private blockchain. A public blockchain allows anyone in a network to be involved in the process of adding blocks. A consortium blockchain requires participants to be pre-selected or from a union of organizations. A private blockchain is fully operated by one organization.

In the public blockchain system, every user receives a unique public key and a unique private key. These two keys can be used for privacy and authentication. When a member wants to transact with another member of the system, the transaction is encrypted using the public key of the other party and is made available publicly in the system (Privacy). For authentication, a member can use his or her private key to encrypt the transaction (Authentication) and make it publicly available. This is called a digital signature.

On this basis, blockchain becomes a chain of digital signatures that are joined together in clusters with a specific size called block. The blocks are created through the verification of each signature in the cluster signature by a third party called miners. Miners' role is to solely provide computational power to perform cryptographic proof of the authenticity of transactions.

Why are digital ledgers relevant to land administration?

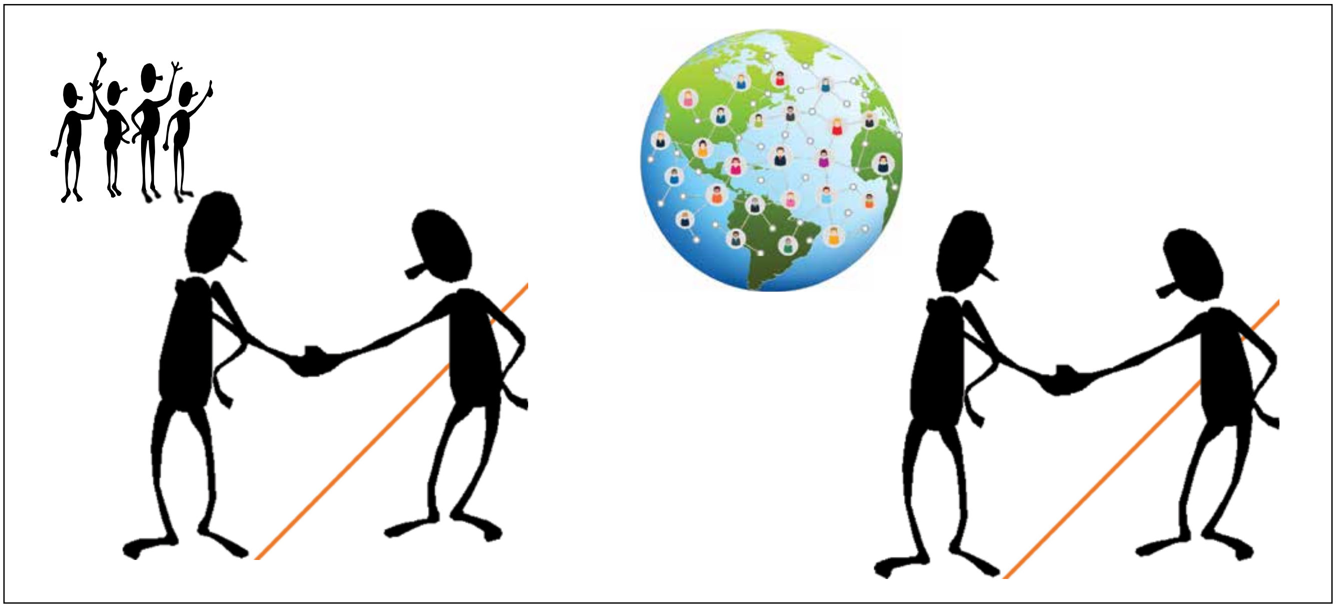
Land registration is a process by which the ownership of a piece of land is formally recognised and recorded. A piece of land, often named “land parcel”, is issued a certificate title as a result of land registration. The process involves issuing a title for land parcels that do not have a title as well as transferring the title of a land parcel from a rightful claimant to another.

Broadly speaking there are two types of land registration, and they are title based and deed-based systems. In the deed-based system of registration, a deed, being a document, which describes a transaction (e.g. transferring the ownership of land from one person to another), is registered. This deed is proof that a land transaction took place, but it is not proof of the legal rights of the involved parties. As such a transferee must trace the ownership of the land back to its root and establish if the transferor is a rightful claimant. In the title-based system, it is not the transaction that is registered, but it is the legal consequence of it which is registered. The land right itself together with the name of the rightful claimant and the spatial extent of that right are registered.

Deed and title-based systems of land registration are the result of centuries of optimising land administration systems. Early land registration systems indeed were paperless and based on oral agreement and relied on human witnesses. In small communities, the ownership of land could be transferred from one person to another by shaking hand backed by witnesses (leaders and elders) as the proof of transaction. Such systems still exist in small communities such as villages.

Clearly, the oral land registration was not going to be effective in ever-growing societies. This was when the deed system was born and papers were used to “witness” the transfer. Transferees and transferors go in front of an authority and declare there that one transfers the right to another. Public offices such as courts and notaries keep a record of activities where the transaction is witnessed in writing. Deeds are then left in the hands of the ‘new’ owner. The deed-based system is vulnerable to fraud such that the chain of transactions can be broken. A deed of land can be unlawfully altered and the land transferred to several transferees at the same time. As such legal professionals are heavily involved in the deed-based systems, so there is no break in the transaction chains. The title based system was born as a result of this flaws in the deed based system. When a transferee and transferor go to a title office, the registrar changes the name of the “current holder” to the “new holder” dispossessing the current holder’s right and guaranteeing the new holder’s right.

What is shared in both the title based and



From oral agreement to distributed digital agreement for land registration

deed-based system of land registration is the need for verification of transaction by an intermediary system before registration. Digital ledgers can be useful tools for this verification.

How would digital ledgers help with land administration?

The verification process in land registration involves two key aspects. First, if the subject land exists and second the transferor is the rightful claimants. In the deed-based system, the chain of transactions is verified by a legal expert making sure that the transferor in each isolated transaction is a rightful claimant of the subject of transfer and establish every prior transaction is valid. After that a summary the transaction is registered in a public notary and recorded in a central deeds register. In the title system, the registrar checks if the transferor is a rightful claimant, the land exists and is owned by the transferor but does not concern the previous transaction of the subject land. What is critical in the verification processes of both deed and title systems, is the trust in and accountability of the intermediary system. Digital ledgers are always in a state of consensus. In this state, they are automatically checked in given time intervals.

They possess a self-auditing ecosystem of a digital value such that the network reconciles every transaction periodically. Such a system is inherently transparent as it is public and more importantly it can hardly be corrupted because altering any details of the land transaction on the distributed databases would require a tremendous amount of computing power to change the entire network.

What is critical in the verification processes of both deed and title systems, is the trust in and accountability of the intermediary system. Digital ledgers are always in a state of consensus. In this state, they are automatically checked in given time intervals

What are the technical challenges in adopting digital ledgers in land administration?

While digital ledgers are promising technologies to improve land administration, there are challenges in realising them. The problems have roots in spatial and non-spatial nature of land transaction data. In the transfer of a land, only the ownership of the land changes and the spatial extent of it stays without change. In the land subdivision or consolidation process, it is the spatial extent that changes. In some cases, both spatial and non-spatial aspects of land change.

This poses a challenge that the land administration system enabled by digital ledgers may complicate verifications of the transactions in the cryptographic process. Moreover, the growing size of a chain requires more computing power to join a blockchain network and that is against its design principle of decentralization. The total blockchain size of the Ethereum, one of the blockchain application, has exceeded 1 Terabyte by the May of 2018 and it already makes some nodes with lower computing power unable to synchronize with the network. This is another challenge for adopting digital ledger when storing a large volume of land transaction data.

Geo-information tools, governance, and wicked policy problems

An alternative view of geo-information tools as problem recognizers, as problem analysts and advocates, as mediators, and as problem solvers is more appropriate

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What you see depends on where you stand

The emblematic intergovernmental Group of Earth Observations (GEO) sees food, water and energy security, natural hazards, pandemics of infectious diseases, sustainability of key services, poverty, and climate change as societal challenges [1]. In response, GEO is developing an infrastructure of earth observing systems, hardware, and software tools to connect the demand for geo-information with the supply of vast data about the Earth. At the same time, think tanks like the Overseas Development Institute (ODI) observe the complexity and unpredictability of global economic, social, and political developments and develop guidelines to plan and strategize against the odds [2]. We regard the abovementioned societal challenges as wicked policy problems [3]—involving multiple or unknown causes, anticipated and unanticipated effects, and high levels of disagreement among governance stakeholders concerning the nature (and even the existence) of a problem and the appropriateness of solutions. In this Special Issue, we attempt to take the pulse of how we, as geo-information scientists, tackle wicked problems in the global North and South.

To get a sense of the number of published articles on the key themes of the Special Issue, we searched the Web of Science for *"Tools"* AND *"GIS"* AND *"Governance"*. Figure 1 shows the distribution of the 87 hits. Searching for Methods or Concepts, instead of Tools, brings about 62 and 23 hits, respectively, with a similar distribution. The upward trend in the number of articles in the last few years testifies to a growing interest in the problem and suggests an emergent integration of the *"technical"* and *"social"* research clusters in GIScience, which were operating in isolation in the past [4].

In the past, *"technical"* research referred to geo-information technology (geo-IT) as revolutionary. Geo-IT would make it easy to identify who owns geo-information, whether it is fit for the purpose at hand, and who can access and integrate it with other information and how. Researchers argued that accessible and integrated data lead to cost savings in the short term, improved service delivery, and more effective policy-making in the medium term, as well as macroeconomic benefits, such as greater competitiveness and innovation, job creation, new firms, and increased Gross Domestic Product (GDP) and tax returns—in other words, better governance—in the long term. The perceived challenge was for independent, verifiable, and repeatable research to provide hard (as

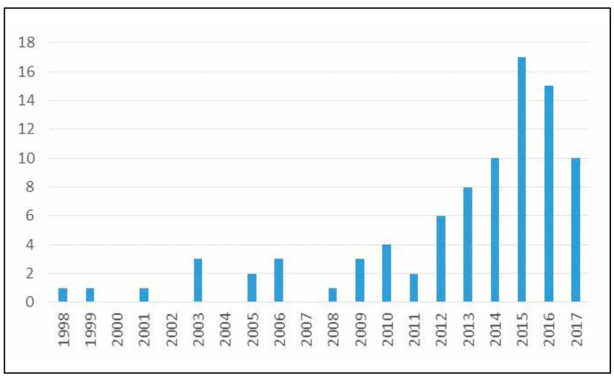

Figure 1. Temporal distribution of hits searching for the topics "Tools" AND "GIS" AND "Governance" in the Web of Science.

opposed to anecdotal) evidence of the positive short-, medium-, and long-term macroeconomic impacts of geo-IT and spatial data infrastructures (SDI). The "social" research sensitized us to contextual issues of importance to geo-IT and SDI implementation, e.g., the need for sustained political support, for legislative backing, for building and maintaining trust, for a level playing field and clear rules, and the need for involving the private sector to help define rules and spot opportunities. The perceived challenge was how to improve institutional arrangements and human capacity so that global innovations in geo-information technology could disappear into the woodwork and become "infrastructure" in specific social contexts. However, prescribing the ideal context of geo-IT implementation only helped to point out "where to go" but not "what actually happens" on the way to the destination [5].

During the same time, public administration scholars were warning against unidirectional causal relations between IT and public administration and spoke about "implications" instead of causal consequences [6]. They argued that autonomous political, legal, economic, and professional developments in and around public administration, and changes in ideas and ideals, are as important to the effects of IT applications on public administration as the technological developments themselves. Moreover, empirical studies in the public sector were indicating that the capacities to collect, store, aggregate, analyze, and present digital data rationalized policy-making processes, but also impinged on their democratic quality. As for the role of information in public policy-making, Van de Donk and Snellen [6] suggested that ideology and interests have always had higher emotional loadings than information for public policy actors:

"The real world of information processing in the domain of public policy making [is] characterised by several types of information (manipulated statistics, high quality research, gossip, editorial comments, evaluation reports, corridor analysis); information pathologies (faulty receptors, failures in communication, information overload, systematic biases) and information politics (manipulation, non-registration, withholding, biased presentation, adding other information, timing, leaking and so on). When looking with an information processing perspective on policy making, it is not surprising at all that one comes up with such a metaphor as a "garbage can"" (p. 391).

This view may be too pessimistic. If we consider policy-making as a series of steps in a policy cycle [7] it is clear that geo-information tools have played significant roles in some of the policy cycle steps, e.g., in problem recognition, policy monitoring, and policy enforcement [8]. For instance, space imagery influenced problem recognition and agenda setting for the environment. In *An Inconvenient Truth*, Al Gore describes how a single image of the earth from space, taken 50 years ago by a crewmember of the Apollo 8 mission, *"exploded into the consciousness of mankind. In fact, within two years of this picture being taken, the modern environmental movement was born. The Clean Air Act, the Clean Water Act, the Natural Environmental Policy Act, and the first Earth Day all came about within a few years of this picture being seen for the first time."* Geographic Information Systems (GIS) and Remote Sensing (RS) contribute to policy monitoring, when strategic actors do not shy away from political confrontation, as, for example, the monitoring of deforestation policy in the Brazilian Amazon has shown [9]. Courts of law use remote sensing as evidence in policy enforcement when crimes take place over longer periods of time, when legal disputes relate to objects identifiable from space, when data interpretation by nontechnical experts is possible, and when data authenticity and reliability are certain [10].

Political scientists point out that only when the problem is well structured or tame can policy be considered the product of an orderly sequence of steps in a policy cycle (see, e.g., Stone [11]; Sabatier [12]). However, when the problem is moderately structured or wicked, looking at policy-making as steps in a policy cycle and at geo-information tools as collectors, processors, and disseminators of data is not productive. In this case, we need a different conceptual framework for policy-making and for geo-information tools.

Where do we stand?

Defining a vague term like governance is like trying to nail a pudding to the wall [13]. Yet, vagueness may be the source of the term's popularity, so much so that Pollitt and Hupe [14] refer to governance as a "magic concept". Because magic concepts have a large breadth of scope, they give rise to multiple, overlapping, sometimes conflicting definitions. However, definitions can only fulfil explanatory functions if specified systematically for specific purposes [14]. Definitions of governance can be normative or descriptive.

On the normative side, the most popular is "good governance", a notion that generated such a large catalogue of virtuous characteristics over time that its identity is uncertain. Thus, two decades ago, the foremost attributes for good governance were effectiveness, accountability, transparency, and the rule of law. Currently, the list of recommended qualities of good governance includes *"equity, participation, inclusiveness, democracy, widespread service delivery, sound regulation, decentralization, an open trade regime, respect for human rights, gender and racial equality, a good investment climate, sustainable energy use, citizen security, job creation, and a variety of other ends"* (p. 17, [15]). Specifying governance as "good governance" serves as a potent myth, a shared frame of reference that enables individuals and organizations to deal with contradictions in everyday life that can never be fully resolved [16]. As such, myths are neither true nor false, but either living or dead [17]. What is of interest is what myths represent, and how myths may or may not contribute to established bases of meaning and experience. Instead of "good governance", Merilee Grindle has been advocating for two decades for "good enough governance" as a platform for critically questioning the long menu of institutional changes and capacity-building initiatives deemed important or essential [18,19]. In a recent article, titled Good Governance, R.I.P., she finally declared "good governance" dead [15].

Descriptive definitions of governance separate the performance of governance agents (the means) from the aspirations (goals) of their principals. For instance, Fukuyama (p. 350, [20]) describes *"governance as a government's ability to make and enforce rules, and to deliver services, regardless of whether that government is democratic or not."* By excluding democracy from the definition, Fukuyama rejects the orthodoxy that democracy and good governance are mutually supportive. Instead, he argues that the "democracy–good governance" link is more of a theory than an empirically demonstrated fact, and that we cannot empirically demonstrate the connection if we define one to include the other. Similarly, De Herdt and De Sardan (p. 4, [21]) describe governance as *"an emergent pattern or order of a social system, arising out of complex negotiations and exchanges between "intermediate" social actors, groups, forces, organizations, public and semi-public institutions in which state organizations are only one—and not necessarily the most significant—amongst many others seeking to steer or manage these relations."* Choosing this descriptive focus allows them to analyze public authority as the product of a social process.

In this Special Issue, we also define governance descriptively—as the attempts of stakeholders (social actors, groups, organizations, public, and semipublic institutions) to structure policy problems [22]. Thus, we conflate "governance" with a constructivist view of policy-making as "problem structuring" and use Hoppe's typology to distinguish four ideal-types of policy problems (see Table 1).

At the heart of the typology is the opposed pair of structured (or tame) versus unstructured (or wicked) problems. Problems are structured or tame (box 1) when stakeholders have far-reaching agreement on norms and values, and are certain about the factual and cause–effect knowledge needed to solve them. In contrast, unstructured or wicked problems (box 4) are hotly debated political issues where ethical disagreement and divisiveness in stakeholders' preferences perseveres, while factual and cause–effect knowledge is uncertain. Because stakeholders attempt to solve 'new' problems by mixing solutions to 'old' problems, they are inclined to quickly move a wicked problem into a more structured direction that is more familiar to them and more compatible with existing standard operating procedures. Moderately structured problems appear in two variants—with consensus (box 2) or with dissensus (box 3) regarding stakeholders' goals and values. This definition of governance casts a different light on the uses of geo-information tools depending on how stakeholders frame the policy problem: as a problem recognizer for unstructured problems, as problem analyst and advocate or mediator for moderately structured problems and as problem solver for structured problems (see Table 1). A few indicative examples are in order.

Geo-information tools as problem recognizer: The best-documented example is the detection of the ozone hole by way of remote sensing (RS) [8]. Concern about the detrimental effect of chlorofluorocarbons (CFCs) on the ozone layer stimulated the US Congress to commission NASA to develop the Total Ozone Mapping Spectrometer (TOMS) sensor to monitor the state of the ozone layer. The TOMS sensor was launched in 1978 on-board the NIMBUS satellite and did not report any anomalies until 1986. At that time, NASA confirmed, after re-analysis of the TOMS data, that the ozone hole had been growing since 1978. In response to these findings, the 1987 Montreal Protocol prescribed a 50% reduction, and four years later, a complete ban on the use of CFCs.

Geo-information tools as analyst and/or advocate: The classical example is John Snow's proto-GIS in 1854 that clustered cholera deaths of people accessing water from the Broad Street well in London [23]. Snow's quantitative analysis, combined with Reverend Henry Whitehead's extensive local knowledge of the community, provided strong evidence in support of his theory of cholera as a water-borne disease. Moreover, his analysis served as an advocacy tool that ultimately led to the endorsement of his theory by local officials. The latter concluded unanimously that the *"striking disproportionate mortality in the "cholera area" ... was in some manner attributable to the use of impure water of the well in Broad Street"* (p. 182). The pump's handle was removed soon after and the epidemic was contained.

Geo-information tools as mediator: An illuminating example of geo-information tools as mediator between conflicting interests is the Ogiek Peoples Ancestral Atlas, which included their hitherto excluded voices in contests about land. The Ogiek Indigenous People in the Mau Forest in Kenya planned the Atlas to define their ancestral territories within the Mau Forest Complex, and secure their rights and interests against the inflow of migrants. Prior to the Ancestral Atlas, the community had constructed a Participatory 3D Model of the territories. The model reinforced the bonds among the 25 Ogiek clans and their sense of belonging to a single cultural entity, with a unique cultural identity and indigenous knowledge system, instead of belonging to scattered clans [24]. The Ancestral Atlas depicted the tacit spatial

Table 1. Four types of policy problems and related tools (adapted from Hoppe [22]).

Spatial Knowledge	Policy Goals and Values	
	Consensus among Stakeholders	Dissensus among Stakeholders
Certain (facts and cause–effects)	**(1) Tame or structured problems** - Debate on technicalities - Geo-information tools as problem solver	**(3) Moderately structured problems** - Participation to debate goals and values - Geo-information tools as mediator
Uncertain (facts and cause–effects)	(2) Moderately structured problems - Participation to debate cause–effects and optimize the collection of facts - Geo-information tools as analyst and/or advocate	(4) Wicked or unstructured problems - Endless debate -Geo-information tools as problem recognizer

knowledge of a semiliterate indigenous community, accumulated over generations in intimate interactions between the community and their natural environment.

Geo-information tools as problem solver: Finally, geo-information tools can provide the means to solve highly complex but still tame problems—i.e., when the spatial facts are or can be easily available from remote sensing, censuses, and field observation, the cause–effect links are relatively well understood and stakeholders agree on values and policy goals. Numerous examples of such uses figure in standard RS/GIS textbooks (e.g., Tolpekin and Stein [25]).

In addition to the problem typology, Hoppe [22] discusses how governance stakeholders tend to move from box 4 to box 1, depending on the way of social organizing—either individualist, or hierarchist, or egalitarian—they value most [26]. The three ways of social organizing correspond to the market, hierarchy, or network social coordination, respectively [27]. Each way is supported by (and, in turn, supports) a "cultural bias"; that is, a compatible pattern of perceiving, justifying, and reasoning about nature, human nature, justice, risk, blame, leadership, and governance. For instance, hierarchists tend to frame wicked problems as structured and prefer to move to box 1 sooner rather than later. Egalitarians view wicked problems from the perspective of fairness and are inclined to move to box 3, while individualists attempt to exploit any bit of usable knowledge before moving to box 1. The question remains as to how several stakeholders with a mix of inclinations (individualist, or hierarchist, or egalitarian) manage to move out of box 4 *together*? They must either reach some sort of congruence that has elements of most ways of social organizing—i.e., a hybrid way of social organizing—or they must shun the participation of "troublemakers". For instance, Chandran et al. [28] discuss how the hierarchist UN Secretariat of the Convention on International Trade in Endangered Species (CITES) questioned the use of a GIS-based tool developed by the United Nations University, because the tool accorded an excessively important role to egalitarian NGOs (the "troublemakers"), and successfully excluded them from the debate.

In sum, defining governance as the structuring of wicked policy problems requires us to rethink the role of geo-information tools in governance.
At the same time, the use of geo-information tools in problem structuring can reveal the degree of hybridity of social organizing, according to [26], or of social coordination, according to Bouckaert, Peters, and Verhoest [27].

Policy problems and geo-information tools

Contributors to the Special Issue cover a spectrum of policy problems, from renewable energy, to climate change and bioenergy, to rural water supply and, finally, the coordination of spatial data infrastructures, which underpin efforts to address societal challenges [4]. The geo-information tools they develop and use in their analyses depend on how they frame the policy problem at hand.

Renewable energy is a priority for European countries and cities. Many of them have developed ambitious targets for greenhouse gas reduction; some of them, such as cities in the Netherlands, even aim to become carbon-neutral within the next 20 to 35 years [29,30]. However, the implementation of renewable energy systems such as wind turbines or solar farms in The Netherlands has been particularly slow compared with in other European countries. Devine [31] sees two main reasons for this: (a) limited institutional capacities of local decision-makers with respect to the implementation of renewable energy policies; and (b) strong opposition from local communities and individual citizens towards the implementation of large-scale renewable energy projects. Additional economical, institutional, and political factors may play a role [32]. For the city of Enschede, in The Netherlands, Flacke and de Boer [33] framed the problem as moderately structured with goal dissensus; the knowledge that a combination of wind turbines and solar farms can generate more renewable energy is certain, while local stakeholders may value things like aesthetics (the visual impact of turbines in the landscape) more than the government's ambitious targets. The authors developed an interactive planning support tool, named COLLAGE, and deployed it in workshop settings, involving stakeholders in the participatory mapping of wind turbines and solar panels in Enschede. They show that the COLLAGE tool helps to increase citizen awareness for renewable energy, triggers social learning about renewable energy, supports improved engagement and participation of the public, and thereby aids local energy governance. The authors show that engaging with local stakeholders and communities early in the planning phase can lower public dissensus and increase the viability, legitimacy, and local relevance of renewable energy strategies. COLLAGE is a good example of a geo-information tool as mediator between groups of stakeholders with diverging goals and values (box 3, Table 1).

Climate change raises equity issues, not only between continents and countries but also between regions, cities, and residents [34,35]. In this century of urbanization, where most people live in cities, the question necessarily turns to who is or will be affected in cities and how. Not only impacts, but also mitigation and adaptation policies are subject to political economy evaluations, with important questions being who can decide to implement adaptation and mitigation and where, to whom, and how it is applied. Low-income residents are among the most vulnerable groups to climate change in urban areas, particularly regarding heat stress. However, their perceptions about heat and the impacts they face often go undocumented, and are seldom considered in decision-making processes delivering adaptation. Matmir, et al. [36] evaluate the perceptions of New York City residents concerning past impacts as well as the future need for adaptation to heat waves. Employing online interviews, the authors compare the heat impacts of different income groups and simulate adaptation scenarios. By using online interviews and applying Fuzzy Cognitive Mapping, the authors aim not only to calculate socially useful adaptation options, but also to give low-income groups a voice in the climate change adaptation planning process. The combination of online interviews and Fuzzy Cognitive Mapping is yet another example of a *geo-information tool as mediator* that includes previously unheard citizens in the policy-making process and reveals consensus or dissensus among income groups (box 3, Table 1).

Bioenergy generation is high on the European political agenda for the circular economy. Bioenergy refers to the reuse of biomass as an excellent raw material for the production of wood pellets for heating. In 2009, the overall supply of biomass in the Danube region (excluding non-EU countries where data was not available) was estimated at 1136.2 petajoules (PJ) with an agricultural contribution of 23%. Lisjak, et al. [37] frame bioenergy generation in the Danube region as a moderately structured problem with knowledge uncertainty. They assume that bioenergy stakeholders—a network of national experts representing each country in the Danube region who act as 'ambassadors' of open data, biomass producers (owners of vineyards and orchards), and biomass utilizers—are convinced of the role of biomass reuse as a common good.

The knowledge uncertainty here refers to the lack of spatial facts, e.g., the location of available biomass (piles of branches) and their estimated volume. To produce the lacking spatial facts and close the data gap, the authors developed a smartphone-based geo-information tool: the 'Waste2Fuel' app. An owner of a vineyard or an orchard, standing close to the location of a pile of branches, and armed with the 'Waste2Fuel' app, can select 'Add biomass site', open a data form with fields to input a short description, a contact number, and the estimated volume of the pile, and enter the data. The biomass utilizer will receive this information on her smartphone and organize a pick-up. This kind of geo-information tool is the essence of Citizen Science, *"a complement, and even substitute, to data from such traditional sources... Individuals are no longer passive users of data generated by a designated institution on their behalf. On the contrary, they play a far more direct role in the creation and utilisation of content."* [37] Citizen Science comes to the rescue when facts are not readily available and citizens are willing to collect them and share them to minimize the uncertainty in factual spatial knowledge [38]. The Waste2Fuel tool and Citizen Science in general are applicable when the collection of discrete facts is the main challenge (box 2, Table 1).

Rural water supply in Tanzania is a wicked policy problem that persists since the country's liberation from colonial rule. Currently, nearly half of rural water points are not functional and about 20% of newly constructed water points become nonfunctional within one year. Rural citizens—the largest part of a population of 44 million people—soon return to traditional, unimproved water sources and endanger their health and well-being. The problem's wickedness is manifest in the lack of spatial facts regarding rural water points and the persistent lack of agreement at different levels of government on how to tackle the problem. In the first of three contributions on rural water supply policy-making in Tanzania, Verplanke and Georgiadou [39] discuss how the Ministry of Water bracketed out the disagreement among different levels of government on how to tackle rural water supply and assumed that the problem was one of data collection only. The Ministry developed the Water Point Mapping System (WPMS) database to support the monitoring of all water points, and improve policy-making and water supply services in rural areas.

The focus on the massive data collection for the WPMS database effectively moved the rural water supply problem from box 4 directly to box 2 (Table 1). The authors attributed some of the errors in the database to the bracketing-out of stakeholder disagreement and the discretionary nature of water point mapping. Katomero et al. [40] discuss how the bracketed-out disagreements later reappeared as three pervasive governance tensions, and moved the problem back to box 4. The first tension is between formal government standards and informal practices used by district water engineers and villagers to classify water points. The second tension is between the new and old administrative hierarchies at the district level. The third tension is between new and existing communication channels at the reporting and receiving ends of information. Finally, Lemmens et al. [41] discuss a mobile phone-based software tool, developed to serve as a boundary object—an object with different meanings and serving different purposes—for different stakeholders debating a wicked problem.

The tool helped the researchers to elicit conflicting views of stakeholders over a period of 4 years, and, in the process, assisted them in continuously redesigning the tool. They describe the current architecture of the tool's frontend (the SEMA app) and backend and discuss how the perceptions and use patterns of stakeholders over time affected the tool design and resolved the tension over what to report (by decreasing the discretion of reporters) and who should report (by constraining the reporting "crowd"). As such, the tool acted as a problem recognizer in the context of a wicked policy problem (box 4, Table 1).

The remaining two contributions invert the perspective of the Special Issue in an innovative fashion. Instead of studying how geo-information tools are used in policy-making, the authors discuss what the use of geo-information tools reveals about the hybridity of policy-making, governance, and SDI governance in particular. This kind of research has a family resemblance with previous studies by Anand [42] and Richter [43]. For example, Anand [42] analyses the formal and informal practices in municipal water supply in Mumbai in order to reveal the social production of "hydraulic citizenship", a form of belonging to the city enabled by claims residents make to the city's water infrastructure. Richter (2014) studies formal and informal ways of recording information on land ownership in Indian cities in order to reveal the blurred governance space between urban administration and urban society. Sjoukema et al. [44] examine the governance history of the SDIs in The Netherlands and in Flanders (Belgium), using the evolution of large-scale base maps as SDI proxies and, effectively, as geo-information tools. Their longitudinal study shows that SDI governance has been adaptive, that governance models (individualist, hierarchist, or egalitarian) did not hold up very long, as they were either not meeting their goals, were not satisfying all stakeholders, or were not in alignment with new visions and ideas. They argue that adaptive governance with a broader mix of individualist, hierarchist, or egalitarian policy instruments can better respond to changes. Chantillon et al. [45] focus empirically on Belgium to understand what kinds of social coordination (market, hierarchist, and network) are used for geospatial e-services and data in various regions. They show that Flanders combines hierarchy with network (egalitarian) governance, whereas the Brussels administration prefers a hierarchist way of working.

The transposition of the Infrastructure for Spatial Information in the European Community (INSPIRE) Directive stimulated a turn towards a more network-oriented (individualist) governance in the Walloon and the Brussels Capital Regions. They conclude that the current status of social coordination is a weak form of network governance.

Conclusions

We have shown that the mainstream view of geo-information tools as contributing to collection, analysis, and dissemination of data may not be so productive when we deal with wicked policy problems. The contributions to the Special Issue show that an alternative view of geo-information tools as problem recognizers, as problem analysts and advocates, as mediators, and as problem solvers is more appropriate, mainly for three reasons: First, the framing of the policy problem (as tame, moderately structured, or wicked) by the researchers themselves becomes more transparent, and increases the researchers' reflexivity. Second, geo-information tools can now be seen as an integral part of a social context, and as interventions in larger political systems, infused with dissensus on policy goals and values, as well as uncertainty regarding spatial knowledge (spatial facts and cause–effect links). Last, but not least, this view enables us to invert the lens and study not only how geo-information tools are used in policy-making and governance, but also what the use of geo-information tools in a certain social context reveals about the hybrid nature of policy-making, governance, and SDI governance in particular.

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CORS usage for GPS survey in Greater Accra region

This study explores the existing CORS network particularly the Greater Accra CORS to know the extent of its usage for GPS surveys in Ghana and to determine its usefulness in ensuring uniform and homogenous data collection

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Ghana's control network is bedeviled with the issue of non-closure of survey works on some controls in certain parts of the country due to varying methods used in establishing them as part of the control network of the country. This poses great threat to geospatial data in Ghana which may produce overlaps leading to litigations and uncertainties. To ensure homogeneity in surveys may require the establishment of new refined controls that are homogeneously adjusted. The current use of GPS for most surveys has provided the impetus for developing a new homogeneous three dimensional framework that will support differential GPS surveys in Ghana. The established Continuously Operating Reference Stations (CORS) can aid as a starting point to obtaining a country-wide homogeneous framework for all surveys in Ghana. Invariably, even though a few of such CORS are in existence, their knowledge is considerably low among potential users making patronage and exploitation very low. In this research, we seek to investigate the merits and limitations of the system and suggest remedies to factors militating against the use of the Accra CORS.

Aims and objectives

The main aim of the project is to explore the use of CORS for GPS survey in Greater Accra.

Specific Objectives include:

- To identify the advantages of CORS for GPS survey.
- To investigate the limitations of CORS for GPS survey
- To suggest solutions/remedies of problems in CORS usage for GPS survey.

Study area

The study area is limited to a 25 km. Radius around the Accra CORS station in the Greater Accra Region. The Greater Accra Region of Ghana (Figure 3.1) is the smallest of all the ten administrative regions in the country. It is situated in the south-central part of Ghana and lies between latitudes 5° 30´ North and 6° 03´ North and longitudes 0° 30´ West and 0° 35´ East. It shares borders with the Eastern Region to the north, the Volta Region to the east, on the south by the Gulf of Guinea and Central Region to the west. It has a coastline stretching from Kokrobite in the west to Ada in the east. The region covers an area of about 3,245 square km. It is the second most populated region, after the Ashanti Region, with a population of almost 3 million. The Greater Accra Region currently harbours the seat of government in Accra.

The Region is predominantly a low-lying undulating coastal plain with heights scarcely reaching more than 250 feet above sea level except where the topography is broken by hills. On the north -eastern part of the region are the shai Hills which rise to about 1,000 feet. On the western end are the rounded low hills of between 400-500 feet found on the Togo series and the Cape Coast formations. A section of the Akwapim Ranges intrudes into the eastern half of the region with heights rising to about 700 feet.

The vegetation of the region is of the coastal savanna grassland type but occurring here and there within the savanna are thickets of forests along the stream courses and mangrove and swampy vegetation along the coastal lagoons. Along the piedmont of the Akwapim Ranges at the north-western section of the region can be found a gallery of forests and remnants of high forest vegetation.

The location of Accra and Tema in the region has made Greater Accra the industrial centre of the country. The region boasts of more than 200 major manufacturing industrial establishments which include an oil refinery mostly located in Accra and Tema. For this reason the region consumes about 46.5% out of the total electricity generated in the whole country. Accra and Tema are also the largest market area for the country's manufactured products.

Materials used

Materials used in this study include:

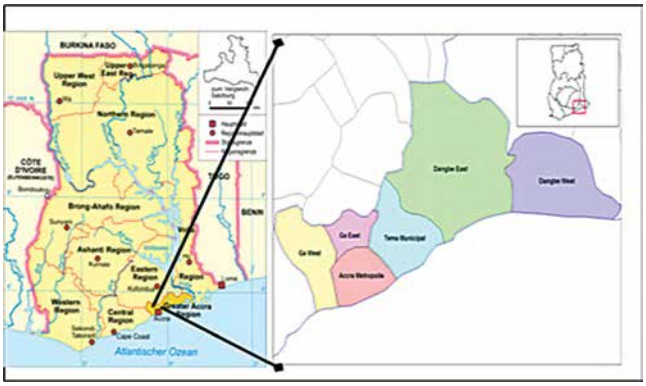

Figure 1: The Study Area (Greater Accra Region)

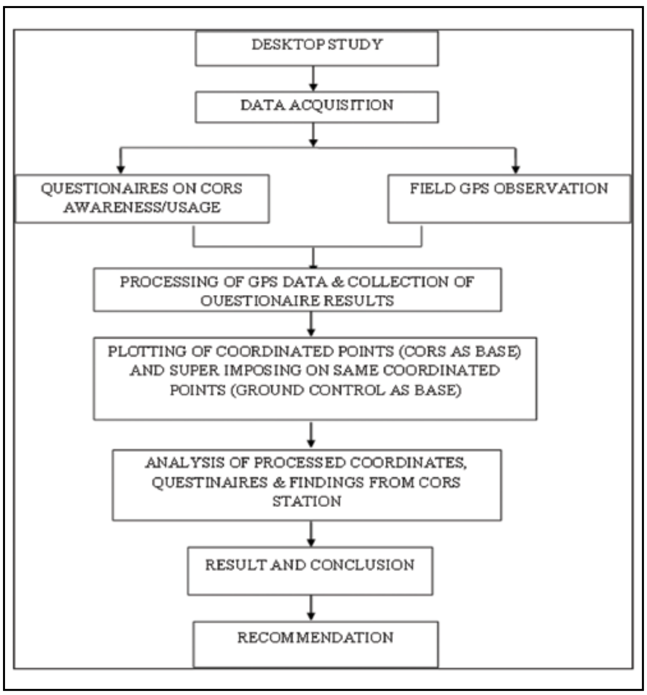

Figure 2: Research Methodology Flowchart.

- The Accra CORS used as reference for field GPS survey.
- Geodetic GPS receivers and processing software.
- Structures Questionnaires and Interviews.
- AutoCAD and ArcGIS for drawing and analyzing results

Coordinate systems used

Projected Coordinate System: - Accra_Ghana_ Grid (based on War Office spheriod)

Methodology

In this research, the use of questionnaires was deployed in conjunction with field observation (GPS observation using the CORS as the base station). A purposive sampling technique was used in questionnaire administration and feedback and vital information from the questionnaires were obtained and analyzed. The methodological steps is described in figure 2 and described below.

Desktop study

This involves assembling requisite materials needed for the project and a careful planning of questionnaire design and acquisition of field GPS data.

Questionnaires

The questionnaires were tailored towards getting enough information about the use of the Accra CORS established by the survey department of Ghana situated in 37. As such, the target groups were Geospatial data collectors therefore a purposive sampling approach was used in addition to structured questionnaire. The head of the GRN section and a staff were also interviewed.

Field GPS observation

The field observation was performed based on the approved and frequently used differential positioning technique in Ghana. This technique was undertaken in post-processing mode. GPS data were acquired from different locations in Accra that are considerably within the CORS range. This range encompasses areas for which survey works are mostly done for cadastral plans preparation for title registration.

This is to test the results of processed GPS data using the CORS as reference station against the results gotten from processed GPS data using other ground controls as reference which in actual fact is still accepted by the Survey Department of Ghana. Most of these GPS survey works were carried with different survey instruments such as the Sokkia single frequency GPS, Ashtech single frequency GPS and the Topcorn dual frequency GPS.

Table 1: GPS field Observation Controls Information

Location (date)	GPS instrument	Software	Ground reference & closures used
Domiabra (24th March, 2016)	Ashtech Locus Single frequency	Ashtech Solutions 2.60	SGGA 905 98 3 SGGA 905 98 2
Ablekuma and Obakrowa (25th March, 2016)	Ashtech Locus Single frequency	Ashtech Solutions 2.60	SGGA 7 91 724 SGGA 7 91 640
Achiaman (28th March, 2016)	Topcorn Hyper Lite Plus Dual frequency	Topcorn Tools 8.2.3	SGGA J799 14 4 SGGA J799 14 5
Bortianor (29th March, 2016)	Sokkia single frequency	Spectrum survey 3.22	SGGA 905 98 3 SGGA 905 98 2
Doblo Gonno (30th March, 2016)	Dual frequency Topcorn Hyper Lite Plus	Topcorn Tools 8.2.3	SGGA J799 14 4 SGGA J799 14 5

After field data were acquired, a formal request was sent to the Accra GRN station on the 12TH day of April, 2016 requesting for reference data needed to process the field data on specific field observation dates. It is noteworthy that the CORS data was granted on the 25TH of April 2016 which is 13 clear days after the request was placed for it.

Data processing

The processing was done post-processed and was carried in two instances. The first processing was processing of the field data with the specific GPS brand of software where the ground control was used as reference in which the results were used to prepare cadastral plans. The second processing was processing of the field data with the GNSS 3.80 software where the COR station was used as reference. For compatibility reasons, the GPS field data was converted into Receiver Independent Exchange Format (RINEX) which is a data interchange format for raw satellite navigation system data using tools in the specific brand of GPS software so as to have all data in the same format for processing with single GNSS software.

Plotting

The post-processed coordinates of the various GPS field observation were plotted for a graphical appreciation and analysis. AutoCAD 2010 was used to plot the coordinates post-processed from both ground control as reference in one case and the CORS as reference in the second case. ArcGIS 10.2 was also used to add a more graphical touch to the AutoCAD drawing and present the opportunity to do good analysis. The results of the plotting are shown in the following section.

Results and analysis

This chapter presents and discusses the results obtained in the study. The discussions focuses on the positional reliability of the Accra CORS data for post-processing differential GPS survey in Greater Accra region of Ghana. This analysis is done relative to field GPS data for post-processing differential GPS survey in Greater Accra where controls are used as references.

Field GPS data processing (ground control reference)

The reference coordinates used for the various survey works are based on the Ghana Grid system.

Results from questionnaires

A total number of 30 questionnaires were administered out of which 28 were received back. The categorization of sampled respondents includes private Professional surveyors in the Ghana Institution of Surveyors (GhIS). Figure 3.2 shows a chart of Users and Non users of the Accra CORS from respondents.

The results show that:

- 61% professionals are unaware of COR stations availability in the Greater Accra for GPS survey works and other GNSS applications at all.
- 39% professionals are aware of COR stations availability in the Greater Accra for GPS survey works and other GNSS applications.
- 28% professionals out of 39% of those who are aware from the collated answered questionnaires, have used the COR stations for their GPS surveys.
- Similarly 11% of these 39% professionals who are aware of the COR station, are outright non-users for any of their GPS survey works.

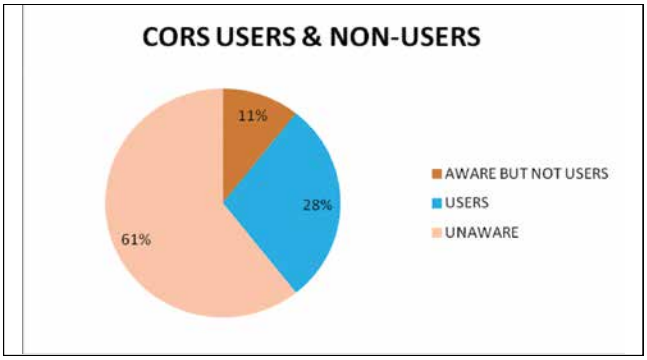

Figure 3: Users and Non-Users of the Accra CORS

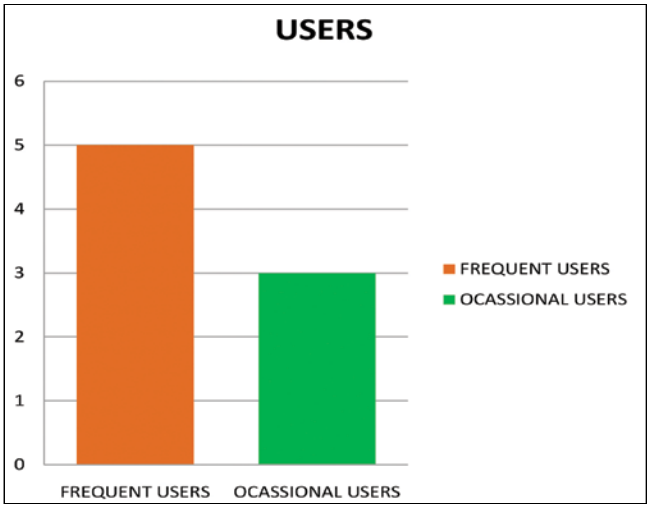

Figure 4 is a bar chart showing frequent and occasional users of the CORS.

Figure 4 is a bar chart shown frequent and occasional users of the Accra CORS

- Regular/Frequent users of the Accra COR station constitute 17.5% out the total number users. These professional surveyors use it to carry out most of their survey works within the allowable threshold of 100km further from any CORS within Greater Accra Region.
- A sizeable 10.5% of those interviewed seldom uses the Accra GRN or any other COR station in Greater Accra because they are either not aware of the availability of COR or they do not know the functional capability of COR station in their various GPS survey works.

Some of the general comments made by some of these professional surveyors who are either aware and does not use CORS include:

- The Lack of adequate and sufficient publicity from the Survey Department about the usefulness of the COR station in GPS surveys.
- The lack of alternate power generating plant for the Accra COR station giving rise to loss of reference data at times when they are most needed.
- The cumbersome, bureaucratic and time wasting nature of the managers of the COR station compelling them to give preference to the readily available ground control station for their GPS surveys.
- The unavailability of a quick mechanism of obtaining such reference data without coming to the Survey Department.

Table 2: Positional differences in coordinates

POINT ID (INSTRUMENT TYPE)	PROCESSED FIELD DATA (GROUND CONTROL AS BASE)		PROCESSED FIELD DATA (CORS AS BASE)		POSITIONAL DIFFERENCES	
	Northings (X)	Eastings (Y)	Northings (X)	Eastings (Y)	ΔX	ΔY
ACCRA GRN (CORS)			334375.516	1197017.218		
ASHTECH LOCUS SINGLE FREQUENCY	24.283 km from CORS	DOMIABRA				
AA1	341024.842	1117631.361	341024.842	1117631.361	1.685	9.635
AA2	341028.585	1117531.935	341028.585	1117531.935	1.424	9.481
AA3	341095.641	1117533.021	341095.641	1117533.021	-3.892	-0.930
AA4	341096.048	1117633.477	341096.048	1117633.477	-3.893	-0.929
				AVERAGE	-2.724	-5.245
	25.064 km from CORS	DOMIABRA				
BB1	342743.500	1115214.763	342743.500	1115214.763	-3.892	-0.895
BB2	342690.289	1115210.222	342690.289	1115210.222	-3.894	-0.896
BB3	342764.782	1114975.073	342764.782	1114975.073	-3.899	-0.894
BB4	342885.557	1115025.850	342885.557	1115025.850	-3.897	-0.895
BB5	342841.744	1115146.757	342841.744	1115146.757	-8.837	-1.140
BB6	342777.673	1115120.370	342777.673	1115120.370	-8.835	-1.136
				AVERAGE	-5.542	-0.976
	24.523 km from CORS	DOMIABRA				
CC1	344189.616	1117064.865	344189.616	1117064.865	-3.833	-0.844
CC2	344163.128	1117159.859	344163.128	1117159.859	-3.834	-0.847
CC3	344085.831	1117124.411	344085.831	1117124.411	-4.347	-1.494
CC4	344134.309	1117035.338	344134.309	1117035.338	-4.313	-0.406
				AVERAGE	-4.082	-0.898
	22.887 km from CORS	DOMIABRA				
DD1	314964.621	1124439.925	314964.621	1124439.925	-5.381	2.450
DD2	315002.692	1124352.591	315002.692	1124352.591	-5.412	2.747
DD3	315070.034	1124370.915	315070.034	1124370.915	-4.699	-1.362
DD4	315028.131	1124462.726	315028.131	1124462.726	-4.386	-1.287
				AVERAGE	-4.970	-1.962
ASHTECH LOCUS SINGLE FREQUENCY	14.989 km from CORS	ABLEKUMA & OBAKROWA				
A1	346536.019	1149260.934	346536.019	1149260.934	-0.528	-2.422
A2	346605.795	1149266.080	346605.795	1149266.080	-0.479	-2.900
A3	346596.456	1149378.354	346596.456	1149378.354	-0.421	-1.579
A4	346526.666	1149366.674	346526.666	1149366.674	-0.421	-1.573
				AVERAGE	-0.462	-2.119
	25.317 km from CORS	ABLEKUMA & OBAKROWA				
B1	363645.338	1119182.473	363645.338	1119182.473	3.708	-2.862
B2	363742.588	1119252.906	363742.588	1119252.906	3.803	-2.197
B3	363710.617	1119310.294	363710.617	1119310.294	3.803	-2.195
B4	363582.798	1119212.098	363582.798	1119212.098	3.706	-2.863
				AVERAGE	3.755	-2.529
TOPCORN HYPER PLUS DUAL FREQUENCY	22.187 km from CORS	ACHIAMAN				
AB1	374559.840	1136247.685	374557.760	1136247.624	-2.080	-0.061
AB2	374519.465	1136186.392	374518.617	1136187.196	-0.848	0.804
AB3	374423.158	1136232.384	374421.516	1136228.790	-1.642	-3.594
AB4	374465.626	1136283.076	374462.584	1136286.294	-3.042	3.218
AB5	374504.363	1136346.085	374500.653	1136345.095	-3.710	-0.990
AB6	374597.314	1136308.007	374595.235	1136306.692	-2.079	-1.315
				AVERAGE	-2.234	-1.664
SOKKIA STRATUS SIGLE FREQUENCY	22.737 km from CORS	BORTIANOR				
P1	307082.107	1127594.411	307082.107	1127594.411	-2.862	-0.953
P2	30959.575	1127531.412	306959.575	1127531.412	-2.201	1.174
P3	307003.661	1127445.281	307003.661	1127445.281	-2.085	-0.521
P4	307129.440	1127503.380	307129.440	1127503.380	-2.229	-0.688
				AVERAGE	-2.344	-0.834
TOPCORN HYPER PLUS DUAL FREQUENCY	24.948 k from CORS m	DOBLO GONNO				
PP1	374386.771	1125530.940	374382.590	1125531.970	-4.181	1.030
PP2	374385.860	1125446.937	374195.437	1125509.936	-9.061	0.510
PP3	374204.498	1125509.426	374200.198	1125465.245	0.055	2.075
PP4	374200.143	1125463.170	374381.071	1125447.712	-4.789	0.775
				AVERAGE	-4.522	1.098

- Some also raised issues of not being abreast with the technological advancement and therefore find it difficult to do the data processing on their own. They therefore rely on other professionals to get their GPS survey works processed and most of the time, these reliant professional are not always available to help them hence the need to resort to the use of ground controls which is relatively faster for data post-processing.

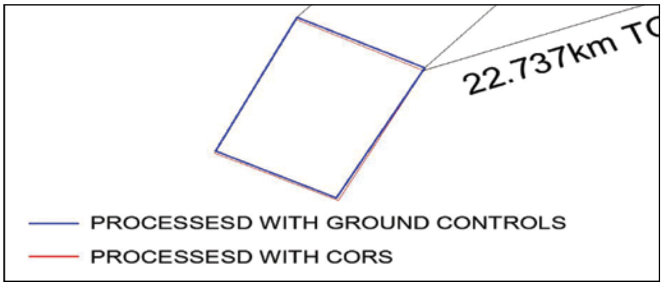

Figure 5: Single Frequency (approximately 23km from CORS, Bortianor)

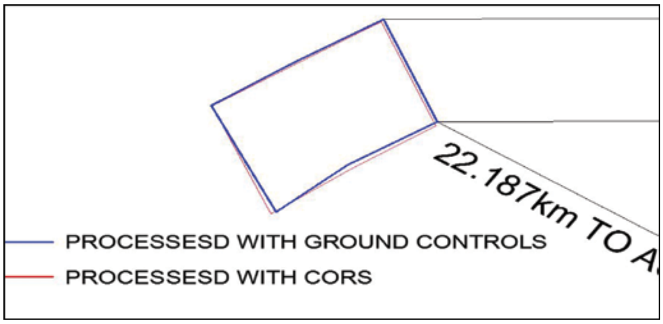

Figure 6: Dual Frequency (approximately 23km from CORS, Achiaman)

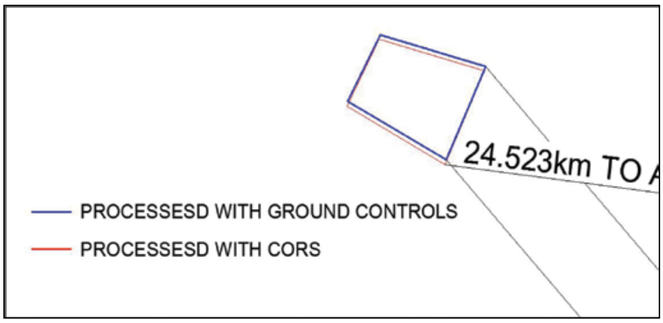

Figure 7: Single Frequency (approximately 25km from CORS, Domiabra)

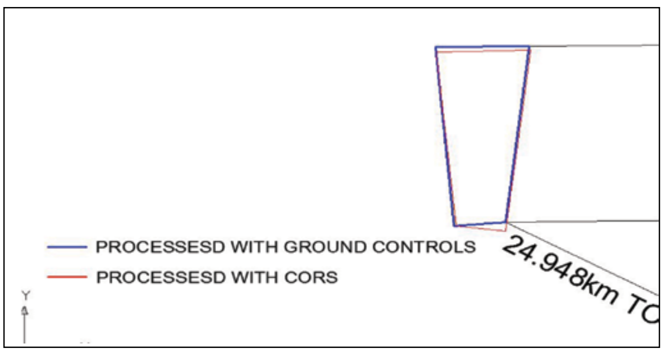

Figure 8: Dual Frequency (approximately 25km from CORS, Doblo Gonno)

Positional differences in proccessed coordinates by the differing bases

The differences in the coordinates obtained through the use of CORS data for differential GPS positioning as against using other ground controls is shown in Table 2

Composite plans of results

Figure 5 and Figure 6 shows composite plans from results obtained using CORS and from other ground controls within distances less than 25 kilometers from the CORS.

From the results of observations taken approximately 23 kilometers range away from the Accra COR station, results showed that an average of -2.344 feet change in Northings and -0.834 feet change in Eastings was obtained for Bortianor with a single frequency Sokkia Stratus GPS with an occupation time of 20 minutes. Likewise an average of -2.234 feet change in Northings and -1.664 feet change in Eastings was obtained for Achiaman using the a dual frequency Topcon hyper plus GPS with an occupation time of 4 minutes. Comparatively, both Northings and Eastings shows a remarkable similarity in change in Northings and a slight difference in the change in Eastings. The changes are relatively minimal and acceptable for preparation of cadastral plans in conformity with the standards of GPS surveys in Ghana as stipulated by the Technical Guidelines of Survey in Ghana. This gives room to say that even with an increased occupation/observation time within such a range away from the Accra COR station, finer results are bound to be achieved which makes the Accra COR station very good to use for GPS survey works in cadastral plan preparation and other GPS survey related works over such a distance.

Figure 7 and 8 shows composite plans for distances at approximately 25 kilometers from the Accra CORS.

From the results obtained at approximately 25 kilometers away from the Accra COR station, an average of -4.082 feet change in Northings and -0.898 feet change in Eastings was obtained for Domiabra with a single frequency Ashtech Locus GPS with an occupation time of 25 minutes. Likewise an average of -4.522 feet change in Northings and 1.098 feet change in Eastings was obtained in Doblo Gonno using the a dual frequency Topcon hyper plus GPS with an occupation time of 5 minutes. Comparatively, both Northings and Eastings shows a remarkable similarity in change in Northings and a slight difference in the change in Eastings for both single and dual frequency GPS observations. The changes are relatively minimal in the in Easting as compared to the change in Northings. However, this presents the opportunity to say that even with an increased occupation/ observation time within an approximate 25 kilometers range away from the Accra COR station, finer results are bound to be achieved which makes the Accra COR station very good to use for GPS survey works in cadastral plan preparation and other GPS survey related works even over such a distance.

It is identified that, over a range of either 23km or 25km away from the Accra CORS, there is a consistent change in the position relative to positions processed using ground controls as base and in as much as these positions of points are safe for the preparation of cadastral plans accepted by the Survey Department, the CORS can also be used in that regard as well. Mindfully, the Accra COR station was established with a range of 100 km for any GPS survey undertaken. Since Accra is not beyond 26 km, then all GPS survey in Accra can be carried out using the Accra CORS as base. Based on such results, the CORS station can guarantee a system of homogenous and consistent coordinates which the using the ground controls as base may not guarantee. As GPS usage with respect to ITRF also guarantee plate tectonic movement detection and compensation, in case of any future shifts in coordinate systems GPS surveys conducted with the COR station as a reference could accommodate and ascertain such shifts which cannot be guaranteed in the case of using the ground controls as base.

Conclusion

The study aimed at exploring the use of CORS for GPS survey in Greater Accra through participatory/interview analysis coupled with Field GPS survey of some parts of the capital city of Accra.

The research questions that this study seeks to uncover in relation to the findings from this research includes:

What are the advantages of CORS usage for GPS survey?

The first obvious answer to this question is the fact that the CORS guarantees a homogeneous differentially corrected coordinates from GPS observations in addition to acting as a Control framework. It was also determined that positional differences though at times minimal existed between results processed using the CORS and those from existing ground controls for which observations have been made about their non-homogeneity. The results showed changes in the Northings and Eastings for both single and dual frequency as 2.344 feet,-0.834feet and 2.234feet,-1.664feet respectively over an approximate range of 23km away from the Accra COR station. It goes further to show that over an approximate distance of over 25 km away from the Accra COR station, the change in Northings and Eastings of both single and dual frequency observations are -4.082feet, -0.898feet and -4.522feet, 1.098feet respectively.

What are the limitations of CORS usage for GPS survey?

The results gathered from the questionnaires raised concerned limitations about the Accra COR station including:

- The lack of a backup battery system or energy generating system as a stand-by for the Accra COR station. This poses serious limitation in the collection of reference data for post processing of field data.
- The Lack of adequate and sufficient publicity from the Survey Department about the existence, operationality and usefulness of the COR station in GPS surveys.
- The cumbersome, bureaucratic and time wasting nature of the managers of the COR station compelling to give preference to the readily available ground control station for GPS surveys.
- The more time needed to be spent on the observation time at any range of 12 km away from the Accra COR station as gathered through the questionnaires/ interviews from personnel responsible for managing the Accra COR station.
- The unavailability of a ready system of transmitting reference data to users say by text or through the internet.

How can we remedy problems posed by using CORS for GPS survey?

This objective is highly imperative to the success and sustainability of the Accra CORS. Some of the suggestions to remedy problems posed by using the Accra COR station include:

- A shift of focus into giving adequate publicity of the Accra CORS at various levels ranging from the Ghana Survey Department, Ghana Institution of Surveyors (GhIS) and the Licensed Surveyors association.
- Making the Accra COR station more efficient by mobilizing capital and providing needing resources such as radio receivers and other technological equipment capable of enabling real time processing of GPS data.
- Setting up a more organized and concrete unit equipped with more expertise that will facilitate a quick response to CORS reference data to drive surveyors to explore it usage in their GPS survey works.
- Mobilizing resources to establish an ultra-modern power generating plant to assist in the reference data recording process in a non-stop fashion to make data available at any time, any day and every day.

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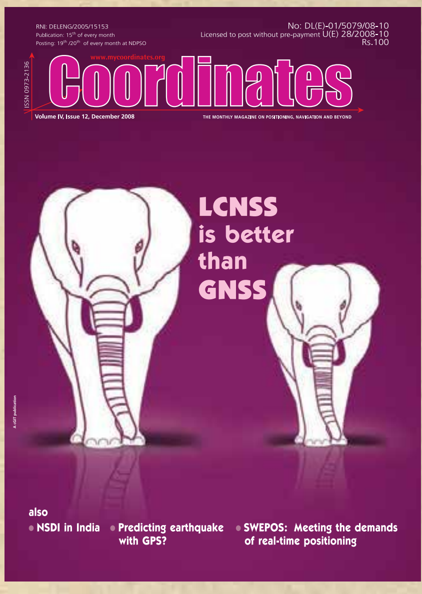
The paper was presented at FIG Congress 2018, Istanbul, Turkey, 6-11 May 2018.

In Coordinates

10 years before...



mycoordinates.org/vol-4-issue-12-December-08

Couldn't we predict the Wenchuan Earthquake with GPS?

Shunji Murai and Harumi Araki

Pre-signals of the Wenchuan Earthquake existed in the daily change of distance between GPS stations; Wuhan to Lhasa and Kunmin to Lhasa with larger than 3 sigma on the 6th May 2008, six days before the Earthquake. Similar presignals larger than 3 sigma existed in the daily change of the triangle area; Lhasa-Xian-Wuhan on the 6th May 2008, also six days before the Earthquake. The epicenter of the Wenchuan Earthquake is included in the critical triangle.

LCNSS is better than GNSS

María D Laínez and Miguel M Romay
GMV Aerospace and Defence S.A.

GNSS do not only require a significant number of satellites in orbit but also a rather complex ground infrastructure (orbitography and integrity stations, uplink stations, control centres, etc.) worldwide distributed. The cost of a GNSS is limiting the capability of some countries or regions to develop their own systems. Consequently those countries need to deploy their own augmentation systems and establish agreements with other states. This situation may change if the development of Low Cost Navigation Satellite Systems (LCNSS) became a reality.

LCNSS are designed to optimise performances over the area of interest while trying to minimise the overall costs. Acceptable performances (comparable to those provided by GPS today) can be obtained with a few satellites (5 to 10) and a reduced ground segment, as there is no need to deploy Ground Stations worldwide but only over the coverage and neighbour areas.

Meeting the demands of real-time positioning

Lars Jämtnäs and Bo Jonsson
National Land Survey of Sweden.

A multi-purpose network of permanent reference stations is beneficial for both users and providers of national geodetic infrastructure. It facilitates the development of services for positioning and non-safety-of-live navigation, and also the successful integration of GNSS technique into a wide range of applications. The professional use of these techniques is increasing very rapidly outside the conventional surveying community, which in turn spurs the development of more user friendly equipment and positioning concepts.

The long-term plan for SWEPOS, which was developed in the early 1990s, will be completed in coming years. Further information about the SWEPOS network can be found at: www.swepos.com


JAVAD
Total Solution
From 0 to ∞
J-Mate
JAVAD
Monitor document and record the health of your shots
BEAST MODE RTK
Spectrum Analyzer
180-pound Gorilla Test
Double Bubble
Lift & Tilt
Photogrammetry
VB-RTK
Localizations
Points, lines & curves
Trajectory
Photo & audio
REVERSE SHIFT<<it
Advantages of short baselines
RAMS
Remote Assistance & Monitoring Services
For all others see www.javad.com

Front

The TRIUMPH-LS and its field software, J-Field,

have many revolutionary and innovative features as compared to current GNSS systems:

• The TRIUMPH-LS contains everything needed to function as a **complete RTK rover** in one small, compact, ergonomic and very portable unit: an 8**64 channel GNSS receiver, a UHF or spread spectrum radio, a GSM modem, a Wi-Fi adapter, two internal cameras, a flashlight, and a bright 800x480 pixel display.** Included with the system is a collapsible monopod rover pole which allows the unit to be quickly folded up to fit in a very small space, **perfect for carrying the system through the woods** or quickly stowing inside a vehicle. The lack of a data collected bracketed to the rover pole increases further increases its portability and the user can **carry the system through the woods** without having to worry about a data collector bracketed to the rover pole getting caught in brush.

• This system was ergonomically engineered; the head height vertical display allows the user to operate the TRIUMPH-LS while standing in an upright position and looking forward. The user does not need to bend their neck to look down to view the display as is traditionally done with a system having a data collector attached to a rover pole. This feature allows the system to be used **without the neck soreness** that can plague a user bending their head downward to view a data collector for extended periods of time.

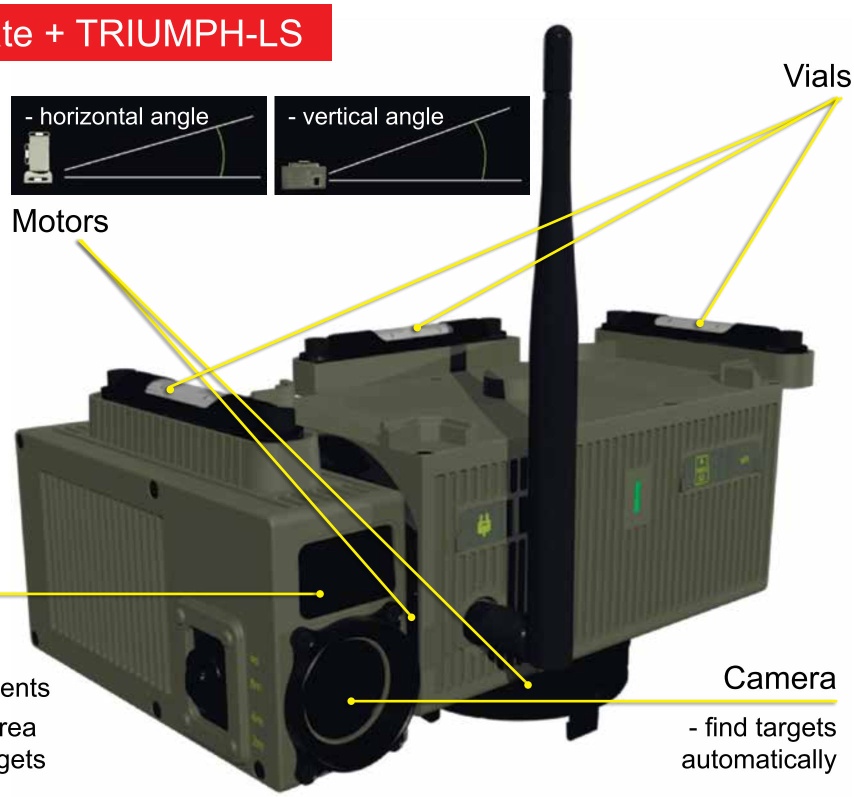
Why follow a workflow designed for yesterday's equipment?

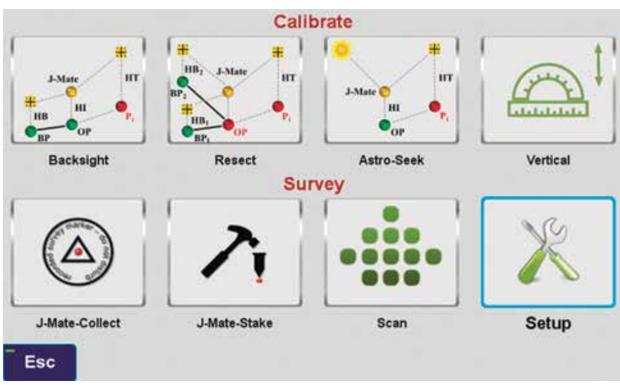
This is J-Mate

J-Mate features a **camera** that can also find targets automatically, and a **laser module** for accurate distance measurements. It scans and examines the area around the intended target to ensure reliable identification. Two **precision encoders** measure vertical and horizontal angles to the target. Three **precision vials** allow a visual check on levelness of the instrument.

Take control with J-Mate + TRIUMPH-LS

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





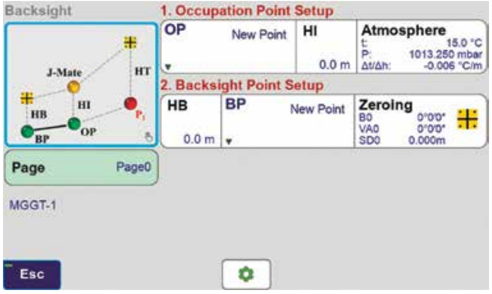
With J-Mate you can establish your occupied position via three different ways: 1) Backsight; 2) Resection; or 3) our new Astro-Seek (more of that later).

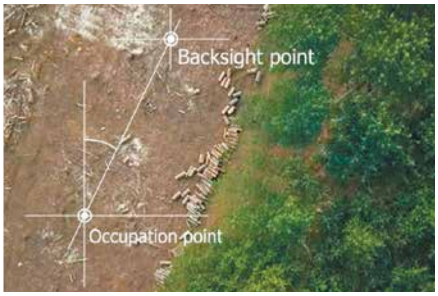
When you click the Setup icon of the J-Mate screen you get access to parameters that tunes J-Mate to your desire.

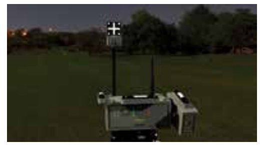
After the J-Mate is calibrated, you can proceed with your work as normal via the Collect or Stake icon.

Backsight icon

If GNSS signals are available at the job site, click the J-Mate Backsight icon.



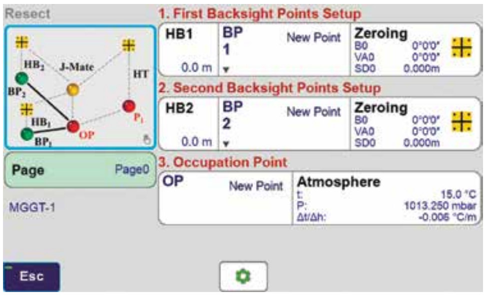


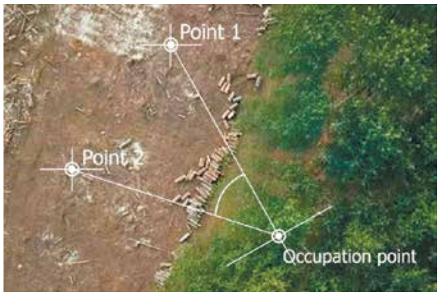


This screen appears which guides you to determine the accurate positions of the Occupation Point and the Backsight Point, to establish an azimuth and calibrate the J-Mate angular encoders.

Resect icon

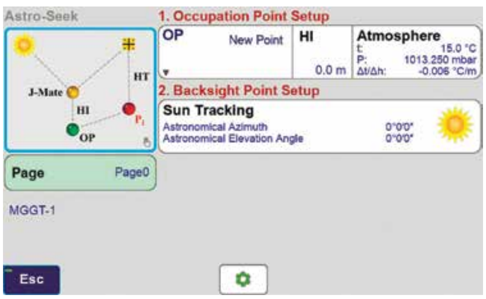
If GNSS signals are not available at the Occupation Point, click the “J-Mate-Resect” icon





Shoot two or more known points to establish an accurate position and calibrate the encoders. Then continue to shoot the unknown points.

Astro-Seek icon

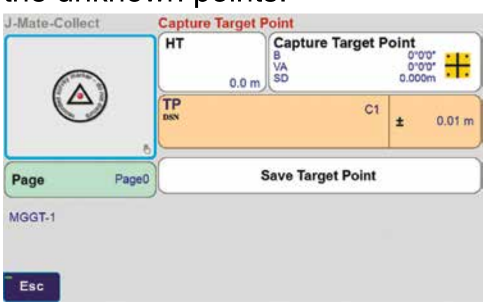


And now our new feature!

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

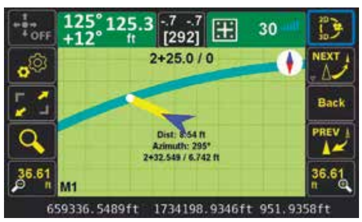
J-Mate-Collect

After calibration is performed, click the J-Mate-Collect icon to shoot the unknown points.



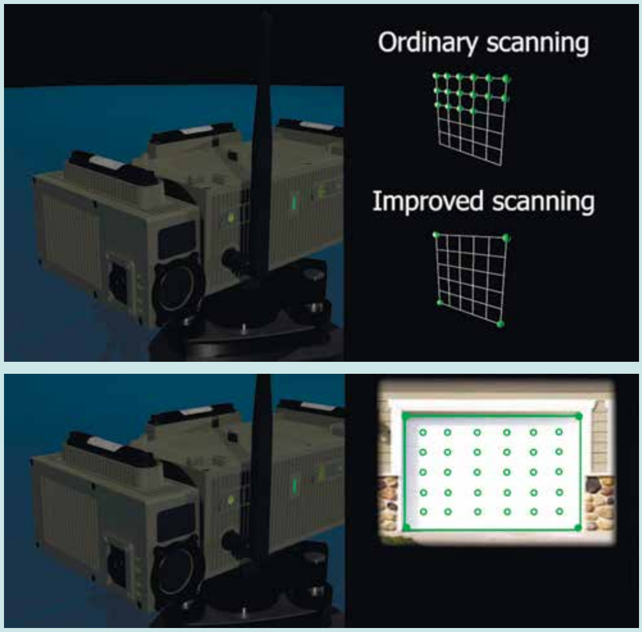
J-Mate-Stake

Click the J-Mate-Stake icon to use for stakeout.



The functions and features of the J-Mate stakeout are very similar to our conventional GNSS stakeout: RTK solutions guide you to the stake points. But with the J-Mate the camera follows the “+” sign that you carry and then the encoders and laser measurements (shown on screenshots) provide guidance to the stakeout features. This is similar to Visual Stakeout and other useful and innovative features of our TRIUMPH-LS GNSS RTK stakeout.

Smart laser scanner



J-Mate is also a camera-aided, smart laser scanner. The camera identifies redundant points that do not need to be scanned, but instead can be copied or interpolated from other readings without loss of information. That is, if the camera identifies a completely uniform flat area, it only scans the four corners of that area and interpolates in between. This feature can increase the effective speed of the scanner to much higher than its native 10-points-per-second speed.

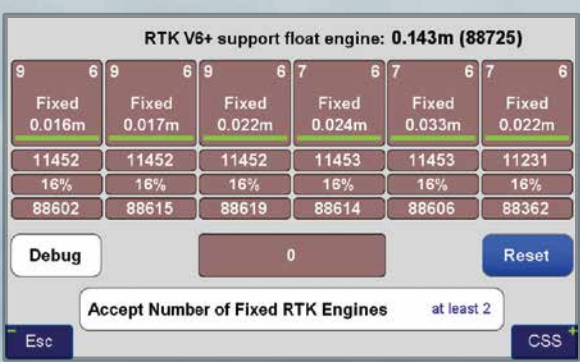
The scanning feature can also be used to find items like wires and poles and "closest-in-view" items and shoot them automatically.

Seize the day with J-Mate + TRIUMPH-LS

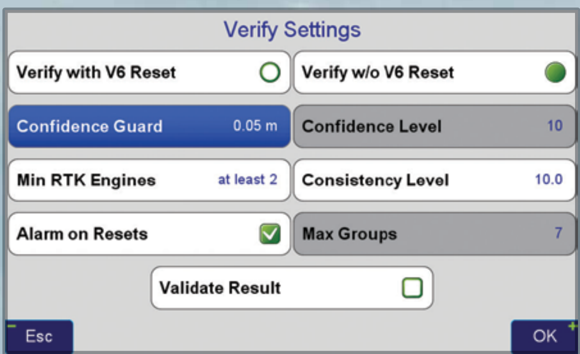
And all components fit in this small carrying case.

So we have a "**Total GNSS**" with a "**Robotic Total Station**" and a "**Smart Laser Scanner**". We call it our **"Total Solution"** and it can be operated by one person to perform jobs.

- The field software, J-Field, is included **at no extra charge** with the system. There is no need for an external data collector or software. J-Field is constantly being improved and updates will always be available free of charge with the system. The updates can be **downloaded through Wi-Fi** and are very simple to install, requiring only a couple button presses to update the system.



- J-Field, features **6 separate parallel RTK engines** that all run simultaneously with separate assumptions. This allows for fixes to be obtained quicker than if only a single RTK engine was used.



- It has an advanced **RTK verification system** that can be used in difficult RTK environments where there is high multipath and/or tree canopy cover. This process will automatically reset the RTK engines and eliminate points from being collected with bad RTK fixes that often plague other systems in difficult locations.

- J-Field has many **customization** features that can be used to increase productivity as your knowledge of the system grows. The stake and collect screens have **10 white boxes** that are easily customized to display a number of fields which the user may desire.

Scan me
and wach
full video

FR

TRIUMPH-LS vs. R-10

Stephen K. Drake, PLS, CFedS

Scan to read details of competition >

JAVAD TRIUMPH-LS rover, TRIUMPH-2 base, with spread spectrum radio, and a set of pods I have hiked up mountains all over the country, even at a 115 degrees in the desert, thankful the whole set weighs less than my R8 tripod.

Trimble R-10 rover, TSC3 controller, and R-8 base, with its bonus (heavy) tripod. (yea I want to hike that up the mountain for my setup…) The market heavy weights! (yea pun intended).

Where Have You Been With Your TRIUMPH-LS Lately

"Btw, pardon my French, but holy shit. I got some ridiculous 'fixes' today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it."

"Truly amazing with a 4" grape vine directly overhead and the tree cover."

"Got some shots that he could not get with our gr5's."

"This thing is bad ass!"

"I often get 2 days of work done, in a day."

"I got some ridiculous 'fixes' today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it."

Spatial heterogeneity, scale, data character, and sustainable transport in the big data era

This paper attempts to clarify why the paradigm shift is essential and to elaborate on several concepts, including spatial heterogeneity (or scaling law), scale (or the fourth meaning of scale), data character (in contrast to data quality), and sustainable transport in the big data era

Bin Jiang
Faculty of Engineering and Sustainable Development, Division of GIScience
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In light of the emergence of big data, I have advocated and argued for a paradigm shift from Tobler's law to scaling law, from Euclidean geometry to fractal geometry, from Gaussian statistics to Paretian statistics, and – more importantly – from Descartes' mechanistic thinking to Alexander's organic thinking. Fractal geometry falls under the third definition of fractal – that is, *a set or pattern is fractal if the scaling of far more small things than large ones recurs multiple times* (Jiang and Yin 2014) – rather than under the second definition of fractal, which requires a power law between scales and details (Mandelbrot 1982). The new fractal geometry is more towards living geometry that *"follows the rules, constraints, and contingent conditions that are, inevitably, encountered in the real world"* (Alexander et al. 2012, p. 395), not only for understanding complexity, but also for creating complex or living structure (Alexander 2002–2005, Jiang 2016, Jiang 2018b). This paper attempts to clarify why the paradigm shift is essential and to elaborate on several concepts, including spatial heterogeneity (or scaling law), scale (or the fourth meaning of scale), data character (in contrast to data quality), and sustainable transport in the big data era.

Current geographic information systems (GIS), which were first conceived and developed in the 1970s, are still largely based on the legacy of conventional cartography (Goodchild 2018). Although computer technology has advanced dramatically since then, the legacy or the fundamental ways of thinking remains unchanged. For example, GIS representations of raster and vector and even so-called object-oriented representation are still constrained among geometric primitives such as pixels, points, lines, and polygons (Longley et al. 2015). These geometry-oriented representations help us to see things that are more or less

Table 1: Comparison of the scaling law versus Tobler's law (Note: These two laws complement each other and recur at different levels of scale in geographic space or the Earth's surface.)

Scaling law	Tobler's law
far more small things than large ones	more or less similar things
across all scales	available on one scale
without an average scale(Pareto distribution)	with an average scale (Gauss distribution)
long tailed	short tailed
interdependence or spartial heterogeneity	spatial dependence or homogeneity
disproportion (80/20)	proportion (50/50)
complexity	simplicity
non-equilibrium	equilibrium

similar, characterized by Tobler's law (1970), or commonly known as the first law of geography. For example, the price of your house may be similar to those of your neighbors, but there are far more low house prices than high ones. This notion of far more lows than highs – or far more smalls than larges in general – is what underlies scaling law for characterizing spatial heterogeneity. The concept of spatial heterogeneity, as conceived in current geography literature, is mistaken because it does not recognize the fact of far more smalls than larges (Jiang 2015b). This notion of far more smalls than larges adds a fourth meaning of scale; that is, a series of scales ranging from the smallest to the largest form the scaling hierarchy (Jiang and Brandt 2016). The scaling hierarchy can be further rephrased as: numerous smallest, and a very few largest, and some in between the smallest and the largest. In order to see far more smalls than large one, we must adopt a topological perspective on meaningful geographic features such as streets and cities instead of the geometric primitives. In other words, we must shift our eyes from geometric details to overall data character (which will be further elaborated on below). Tobler's law depicts a fact as a local scale. However, geographic space is governed by not only Tobler's law but also by scaling law. These two laws are complementary to each other (Table 1). Calling for a shift from Tobler's law to scaling law is not to abandon Tobler's law, but to shift from thinking that is dominated by Tobler's law to thinking dominated by scaling law because scaling law is universal and global.

Benoit Mandelbrot, the father of fractal geometry, remarked that unlike things we see in nature, Euclidean shapes are cold and dry. Christopher Alexander, the father of living geometry, referred to structures with a higher degree of wholeness as living structures. Wholeness is defined mathematically as a recursive structure, and it exists in space and matter physically and reflects in our minds and cognition psychologically (Alexander 2002–2005, Jiang 2016, Jiang 2018b). A cold and dry structure versus a living one vividly describes the difference between Euclidean shapes and fractal or living structures. A shift from Euclidean geometry to fractal or living geometry is not to abandon Euclidean geometry, but Euclidean geometric thinking. Euclidean geometry is essential for fractal geometry, since one must first measure it in order to see whether there are far more smalls than larges. However, Euclidean geometric thinking differs fundamentally from that of fractal geometry. For example, Euclidean geometric thinking tends to see things individually (rather than holistically) and non-recursively (rather than recursively); refer to Jiang and Brandt (2016) for a more detailed comparison about these two geometric ways of thinking. The shift from Euclidean to fractal or living geometry implies that fractal or living geometry is to be the dominant way of thinking. To present a practical example, a cartographic curve is commonly seen, under the Euclidean geometric thinking, as a set of more or less similar line segments; however, it should more correctly be viewed, under the fractal or living geometric thinking, as a set of far more small bends than large ones, and importantly small bends are recursively embedded in the large ones.

> Space is a living structure with a high degree of wholeness. A country is a living structure that consists of far more small cities than large ones; a city is a living structure that consists of far more short streets than long ones, or far more less-connected streets than well-connected ones

According to Tobler's law, the price of your house is similar to those of your neighbors. In other words, averaging your neighbors' housing prices would lead to your housing price. In this case, the average makes a good sense for predicting your housing price, as all neighboring housing prices can be characterized by a well-defined mean. In order for the prediction to make sense, there is a condition to meet; namely, the neighboring housing prices are more or less, or with a well-defined mean. This is indeed true for housing prices on a local scale. This condition is violated on a global scale, since there are far more low prices than high ones. In this case, the average does not make good sense; it lacks an average or scale-free or scaling.

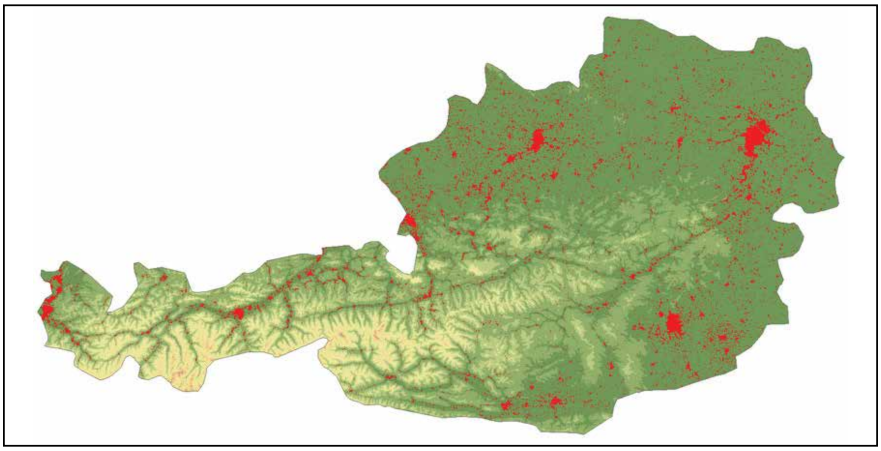

Figure 1: (Color online) Living structure of all natural cities derived from Austria's OSM data (Note: This topographic rendering is based on head/tail breaks (Jiang 2013, 2015a). Unlike traditional renderings, this head/tail breaks induced rendering clearly shows the living structure of far more low elevations than high ones.)

Things with more or less similar sizes can be well modeled by Gaussian statistics, whereas things with far more smalls than larges should be well characterized by Paretian statistics. In this regard, we have developed a new classification scheme for data with far more smalls than larges. This classification scheme is called head/tail breaks (Jiang 2013), which recursively breaks data into the head (for data values greater than an average) and the tail (for data values less than an average) until the condition of a small head and a long tail is violated. A head/tail breaks-induced index called the ht-index (Jiang and Yin 2014) can be used to characterize the notion of far more smalls than larges or underlying scaling hierarchy. As mentioned above, the new definition of fractal is based on the notion of far more smalls than larges.

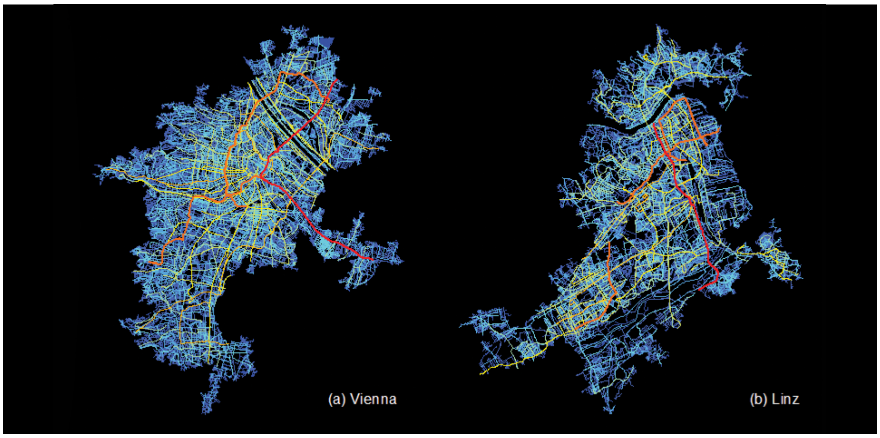

Figure 2: (Color online) Living structure of natural streets of (a) Vienna and (b) Linz (Note: The living structure shows far more less-connected streets – indicated by many cold colors than well-connected ones – indicated by a very few warm colors.)

Under Euclidean geometric thinking that focuses on geometric details, data quality or uncertainty is one of the priority issues in GIS. This kind of thinking is evident in many scientific papers and talks about, for example, data quality of OpenStreetMap (OSM). I believe that the GIS field has over-emphasized the data quality issue, so I would like to add a different view, arguing that data quality is less important than data character. By data character, I mean some overall character of geospatial data, or the wholeness, or living structure as briefly mentioned above. To illustrate, this link (https://twitter.com/binjiangxp/status/985322539625967618) shows a cartoon and a photo of Kim Jong-Un. The photo on the right has the highest geometric details, and the cartoon on the left has the lowest geometric details. However, the cartoon on the left captures the highest character or personality. This link (https://twitter.com/binjiangxp/status/985322961342263296) further illustrates the living structure of the street network of a small neighborhood. The street network on the right has the highest data quality, while the graph on the left captures the highest data character – far more less-connected streets than well-connected ones. What I want to argue is that if the street network on the right suffers from some errors, this would not have much effect on the data character on the left. It is in this sense that quality is not super-important compared to data character. If data quality or geometric details were compared to trees, then data character would be the forest. To present a specific example, Jiang and Liu (2012) adopted a topological perspective and examined the scaling of geographic space based on OSM data of three European countries: France, Germany, and the UK. There is little doubt that there were numerous errors in the OSM data, but they have little effect on the finding – the scaling or living structure of geographic space in which there are far more small things than large ones.

The legacy of GIS has been driven substantially by the mechanistic thinking of over past 300 years of science (Descartes 1637, 1954). Everything we have achieved in science and technology benefits greatly from mechanistic thinking, but it is limited in terms of how to make a better built environment (Alexander 2002–2005). This mechanistic thinking is reflected in the GIS representations of raster and vector, and in the box counting for calculating fractal dimensions. It is also reflected in top-down imposed geographic units such as census tracts; these are clearly very useful for administration and management, but of little use for scientific purposes. Space is neither lifeless nor neutral, but has a capacity to be more living or less living (Alexander 2002–2005). In other words, space is a living structure with a high degree of wholeness. A country is a living structure that consists of far more small cities than large ones. Figure 1 shows all the natural cities of Austria, derived from street nodes of the country's OSM data. Seen from the figure, all cities have very natural boundaries, and they are quite coherent, with a topographic surface that reveals the underlying living structure of far more small cities than large ones. Natural cities are objectively defined cities, from a massive number of geographic locations, such as social media locations (Jiang and Miao 2015); please refer to the Appendix of the paper for details on the derivation of natural cities.

Geographic space is a living structure, not just at the country scale, but also at the city scale. Figure 2 shows natural streets of Vienna and Linz, which demonstrate striking living structures with far more less-connected streets than well-connected ones. The natural streets are able to capture the underlying scaling or living structure of far more the less-connected than the well-connected, and are therefore able to predict up to 80 percent of traffic flow. In other words, traffic flow is mainly shaped by the living structure and has little to do with human travel behavior. In this circumstance, human beings can be thought of as atoms or molecules that interact with each other, and with the natural streets to shape the traffic flow. Traffic is not a phenomenon, but an outcome of the living structure. This is in line with the famous statement by Winston Churchill – *We shape our buildings and afterwards* *our buildings shape us*. With respect to sustainable transport, we can paraphrase Churchill: We shape our transport system, and it will shape us, so make sure we shape it well so that we will be well-shaped too. To be more specific, we shape our transport system as a living structure and it then shapes our sustainable mobility.

This social physics perspective offers new insights into traffic flow. To this point, I would like to end this paper with the following excerpt (Buchanan 2007):

"There's an old way of thinking that says the social world is complicated because people are complicated … We should think of people as if they were atoms or molecules following fairly simple rules and try to learn the patterns to which those rules lead … Seemingly complicated social happenings may often have quite simple origins … It's often not the parts but the pattern that is most important, and so it is with people."

Acknowledgement

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The two related presentations:

https://www.researchgate.net/publication/326304703_A_Geospatial_Perspective_on_Sustainable_Urban_Mobility_in_the_Era_of_BIG_Data

https://www.researchgate.net/publication/326250247_Challenging_the_Establishment_of_Cartography_and_GIS

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New trends in development of agricultural land consolidation

Increasing the efficiency of agricultural production; providing sustainable development of agrarian sector; rational use of land, labor and capital in agriculture; optimization of agricultural production structures both in territorial and production aspects

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We can treat Agricultural Land Consolidation as a merging, enlargement, eliminating of mosaic land ownership and improvement of configuration as well as optimization of size of land plots in order to increase the efficiency of agricultural production via rational use of scare resources: land, labor and capital based on reduction of transaction costs.

The specific objectives of Agricultural Land Consolidation are the following: increasing the efficiency of agricultural production; providing sustainable development of agrarian sector; rational use of land, labor and capital in agriculture; optimization of agricultural production structures both in territorial and production aspects; increasing the competitiveness of agricultural producers in domestic as well as foreign markets; environmental protection; development of production as well as social infrastructure in agriculture.

Agricultural Land Consolidation should be carried out based on the following principles: voluntariness; openness and transparency; financial and economic feasibility; taking into account the interests of the population groups involved including women and youth as well as indigenous people; step by step implementation; consideration of local conditions; state and NGO support.

In theory, Agricultural Land Consolidation can be carried out as Voluntary Land Consolidation and Compulsory Land Consolidation as so-called compulsory "collectivization" as well as compulsory consolidation of the collective farms (kolkhozes) and compulsory transformation of some of them into the state farms (sovkhoses) took place respectively in the former Soviet Union in the thirties and the fifties of the last century.

In the result of collectivization in the 20-30-ies of the last century about 25 million peasant farms were converted into 240 thousand collective farms. In the 50-60-ies of the last century took place the consolidation of the collective farms. It was also carried out mainly by administrative methods. Many collective farms were transformed into the state farms. As a result, the number of collective farms decreased to 44.5 thousand by 1960 and to 29.1 thousand by 1990. In 1990 the average size of collective farm and state farm was amounted respectively 5,873 hectares and 15,276 hectares of agricultural land.

The present stage of Agricultural Land Consolidation in the Russian Federation is featured by development of agricultural holdings and increasing size of private farms. Currently there is a trend of development of Agricultural Land Consolidation at the regional level. There are different models of Agricultural Land Consolidation in Russian agriculture. The first of them Nizhny Novgorod Model was intended to consolidate the land shares with the aim of creating production cooperatives. However, due to the absence of post-privatization support this task remained unfulfilled. In this regard, noteworthy Belgorod and Orel Models, which are used respectively in Belgorod and Orel regions based on buying and renting of land shares by private farms, agricultural holdings as well as local authorities.

Both administrative and economic methods, for example, development of Agricultural Land Market could be used for Agricultural Land Consolidation. In our opinion, preference should be given to Voluntary Land Consolidation. In that sense, development of Agricultural Land Market is very important for stimulation of Agricultural Land Consolidation.

However, Agricultural Land Market in Russia is still not formed, which impedes the formation of a flexible system of land tenure and land use. Most of Agricultural Land Market Transactions are leasing of land shares now. Meantime, agricultural land selling and buying transactions as well as agricultural land mortgage transactions are limited.

By its nature, Agricultural Land Market represents a market of imperfect competition. This is manifested in the following. The number of sellers and buyers of land plots does not match among themselves. Market information on the transactions is incomplete and non-transparent. Transactions are mostly local in nature. The supply and demand for the land plots are inelastic.

In this market, there are externalities, such as the state registration of the deals, restrictions on the sale and purchase of agricultural land, which prevent the formation of equilibrium prices of agricultural land plots. There is also inappropriate agricultural land use, pollution, and illegal allotment for commercial needs.

The agricultural land is the product of a special kind, the main means of production in agriculture, the cost of which may increase if the normal use for a period. The price of the land is determined based on the interaction between market regulators: land rent and interest rate. Fertility and location of the land plot as well as the additional costs of capital determine the amount of rent. With increasing size of land plots used for agricultural production, efficiency of farming is increasing due to the relative reduction of transaction costs per unit of land area. The maximum efficiency of agricultural production is achieved in the case when the level of transaction costs per unit of land is reduced to a minimum.

However, further increasing the size of land plots used in agriculture leads to decreasing of efficiency of agricultural production due to the increase in transaction costs per unit of land area.

The major problem is to evaluate the effectiveness of projects related to consolidation of agricultural lands. In our opinion, evaluation of the effectiveness of mentioned above projects should be carried out based on benefit-cost analysis. The most important condition for application of benefit-cost analysis for evaluation of land consolidation projects is to ensure comparability of indicators of costs, benefits as well as efficiency based on international financial reporting system. It could create additional incentives to attract outside investors in Russian agriculture.

Thus, the consolidation of agricultural land is the basis for the development of investment process in agriculture, which allows increasing its efficiency by reducing transaction costs and attracting outside investors to allocate their capital in agriculture.

Land tenure

According to the Federal Service on State Registration, Cadaster and Cartography of the Russian Federation (Rosreestr), the state and municipal owned land amounted 1,579.1 million hectares, or 92.2 %, private land -115.3 million hectares, or 6.7 % and land owned by legal entities - 18.1 million hectares, or 1.1 % of the total Russian Federation's territory in 2015.

The most important piece of the Russian Federation's territory is agricultural land. According to the Rosreestr, the state and municipal owned agricultural land amounted 255.3 million hectares, or 66.5 %, private land -111.1 million hectares, or 29.0 % and land owned by legal entities - 17.3 million hectares, or 4.5 % of the total Russian Federation's agricultural land in 2015. The total agricultural land area was estimated 383.7 million hectares, or 22.4 % of the total Russian Federation's area in 2015. The cropland, perennial, pastures, hay field lands as well as idle land were amounted 197.7 million hectares, or 51.5 % of total agricultural land area in 2015 (See Table 1).

Table 1. Agricultural Land, Russian Federation, 2015, million hectares

Item	Area	%
Agricultural Land	197.7	51.5
Forest Land	24.8	6.5
Bush Land	19.2	5.0
Road Land	2.3	.6
Building Site Land	1.1	.3
Water Land	13.1	3.4
Others	125.5	32.2
Total	383.7	100.0

Source: Rosreestr, 2016

Table 2. Land Use of Parastatals, Russian Federation, 2015, 1000 hectares

Item	Total	Cropland	Idle Land	Perennial	Hay Field Land	Pasture
Joint Stock Companies and Partnerships	60,526.9	42,930.5	935.4	216.9	4,380	12,064.1
Production Coops	43,100.5	25,064	1,043	78.8	3,972.4	12,942.3
State and Municipal Enterprises	6,116.5	2,779.7	80.8	45.1	597	2,613.9
Research Institutions	1,713.5	1,309.4	19.8	13.4	108.2	262.7
Subsidiary Farms	923.9	572.6	22.8	3.5	108.2	216.8
Others	4,405.2	2,818.8	71.4	13.8	309.4	1,191.8
Tribal Land	15.8	.3	-	-	8.8	6.7
Kazak Society Land	89.5	60.4	.1	.1	6	22.9
Total	116,891.8	75,535.7	2,173.3	371.6	9,490	29,321.2

Source: Rosreestr, 2016

The dominant role in the Russian agricultural land use has played joint stock companies as well as production coops (See Table 2).

The share of joint-stock companies and partnerships in the total area of agricultural land of parastatals amounted 51.8% and in the area of cropland 56.8% in 2015. The share of production coops in the total area of agricultural land of parastatals was amounted 36.9% and in the area of cropland – 33.2 % in 2015.

Land tenure of the largest agricultural holdings in the Russian Federation in 2016 is shown in Table 3. As we can see from Table 3 these businesses have consolidated large area of agricultural land.

The average size of agricultural holding amounted 490 thousand hectares in 2016. It varied from 340 thousand hectares to 790 thousand hectares in 2016. However, compared to the total area of agricultural land used by parastatals, the land ownership of agricultural holdings are insignificant. It was not exceeded 5% of the total agricultural land area used by parastatals in 2015-2016.

Table 3. Land ownership of agricultural holdings, Russian Federation, 2016, 1000 hectares

Item	Agricultural Land Area	%
Prodimex & Agrokultura	790	16.1
Miratorg	594	12.1
Rusagro	594	12.1
Ivolga-holding	511	10.4
HK Ak bars	505	10.3
Agrokomplex	456	9.3
Rosagro	400	8.2
Avangard-agro	370	7.5
Krasny Vostok agro	350	7.1
Cherkizovo & Napko	340	6.9
Total	4,910	100.0

Source: Who owns Russia. The largest owners of farmland in Russia http://www.business Life dated April 19, 2016.

Private farms have played an important role in the Russian agricultural private land use (See Table 4). The share of private farms in the total area of the private agricultural land use amounted 31.5% and in the area of cropland – 39.9 % in 2015.

However, the total agricultural land area has been reduced (See Table 5). According to the Rosreestr, the total agricultural land area decreased by .3 million hectares in 2015 compared to 1990 from 222.4 million hectares to 222.1 million hectares, or by .1%. The cropland area decreased by 9.5 million hectares in 2015 compared to 1990 from 132.3 million hectares to 122.8 million hectares, or by 7.2%. Moreover, in 2015 compared to 1990, the area of pasture land increased by 5.2 % and idle lands- in 16.3 times.

Table 4. Land Use of Private Farms and Citizens, Russian Federation, 2015, 1000 hectares

Item	Total	Cropland	Idle Land	Perennial	Hay Field Land	Pasture
Private farms	23,901.7	16,424.7	124.8	18.1	1,074	6,260.1
Individual Entrepreneurs	2,737.1	2,029	32.3	13.5	117.7	544.6
Personal Subsidiary Farms of Citizens	7,439.7	5,116	71.6	215	1,010.1	1,027
Service Land	53.4	10.7	-	.4	37.5	4.8
Horticulture	1,109.7	49.8	1.5	1,053.7	1.5	3.2
Vegetable Growing	271.4	270	.7	.4	-	.3
Dacha Land	79.6	63.2	1.3	6.9	2.8	5.4
Housing	559.6	466.9	.6	63.2	9.3	19.6
Livestock Farms Land	319	45.7	.1	.1	65.8	207.3
Grazing	15,134.2	1,239	108.8	8.2	3,198.9	10,579.3
Agricultural Land Owners	10,679.8	7,983.4	159.4	23.5	616.9	1,896.6
Land Shares	13,508	7,417.7	904.9	31.1	1,475.2	3,679.1
Total	75,793.2	41,116.1	1,406	1,434.1	7,609.7	24,227.3

Source: Rosreestr, 2016

After boom at the first period of reform, the number of private farms has been decreased due to severe macroeconomic instability and lack of market infrastructure as well as market economy knowledge. In 2015 the number of private farms decreased by 6.3 % compared to 1995(See Table 6).

However, the average size of agricultural land occupied by private farm has been increased due to land consolidation. It was estimated 69.3 hectares in 2015. Thus, it increased by 61.5 % compared to 1995.

Table 5. Agricultural Land, Russian Federation, 1990-2015, million hectares

Item	1990	2000	2010	2011	2012	2013	2014	2015	2015/1990, %
Agricultural Land - total, including:	222.4	221.1	220.4	220.3	220.2	220.2	220.2	222.1	99.9
Cropland	132.3	124.4	121.4	121.4	121.4	121.5	121.5	122.8	92.8
Pasture	87.9	90.9	92.0	92.0	92.0	92.0	92.0	92.5	105.2
Idle Land	.3	3.9	5.1	5.0	5.0	5.0	4.9	4.9	16.3 times

Source: Rosreestr, 2016

Table 6. Private Farms, Russian Federation, 1995-2015

Item	1995	2000	2010	2013	2014	2015	2015/1995,%
Number of farms, 1000	279.1	263.7	261.7	258.5	258.9	261.6	93.7
Total land area, 1000, ha	11,982.1	15,368.7	16,284.1	17,128.8	17,681.6	18,130.4	151.3
Average land size, ha	42.9	58.3	62.2	66.3	68.3	69.3	161.5

Source: Rosreestr, 2016

Legal framework

The legal framework for Agricultural Land Consolidation in Russia includes the Constitution of the Russian Federation, the Civil Code, the Land Code as well as other legal acts. In 2010- 2017, some existed legislative acts were amended and adopted new laws that have a significant impact on the development of Agricultural Land Consolidation in Russia.

The Federal Law of the Russian Federation issued on December 29, 2010, #435-FZ "On turnover of agricultural lands" amended the Federal Law of the Russian Federation issued on July 24, 2002, #101-FZ "On turnover of agricultural lands" as well as some other laws. The right and the order of compulsory withdrawal of the agricultural land plots were settled. According to the Law, it is possible through court in case when the land is not used 3 years and more, and at essential decrease in fertility or considerable deterioration of ecological conditions.

The Federal Law of the Russian Federation issued on June 23, 2014, # 171-FZ "On amendments to the Land Code of the Russian Federation and certain legislative acts of the Russian Federation" amended the Land Code of the Russian Federation. According to the Law, the goal of the amendment was to optimize the procedure for transferring land plots available in state or municipal ownership via development of land auction trading in Russia. The possibility of allocation of land plots for development, not only for housing, but also for other types of construction, including social was recognized.

Land plots had to be transferred without bidding only for the construction of important infrastructure projects, for individual housing construction, personal subsidiary farming and in other specific cases. The authorities had to put up for sale vacant land plots based on applications of citizens and legal entities, except if they were reserved for state or municipal needs, limited in circulation, etc. According to the Law, the starting auction price of the land plot was the cadastral value. Information on the availability of free land plots authorities had to oblige to show on the official websites. The Federal Law #171 was entered into force on March 1, 2015.

On December 24, 2014, in accordance with the Order # 540 of the Ministry of Economic Development of the Russian Federation issued on September 1, 2014, a new classification of types of permitted land use within the land categories was introduced. According to it, owner of the land plot shall have the right to choose any type of permitted use of the installed for the given land plot. The order identifies 12 target types or zones. They are agricultural, residential, public, business, recreational, industrial, transport, defense and security, special protection, forest, water, general use. In turn, each zone is divided into smaller sub-zones. For example, agricultural zone divided into crop, animal husbandry subzones, etc.

The Federal Law of the Russian Federation issued on July 3, 2016, # 354-FZ "On amendments to certain legislative acts of the Russian Federation to improve the procedure for seizure of land plots from lands of agricultural purpose when they are not in use for the intended purpose or use in violation of the legislation of the Russian Federation" amended some earlier issued federal regulations including the Civil Code of the Russian Federation and the Federal Law of the Russian Federation issued on July 24, 2002, #101-FZ "On turnover of agricultural lands". The Law is focused on development of Agricultural Land Market and Agricultural Land Consolidation via involvement of unused agricultural land in turnover and improvement the procedure of withdrawal of agricultural land plots in case of their misuse. The mentioned above law stipulates that agricultural land plots located less than thirty kilometers from the borders of rural settlements could not be used for nonagricultural activities. Agricultural land plot, except land subject to mortgage, or land, in respect of the owner which the court instituted bankruptcy proceedings, could be forcibly withdrawn from the owner in a judicial procedure in case if such land not used for agricultural production for three or more consecutive years.

According to the Federal Law #354, the starting auction price of the withdrawn agricultural land plot is the market value of such land, determined in accordance with the Federal Law of the Russian Federation issued on July 29, 1998, #135 "On valuation activity in the Russian Federation" amended on July 29, 2017, or the cadastral value of such land if the results of the state cadastral valuation approved no earlier than five years before the date of the decision on public tenders.

The method of determining the starting auction price of the seized land plot at public auction must be stated in the court decision on seizure of a land plot and selling it at public auction. Private farms and parastatals involved in state agricultural production support programs could lease state and municipal land up to 5 years without bidding or via land auction in case of availability of several applications. Thus, the implementation of the mentioned above law will allow redistributing and consolidating unused agricultural land in order to increase the efficiency of agricultural production by reducing transaction costs.

According to the Federal Law of the Russian Federation issued on July 13, 2015, # 218-FZ "On State Registration of Immovable Property" the state registration of real estate procedure became more accessible and clarified as well as simplified. The Federal Law # 218 replaced the law on state registration of rights to immovable property and transactions with it. The Federal Law #218 was entered into force on January 1, 2017. The Federal Law # 218 allows in some cases to record restrictions of rights and encumbrances to immovable property, including an easement, mortgage trust management and lease. It provides unified recording and registration procedure for real estate.

According to the Law, the Unified State Register of Immovable Property (EGRN) will be introduced. It will be carried out exclusively in electronic form. It will include the Real Estate Cadaster, the registry of the rights on Real Estate, the registry of the boundaries, registry of the deeds, cadastral maps and registry of the of documents. The EGRN will register the land rights without the application of the owner or transferee.

The procedure will be performed based on information received from notaries. The Law reduced duration of cadastral registration and registration of rights. For example, it constitutes 5 working days for the cadastral registration and 7 working days for registration real estate rights.

The Federal Law of the Russian Federation dated December 30, 2015, # 431-FZ "On geodesy, cartography and spatial data and on amendments to certain legislative acts of the Russian Federation" was issued to ensure the creation of national geodetic, levelling and gravimetric networks to carry out geodetic and cartographic works. Owners of real estate objects, which are points of the above networks, are required to ensure their safety and notify the authorized body about all cases of damage or destruction. In addition, they must provide the possibility of performing to geodetic, cartographic and repair as well as restoration works.

According to the Law, the federal, departmental and regional spatial databases will be established. Access to these databases will be possible via the Internet. The state information system of maintenance of a unified electronic cartographic base will be introduced. The use of this information will be paid. In accordance with the article #32 of the Law, it came into force since January 1, 2017. According to the Law, on January 1, 2017, were changed the names of licensed types of activities and reduced the list of types of geodetic and cartographical works of federal appointment, subject to licensing. Reissuance shall be subject to all existing licenses to conduct such work. The legislation also clarifies the education requirements related to the mentioned above activities. Territorial bodies of the Rosreestr are issued licenses for execution of geodetic and cartographic works. Officials of the Rosreestr must supervise the licensing of geodesic and cartographic activities, carry out inspections and issue orders to eliminate violations. Since January 1, 2017, a subject of licensing is determination of the parameters of the figure of the Earth and gravitational fields, the creation or updating of state topographic maps and plans, the creation of the state geodetic networks, leveling networks, gravimetric and geodetic networks special purpose networks, including networks of differential geodetic stations. Surveyor organizations must have a license to carry out works for establishment, modification and refinement of data related to the state border of the Russian Federation, borders between subjects of the Russian Federation and municipal boundaries. Other types of geodetic and cartographic works can be carried out without registration of the license.

The Federal Law of the Russian Federation issued on July 3, 2016, # 237-FZ "On State Cadaster Valuation" is focused on improving procedures of the cadastral valuation. It introduces the Institute of cadastral surveyors. The Law also transfers the authority on determination of cadastral value to state budget institutions, which will dealt with cadastral valuation on a regular basis. According to the Law, these bodies should use a uniform methodology that will improve the quality of the state cadastral valuation. The Law was entered into force January 1, 2017. Article #19 of the Law devoted the peculiarities of conducting urgent cadastral valuation will enter into force on January 1, 2020.

Institutional framework

On December 25, 2008, in accordance with the President of the Russian Federation Decree #1847 "On the Federal Service of State Registration, Cadaster and Cartography", the Federal Service of Real Estate Cadaster as well as the Federal Agency of Geodesy and Mapping were dissolved. According to the Decree, the Federal Registration Service was renamed into the Federal Service for State Registration, Cadaster and Cartography (Rosreestr). The functions of mentioned above agencies were transferred to the Rosreestr, which is now under authority of the Ministry of Economic Development of the Russian Federation. At the regional level local offices of the former Federal Service of Real Estate Cadaster as well as Land Cadaster Chambers were transferred to the Rosreestr.

An important role in providing the institutional framework for the development of Land Consolidation in Russia plays the Federal Target Program "Development of the unified state system of registration of rights and cadastral registration of immovable property for 2014 – 2020" approved by the Resolution of the Government of the Russian Federation issued on October 10, 2013, # 903 and amended by the Resolution of the Government of the Russian Federation issued on December 22, 2016, # 1444.

The state customer and the program coordinator is the Ministry of Economic Development of the Russian Federation. The Government customers of the program are the Ministry of Communications of the Russian Federation, the Rosreestr, the Federal Tax Service and the Federal Property Management Agency.

The super goal of the program is harmonization of land and property relations based on respecting the balance of interests, mutual responsibility and coordinated efforts of the Government, businesses and society, enabling the transition to innovative socially oriented type of economic development of the Russian Federation. The objectives of the program are the following:

- Merging the unified state register of rights to immovable property and transactions with it and state property cadaster into a unified state information resource;
- Ensuring the provision of services on the principle of "one window" and the transition to assessing the quality of service;
- Improving the quality of these information resources to ensure investment attraction and enhance the efficiency of real estate taxation.
- The total funding of program is amounted 27,100.65 million rubles. Expected outcomes of the program implementation can be described as the following:
- The increase the number of the Russian Federation's regions which implemented the unified state register of immovable property up to 85 units;
- The increase the number of the Russian Federation's regions which ensure the transition to the state system of coordinates from the local coordinate system adopted for conducting uniform state register of immovable property of up to 85 units;

- The increase the proportion of individuals who report positively on the quality of the work of the registration authorities in the total number of respondents to 90 percent;
- The reductions of waiting time in queues for applicants for uniform state register of immovable property information up to 10 minutes.

Regional land policies

Development of Agricultural Land Consolidation in the Russian Federation is mostly depended on Regional Land Policies. One of the successful examples of them is Orel Oblast Land Policy. Orel Oblast Land Policy is based on legal framework included the Federal Legislation as well as local regulations.

Orel Oblast Land Legislation is based on the following legislative acts: The Decree of the Head of Administration of Orel Oblast # 616 issued on December 12, 1997, on farm reorganization and land privatization; Target Program on development of the Legal Basis of Orel Oblast Land Reform approved by the regional authorities on October 10, 1998; Orel Oblast Law issued on June 5, 2003, #331-OZ"On turnover of agricultural lands in Orel Oblast"; Orel Oblast Law issued on May 8, 2015, # 1785-OZ "On amendment to Decree of Orel Oblast Government "On turnover of agricultural lands in Orel Oblast".

Orel Oblast agricultural land was amounted 2, 031.7 thousand hectares, or 82.4 % of total regional land in

Table 7. Orel Oblast Land Categories, 2008-2015

em	2015		2008		2015/ 2008, %
	1000 hectares	%	1000 hectares	%	
Agricultural Land	2,031.7	82.4	2,106.6	85.5	96.4
Urban Land	197.9	8.0	196.0	7.9	101.0
Industrial Land	23.1	1.0	22.6	.9	102.2
Special Protected Regime Land	35.5	1.4	32.1	1.3	110.6
Forest Land	169.2	6.9	100.0	4.1	169.2
Water Land	1.2	-	1.2	-	100.0
Reserve Land	6.6	.3	6.7	.3	98.5
Total	2,465.2	100.0	2,465.2	100.0	100.0

Source: Orelreestr, 2016

Table 8. Break down of Orel Oblast's Land, 2015, 1000 hectares

Item	Total	Agri Land	Crop land	Forest Land	Water Land	Building Site Land	Road Land
Agricultural Land	2,031.7	1,896.4	1,508.0	62.9	12.4	4.9	38.2
Urban Land	197.9	143.2	57.1	10.6	2.6	14.7	22.4
Industrial Land	23.1	2.8	.8	4.8	1.3	2.1	10.8
Special Protected Regime Land	35.5	2.0	.7	32.9	.1	-	.4
Forest Land	169.2	1.7	.2	165.5	.6	.1	.6
Water Land	1.2	-	-	-	1.2	-	-
Reserve Land	6.6	5.1	3.3	.6	-	-	.4
Total	2,465.2	2,051.2	1,570.1	277.3	18.2	21.8	72.8

Source: Orelreestr, 2016

2015 (See Table 7). However, the total agricultural land area has been reduced in the region.

Break down of Orel Oblast's Land in 2015 is shown in Table 8. As we can see from Table 8 the cropland was amounted 79.5 % of the agricultural land in the region in 2015. The share of the agricultural land in the total area of land available in agriculture was amounted 93.3% in the region in 2015.

The private land ownership plays the dominant role in the regional land tenure (See Table 9). The share of private land ownership was amounted 49.4 % of the total land in the region in 2015. The share of the state and municipal land amounted 40.0 % and legal entities – 10.6 % of the total land in the region in 2015.

The private land ownership plays the dominant role in the regional agricultural land tenure too. It consists mostly of land shares owned by the former collective and state farmers (See

Table 9. Land Tenure, Orel Oblast, 2015, 1000 hectares

Item	Total	Private owner ship	Ownership of legal entities	State and municipal ownership				
				Total	Citizens		Legal entities	
					In use	Lease	In use	Lease
Agri Land	2,031.7	1,156.4	259.1	616.2	-	.7	28.7	13.9
Urban Land	197.9	60.1	1.7	136.1	.2	.1	5.6	1.1
Industrial					-	-		
Land	23.1	.2	.9	22.0			8.8	1.4
Special Regime Land	35.5	-	-	35.5	-	-	33.2	-
Forest Land	169.2	-	-	169.2	-	-	-	-
Water Land	1.2	-	-	1.2	-	-	-	-
Reserve Land	6.6	-	-	6.6	-	-	-	-
Total	2,465.2	1,216.7	261.7	986.8	.2	.8	76.3	16.4

Source: Orelreestr, 2016

Table 10. Land Use of Private Farms and Citizens, Orel Oblast, 1990-2015

Item	Year	Total Land, 1000 hectares	including Agri Land 1000 hectares	including Cropland, 1000 hectares	Total Land, 2015/1990, (+,-) 1000 hectares
Private farms	1990	-	-	-	-
	2015	201.0	200.2	183.0	+201.0
Personal Subsidiary Farms of Citizens	1990	42.0	39.9	33.6	-
	2015	85.3	82.3	74.3	+43.3
Individual Housing	1990	-	-	-	-
	2015	4.9	2.4	1.9	+4.9
Collective Horticulture	1990	3.7	3.7	-	-
	2015	9.9	8.8	.1	+6.2
Collective Vegetable Growing	1990	2.7	2.7	2.7	-
	2015	2.4	2.4	2.4	-.3
Land Shares, Grazing, Haymaking Land and etc	1990	-	-	-	-
	2015	289.4	288.9	131.4	+289.4
Total	1990	48.4	46.3	36.3	-
	2015	592.9	585.0	393.1	+544.5

Source: Orelreestr, 2016

Table 9). The private land ownership was amounted 56.9 % of the total agricultural land in the region in 2015. The share of the state and municipal land amounted 30.3 % and legal entities – 12.8 % of the total agricultural land in the region in 2015.

Break down of Orel Oblast's land use of private farms and citizens are shown in Table 10. As we can see from Table 10 the private land use tends to increase in the region. The total area of land used by private farms amounted 201 thousand hectares, or 9.9% of the total agricultural land in the region in 2015. The total area of personal subsidiary farms of citizens increased in 2015 compared to 1990 by 43.3 thousand hectares, or by more than 2 times. The total area of land shares owned by the former collective and state farmers as well as land used for grazing and haymaking amounted 289.4 thousand hectares, or 14.2 % of the total agricultural land in the region in 2015. The main role in Orel Oblast agricultural land use plays joint stock companies and partnerships (See Table 11).

They occupied 1,305 thousand hectares, or 86 % of agricultural land of parastatals of the region in 2015. They have also rented the most of agricultural land shares in Orel Oblast in 2015.

The production coops occupied 143.5 thousand hectares, or 9.5% of agricultural land of parastatals of the region in 2015. The state and municipal enterprises, research institutions and subsidiary farms as well as other parastatals occupied 68.3 thousand hectares, or 4.5% of agricultural land area of Orel Oblast in 2015.

Table 11. Land Use of Parastatals, Orel Oblast, 2015, 1000 hectares

Item	Area	Land Shares	Including not claimed land shares	Legal entities land ownership	State and municipal land ownership
Joint stock companies and partnerships	1,305	762.1	146.0	95.8	284.9
Production coops	143.5	90.1	37.8	.8	41.8
State and municipal enterprises	6.1	.2	-	-	5.9
Research Institutions	27.3	-	-	-	27.3
Subsidiary farms	19.1	2.6	-	-	10.1
Others	15.8	1.3	-	-	4.3
Total	1,516.8	856.3	183.8	96.6	374.3

Source: Orelreestr, 2016

Table 12. Private Farms, Orel Oblast, 1994–2015

Item	1994	2000	2010	2013	2014	2015	2015/1994,%
Number of farms	1,754	1,420	1,247	1,293	1,302	1,292	73.7
Total land area, 1000 hectares	89.2	124.6	177.5	196.2	198.2	201.0	225.3
Average land size, hectares	50.8	87.7	142.3	151.7	152.2	155.6	306.3

Source: Orelreestr, 2016

In 2015, there were 1,292 private farms in the region. The number of private farms has been decreased. In 2015, compared to 1994 the number of the private farms decreased by 26.3% in Orel Oblast. However, their total area and cropland have been increased. In 2015, compared to 1994 the total land area of the private farms increased by more than 2.2 times in the region. In 2015, the average size of the private farm was amounted 155.6 hectares. In 2015, it increased by 3.1 times compared to 1994 due to land consolidation (See Table 12). This trend reflects the process of development of consolidation of agricultural lands in Orel Oblast.

Conclusion

The following measures must be implemented to strengthen the organizational as well as institutional sustainability of development of Agricultural Land Consolidation in the Russian Federation.

- The Agricultural Land Market and Agricultural Land Consolidation Legislation must be revised and improved both at the federal as well as regional level;
- The institutional framework for implementation of Agricultural Land Consolidation must be improved both at the federal as well as regional level too;
- The Agricultural Land Auctions must be introduced to stimulate development of Agricultural Land Market and Agricultural Land Consolidation in the regions of the Russian Federation;
- The training and retraining programs related to Agricultural Land Consolidation issues must be introduced;
- The public relation campaign to strengthen people's ability to understand the role and importance of Agricultural Land Consolidation Development must be initiated;
- The pilot projects focused on Agricultural Land Market as well as Agricultural Land Consolidation Development should be launched in the some of the regions of the Russian Federation to make demonstration effect;
- The Agricultural Land Consolidation Development Experience should be collected, scrutinized and disseminated.

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"We are positive about the growth of the GNSS simulator market"

Says **Mark Sampson,** LabSat Product Manager in an interview with Coordinates

'LabSat 3 WIDEBAND can handle almost any combination of constellation and signal that exists today'. Could you please explain this briefly?

LabSat 3 Wideband is an RF signal record and replay system with three independently tuneable wideband channels which can be adjusted to operate anywhere in the L-Band GNSS range. A powerful web-based graphical interface gives users the power to adjust quantisation, bandwidth and individual channel frequency. This allows for the capture and replay of most GNSS signals and even a few non-GNSS signals.

What are the advantages of LabSat 3 over its predecessors?

LabSat 3 and LabSat 3 Wideband are compact, self-contained, battery-powered devices that can easily fit into a backpack for mobile GNSS recording. Both devices are available with three RF channels allowing a minimum of 3 constellations to be recorded and replayed. LabSat 3 Wideband can record up to 56MHz bandwidth on each of its RF channels allowing multiple constellations to be recorded in each channel.

What are the key features of SatGen software?

SatGen software allows the user to create a GNSS RF I&Q or IF data file that can be replayed on a LabSat providing true multi-constellation simulation capability. SatGen can generate static position simulations or scenarios which are based on a user-generated trajectory file. SatGen compliments the LabSat range of GNSS simulators, and is available in single, dual, triple and multi-frequency/ multi-constellation versions.

How do you see the growth of GNSS simulators market in years to come?

With the boom in wearable devices and autonomous transport we expect to see an increase in all areas of testing from R&D through to production testing. As manufacturing volumes of GNSS enabled devices increase, so the need to test with equipment which produces consistent and repeatable RF signals becomes more pressing. Simulators and record and replay devices are essential in minimising time to market and maximising end-of-line production quality. We are positive about the growth of the GNSS simulator market and think it will continue to grow and prosper in the years to come.

New China-Brazil Earth resources satellite in launch in H2 2019

The China-Brazil Earth Resource Satellite-4A (CBERS-4A) will be launched in the second half of 2019, according to Li Guoping, secretary-general of the China National Space Administration (CNSA).

With a spatial resolution of two metres, the CBERS-4A satellite will offer the highest precision among CBERS satellites, though other Chinese optical remote sensing satellites can offer sub-metre resolution. CBERS satellites are remote sensing satellites specifically designed for Earth observation from orbit for use in areas including environment monitoring, meteorology and map making. *https://gb`times.com*

NGA seeks remote sensing tech for agricultural delineation challenge

The National Geospatial-Intelligence Agency is accepting proposals for a new program aimed at developing a system that can visualize agricultural field outlines from satellite sources.

The Agricultural Delineation contest tasks industry to contribute ideas for a remote sensing platform that utilizes satellite imagery to outline large homogenous and heterogeneous fields that are prominent in the sub-Saharan Africa region.

The agency said satellite-based remote sensing technology significantly aids plant health observation processes that are crucial in estimating farm yields and tracking agricultural productivity. NGA will award a total of $15K and select at least one submission as the winner. Winners may opt not to transfer intellectual property or property rights for their technologies.*https://blog.executivebiz.com*

Moroccan RS satellite successfully put into orbit

European lightweight Vega class rocket with a Ukrainian engine successfully launched the Mohammed VI-B Moroccan Earth Remote Sensing Satellite (ERS) into a sun-synchronous earth orbit.

The mass of the Mohammed VI-B satellite, created by Thales Alenia Space with the participation of Airbus on the order of the Kingdom of Morocco, is 1,108 kg. The satellite will be used primarily for mapping and land surveying activities, regional development, agricultural monitoring, the prevention and management of natural disasters, monitoring changes in the environment and desertification, as well as border and coastal surveillance.

The Vega was developed by the European Space Agency (ESA) in cooperation with the Italian Space Agency (ASI). It is intended for launching into a solar-synchronous orbit with a height of 1,200 km satellites weighing up to 1,200 kg or into a polar orbit with a height of 700 km satellites weighing 1,500 kg. *https://en.interfax.com*

ABB to manufacture an optical sensor for GHGSat

ABB Measurement & Analytics Business Unit in Québec City, Canada has signed a contract with Montréal-based company GHGSat to manufacture and test the optical sensor onboard the company's third microsatellite (GHGSat-C2) aimed at monitoring greenhouse gases (GHG) emitted by industrial facilities around the world. GHGSat-C2, scheduled for launch in early 2020, will further the deployment of the GHGSat satellite constellation. *www.abb.com*

Ethiopia To Build And Launch RS Satellite With Chinese Help

Ethiopian scientists and engineers are building a small Earth observation satellite in cooperation with and with funding from China, which will be launched from China in 2019, according to a report in The East African newspaper. This announcement is the culmination of much effort to bring Ethiopian space ambitions to reality.

Twenty Ethiopian aerospace engineers are involved in the satellite project. Furthermore, about 60 masters and Ph.D. students are also taking part in research and training at the space institute, as well as at the country's multibillion-dollar Entoto Observatory and Research Centre.

Kerala, India join hands with Airbus

The Kerala government signed a MoU with Airbus BizLab India, a global aerospace accelerator which is part of Airbus, for establishing the Aerospace Innovation Centre in Thiruvananthapuram.

Under the agreement, the Airbus will provide support and mentoring for startups in Kerala and conduct regular workshops and discussions with experts from the aerospace and defense sectors.

Further, the France-headquartered company, which has set up facilities in Bengaluru, Toulouse (France), Hamburg (Germany) and Madrid (Spain) to create a global network of business accelerators, is to run training programmes to acquaint participants with aerospace technologies. *www.uniindia.com*

SAR remote sensing experiment site unveiled in northern China

A synthetic aperture radar (SAR) remote sensing experiment site was unveiled in Zhangjiakou, northern China's Hebei Province, according to the China Science Daily.

The experiment site, covering an area of 46,000 square meters, has a comprehensive remote sensing experiment center and a remote sensing information center.

Operated jointly by the Chinese Academy of Sciences and the city of Zhangjiakou, the experiment site is a platform to conduct remote sensing technology research and push forward the transformation of innovation achievements. *www.xinhuanet.com*

£1.5 million geospatial competition open to improve public services

The Geospatial Commission has partnered with Innovate UK to launch a new government competition, where organisations can apply for a share of £1.5 million to fund projects which use data linked to a location. Between £50,000 to £750,000 could be granted to eligible organisations.

The aim of the competition is to explore the benefits and challenges of crowdsourcing data. It will encourage different organisations to work together to identify innovative new ways for crowdsourced data, to either:

- improve the delivery of public services
- support the third sector
- enhance the quality of open public datasets

This new competition an example of how advances in technology can be used to foster economic growth, deliver outstanding public services and generate savings for the public.*www.gov.uk*

UK Hydrographic Office presents Guyana with marine geospatial data

The UK Hydrographic Office (UKHO) has officially handed over marine geospatial data to the Guyanese Government after a campaign of hydrographic surveying.

Delegates from UKHO presented the data to government officials at a special event to celebrate the completion of the survey. Two workshops were held to brief ministers and provide technical support for applications of the data, which will help Guyana support the development of its marine economy.

The data, which was collected over a period of four months between 2016 and 2017, will initially be used to update nautical charts of the Demerara River. This will enable ships to confidently reduce under-keel clearance and maximize cargo-carrying capacity, paving the way for increased import and export activity.

UK Galileo engineers forced to move to EUROPE as EU blocks British from project

Surrey Satellite Technology (SSTL), an independently operated subsidiary of aerospace company Airbus, took the decision in order to carry out a vital classified test on the navigation payload which it supplies to Galileo once Britain quits the bloc on March 29, 2019.

Brussels is planning to cut Britain's access to the secure elements of Galileo, arguing EU law prevents non-member countries from using the system's encrypted navigation system.

The move has enraged the British Government – UK scientists were instrumental in developing much of the technology utilised by Galileo, while Britain has believe to have ploughed £1billion into the project.

Work on Galileo accounts for half of SSTL's annual revenues, and unless the dispute is worked out, the company's latest contract to carry out work on the system will be its last involvement. SSTL is not allowed to bid to provide the fourth set of satellites due to be launched under the umbrella of Galileo. *www.express.co.uk*

NMCG brainstorms on G-governance of Namami Gange programme through Geospatial technology

National Mission for Clean Ganga (NMCG) organized a brainstorming session on World GIS Day 2018 in New Delhi with the theme 'G-Governance of Namami Gange programme through Geospatial Technology'. The objective of the session was to share the knowledge on use and application of geospatial technology for monitoring and management of various activities being undertaken under Namami Gange Programme, and also provide feedback on the current use of this technology with reference to Ganga Basin.

Speaking on the occasion Shri U.P Singh, Secretary, Ministry of Water Resources River Development & Ganga Rejuvenation said that the lack of reliable data is the biggest challenge in the water sector. Geospatial technology can give vital information about the river basin for better monitoring, planning and feedback about programmes for river cleaning and rejuvenation, he said.

NMCG has signed an MoU with National Remote Sensing Centre (NRSC) in the use of geospatial technology in June 2015. They have developed Bhuvan Ganga Geoportal and Bhuvan Ganga Mobile Application .

Bhuvan Ganga Geoportal is available for water quality monitoring, hydrological monitoring, geomorphological monitoring, bio-resources monitoring, and comprehensive geospatial database. Speaking on the occasion Shri Santanu Chowdhury,Director, National Remote Sensing Centre said that the Bhuvan Ganga mobile application is a user-friendly application to enable user/ public to collect and report information on various pollution sources that affect water quality of River Ganga.

IIT Kanpur is executing a project on 'Reconstructing the Ganga of the Past from Corona archival imagery'Deliverables of Corona project would be to make all processed Corona images available for upload on public portal such as Bhuvan, develop an Atlas of the Ganga River showing a comparison between 1960s and the present, establish the reference condition of the Ganga river and quantify the changes in morphological characteristics and land-use/land-cover within the Ganga valley between 1960s and present, propose a policy document on 'desirable' land-use within the Ganga valley, capacity building for Corona image processing through training workshops including development of a working manual.

Another project under execution is on 'Generation of Digital Elevation Model/ Digital Terrain Model using suitable sensors on airborne platform for a corridor along the main stem of River Ganga' by Survey of India. *http://pib.nic.in*

FCC approves use of Galileo GNSS in the US

The FCC has granted in part the European Commission's request for a waiver of Commission rules so that non-federal devices in the US may access specific signals transmitted from the Galileo. While private users were free to use the European GNSS, with this ruling entity such as telecommunications companies can now also use Galileo.

The Order approved finds that the Galileo GNSS is uniquely situated with respect to the US GPS, since the two systems are interoperable and RF compatible pursuant to the 2004 European Union/ United States Galileo-GPS Agreement.

Specifically, the Order permits access to two of the Galileo system's satellite signals — the E1 signal transmitted in the 1,559 – 1,591 MHz portion of the 1,559 – 1,610 MHz Radionavigation-Satellite Service (RNSS) band, and the E5 signal transmitted in the 1,164 – 1,219 MHz portion of the 1,164 – 1,215 MHz and 1,215 – 1,240 MHz RNSS bands.

The order does not grant access to the Galileo E6 signal, which is transmitted over the 1,260 – 1,300 MHz frequency band, since this band is not allocated for RNSS in the US or used by the US GPS to provide position/ navigation/timing (PNT) services. The FCC pointed out that granting access to the Galileo E6 signal could constrain US spectrum management in the future in spectrum above 1,300 MHz, where potential allocation changes are under consideration.

The omission of the E6 signal also means that radio amateurs would not have to protect Galileo receivers from interference on 23 centimeters, which has been a significant issue in Europe.

Russian ambassador to Finland summoned over GPS disruption

Russia's Ambassador to Finland Pavel Kuznetsov has been summoned to a meeting on with Finnish state secretary Matti Anttonen over the disruption of Finland's GPS signal during recent NATO war games.

The Finnish foreign ministry said that the disruption of Finland's GPS signal during recent NATO war games came from Russian territory. The Kremlin dismissed an earlier allegation from Finland that Russia may have intentionally disrupted the signal during the war games. Earlier in November, Finland's air navigation services issued a warning for air traffic due to a large-scale GPS interruption in the north of the country. Russia was also recently accused by Norway, which had posted a similar warning in its own airspace. *www.channelnewsasia.com*

Russia to develop Glonass orbital navigation system with six new satellites

Russia will continue developing its Glonass orbital navigation system with the launch of six new satellites, First Deputy CEO of State Space Corporation Roscosmos forRo Orbital Grouping Development and Priority Projects Yuri Urlichich said.

"We will have new satellites in other orbits that will help us solve the tasks of improving accessibility on the territory of Russia. We are planning to launch six space vehicles that will qualitatively improve the Glonass system. This will improve the accuracy, accessibility and integrity of the system," Urlichich said.*http://tass.com*

New ESA facility puts satnav at the service of science

Global satellite navigation systems are continuously bathing Earth in satnav signals. As well as helping in our daily lives, these signals are also tools for cutting-edge science. A new ESA facility, based at ESA's astronomy centre near Madrid, is championing their use for everything from Earth monitoring to fundamental physics.

The new ESA Global Navigation Satellite Systems (GNSS) Science Support Centre is based at ESA's European Space Astronomy Centre, ESAC, near Madrid. Run by ESA's Galileo Science Office, the GSSC integrates IT and satnav infrastructure to deliver advanced data processing services to the scientific community.

Precisely timed to a few billionths of a second and highly stable, satnav signals can be used as a point of reference for many scientific sectors, including Earth and atmospheric sciences, astronomy, highly precise timing metrology as well as the study of relativity and other fundamental physics topics.

Current satnav infrastructure plans worldwide should see more than 120 satnav satellites in orbit in coming years. This number includes Europe's own Galileo constellation.

Among the activities to be supported by the new GSSC are big data processing of large amounts of satnav data, crowdsourcing as a means of weather monitoring and a scientific assessment of satnav performance in Antarctica.

Two new Beidou-3 satellites launched

Two new Beidou-3 satellites launched. The launch means that a total of 19 Beidou-3 satellites are now in orbit – enough to start providing basic navigation services when testing is complete. By 2020 the system will be expanded to a network of 35 satellites – enough to provide a global navigation and communications system, which industry insiders said could rival the dominance of GPS. *www.scmp.com*

Tunisia to host second China-Arab Forum on BeiDou GNSS Use

Tunisia will host the second forum on Chinese and Arab country cooperation on the use and adoption of BeiDou, in the first half of 2019.

The BeiDou Navigation Satellite System (BDS) will provide services to countries and regions involved in the China-led Belt and Road Initiative (BRI) by the end of 2018; by around 2020, BDS will have "gone global" said Ma Jiaqing, deputy director of the China Satellite Navigation Office, in an article posted on Xinhuanet, based on a report from sources at the 13th Meeting of the International Committee on Global Navigation Satellite Systems (ICG).

Tunisia is home to a regional BDS centre, located in Tunis. The China-Arab States BDS/GNSS Centre was created in 2016 as a pilot programme between China and the Arab Information and Communication Technology Organization (AICTO).

Telit announces the First NavIC-enabled GNSS Module

Telit has announced the SL869T3-I. The new positioning module combines GPS, NavIC, and GAGAN, which enables the creation of high-performance position reporting and navigation solutions.

The SL869T3-I complies with Automotive Industry Standard 140 (AIS-140). An Indian government mandate that requires the use of NavIC for vehicle location tracking devices in all public transportation vehicles, effective April 2019. *https://iotbusinessnews.com*

SOYUZ 2.1B launches new Glonass-M navigation satellite

Russia has continued the expansion of its GLONASS constellation on Nov 3, 2018 launch of a Soyuz 2.1b rocket from the Plesetsk Cosmodrome located in northern Russia.

With the failure of a Soyuz-FG rocket to send two crew members to the International Space Station on Oct.11, it was feared the GLONASS-M launch might slip further. With the cause of that accident determined to be a faulty sensor, pre-launch activities for the GLONASS-M mission got back on track. *www.spaceflightinsider.com*

Navigation without relying on satellites

The UK's first quantum accelerometer for navigation has been demonstrated by a team from Imperial College London and M Squared.

Most navigation today relies on a GNSS, such as GPS, which sends and receives signals from satellites orbiting the Earth. The quantum accelerometer is a self-contained system that does not rely on any external signals. This is particularly important because satellite signals can become unavailable due to blockages such as tall buildings, or can be jammed, imitated or denied – preventing accurate navigation. One day of denial of the satellite service would cost the UK £1 billion.

Now, for the first time, a UK team has demonstrated a transportable, standalone quantum accelerometer at the National Quantum Technologies Showcase, an event demonstrating the technological progress arising from the UK National Quantum Technologies Programme – a £270m UK Government investment over five years. The device, built by Imperial College London and M Squared, was funded through the Defence Science and Technology Laboratory's Future Sensing and Situational Awareness Programme, the Engineering and Physical Sciences Research Council, and Innovate UK. It represents the UK's first commercially viable quantum accelerometer, which could be used for navigation.

Accelerometers measure how an object's velocity changes over time. With this, and the starting point of the object, the new position can be calculated. *https://phys.org*

Eyesight and Exsun partnership

Eyesight a leading provider of edge-based computer vision AI solutions for the automotive industry, has teamed up with top Chinese GPS and telematics firm Exsun to make trucking safer, helping commercial trucks comply with new Chinese regulations which came into place in order to reduce accidents caused by driver drowsiness and inattentiveness. To meet new safety requirements, Eyesight and Exsun have signed a multi-million dollar deal to produce an aftermarket Driver Monitoring System. Eyesight's camera and Computer Vision AI will be part of Exsun fleet management and telematics solutions, which are installed in hundreds of thousands of trucks. *www.eyesight-tech.com*

Hyundai Mobis to launch an 'Open Innovation Center' in Silicon Valley

Hyundai Mobis is launching its first open innovation center, 'M.Cube' in Silicon Valley of the US to make a full-fledged commitment to source and invest in startups possessing new technologies for future vehicles such as self-driving. It will use M.Cube as its core base to discover and invest in startups with strong growth potential in the areas such as self-driving (sensors, logic, software platforms), connectivity (Infotainment, biometrics) and innovative new businesses (AI, vehicle security), to strengthen its technologies for future vehicles. *http://mobis.co.kr/*

XPENG Motors partnersship with NVIDIA

XPENG Motors has signed a strategic partnership agreement with NVIDIA, the world's leader in AI computing, and its China partner Desay SV to jointly develop Level 3 autonomous driving technology tailored for the driving environment in China. Powered by Xavier, XPENG Motors will self-develop the software for China's typical traffic conditions and user scenarios and will work with Desay SV to jointly develop the computing hardware platform for autonomous driving. *www.xiaopeng.com.*

SCISYS launches Cartosys for location-based data, maps and apps

SCISYS UK Ltd has launched its location-based services toolkit, Cartosys. It has been designed to drive the deployment and take-up LBS by offering a new approach to how organizations discover, create and share location-based data, maps and apps.

Virtual Surveyor 6.1 handles more than drone data

Virtual Surveyor 6.1 now handles on-the-fly projections that previously required a separate software package to set the data in the proper coordinate system. It has become popular among surveyors because it bridges the gap between UAV photogrammetric processing applications and engineering CAD packages. The software generates an interactive onscreen environment with UAV orthophotos and digital surface models where the surveyor selects survey points and breaklines to define the topography, creating highly accurate topographic products for CAD input up to five times faster than otherwise possible. *www.virtual-surveyor.com.*

ISO releases first Global Drone Standard

On November 28, the International Organization for Standardization (ISO) released the first ever draft global standard for unmanned aircraft systems (UAS) operations. The standard, titled Draft International Standard for Unmanned Aircraft Systems Operations, represents an important step in standardizing UAS operations around the world. Although ISO will publish the standard for global adoption starting in 2019, compliance is not mandatory. The standard is nevertheless important because the Federal Aviation Administration (FAA) and sister agencies worldwide will likely use it as a foundation for future rulemaking. Operators, service providers, and manufacturers should thus strongly consider early adoption of the standard in preparing for forthcoming regulation.

The draft, ISO 21384-3, is the first in a four-part series of UAS standards that ISO is currently developing. The next three draft standards are to address general specifications, manufacturing, and unmanned traffic management. This maiden draft addresses operational procedures, making it particularly relevant to anyone who operates UAS for commercial purposes. The draft standard covers safety, autonomous operations, data protection, and overall operational etiquette.

The standard, not surprisingly, first directs UAS operators to follow the existing statutes and regulations of the operators' jurisdictions. But it also provides guidance for use in the absence of specific regulations. *www.lexology.com*

Drone Delivery Systems and FlytBase join hands

Drone Delivery Systems and FlytBase have announced a partnership for the development of a precision landing kit, compatible with any delivery drone, to allow for secure and precise drone delivery to AirBox Home, which is the world's first smart drone delivery mailbox. *https://uavcoach.com*

Boeing and SparkCognition to Launch Joint Venture SkyGrid

Boeing and SparkCognition have recently launched SkyGrid, a new company that will enable the future of urban aerial mobility. Based in Austin, Texas, SkyGrid will develop a software platform to ensure the safe, secure integration of autonomous cargo and passenger air vehicles in the global airspace. Using blockchain technology, AI-enabled dynamic traffic routing, data analytics and cybersecurity features, SkyGrid's platform will go beyond unmanned aircraft systems (UAS) traffic management (UTM). *www.sparkcognition.com.*

DARPA conducts autonomous drone operations against communications and GPS jamming

DARPA has conducted a demonstration test series at Yuma Proving Ground, Arizona, USA, showcasing its Collaborative Operations in Denied Environment program for autonomous drone operations in the face of enemy jamming and area-denial efforts.

In the test, deployed CODE-equipped unmanned aerial systems adapted to unexpected threats in an anti-access area denial environment. The drones shared information, planned and allocated mission objectives and tactical decisions among themselves, and operated with a minimal of communications to represent possible enemy jamming.

The tests began with the mission commander interacting with and directing the drones until communications were deemed degraded or cut off. The CODE vehicles then autonomously continued the mission plan without live human direction and communicated with each other on the best ways to accomplish their objectives. This ability would be vital towards long range engagements of mobile ground and maritime targets in high-threat or denied areas, according to DARPA.

Stanford Scientists created a microdrone that can lift 40 times of its own weight

Scientists from Stanford and EPFL in Switzerland created a new micro-drone that can pull objects that weigh 40 times its own weight. FlyCroTug, a micro-drone has the capacity to lift 40 times of its own weight with the use of interchangeable adhesives on the drone's base.

Microspines on the FlyCroTug's base allow it to dig into rough surfaces, such as carpet or dirt, in order to get traction for pulling. For smooth surfaces, like glass, ridged silicone on the base allows the drone to grab the surface using a kind of suction grip. Both of these adhesives only grip in one direction, so they can be easily removed if need be. Using these adhesives, the FlyCroTug, which weighs only 100 grams (.22 pounds), can pull up to four kilograms (or 8 pounds).

New multi-rotor UAV setting standards for lift capacity

Mobile Recon Systems has announced a new unmanned multi-rotor air vehicle (UAV) capable of lifting more than its own weight. This model, called "Dauntless", is designed to set new records for what multi-rotor UAVs can carry. At 78 pounds, the Dauntless has easily lifted an additional payload of 100 pounds as a tethered quadcopter. It is designed to lift over 200 pounds as an octocopter, with a generator-powered flight time of several hours.

Septentrio boosts its portfolio with mosaic GNSS module

Septentrio has announced the launch of the mosaic high precision GNSS receiver module. Small in size, but huge in performance, this module sets a new benchmark for the mass market positioning building blocks. It supports more than 30 signals from all six GNSS constellations, L-band and various satellite-based augmentation systems. Unlike many dual band receivers on the market, it supports correction services and uses RTK technology together with Septentrio's industry-renowned algorithms to guarantee maximum accuracy and availability. The surface-mount design of mosaic is optimised for automated assembly and ease of integration, with a full library of well-documented and flexible interfaces. *www.septentrio.com*

Oscar – a new RTK receiver by Tersus GNSS Inc.

The Oscar is a new generation GNSS RTK system. Support calibration free tilt compensation function, no need to leveling pole. Easily configuration with a 1.3-inch large interactive screen. With an internal high-performance multi-constellation and multi-frequency GNSS board, the Oscar can provide high accuracy and stable signal detection. The high-performance antenna can speed up the time to first fix (TTFF) and improve anti-jamming performance. The built-in large capacity battery can support up to 10 hours of fieldwork. The radio module in the package supports long communication ranges. The rugged housing protects the equipment from harsh environments.

GNSS smart antenna for precision agriculture

Ag Leader has unveiled new guidance and steering solutions for precision agriculture, including a dual-antenna automated steering system and the latest in GNSS technology.

The GPS 7500 is a field-ready, multi-frequency GNSS smart antenna providing the latest technology including access to multiple GNSS signals for up to sub-inch accuracy and increased performance in variable terrain.

When combined with NovAtel's TerraStar-C PROdifferential correction service, GPS 7500 receives multi-constellation support for better satellite availability.

A full range of performance accuracies are available from GLIDE to RTK, offering a variety of solutions for customers. Combined with SteerCommand, the GPS 7500 offers sub-inch real-time kinematic (RTK) accuracy using the Relay 400, Relay 900 or InCommand NTRIP Client.

SP20 handheld GNSS receiver

The SP20 handheld GNSS receiver offers innovative camera-enabled centimeter accurate logging in an everyday GIS and Survey tool.

Rugged, lightweight and versatile, the SP20 delivers high-end performance. Yet it's an easy-to-use, time-saver tool that delivers the accuracy (meter to centimeter) you choose, that's just right for the job.

With Android-based ease and versatility it's the optimal tool for cadastral, construction, or topo surveys; a range of GIS jobs from data collection to inspection and maintenance; as well as for non-traditional geospatial professionals. The 5.3" screen neatly displays the new workflow using a camera to ensure 2D centimeter accuracy handheld and 3D centimeter accuracy with monopole setup.

U.S. Air Force to battle hostile navigation environments

Rockwell Collins has been selected by the U.S. Air Force Life Cycle Management Center (USAF AFLCMC) to provide its latest-generation Digital GPS Anti-Jam Receiver (DIGAR). With unsurpassed GPS threat protection levels, DIGAR receivers will bring highly-reliable navigation for U.S. Air National Guard and U.S. Air Force Reserve F-16 aircraft operating in contested, electromagnetic environments. This will be the first combat fighter aircraft to be installed with the latest version of the receiver. *www.rockwellcollins.com.*

Carlson Survey OEM 2019 Released

The Carlson Survey 2019 OEM has just been released with the AutoCAD® 2018 OEM engine built-in. Carlson Survey users can read and write directly with the current AutoCAD DWG-drawing file format.

Some of the new commands found in Carlson Survey OEM 2019 include:

- Elevation Along Entity – A new command that allows users to create points at an elevation interval along a 3D polyline.
- Import Angle/Distance File – A new command that allows users to draw a polyline using angles and distances in text file.
- Arc Annotation – An added option that allows users to strip degrees leading zero for delta angles.
- Arc Dimensions – A new command that allows users to label arc values along the chord or radial lines.

Trimble announces new versions of eCognition software

Trimble has announced t eCognition® version 9.4 featuring updates to eCognition Developer and the eCognition Oil Palm Application. Trimble's eCognition is a software platform for advanced geospatial image analysis for environmental, agriculture, forestry and infrastructure applications.The software extracts accurate geo-information from remote sensing data. eCognition's intelligent information extraction capabilities accelerate mapping, change detection and object recognition by delivering standardized and reproducible image analysis results. *https://geospatial.trimble.com.*

Quectel Launches Dead Reckoning GNSS Module

Quectel Wireless Solutions has launched a compact dead reckoning GNSS module L26-DR recently.

It is a concurrent multi-GNSS receiver module embedded with dead reckoning(DR) solution, which greatly improves the positioning accuracy and speed while simplifying customer designs. The DR capability ensures the module to deliver the highest-performance positioning solution available, even when GNSS signal is absent or compromised. Equipped with 6-axis sensor MEMs and a powerful GNSS core, the module provides high sensitivity, fast GNSS signal acquisition and tracking with low system integration effort. *https://iotbusinessnews.com*

GNSS receiver for severe reception conditions

Nippon Telegraph and Telephone Corporation (NTT) and Furuno Electric have developed a receiver for GPS and other GNSS to improve time-synchronization accuracy in areas with severe reception conditions such as among buildings and in mountainous areas.

The new receiver promises to enable time synchronization accuracy close to that obtained in open-sky reception environments with no obstructions, even in environments previously considered poor and unsuitable for accurate time synchronization. According to Furuno, time error was reduced to approximately 1/5 of earlier values during tests of the receiver.

Accurate time synchronization with Coordinated Universal Time (UTC), GNSS such as GPS, is used in a wide range of fields such as synchronizing mobile base stations, financial trading, earthquake measurements and other purposes.*www.spacetechasia.com*

Imagination Technologies Introduces Comprehensive GNSS IP Core

Imagination Technologies has announced the offering of the Ensigma Location GNSS IP core that supports GPS, GLONASS, Galileo, and BeiDou as well as several Satellite-Based Augmentation Systems (SBAS) including WAAS and EGNOS. Designed for ultra-low power consumption, the IP is designed to optimize battery powered remote IoT sensors and edge devices, wearables, health monitors, consumer mobile products, automotive after-sales products such as insurance boxes and road tolling equipment, and asset tracking devices.

CHC Navigation introduces the Alpha3D Mobile Mapping Solution

CHC Navigation launched Alpha3D Mobile Mapping Solution providing, a unique combination of leading sensors technologies and CHCNAV core GNSS expertise. It offers geospatial professionals a premium high-performance, vehicle-independent mobile mapping solution to capture mass data in continuously changing world environments, enabling them to get work done quickly and more accurately to increase their ROI.

New version of Trimble earthworks grade control platform

Trimble Earthworks for Motor Graders is a GNSS-based, 3D grade control solution designed to make fine grading more accurate, faster and easier than ever before. In addition, it now gives excavator operators using tiltrotators the advantage of automatic machine control, which can result in increased productivity.

It leverages Inertial Measurement Unit (IMU) sensor technology in combination with GNSS, resulting in increased accuracy and stability in fine grading applications. Operators will enjoy the same intuitive, easy-to-use and learn Trimble Earthworks software available for excavators and dozers.

Trimble announces machine control and payload management on one platform

Trimble announced the Trimble LOADRITE Payload Management for Trimble Earthworks Grade Control Platform for Excavators integration. This integration will help increase productivity and efficiency for excavator operations, allowing contractors to track bucket-by-bucket payload, and monitor mass haul progress from the same Trimble Earthworks display. The versatile system can be installed on any hydraulic excavator that has Trimble Earthworks, and offers an easy transition between grade control and payload management, maximizing the contractor's investment.

DJI supports major test of drone airspace integration

DJI has demonstrated how its AeroScope remote identification technology can be a key element in an unmanned traffic management (UTM) system that safely integrates drones and traditional aircraft into the same airspace.

The AeroScope solution was featured in Operation Zenith, a full-scale test of how a UTM system can enable beneficial uses of drones in controlled airspace while helping monitor unauthorized or uncooperative drone activities. It demonstrated eight scenarios in which drones successfully worked in concert with traditional aircraft movements at Manchester Airport in the United Kingdom. Operation Zenith was led by the aviation technology company Altitude Angel, as well as Manchester Airport and NATS, the UK's leading provider of air traffic control services, and included a wide range of government, industry and academic participants. *www.dji.com*

New software release by Cadcorp

Cadcorp, the UK based developer and supplier of GIS and web mapping software, has announced its latest release – Cadcorp SIS 9. It is a complete set of geospatial tools covering desktop, server, web, and application development environments. It includes multiple performance improvements as well as new and enhanced functionality.*www.cadcorp.com*

Bentley Systems Announces the Acquisition of ACE enterprise Slovakia

Bentley Systems Incorporated has announced the acquisition of ACE enterprise Slovakia, provider of innovative technology solutions to interface with enterprise resource planning (ERP), enterprise asset management (EAM), and GIS. ACE enterprise has been a technology partner of Bentley Systems. *www.bentley.com*

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16-18 Jan
Rotterdam, the Netherlands
https://tusexpo.com

GeoInsurance Europe 2019
22-23 January
London, UK
https://geo-ins-eu.coriniumintelligence.com

Cognizant Autonomous Systems for Safety Critical Applications (CASSCA) 2019
28-29 January
Reston, VA USA
www.ion.org

International LiDAR Mapping Forum (ILMF)
28 - 30 January
Denver, United States
www.lidarmap.org

International Technical Meeting (ITM)/ Precise Time and Time Interval Systems and Applications (PTTI) 2019
28-31 January
Reston, VA USA
www.ion.org

March 2019

2019 URSI Asia Pacific Radio Science Conference
9 - 15 March
New Delhi, India
www.aprasc2019.com

Munich Satellite Navigation Summit
25 - 27 March
Munich, Germany
www.munich-satellite-navigation-summit.org

Land and Poverty Conference 2019
25 - 29 March
Washington, DC, USA
www.worldbank.org

April 2019

Pacific PNT
8-11, April
Honolulu, HI USA
www.ion.org

European Navigation Conference 2019
9 - 12 April
Warsaw, Poland
http://enc2019.eu

FIG Working Week 2019
22 - 26 April
Hanoi, Vietnam
www.fig.net/fig2019

AUVSI Xponential 2019
29 April - 2 May
Chicago, United States
www.auvsi.org/events/xponential/auvsi-xponential-2019

May 2019

13th Annual BasÌŒka GNSS Conference,
5 - 8 May
BasÌŒka,Krk Island, Croatia

4th Joint International Symposium on Deformation Monitoring and Analysis
15 - 17 May
Athens, Greece
http://jisdm2019.survey.ntua.gr

Geo Business 2019
21 - 22 May
London, UK
www.GeoBusinessShow.com

June 2019

HxGN LIVE 2019
11 - 14 June
Las Vegas, USA
https://hxgnlive.com/2019

TransNav 2019
12 - 14 June
Gdynia, Poland
http://transnav.am.gdynia.pl

July 2019

Esri User Conference
8 - 12 July
San Diego, California
www.esri.com

August 2019

The South-East Asia Survey Congress(SEASC) 2019
15 - 19 August
Darwin, Australia
https://sssi.org.au

September 2019

GI4DM
3 - 6 September
Prague, Czech Republic
www.gi4dm2019.org

Intergeo 2019
17 - 19 September
Stuttgart, Germany
www.intergeo.de

ION GNSS+2019
16 - 20 September
Miami, Florida, USA
www.ion.org

ISDE 11
24 - 27 September
Florence, Italy
digitalearth2019.eu

Interdrone
3-6 September 2019
Las Vegas, USA
www.interdrone.com

October 2019

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

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LabSat 3 WIDEBAND

The most powerful LabSat yet, the new LabSat 3 WIDEBAND captures and replays more GNSS signals at a much higher resolution than before.

Small, battery powered and with a removable solid state disk, **LabSat 3 WIDEBAND** allows you to quickly gather detailed, real world satellite data and replay these signals on your bench.

With three channels, a bandwidth of up to 56MHz and 6 bit sampling, **LabSat 3 WIDEBAND** can handle almost any combination of constellation and signal that exists today, with plenty of spare capacity for future planned signals.

LabSat 3 WIDEBAND can record and replay the following signals:

- GPS: L1 / L2 / L5
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- BeiDou: B1 / B2 / B3
- QZSS: L1 / L2 / L5
- Galileo: E1 / E1a / E5a / E5b / E6
- SBAS: WAAS, EGNOS , GAGAN, MSAS, SDCM
- IRNSS

www.labsat.co.uk