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Legal Innovation in Land Law-Is the Future Here?

"And You Shall Bring Forth the Old Before the New…" (Leviticus 26;10)

# Abstract:

The law supports and regulates innovation in other disciplines, but also constitutes in itself an arena of innovation, legal innovation. While jurists can intuitively identify legal innovation, the characteristics of legal innovation attract relatively little attention from legal scholars and innovation researchers outside the discipline of law. Land law is perceived, at first blush, as one of the more conservative, less innovative, branches of law. Nonetheless, the development of land information systems, the establishment of platforms for information sharing and virtual transactions, the development of electronic land registration systems and the emergence of ideas for implementing decentralized land registration through Blockchain have compelled land law to contend with technological innovation and perhaps even develop legal innovation. The aircraft, satellite and drone, and the development of crowded urban areas, have led land law to innovative changes in the three-dimensional concept of property rights in land.

This article will examine the general contours of legal innovation through the prism of land law. Part I will theoretically examine what innovation is, what legal innovation is, and what can be learned from innovation research in other fields about the general contours of legal innovation. Part II will analyze the characteristics of legal innovation arising from technology's penetration of land law, and will draw general conclusions from them as to the general contours of legal innovation. The article shows that the motives that drive legal innovation are often needs that evolve outside the realm of law. Legal innovation is not born of a sudden flash of inspiration but develops from a slow and gradual process that begins with law practitioners before being established by judges, legislators or academicians. It meets with an apprehension towards innovation, but is picking up pace.

Research on legal innovation is in its inception. It requires systematic and comparative investigation in the different branches of law, in disparate countries and in varying periods. It must integrate into the multi-disciplinary research of the innovation phenomenon. It can potentially enhance the understanding and evaluation of innovation processes in law and beyond.

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# Introduction

In recent years, the term ‘innovation’ has become a successful brand. Technological progress and the economic success it has brought innovators has transformed technological innovation into an object of admiration. Everyone wants to leap ahead with a start-up company.[[1]](#footnote-1) Tech companies champion the "passion for innovation" and attempt to attract creative minds to innovation-stimulating work environments.[[2]](#footnote-2) The law, especially intellectual property law, supports and regulates technological and creative innovation.[[3]](#footnote-3) Patent laws require that patents reflect "new and "nonobvious" inventions.[[4]](#footnote-4) Legal scholars attempt to use various branches of law to promote innovation and growth in the economy and other areas.[[5]](#footnote-5) But is law itself an arena of innovation – of legal innovation? Do the concepts, doctrines, theories and techniques produced by the law encompass innovation? If so, when and to what extent?

The law is more preoccupied with identifying innovation in other areas than in analyzing the characteristics of its own legal innovation. Jurists can identify legal innovation in much the same way as they identify pornography: "I know it when I see it".[[6]](#footnote-6) The combination "legal innovation" appears in academic literature, but probably with considerably lesser frequency than other legal terms orid phenomena.[[7]](#footnote-7) The characteristics of legal innovation are accorded relatively little attention by researchers of law.[[8]](#footnote-8) The OECD's Frascati Manual, which enumerates a list of disciplines against which to examine innovation in research and development (R&D), included law as a subcategory of innovation research in the social sciences, but whereas it demonstrated what might constitute innovation in the arts, education, social sciences, and even humanities, it refrained from demonstrating the criteria for innovation in law.[[9]](#footnote-9)

The interest judges evince in the innovation phenomenon is yet more tenuous. The combination "legal innovation" appears in US Supreme Court rulings only once, merely quoting a lower court.[[10]](#footnote-10) The combination "doctrinal innovation" is mentioned there a mere four times.[[11]](#footnote-11) In federal court rulings, the combination appears 21 times.[[12]](#footnote-12) Some of these mentions appear in the context of ruling that the court **did not** have a case of legal innovation on its hands.[[13]](#footnote-13) Only in rare instances do judges accord the title "legal innovation" to a legal process that they are evaluating,[[14]](#footnote-14) and sometimes they use it to label that which they deem excessive innovation.[[15]](#footnote-15) Perhaps judges are too modest to describe their own novelties as "innovation," but they may either fear that their novelty will be considered "a pejorative"[[16]](#footnote-16) or that "if the laws are thought to be stifling towards legal innovations, then Congress is the avenue to change these laws, not this Court."[[17]](#footnote-17)

What was said about legal innovation in general is all the more applicable to land law, which is generally considered a conservative branch of law in which innovation is uncommon.[[18]](#footnote-18) As early as the most ancient societies, land was a central asset in human life and society; therefore, major mechanisms of property regularization were "invented" thousands of years ago.[[19]](#footnote-19) The recognition of private ownership, the regularization of common ownership, and the treatment of adverse possession as a source of ownership were familiar concepts in ancient legal systems.[[20]](#footnote-20) Most of the basic categories of land usages have been serving human society since its inception: agriculture, residence, private and public use. The concept of expropriation for public use, and even the limitations inherent, have been known for thousands of years.[[21]](#footnote-21) *Prima facie,* it might appear that this age-old branch of law is not the appropriate venue for investigating the phenomenon of legal innovation. Perhaps it is more appropriate to research branches of law that are the modern development of contemporary times, such as consumer protection laws,[[22]](#footnote-22) class actions,[[23]](#footnote-23) or measures of fighting money laundering.[[24]](#footnote-24) Even family law, which, much like land law, has supported human society for thousands of year, has been altered by far-reaching legal innovations arising from changes that occurred in the modern family and in reproduction technology.[[25]](#footnote-25) The tempo of change in the field of land law certainly does not approach the rate of technological change outside the court. This is plainly evident upon examining the rate of change undergone by the cellular phone models each of us has possessed in the last decade. Legal innovation generally lags far behind technological innovation.[[26]](#footnote-26)

Nonetheless, over the past century, and particularly in recent decades, technology has accelerated the pace of innovation in land law. The development of land information systems, the establishment of platforms for information sharing and virtual transactions, the development of electronic land registration systems and the emergence of ideas for decentralized land registration through Blockchain have compelled land law to contend with technological innovation and perhaps even develop legal innovation. The aircraft, satellite and drone, and the emergence of crowded urban areas have led land laws to innovative changes in the concept of property rights in land.

The purpose of this article is twofold. Part I will propose viewing legal innovation as an avenue of research to be examined within the context of the broader phenomenon of innovation. It will examine what innovation is, whether legal innovation exists, and how tools from innovation research in other areas can be used to deepen the research insights concerning the phenomenon of legal innovation. Part II will analyze the phenomenon of legal innovation in the field of land law, with a focus on innovations stemming from technological innovation. It will examine whether, and to what extent, these changes led or will lead to legal innovation, and will sketch out the contours characteristic of this innovation. The article will conclude with the lessons that arise from an analysis of legal innovation in the field of land law as pertains to the general characteristics of legal innovation, and indicate possible avenues for expanding the research of the phenomenon in the future.

#  Research of Legal Innovation

## What is Innovation?

Life and humans are constantly innovating. Humans create new things: products, services, ideas, works and inventions. Is every new thing an expression of "innovation"? The term "innovation" derives from the verb "to innovate," which the dictionary renders, "to introduce new things, ideas, or ways of doing something".[[27]](#footnote-27) Innovation is the "first attempt to implement an idea in reality".[[28]](#footnote-28) The OECD's Frascati Manual states that innovation relates to information that is novel, creative, uncertain, systematic and reproducible.[[29]](#footnote-29) As such, innovation is the result of two primary components: an idea and its implementation. It is an action capable of altering reality. The discourse on innovation is very familiar in technological fields. The quest for innovation is the very heart of scientific research and artwork. There is scarcely any field that does not involve innovation: medicine, management, teaching, media, transportation, security, and so on. As we shall see further on, innovation exists in the field of law as well.

What motivates the innovator and what generates the success of his or her innovation? Society in general, and commercial companies in particular, have a vested interest in promoting innovation due to the various benefits it engenders. Both academic bodies of other disciplines as well as commercial companies now engage in researching the motives that drive innovation as well as methods of encouraging it. Innovation can be promoted and developed.[[30]](#footnote-30) Innovation is not merely the result of natural inclination, talent, or random epiphany, and it can find expression in the implementation of existing information, not necessary new, produced by others.[[31]](#footnote-31) Social interaction and data streaming between innovators from varying fields produce and enhance innovation.[[32]](#footnote-32) Innovation is an extended process, not a one-time occurrence. It begins with an idea, but also requires time, resources and additional factors to bring about its implementation.[[33]](#footnote-33) Other directions of research focus on the creativity component that innovation entails.[[34]](#footnote-34) As early as 1926, British social psychologist Graham Wallas identified four stages inherent in every creative process: preparation, incubation, illumination and verification.[[35]](#footnote-35) This theory has since been developed and used in numerous ways, and science now takes extensive interest in the components of creativity and means of enhancing them.[[36]](#footnote-36) Brain researchers are trying to identify the physiological aspects of creativity within the human brain.[[37]](#footnote-37) Behavioral studies indicate that a concrete problem irking the innovator is what breeds creativity, and in some cases, vulnerability is the birth of creativity.[[38]](#footnote-38)

Notwithstanding the respect, not to say admiration, that innovators attract, innovation also sparks fear, apprehension and shock.[[39]](#footnote-39) Joseph Schumpeter, one of the founders of the scientific study of innovation, claimed that combatting the human tendency to cling to current reality and shy away from change is an integral part of the innovation process.[[40]](#footnote-40) Innovation requires those who have grown accustomed to a given reality to relinquish the investment and achievements to which they have become accustomed.[[41]](#footnote-41) As far back as the early 1970s, the thinker Alvin Toffler, in his book Future Shock, foresaw one of today's most common responses to innovation. He predicted that many people would have difficulty acclimating to the dizzying spike in the rate of change that modern society would face. He defined the psychological state of those who would have trouble adjusting to the tempo of innovation as a state of shock, future shock.[[42]](#footnote-42) His prediction, which was based on the rate of change that he witnessed prior to writing the book, i.e., up until the 1970s, is now coming true in full. In a world in which the average age of society is advancing, the acclimation difficulties may exacerbate.[[43]](#footnote-43)

Even if opposition to innovation may be perceived, sometimes rightly, as an expression of apprehension, fear, or shock devoid of a practical basis, innovation in any area has negative ramifications as well, and there are some innovations that should preferably be avoided or passed up.[[44]](#footnote-44) The passion for novelty, and the gains that innovation generates, may blind the innovators to its potential harm.[[45]](#footnote-45) Sometimes innovation has unexpected yet inescapable side effects such as addiction to technology.[[46]](#footnote-46) Innovation produces varying forms of novelties, distinguishable by the intensity of their innovation and the level of influence they exert on society. The literature dealing with commercial innovation differentiates cumulative or negligible innovation from radical or revolutionary innovation.[[47]](#footnote-47) The attempt to appraise innovation confronts several difficulties. The emergence and impact of innovation are often complex processes which extend over time, and are sometimes the result of inter-disciplinary activity; it is therefore difficult to isolate all the components of innovation and evaluate their unique contributions to the innovative result. [[48]](#footnote-48) Moreover, the appraisal of innovation focuses on measurable data such as output (scientific publications, patents), expenses, and income. The focus on measurable or profitable avenues of innovation does not necessarily reflect non-measurable innovation components.[[49]](#footnote-49)

## Does Legal innovation exist?

Is law itself also an arena of innovation, legal innovation? The answer to this question may be influenced by various perceptions of the independent character of the discipline of law. Thomas Ulen claimed that it is only in recent decades that law has become a "science," and that only the use of research methods recognized in other sciences, such as theoretical survey and empirical testing, will lead to scientific innovation that justifies the institution of a noble prize for the study of law.[[50]](#footnote-50) A more optimistic conception of the legal discipline identifies therein, in addition to the influence of other fields, fully unique characteristics capable of producing legal innovation. Legal innovation does not necessarily happen on the podiums or in the writings of theoreticians, but in the day-to-day reality of lawmakers and implementers of law. It finds expression in the creation of legal norms and concepts, in the establishment of institutions that create and implement laws, and in the formulation of legal processes and standard practices. The law innovates itself in these areas but also spurs innovations that impact reality beyond the realm of law. Law is a dynamic discipline that is constantly innovating its sub-branches. At times the innovation finds expression in the formation of new concepts, perceptions or principles, on other occasions in the implementation of existing principles in various situations, and in yet other instances it finds expression in reorganizing information, an idea, or a doctrine. Such innovation alters that which preceded it and also has practical expression. Sometimes it is the product of creativity. Sometimes it is the product of activity within the purview of typical law makers and implementers (such as legislators, magistrates, attorneys, or legal scholars), and sometimes it is borne of the export of ideas from other fields into law. All these channels are arenas of *ex nihilo* legal innovation, even if this form of innovation has not yet been designated a noble prize.[[51]](#footnote-51)

Some of the innovations introduced in the field of law throughout the course of human history are no less astonishing than the technology that gave rise to the aircraft and cellular phone: the emergence of legal instruments (law, constitution, magistrate, bill, company, trust, codex, condominium, registry of rights), the emergence of abstract legal ideas and concepts (good faith, tort liability, human right, environmental protection, consumer protection, intellectual property), the emergence of judicial legal doctrines (equity, estoppel), the emergence of legal process (adversary method, witnesses, jurors, class action) and the emergence of research methods and legal thought (law and economy, a critical approach to law, a feministic, historical, empirical or psychological analysis of law).[[52]](#footnote-52) The development of these innovations required a not insignificant degree of creativity, but also persistence and the ability to confront opposition.[[53]](#footnote-53) In most cases it did not emerge one bout; it evolved from a multi-stage creative process. Many times it arose not only from legal activity, but from creativity and innovation in other fields. In some instances it arose from the need to address changes or innovations that emerged outside the court. Legal innovation stemmed also from rivalry over resources,[[54]](#footnote-54) and from the inclination of some legal scholars towards legal realism that impacts reality.[[55]](#footnote-55) All the innovations mentioned tremendously impacted reality, to a similar degree as technological and scientific innovations have.

Jurists can intuitively sense or gauge the difference between "a major innovation" such as the establishment of a new field of law, or a new concept that impacts its generation, and between a "minor innovation," such as criticism of a judicial decision on a narrow matter.[[56]](#footnote-56) They sometimes tend to overestimate the degree of innovation in their own area of work.[[57]](#footnote-57) In other areas of innovation, technological and scientific, there is an attempt to measure the innovation. I do not know of research efforts in the field of law towards the construction of a method of evaluation of legal innovation. In recent decades the field of law has adopted the ranking method, the evaluation method common in other fields of academic research. This method measures the impact of a legal, academic, judicial or constitutional product on the discourse of researchers, or at the most, of magistrates.[[58]](#footnote-58) The impact factor prioritizes innovations that preoccupy the courts and legal researchers, but does not necessarily reflect the innovation's impact on society at large. It relies on innovations reflected in quantifiable texts (articles, judgments, new, in specific languages) but does not tap the full gamut of factors that can attest to the innovation's conceptual power or the strength of its impact.[[59]](#footnote-59) Law is a very ancient discipline and many of its most revolutionary innovations were born at times when there simply did not exist any means of measuring innovation, or even the aspiration to measure it. Can anyone minimize the innovative value of ideas such as the Tablets[[60]](#footnote-60) or the need for judges[[61]](#footnote-61)? Can anyone second-guess the tremendous contribution made by the development of the deed as a means of payment[[62]](#footnote-62) or the emergence of the innovative idea of a company with a separate legal identity?[[63]](#footnote-63) At first glance, to a layman, and maybe even to jurists, it appears that innovation is not as conspicuous in the field of law as in other disciplines.[[64]](#footnote-64) The impact factor of scientific publications in the field of law is low in comparison with other areas of research.[[65]](#footnote-65) Legal scholars often complain that only a small group of jurists take an interest in their studies.[[66]](#footnote-66) Nonetheless, the limited scope of the discourse does not attest to the absence of legal innovation. It may simply be a case of poor public relations for legal innovation.

## Taxonomy of Legal Innovation

Law follows other developments within society and regulates them. Presumably, the accelerated rate of developments outside the realm of law boosted the rate of legal innovation. Even without an empirical study, any jurist can plainly see the quantitative growth spurt that occurred in recent years in the production of legal materials (case law, legislation, contracts, articles and books). It is now easier to follow the developments as they are documented in electronic databases. The upsurge in quantity presumably entails an increase in the rate of legal innovation. In the general field of innovation research there is room for a deep and systematic investigation of legal innovation. An attempt can be made to define, appraise and maybe even measure the rate of legal innovation, its geographical dispersion, its scope of influence and the processes of its formation.

One of the tools of innovation research in non-legal content areas is the development of innovation taxonomies that attempt to distinguish between types of innovation by branch, geographical dispersion, innovation components, results, and other distinguishing components.[[67]](#footnote-67) Taxonomies are familiar in the field of law as well, but here they do not focus on classifying legal innovation.[[68]](#footnote-68) Many legal studies examine specific areas of legal innovation, or what the researcher deemed legal innovation,[[69]](#footnote-69) and there are also studies that compile multiple examples of legal innovation[[70]](#footnote-70) or attempt to trace the distribution channel of such innovation.[[71]](#footnote-71) The data collected in these studies, as in newer studies, including this article, can serve as basic building blocks for constructing a taxonomy of legal innovation. Such a taxonomy may classify, by various criteria, the diverse forms of expression of legal innovation: abstract legal concepts or ideas (such as human rights), judicial legal doctrines (such as equity), legal instruments (such as a constitution or deed), legal proceedings (such as a class action), technological improvement of legal mechanisms that entail changes in legal concept (such as registration of property rights) or scientific tools for law analysis (economic approach, empirical research). The criteria for comparison may be the type of innovation (an abstract concept, a technological improvement), the branch of law in which the innovation emerged, the disciplinary source (the field of law, an idea borrowed from a different field, or inter-disciplinary idea integration), the incentive for the change (a practical problem, technology, economic profit, academic research), the identity of the innovator (legislator, magistrate, researcher, attorney, other)[[72]](#footnote-72) the character of the innovation process (a sudden flash, gradual development), duration (number of years, decades, centuries), the scope of its geographical impact (universal, local) and its areas of fundamental impact (fields of law, society, social research).

Legal innovation research can help understand the phenomenon and contribute to a new assessment of innovation. It can provide tools to support the development of legal innovation. It may enhance the focus of legal research and extend the scope of impact of its products. It may also provide tools for criticism of the inappropriate or excessive use of the term innovation. Moreover, it may integrate into the general puzzle of innovation research. The development of such a field is a complex endeavor that requires the use of research tools developed in innovation research in other fields, as well as an examination of other legal fields. This is, of course, a mission that this article does not profess to undertake. Further on in this article I will focus on demonstrating the legal innovation phenomenon in land law, a field of law generally deemed conservative and unamenable to innovation.

# **Legal Innovation in Land Law**

## Land Law – A conservative Field

In the course of human history, legal innovations have emerged in land law as well, but the rate of innovation in this field has generally been slower and more gradual. The development of the trust institution, for instance, ascribed to the novel creativity of the equity court in England, was an innovative idea with extensive and diverse impact. It began in the fourteenth century and has endured for several centuries, to this very day. At some point it diverged from the field of land law and was absorbed into company law. [[73]](#footnote-73) It followed from the emergence, centuries prior, of the Islamic Waqf, an institution of public property ownership.[[74]](#footnote-74) The notion of public registration of land transactions, as well, dates back thousands of years. It is alluded to in the Biblical story of the purchase of the Cave of Machpela by Abraham "in the presence of the children of Heth, before all that went in at the gate of his city."[[75]](#footnote-75) It was known in the Ancient Near East and in Greece.[[76]](#footnote-76) Land ledgers were a familiar concept in Central European towns as early as the twelfth century.[[77]](#footnote-77) In 1086, the Norman Conquest of England spawned the birth of the Domesday Book,[[78]](#footnote-78) but the first attempt to develop a national deed registry began only pursuant to the legislation of the 1535 Statute of Enrollments.[[79]](#footnote-79) In the seventeenth century, the US colonies (later to become states) also began instituting these registries.[[80]](#footnote-80) Another three hundred years or so elapsed before the innovative and noteworthy emergence of the title registration system, and its implementation in Southern Australia by Robert Torrens in 1857.[[81]](#footnote-81) This system was based on technological developments that occurred at that time in the surveillance profession, enabling the registration to be governed by precise cadastral survey.[[82]](#footnote-82) Within a few decades it had spread from Oceania to America, Europe and all across the globe.[[83]](#footnote-83)

Another innovative development in the field of land law was the formulation of condominium law. This innovation stemmed from the urbanization process that characterized Europe and America from the start of the industrial revolution, and which has since expanded across the globe. Urbanization brought on the convergence of strangers in city condominiums for purposes of residence or occupation. The new social need is what engendered legal innovation that gave rise to a new industry in land law: condominium law.[[84]](#footnote-84) The legal innovation in this field as well lagged decades, maybe centuries, behind the actual development rate of condominiums. The initial laws in this field were legislated as late as in the twentieth century, post-World War I,[[85]](#footnote-85) but upon their legislation, it was rightfully said of them in 1963 that "Seldom have hard-nosed lawmakers greeted innovation more cordially than they have greeted the condominium."[[86]](#footnote-86) The twentieth century brought to the field of land law a rush of innovation that broke open new avenues. Salient examples of this, though by no means exhaustive, include the recognition of native rights,[[87]](#footnote-87) the emergence of planning and construction law in general and zoning in particular,[[88]](#footnote-88) and the incorporation of environmental considerations in the regulation of land usage.[[89]](#footnote-89)

The examples thus far presented demonstrate how even in the ostensibly conservative field of land law there have evolved original and high-impact processes of legal innovation. The rate of change in this area may be slower than that of the changes in other areas of law. Still, in recent years, technological innovations have brought innovative ideas to the field of land law with unusual velocity compared to the tempo that hitherto characterized the industry. The interval between one development and another is a mere several years, not necessarily decades or centuries. Some of the innovations bring only minor amendments or improvements to the existing land laws. Some spawn the emergence of new legal concepts, and even undermine basic conceptions of land law. In the coming sections I will present and analyze some of the areas of legal innovation that the third millennium has introduced to land law. First I will describe innovations that optimize real estate transactions but do not entail any far-reaching normative changes. Next will come an analysis of initiatives for harnessing innovative technology (Blockchain) for radically changing the land registration and control mechanism by transforming it into an independent and decentralized mechanism without public oversight. I will conclude by analyzing changes to which technology has given rise in the past century in the three-dimensional concept of property rights in land.

## The Use of New Technologies on Land Law

### Land Information Systems

Recent years have witnessed immense technological progress in land information systems. Initial inklings of the concept were expressed as early as the beginning of the 1980s.[[90]](#footnote-90) The technological advances in the field of computers and internet boosted the capacity for collecting data and rendering it accessible to the public. The digitalization of data and the possibility of receiving copies of information by electronic means boost the capacity for data search, facilitate the identification of data, increase the possibilities of its use, and enable the synthesis of information from other sources. Geographic information systems enable the integration of information from other sources in a geographical display on maps and photographs.[[91]](#footnote-91) All these not only enhance the accessibility of the data but also forge brand new integrated data that did not exist in the past. In 2003, a book summarizing the development of geographic information systems stated that one of the future goals of development of the field was "a mobile future."[[92]](#footnote-92) Now, in 2020, this forecast has metamorphosed into reality. The future is already here.

This sort of information system is familiar in the USA[[93]](#footnote-93) and throughout the world.[[94]](#footnote-94) The geographical information available to real estate title holders is vast and relates to a wide range of areas of information vital for realizing, protecting, developing and planning land rights. Governmental, municipal and private information systems provide access to delineations of parcel borders; owner identities (private/public); previous transactions in the asset; tax payments; municipal outline and zoning plans; information on various areas of use (transportation, various infrastructures, environmental quality, security, education, health, religious services, antiquities, voting areas etc.) as well as physical data (climate, geology, water etc.) The information in the various systems is presented as per the geographical location of the asset on a map or an aerial photograph. The viewer can choose the strata of information which he seeks to view, and view it from a personal computer or cell phone. Google's familiar and global geographical information systems Google Earth and Google Maps provide visual information and aerial photographs based on location, as well as additional information, which is sometimes shared by web users, regarding the uses of the land, but Google does not integrate into its maps all the geographical and regulatory information presented in governmental, private and other information systems.[[95]](#footnote-95) Digital copies of records can now be obtained from land records or land registries,[[96]](#footnote-96)

and individuals and authorities can easily and electronically collect extensive and diverse information pertaining to the legal, planning, and economic aspects of any real estate site in which they are interested. The innovations mentioned are more an expression of technological innovation than legal innovation, but still impact the law to some extent. They enhance the decision-making capacities of institutions, corporations and individuals regarding the management, use and planning of land, as well as the performance of transactions therewith.[[97]](#footnote-97) The transparency of information pertaining to land registration is one of the World Bank's criteria for the ease of doing business index published annually.[[98]](#footnote-98) The innovations boost the awareness of individuals of their rights and of any infringement thereof, and helps realize and protect property rights. Courts as well use technological advances to accelerate and fine-tune the accuracy of their resolution of real estate disputes.[[99]](#footnote-99) Due to all this, it can be said that this technological progress involves a fundamental, not just technical, enhancement of property ownership. Moreover, though the innovations described have not yet required the development of new legal concepts, they may lead to such changes in the future. The information's availability may alter the implementation of legal doctrines based on notice of facts or rights, and may at some future point even justify legally requiring the use of technological tools to reduce the risk to the parties to the transaction.[[100]](#footnote-100) As with other technological innovations entailed by making geographical information accessible, the need may arise in the real estate industry as well to legally regulate infringements caused to the privacy of title holders.[[101]](#footnote-101)

The legal, as opposed to technological, innovation inherent in boosting the accessibility of information, is not particularly high. The importance and significance of making information accessible is nothing new. Nor is it unique to law in general or land law in particular. The improvement is not the byproduct of law but of external technological innovations. The emergence is gradual but occurs at a fast rate (a decade or two). The improvement is universal and not unique to any local legal system. It impacts society and the economy, but for the time being, its potential influence on law is limited as it will probably not necessitate the invention of new legal concepts, but, at most, merely require the adjustment of existing legal concepts, doctrines and instruments.

### Sharing Information

Another form of technological innovation that has filtered in to the real estate sector is the ability to create platforms for sharing information. Information sharing occurs in geographical information systems familiar to the public at large such as the Google Earth system which enables the sharing of information depicting geographical sites, and the Waze and Moovit navigation systems that enable the sharing of information about what is happening on the roads.[[102]](#footnote-102) The uniqueness of these systems is in that they not only display information previously collected about land, but also collect data from the user community. The technological ability to share information made it possible as well to share information about properties and the transactions made therewith. Sharing information in this way opens access to properties and uses which in the past could not be commercialized or whose options for commercialization were limited. Sharing triggers a demand for these properties, and sometimes even enables electronic transactions to be made with them.[[103]](#footnote-103) The most salient and widely-known example of this sort of innovation in the real estate sector is the Airbnb platform that enables the sharing of information regarding supply and demand for short-term real estate rentals, and electronically consummates the ensuing transactions.[[104]](#footnote-104) There are also real estate brokerage sites that enable sharing information on real estate supply and demand.[[105]](#footnote-105)

Technological innovation that engenders new products and novel communication options in connection with land is not legal innovation *per se*, yet it impacts the use of land and the implementation of land law. Research of the level of impact of the sharing phenomenon in the real estate sector is in its inception, but is evolving rapidly.[[106]](#footnote-106) The ramifications of the ability to share information may include the need for adaptation of the laws to issues that arise from the new uses of real estate and the new means of concluding transactions. For example, the amplified use of apartments for short-term rentals through Airbnb has already roused several new legal questions such as if and how to allow such use in the case of a condominium,[[107]](#footnote-107) how to prevent discriminatory use of the system,[[108]](#footnote-108) what the liability of owners and renters should be vis a vis third parties,[[109]](#footnote-109) and whether there is room to restrict or apply zoning to this sort of rental.[[110]](#footnote-110) These questions require that legal attention be channeled to a situation which, if not for technological innovation, would never have emerged. This is "reactive" legal innovation that addresses a new social phenomenon that was made possible by technological innovation. At this stage, such phenomena are addressed with standard legal tools that do not require any special conceptual legal innovation.

The scope of influence of sharing technology in the field of real estate is still limited, as real estate transactions generally require registration in public registries. The conclusion of short-term rental transactions via Airbnb is possible since these transactions do not need to be registered in the real estate registry and can therefore be quickly[[111]](#footnote-111) and easily consummated through electronic means, whereas the absence of recordation or registration of a sale, mortgage or long-term lease transaction can result in the loss of the rights or their proprietary priority[[112]](#footnote-112). Therefore, the ability to make such transactions electronically is contingent on further advances in the digital registration of land. We will discuss this in the next chapter.

### E-Conveyancing

The electronic registration of real estate transactions (E-conveyancing) enables real estate transactions to be made and registered in full in the land registry electronically. The technological innovation inherent in this sort of progress is ostensibly no different from the innovation inherent in any type of digital transaction. Electronic commerce has been widespread since the 1990s with respect to various types of chattels, services, information, securities, and coins.[[113]](#footnote-113) The idea of transferring rights in property by way of registration has been around, as well, for as some 150 years. It was unquestionably a marvel of legal innovation and its impact was swift and global.[[114]](#footnote-114) Until the second half of the twentieth century, land registries across the world were based primarily on a manual registration mechanism, but by the first half of the twentieth century information was photocopied and minified[[115]](#footnote-115) and in the final decades of the twentieth century it was typed up by registration clerks into digital format.[[116]](#footnote-116) From that point on, the registers were stored in digital files only. This change saved the cost of storing information and maybe even enhanced its security (backup options), clarity (printed text instead of handwritten manuscript), and accessibility (printing instead of photocopying, and later the invention of the digital copy).

Nonetheless the digitalization of land registry prior to the third millennium pertained only to the final stage of registration and not the earlier stages of the transaction. Real estate contracts as well as powers of attorney and deeds of transfer of rights have been produced or printed with computer programs for many years.[[117]](#footnote-117) Nonetheless, the registration documents were signed, verified, and transferred for registration manually. Transferring the information from the documents to the registry was also done manually, not automatically. The documents were manually stored in the registry or scanned after their manual delivery.[[118]](#footnote-118) The next technological leap required in the digitalization of real estate registration was channeling the whole process to the computer and automating not only the production of the documents but also the signing thereof, their transmission to the registry, their verification, and entry of the information they contained in the registry.[[119]](#footnote-119) Achieving the benchmark of electronic registration is the next step following the technological capacity to digitalize other aspects of real estate transactions such as the transfer of payment from one party to another and payment of taxes and fees; it brings real estate commerce nearer to the end-goal of holistic digitalized handling of all aspects of the transaction, a model which already exists in regard to other assets.[[120]](#footnote-120) Although the technological capacity to perform electronic transactions has existed for several decades, the transition to digital land registration has been slow and tentative. The emergence of the internet made it possible to search for information and obtain it electronically, but there was no way of altering it in this form.[[121]](#footnote-121) Only at a later stage did the monumental technological change occur that transitioned the complete registration process, from start to finish, to an electronic framework. The sluggishness of the process can be explained in light of the economic and public importance of property rights in land, and the resultant concern that digital forgeries, frauds and infringements on the databases would cause significant damage.[[122]](#footnote-122) In 2002, English law set the goal of creating a digital network[[123]](#footnote-123) but only in 2018 was the first digital mortgage deed registered,[[124]](#footnote-124) and full digital registration will not be implemented prior to 2022.[[125]](#footnote-125) The US, Canada (the Ontario District), and Oceana adopted digital registration earlier and more widely.[[126]](#footnote-126)

Digital registration is albeit the result of technological innovation but it is unclear to what extent, if at all, it influences the law or necessitates legal innovation. Its main advantage is the efficiency and speed of the registration process. It enables remote-access to registration, and cuts down on human resources.[[127]](#footnote-127) Yet electronic registration introduced new risks. Most notable is the concern about forged owner identity and electronic theft of the rights. This concern exists, of course, in non-digital registration as well, but the transition to the electronic medium opens the way for new forms of digital forgery and fraud, and also exposes the database to far-ranging forgery risks as opposed to just topical ones.[[128]](#footnote-128) Combatting these risks is primarily a technological pursuit, but it has legal aspects as well. A digital system's weak point is its point of entry. Today's electronic registration systems tend to reduce risk by limiting access to the system to more manageable entities only, such as banks, attorneys or others that engage in real estate.[[129]](#footnote-129) In Australia, only authorized dealers of "good character and reputation", who have the necessary insurance policies may use the service.[[130]](#footnote-130) Also in Ontario, Canada, one of the first countries to institute electronic registration, a special license is required for access to digital registration, which is granted pursuant to application only to attorneys, appraisers, real estate agents, mortgage agents, and applicants who prove in advance "good character/accountability" as well as the financial capability and adequate insurance coverage to indemnify for damages caused as a result of their use. [[131]](#footnote-131) In Israel, access to applications to digitally register real estate transactions is limited to attorneys with a "smart card."[[132]](#footnote-132) Such limitations amplify the dependency of land owners on registration agents and perhaps even undermine some of the aims of digitalization – boosting the accessibility of the registry and the efficiency of the registration process. They also preclude a full transition to electronic registration, as they leave in place the non-electronic registration option for those who cannot use the services of registration agents or choose to refrain from electronic registration. Moreover, most of the currently-operating electronic registration systems do not offer fully automated registration processes, requiring human approval for completion.[[133]](#footnote-133) Are all these restrictions inevitable or are they a reflection of the natural apprehension towards innovation or of the future shock of those who formulated them? Studies on the scope of the frauds perpetrated on electronic land registration systems have yet to be published. It is known that identity thefts of the users of such systems have already been attempted,[[134]](#footnote-134) but random data accrued thus far indicate that the scope of frauds in electronic registration is smaller than that recognized in non-electronic registration systems.[[135]](#footnote-135)

Thus, forgery is the primary area in which electronic registration may impact the law in the future. This impact may be positive and reduce the law's preoccupation with forgery through prevention. Conversely, the law may have to contend with a new phenomenon of electronic forgery and infringements.[[136]](#footnote-136) The changes that emerge in this area may necessitate rethinking the mechanisms of indemnification for those that incur injury through electronic registration. For example, the common entry requirement, that users insure their use of the system, may shift the monetary liability for fraud to insurance entities and elicit a rethinking of the place of indemnification funds for the holders of rights, recognized in some of the property right registration systems.[[137]](#footnote-137) The technological innovation will therefore necessitate economic and legal thought on the question of liability for damages that it causes, should there be such. Electronic land registration, much like the previous examples considered in this Part, is an example of primarily technological, not legal, innovation. The conceptual legal innovation of right registration emerged over one hundred and fifty years ago. The institution of this idea held more innovation than that which electronic registration heralds. Though this digitalization enhances and boosts the efficiency of implementation of Torrens' original idea, it does not change it at the core. The digitalization may require the law to adapt the existing doctrines in the field of land registration to the technological developments. Notwithstanding, at this stage it seems that the intensity of the legal innovation that electronic innovation has brought or will bring to the realm of law is not especially high.

## Distributed Land Registration-The Limits of Technology

### Proposed Use of Blockchain for Land Registration

Start-up companies, technology-geeks forums, and pilots run in various countries, have in recent years examined the possibility of applying a new technology, Blockchain, to implement a far-reaching innovative idea in land law: the creation of a decentralized land registration system not dependent on any authority or primary entity.[[138]](#footnote-138) I shall first explain the characteristics of the technology, and the currently-proposed manner of applying it to land registration. I shall present the changes that such an application may bring to land law, as well as the uncertainties that arise around their feasibility and viability. I will conclude by evaluating the legal innovation inherent in this change.

The Blockchain system is an open source-based digital technology that enables the transfer of encrypted digital data (blocks) from one computer to another (peer to peer), and allows the receiving computer, in turn, to transfer the data block to other computers (smart contract) thereby creating a chain of block transfers (blockchain). Each block, starting with the first (Genesis) is sealed and encrypted with a unique, immutable code (hash). The data formed in this chain of interlinked transfers is stored on all the computers connected to the network (nodes) and a sophisticated algorithm generates a mechanism for the confirmation and agreement of all the network-linked computers, disenabling the alteration of the data transferred in the block, and precluding its transfer by anyone other than the owner of the block. In this way, movements made in the block are immune to change or forgery, and the blocks can be transferred only by the entity to whom the block was sent in a legitimate transfer chain. The information in the transfer chain is stored on all the network-linked computers without the intervention of any central authority. The reliability of the data and the speed of the network's operation depend on the computing power of its computers, and increase in accordance with the level of computing power in the network. The operation of this mechanism is assured through a system called mining, whereby entities that add computing power to the network are rewarded through its operational algorithm with more blocks or block-parts. The computer network that documents the block transactions becomes a reliable ledger of the blocks and their movements. The whole network is a reliable, autonomous register of the blocks' movements, distributed across all the members of the network and revealed to all (a distributed ledger).[[139]](#footnote-139) Each block transferred on the network represents a particular unit – a coin, token or physical asset. The network members may agree that the transfer of each block should be deemed the transfer of one such unit, and this will be reflected in the network's programs and in the consent of its members. In this way, a network based on a chain of blocks programmed to reflect a specific asset can constitute a ledger of movements, transactions and property rights in this asset.[[140]](#footnote-140) As noted above, the notion of transferring rights in physical assets by way of registration in a ledger is not a new idea,[[141]](#footnote-141) and therefore, the transition to a system in which ownership rights in a physical asset find virtual expression in a digital block – is not such a novelty.[[142]](#footnote-142) The significant innovation inherent in the use of Blockchain technology for the registration of rights in assets is the autonomous nature of the network. The technological advantages it offers, such as the transparency of the network and the information's immunity to revision or forgery, are not contingent on the existence of some presiding authority but attained autonomously by the network's working mechanism which is distributed across many independent computers. All that is required for the establishment of this network is the consent of the participants to join, and a sufficient number of participating computers to ensure the working mechanism. The utopic vision of Blockchain enthusiasts is to create universal and autonomous public ledgers that do not require trust clerks and agents to manage them (a trustless public ledger).[[143]](#footnote-143)

The ideas for application of this technology elicit considerable hype among innovation aficionados.[[144]](#footnote-144) Hundreds of patent requests for these applications are submitted globally.[[145]](#footnote-145) The use of Blockchain for registration of asset transfers is already familiar in areas where the consent of the network participants is sufficient for legal recognition of the validity of the transfers. The Blockchain system is at the basis of digital currency commerce.[[146]](#footnote-146) This currency is used on the web, and anyone entering a transaction therewith clearly chose to do so voluntarily. The law has not yet laid down any restrictions regarding methods of transfer of digital coins, which are born of the consent of the network participants, but the decentralized, autonomous nature of these coins has already channeled legal attention to its status as a legal tender, a tax target, and a money-laundering haven.[[147]](#footnote-147) Blockchain networks are now used for supply chain management, as well as commerce with merchandise and chattels including medicine,[[148]](#footnote-148) diamonds,[[149]](#footnote-149) and artwork.[[150]](#footnote-150) There are also active Blockchain applications for copyright commerce[[151]](#footnote-151) and for the issuance of bills of lading.[[152]](#footnote-152)

Notwithstanding, the adoption of the Blockchain system for the registration of property rights and transactions in land already documented in a land record or land register, does not depend solely on the consent or desire of the asset holders. If, at present, it is lawfully required that the transfer of property rights in land be registered in a public registry as opposed to the Blockchain network, there will be no legal validity to the consent of asset holders for their property rights in the asset to be transferred via the decentralized Blockchain network rather than the public registry.[[153]](#footnote-153) Thus, the voluntary use of Blockchain for land registration cannot evolve naturally as did commerce in cryptocurrency or in other physical assets for which there are no public registries. It requires the conscious decision of legislators to replace the currently existing real estate system with the decentralized Blockchain system and confer legal validity to registration in the latter.[[154]](#footnote-154)

### Advantages?

The primary innovation that the Blockchain system can bring to the registration of real estate rights is autonomy and decentralization. This innovation holds many potential risks, some of which are familiar from other areas of use of the Blockchain.[[155]](#footnote-155) The idea that the real estate market will become a decentralized, possibly global, marketplace in which anyone intended to join the block network has the exclusive capacity to perform transactions, without any external intervention, appears, *prima facie,* to run counter to the basic characteristics of every real estate market. At present, real estate registration constitutes a means for authority to oversee transactions or restrict them for various public reasons not limited solely to the desire to uphold the reliability of the transactions and registry. For example, some countries seek to supervise transactions with foreigners,[[156]](#footnote-156) or prevent land grabbing phenomena.[[157]](#footnote-157) The planning and construction laws regulate land use and impose coercive restrictions on the creation of land units and the performance of transactions therewith. Planning information regarding these restrictions is entered in the registry, influences the design of transactions and registration units, and constitutes an integral part of the content thereof.[[158]](#footnote-158) The register records a series of additional involuntary actions forced upon holders of real rights by state authorities, courts or other judicial entities, including encumbrance imposition, property taxation, asset forfeiture, asset expropriation for public needs, and judicial orders to undertake registration activities in accordance with contracts signed or on the grounds of a violation thereof.[[159]](#footnote-159) The decentralization of the Blockchain system, at its technological optimum, renders the block holder the exclusive authority to decide to transfer the block, and the network renders this authority impervious to external intervention. This immunity subverts all the coercive authorities currently involved in the registration. Conversely, were the system to be planned, assuming at this stage that this is feasible, in a manner that eliminates the absolute liberty of the block holder to transfer the block, this retraction of liberty would impinge on the main advantage offered by the decentralization of the system and its severance from public control.[[160]](#footnote-160)

Without adopting the idea of decentralization, the use of Blockchain does not embody any extraordinary innovation. Though the Blockchain system has several other technological perks pertaining to the information it stores, some of these advantages are achieved through alternative channels in the existing registration systems as well. **First**, registration by Blockchain can be public and transparent to all the network participants.[[161]](#footnote-161) The existing registration systems have already developed this same feature[[162]](#footnote-162) although current registers do not reveal to just anyone the full system of transactions made in a given country, but only the map of rights in the specific unit in which the person expressed interest. The digital data is controlled by the authorities, and its security is in their hands. In contrast, in the Blockchain system, each block and registration can be viewed by anyone, gratuitously, and in an electronic format that enables the collection and processing of digital information. The Blockchain bares the big data of the system of rights, as well as the transactions performed in connection with the property for all to see. This may be over-transparency that can be abused. Though there have been proposals for "private" versions of Blockchain, their implementation undermines the notion of decentralization, which as stated, is the system's chief innovation.[[163]](#footnote-163)

**Second**, the information in the Blockchain is well backed-up as it is saved at every node. If one node, or even several, are compromised, this will not harm the data, which will be kept in full in all the remaining nodes. Conversely, the information in the current registries is stored on one server, or at most, on several central servers. Any compromise thereof can severely infringe on the database.[[164]](#footnote-164) The risk of such a compromise is not common, and can probably be solved with simpler, though perhaps not risk-free, backup solutions such as government clouds.[[165]](#footnote-165)

**Third**, the data in the Blockchain is highly resistant to counterfeit due to its verification system, based on a complex algorithm, to which all the network nodes connect. The weight of one node, and even several nodes, attempting to transmit erroneous data to the network, will fail as long as the rest of the nodes do not verify the erroneous information. The information items in a locked block cannot be altered; this includes the time of the transaction and the details of the entity that performed it.[[166]](#footnote-166) In regular electronic systems, what guarantees the reliability of the information is that it is managed by a central authority trusted not to manipulate the data it holds. The risk of registration clerks manipulating information registered in the land register albeit exists, but does not seem to be a significant weakness of the existing land registration system.[[167]](#footnote-167) Moreover, the Blockchain does not supplant the need to examine the reliability of the information streamed thereto. It examines the reliability only of the changes made to the information registered in it, and consequently does not profess to constitute a replacement for the existing inspection mechanisms that examine the identity, legitimacy, and legal validity of transactions generally performed by attorneys, notaries and registration clerks.[[168]](#footnote-168)

**Fourth,** if thus programmed from the start, the Blockchain system allows blocks to be split into non-specific sub-units, and transferred in a decentralized manner to multiple transferees. For example, a bitcoin block can be split and divided among multiple customers at varying values. Such a division enables the mass issuance of blocks to the public, already an accepted practice in the issuance of cryptographic currency (ICO – Initial Coin Offering).[[169]](#footnote-169) In the real estate sector as well, the use of Blockchain can allow electronic real estate blocks to be divided into parts and sub-parts, opening the way for investment of the masses in land purchases, and in funding activity on land. There already exist Blockchain platforms that enable the funding of the masses of projects in the real estate sector, but they do not enable the division of rights registered in the land registries, such as title or mortgage rights in land, but only contractual rights vis a vis other entities registered as owners.[[170]](#footnote-170) It should be noted that the goals of such a division are already achievable through familiar mediums such as the establishment of a company or trust, registering mortgages of varying degrees, and moreover, a property title can be split into parts, so it is difficult to see added value in the proposition of splitting registered property rights into a multitude of sub-parts through Blockchain. Moreover, such a division would cause more harm than good as it would lead to issues of coordination and collective action and would render the land more difficult to use.[[171]](#footnote-171)

### Disadvantages

Whereas the advantages of Blockchain, as compared to the existing registration methods, are not unquestionable, this system has marked disadvantages do not exist in other methods. **First**, the real estate units, the blocks, can be designed only in advance, when the first block is designed. Once a block, or a transaction made therewith, has been sealed, no changes can be made to it *post factum*. This characteristic stands at odds with the lifespan of real rights and creates difficulties which the Blockchain may be incapable of handling. For example, various types of rights, such as rentals, mortgages and easements, form over the course of lifespan of a real estate unit, and not necessarily on its inception. Creating in advance an immutable block for all the rights that may ever form in connection with the asset as well as the full gamut of transactions that may be performed with these rights appears, *prima facie*, complex, and its efficacy seems questionable.[[172]](#footnote-172) Moreover, the uses of the assets and the structure of the registration units evolve over time, and the land registration should reflect these changes. The planning system occasionally seeks to revise the boundaries of land units, or consolidate or divide them. Such revisions may stem from the desire of the parties to divide or alter the asset, but it may also be the upshot of forced planning or expropriation. Such proceedings are subject as well to the surveillance of the borders. The reality is that a legitimate need will often arise to rescind a movement performed in the block due to an error, revisions of a contract, or a breach of contract. It is unclear how the Blockchain system will enable such changes pursuant to the sealing of the blocks. The immutability of the block is one of the system's advantages designed to prevent undesired, fraudulent changes, yet it may undermine the crucial need to make desired changes.[[173]](#footnote-173)

The technological solutions to this problem focus on preprogramming options for change that will enable specific entities to alter blocks.[[174]](#footnote-174) Even if we were to assume that such a solution is technologically feasible, which is by no means certain, it is questionable whether every possible change to block content which may be required at some future time can be foreseen in advance. Furthermore, reprogramming the blocks to enable such patterns of change may compromise the reliability of the system, as it will necessarily infringe on the block-holder's monopoly, and on the immutability of the block and the transactions in which it participates. This may open the way for undesired changes, thereby undermining one of the key advantages of the Blockchain's work method.

**Second**, the Blockchain system is afflicted with general problems that plague electronic information systems. For example, the problem with self-identification upon entry to the system may lead to deception. Though this is a problem that afflicts digital registration systems as well, as previously mentioned, these systems screen the users and allow entry only to attorneys or other authorized entities.[[175]](#footnote-175) Such a solution undermines the decentralized, autonomous nature of the Blockchain network. Moreover, the block-holder's monopoly on the possibility of taking action within a block (a monopoly based on entry passwords) may also cause difficulties when the block-holder is unable to personally take action, such as on his demise, when his rights are bequeathed to his heirs, or if he becomes legally incompetent and requires the appointment of a guardian. The undesirable result in instances when the system cannot be penetrated is that these blocks remain without movement and end up being removed from the land activity cycle. A Google account without movement is not a real estate block without movement. It is unclear whether there is a technological solution to this problem, but should there be such, it would likely render the block accessible to entities other than its owner, or to a central authority. This may prove a breach that infringes on the fundamental innovation of the system.[[176]](#footnote-176)

**Third**, the Blockchain system holds potential new technological risks unknown in the existing systems. This network may become the victim of unique malicious attacks capable of disrupting its working mechanism, such as a disruption of the distributed confirmation algorithm through seizure of control of more than 51% of the network's computing power (51% attack).[[177]](#footnote-177) This is a technological system that is naturally exposed to all and not under governmental control; it is therefore more susceptible to malicious attacks of the sort which have already occurred in the history of the bitcoin system.[[178]](#footnote-178) Moreover, the Blockchain's distributed confirmation mechanism is based on the principle that participants that add computing power to the network receive some form of remuneration. In the bitcoin system, this remuneration is called mining. Yet in the existing registration systems, incentives of this sort are unknown, nor is it clear how "minors" can possibly be remunerated with real estate rights out of nowhere. The Blockchain system requires heightened computing power and electricity consumption, and consequently, a distributed computer mechanism is generally slower than a centralized mechanism.[[179]](#footnote-179) If this is not supplied by computers distributed over multiple stations, it is reasonable to assume that it will be supplied by an authority, thereby once again infringing on the fundamental innovation of this method – the independence and decentralization of its system.[[180]](#footnote-180)

**Forth,** the Blockchain system'smethod of operation does not seem aligned with legal regulations that do not necessarily need to be changed, and which may not even be adaptable to the Blockchain's operation. For instance, when someone performs conflicting transactions in a block, the Blockchain will give priority to one of them based on random, computational calculations, whereas the existing legal systems weigh up considerations like the timing between the transactions, good faith, consideration, and other considerations of justice.[[181]](#footnote-181) The Blockchain does not require any initial registration in the system, whereas initial registration in a regular registry entails inquiries to ensure that the initial registration is correct.[[182]](#footnote-182) Blockchain does not examine a transaction's legal legitimacy, nor does it include a mechanism of liability for errors or problems.[[183]](#footnote-183)

**Finally**, the methods of electronic registration that currently exist already boast high levels of reliability, without the Blockchain system's pitfalls. Even if the Blockchain has some relative advantage, the shift from one system to another involves technological transition costs that may offset the potential advantage of the shift.[[184]](#footnote-184) The fact that good alternatives to Blockchain exist challenges the logic of adopting a slightly better but riskier technology with many drawbacks and unknowns. Most of the attempts made thus far to check out the Blockchain system have been in countries where the existing registration system was problematic (such as Ghana, Honduras, Brazil, Georgia, and Ukraine).[[185]](#footnote-185) The system was tested as well in the US (for instance, in Cook County and in Vermont)[[186]](#footnote-186) but so far, every country to have tested it, including Sweden, has left it in pilot-mode, and has not yet adopted it as an comprehensive, broad-scope substitute for its existing real estate registration system.[[187]](#footnote-187) Pursuant to the experienced gained, what is being voiced today are considerably more modest propositions to incorporate the Blockchain system into the existing registration systems for control purposes, not to replace them.[[188]](#footnote-188)

### Assessment of the Legal Innovation

The Blockchain system seems to constitute a mere technological modification of an existing legal tool (the registration of property rights in land). The technological enhancements of transaction reliability are no more than an implementation with different tools, though not necessarily better ones, of the principles that guided Torrens as far back as a hundred and fifty years ago. In contrast, the innovation of the decentralization of the registry – which goes so far as to abolish public control – stands out in its novelty.

To the extent that technology enables the implementation of this idea, it may drastically change the real estate market and land laws. Such change would be intensely innovative, and it is therefore no surprise that innovation enthusiasts bask in its virtues.[[189]](#footnote-189) Yet the many disadvantages this innovation potentially holds demonstrate the argument that not every change and every form of technological innovation should be embraced. The root of the preoccupation with this technology lies not in the desire to solve a realistic problem or difficulty, but in the very existence of technology. The desire to derive financial benefit from the development of technology and its implementation in the real estate sector merges with the good public relations that innovation enjoys to encourage its incorporation into a field that does not necessarily require this change. Many of the studies that have examined in depth the adoption of Blockchain for land registration share the careful skepticism regarding the technology's adaptation to this field.[[190]](#footnote-190) Nonetheless, the timeless question that dangerously dangles above this innovative idea is whether we have before us a case of needless innovation or just plain old human apprehension towards innovation.

## Changes of the 3D Legal Concept of Land

### *Terra Nullius* of the Age of Progress

 The twentieth century brought changes in the legal perception of one of the basic concepts of land law: the three-dimensional concept of property rights in land. As earth is three dimensional, land is a three-dimensional asset.[[191]](#footnote-191) Human use of land has always focused primarily on the above-ground space, and this still remains the case. Man's experience with the use of caves dates back to prehistoric times, yet the use of subterranean space is still limited compared to the above-ground expanse. The depth of human use of the underground is negligible compared to the depth of this expanse.[[192]](#footnote-192) Nor does the use of the above-ground expanse extend up to particularly elevated heights either. The Tower of Babel is described as having "its top in Heaven"[[193]](#footnote-193), yet even today the tallest building in the world reaches no higher than 828m.[[194]](#footnote-194) The average height of buildings is increasing, as is the prevalence of buildings,[[195]](#footnote-195) yet the average building height (merely 10m) remains significantly lower than that of skyscrapers, and very far from the altitude achieved by aircraft and satellites.[[196]](#footnote-196) Most of the spaces above and below the land's surface have yet to be conquered by man, and the same is true of *terra nullius* of the era of progress.[[197]](#footnote-197)

This long-time reality has influenced the traditional perception of property rights in land. Most legal systems have determined that ownership of land extends above and below ground-level in the form of a cone that narrows towards the center of the earth and widens towards the heavens (*ad coelum et ad inferos)*.[[198]](#footnote-198) Notwithstanding, the practical implementation of this traditional doctrine for hundreds of years remained, for the most part, merely theoretical, as the use of underground or above-ground spaces was limited to areas very near to ground-level, at any rate. In societies in which land use was limited, for the most part, to a single stratum near the land's surface, the horizontal, lower and upper limits of the property rights in the land were in most cases determined only upon the intrusion of neighbors on the under-ground or above-ground space near the land's surface.[[199]](#footnote-199)

Technological and social changes of the modern era, particularly the past century, have increased the possibilities for utilization of the spaces above and below the land's surface, thereby challenging the traditional doctrine. In the early twentieth century, aircraft made their appearance in the above-ground area,[[200]](#footnote-200) next came satellites (commencing in the 1950s),[[201]](#footnote-201) and then commercial drones (particularly in the second decade of the third millennium).[[202]](#footnote-202) The paucity of space in urban centers gave rise to marked pressure for the extended use of subsurface areas.[[203]](#footnote-203) The heightened interest in these areas was spurred also by the quest for minerals and the discovery of new technologies for geothermal energy production.[[204]](#footnote-204) The technology triggered change in the dimensions of land utilized, and these changes called for a reexamination of the traditional legal concept that regulates the extension of ownership across all levels of the land. The legal innovation thus spurred is reflected in several conceptual applications: the setting of an upper and lower limit for property rights in land, and the three-dimensional distribution of these rights. Below I will analyze the characteristics of these instances of legal innovation.

### Restrictions in the Air Space

The emergence of aviation was first to challenge the concept, implied by the traditional doctrine, that aircraft flying over land *prima facie* constituted trespassing.[[205]](#footnote-205) Such a construction of the doctrine threatened the development of aviation. The law's response, in legislation and case law, was to expropriate the option for aircraft passage in the space above land as an easement.[[206]](#footnote-206) Aircraft flight was limited by law to an area above a certain altitude.[[207]](#footnote-207) The development of aviation also necessitated clarification of the concept of sovereignty in international law, and it was thus determined, in the spirit of the traditional doctrine, that a country's sovereignty is not limited to the ground level, but extends to the aerial space above as well.[[208]](#footnote-208) Thus, the emergence of aviation forced the law to make a rather minor revision to an existing legal doctrine, with the help of existing legal tools.

The emergence of satellites in the second half of the twentieth century did not, apparently, require any further change in the realm of private civil law, as the cruising altitude of satellites exceeded that of aircraft.[[209]](#footnote-209) The challenge that satellites ushered in actually pertained to international law: determining the upper limit of the concept of sovereignty.[[210]](#footnote-210) With the advent of aviation, the aerial expanse was distributed among states, but the regulation of satellite flight gave rise to a completely different arrangement. The Outer Space Treaty established that the use of outer space "shall be the province of all mankind" (§1) and that it "is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means"(§2).[[211]](#footnote-211) Thus, the Outer Space Treaty distinguished for the first time between sovereignty in Earth's lower atmosphere, derived from sovereignty over Earth's land and aerial spaces, and between sovereignty in outer space. It also established a new ownership regime for outer space – it would belong to all of humanity, with free access for all.[[212]](#footnote-212) Nonetheless, the precise altitude of the line between outer space and Earth's atmosphere is still in dispute.[[213]](#footnote-213) The ability to dispatch into space satellites with geosynchronous orbits, i.e., which move at the velocity of Earth's rotation, thereby permanently remaining over a specific point on Earth, accelerates the need to resolve this ambiguity. Inasmuch as the anchoring points adapted to the operational needs of these satellites above Earth's settled areas are a limited resource, it became necessary to establish a mechanism for distributing this resource among countries and private entities that wished to use it for stationing satellites.[[214]](#footnote-214) Consequently, the states belonging to the International Telecommunication Union agreed that the Union would be in charge of allocating anchoring points to states. The states, in turn, determine the allocation regulations of the resource allocated to them.[[215]](#footnote-215) The basic assumption underlying this arrangement is that the orbit of these satellites, tens of thousands of kilometers away from earth, at the highest sphere of satellite cruising, is in outer space.[[216]](#footnote-216) This arrangement was accepted despite the fact that seven countries above whose territory satellite anchoring points are situated objected to it, demanding in the 1977 Bogota Declaration that the regime governing territorial airspace – in which sovereignty, like ownership, extends indefinitely from the land up – be applied as well to the orbits of geosynchronous satellites.[[217]](#footnote-217)

The legal discourse on regulating outer space was not innovative from the perspective of the variety of opinions expressed. It was influenced by the models of legal regularization of sovereignty in new continents or in the deep sea, on the one hand, and in the aviation airspace on the other.[[218]](#footnote-218) Nor was the decision to declare outer space in the public domain and open to all anything new, as such regimes had emerged in human culture prior even to the emergence of private ownership regimes. In the second half of the twentieth century, such a declaration was even conservative and short-sighted since as of the 1970s, the public domain regime was more criticized than supported. Such a regime attracts negative external influences and creates the tragedy of the commons.[[219]](#footnote-219) Already, the outer-space expanse in which satellites orbit earth contains extensive space debris and suffers a grave space crisis.[[220]](#footnote-220) Elinor Ostrom's winning of the Nobel Prize to some extent rejuvenated the supporters of a common regime in outer space, but her insights were primarily applied towards a scholarly analysis of the existing situation, with its advantages and disadvantages.[[221]](#footnote-221) Thus, even the regulation of ownership and sovereignty in outer space has not yet produced out-of-the-ordinary legal innovation, although space is at the frontier of technological and scientific innovation.

The final challenge aviation presents to the definition of ownership in the above-ground space is the rapid upsurge in the use of drones for civil and commercial purposes.[[222]](#footnote-222) The altitude at which drones fly is relatively low compared to the altitude of aircraft, so the solution adopted for aircraft flight is impertinent to drone flying. The establishment of a minimum allowable altitude for drone flying will end the growing surge of low-altitude drone usage. A general expropriation of the right of passage for drones would infringe too sharply on the ownership and privacy of the land holders.[[223]](#footnote-223) The need to balance the beneficial and positive use of drones with the obligation to respect holders of property rights in land has yet to produce solutions more creative than those sparked by the emergence of aviation. The aviation authorities treat the drone-flying zone as a segment of the general airspace, and have already enacted guidelines regulating drone flying at low altitude.[[224]](#footnote-224) In ownership law, the consideration given this issue by legislators and courts is still in its inception, but it vacillates between the two extremes of existing law – recognizing the right of flying in the airspace vs. protecting private ownership against infringement.[[225]](#footnote-225) An innovative and original legal idea that has not yet moved beyond the academic sphere suggests introducing drone zoning, which in a fashion similar to the familiar planning and construction laws will distinguish between areas in which drone flying will prove significantly beneficial to land use (Manhattan?) and areas which are less suited to this (quiet suburbs?)[[226]](#footnote-226)

### Underground Boundary for Ownership

Much the way novel uses of land challenged the traditional doctrine in the above-ground space, the concept of ownership was similarly challenged in regard to the underground. As early as the late nineteenth century, various legal systems, anchored in European legal tradition, curbed the extension of the traditional doctrine to the underground space. [[227]](#footnote-227) The exploitation of resources in the underground expanse gradually gave rise to a distinction between property rights in minerals and in the space necessary for their exploitation, and between property rights in the land.[[228]](#footnote-228) In states with a historic past, property rights were divided into rights in ancient strata vs. rights in more recent layers of the earth.[[229]](#footnote-229) International law distinguished between property rights in deep-sea waters and their overhead space, and between property rights in the continental shelf.[[230]](#footnote-230) Notwithstanding, the above-ground space crisis in urban areas broadens the need to establish clear-cut boundaries for the downward extension of property rights. [[231]](#footnote-231) Chinese researchers recently suggested allocating underground spaces based on their uses: uses that produce public products (such as security) should be government-owned, whereas those that supply private products (such as residence) would be allotted to individuals.[[232]](#footnote-232) In Israel, a national outline plan for the development of underground space proposes limiting the extension of subsurface property rights in land to 30m below ground-level, or at least establishing an easement for public passage at this point.[[233]](#footnote-233) The President of the Supreme Court at the time wrote that "the limits of expansion [of property rights in underground spaces] must be reconsidered and adapted to the needs of modern life."[[234]](#footnote-234) Even in the event that these suggestions were to be accepted, the legal innovation they represent is fairly resemblant of innovations previously introduced in regard to the upper limit of ownership.

### Ownership in 3D Spaces

Another expression of legal innovation in recent years, arising from the creation of the three-dimensional concept of property rights in land, has been the development of possibilities for splitting land into separate three-dimensional property units. The traditional concept, which originated in Roman law, saw as one piece not only the various different strata of land, but also all the attachments and structures thereof (*quicquid plantatur solo, solo cedit* ).[[235]](#footnote-235) It was formed in a world in which the usage of land was generally limited to a single level. The emergence of multi-level uses in modern times is what led the law to qualify the traditional doctrine and enable the division of property rights in land into separate units layered vertically on top of one another. As noted above, the discovery of minerals and antiquities on land and by sea led, even prior to contemporary times, to the division of ownership over different levels of land.[[236]](#footnote-236) Recently, interesting ideas have been proposed for the division of sovereignty between states over different strata of land.[[237]](#footnote-237) Notwithstanding, the impact of this legal innovation was irrelevant to the majority of municipal areas in the world.

One of the most striking innovations that the twentieth century brought to the urban environment, specifically, was the development of condominium laws. The conception that property rights over various levels of residence could be divided, is not a new legal idea. A text as ancient as the *mishnah* already debates the possibility of separate ownership over the first and second stories of a house.[[238]](#footnote-238) Notwithstanding, in ancient times, the two stories were probably owned by blood relatives, the members of a single family or tribe, and did not reach very high. The industrial revolution marked the beginning of a mass-scale immigration process that continues to gain momentum to this very day, in the context of which millions of people have relocated from rural areas to the urban environment. At present, over 50% of the world's population is urban, and in 2050, a projected 70% of the world's population will reside in the city.[[239]](#footnote-239) The upshot of this mass migration was the convergence of millions of strangers in crowded urban areas limited in space. The need to house these immigrants led to the rapid development of the condominium phenomenon: high-rising buildings designed to house individuals alien to one another in separate units within a single structure. The legal response to the phenomenon began with judicial attempts to qualify the traditional doctrine by separating property rights in things permanently affixed to the land such as apartments and rooms, from property rights in land.[[240]](#footnote-240) Only in the course of the twentieth century did there emerge, first in practice and later in legislation, a specialized branch of land law, condominium law, designed to provide a comprehensive legal response to the new social and architectonic phenomenon. These laws made it possible, for the first time, and in defiance of the traditional doctrine, to create three-dimensional real estate units (apartments or units). They also formed a special system of coownership rules unique to this legal institution.[[241]](#footnote-241) The condominium's legal form now influences the development of cities.[[242]](#footnote-242) The innovation that this form entailed was considerable. Not only did it create something new which was different from the traditional laws of common ownership of land that defined the legal systems until its inception, but it also impacted reality. It was designed to solve a real problem, and it offered a solution that was widely accepted. Although its emergence in the early twentieth century lagged somewhat behind the emergence of the need for condominiums, it wasn't too late. This exemplifies how legal innovation at its best is not the upshot of a one-time occurrence but the product of slow and gradual evolution.

The legal system is currently in the process of developing a more advanced capacity to handle the three-dimensional partition of land. This earliest inklings of this process emerged in the twentieth century, and it has gained strength in recent years. The space crisis in urban districts gave rise to the growing need for the multi-level usage of these zones. Just as the condominium laws separated the property rights in different condominium units, the multi-level development of urban space creates the need to separate the property rights in various levels of urban land, based on usage type.[[243]](#footnote-243) The genesis of the legal innovation in this area was marked by the emergence of air rights in the twentieth century. These laws initially emerged as a practical means of enabling transactions to be made with independent units of air rights above train and transportation facilities, and the registration thereof in the land records.[[244]](#footnote-244) Sporadic legislation enabled this sort of airspace to be leased, or encumbered as a real estate easement, but the federal stance rejected the use of this tool for the transfer of ownership of independent air parcels.[[245]](#footnote-245) In 1973, a version of the Model Airspace Act was proposed, which enabled such a transfer as well, but this version was not promulgated in state or federal legislation.[[246]](#footnote-246) Such legislation was enacted in New-Brunswick, Canada.[[247]](#footnote-247) In 2018, Israel amended its Land Law, explicitly permitting registration in the land registry of a "three-dimensional parcel" which is "a volumetric unit whose boundaries are registered in a three-dimensional manner, located in the depth below the earth's surface or in the space above it, in registered land."[[248]](#footnote-248)

The land laws in most countries worldwide were not quick to indiscriminately recognize the possibility of dividing the strata of land into independent three-dimensional units, not units in condominiums. This can be explained by practical and conceptual obstacles. First, in legal systems that uphold land title registration, precision in defining boundaries is of the utmost importance. To enable the creation of three-dimensional units, there was room to first tackle the challenge of three-dimensional surveillance and mapping (3D cadaster). The field of geodetic surveillance began addressing this challenge only slightly prior to the third millennium, and did not complete its mission until the millennium's second decade.[[249]](#footnote-249) Moreover, the transition to three-dimensional registration required the adaptation of these registers to the presentation of three-dimensional registration units. Although the technology necessary for this is nothing out-of-the-ordinary, the difficulty was in integrating it into the existing registration systems which are generally old and differ in their technological concept and computer infrastructure. This challenge was only surmounted as late as the first two decades of the third millennium.[[250]](#footnote-250)

Beyond the technical difficulties, the notion of three-dimensional land partition must wrangle with new conceptual questions. First, the legislative recognition of three-dimensional land units requires that the land unit's three-dimensional boundaries be explicitly defined. Unlike condominiums, the boundaries of spaces of land are not limited to the architectural structure of a house or units thereof, and there are, *prima facie*, no natural limits to aid the partition. It is the law that needs to set the criteria for this. Legislation that enables three-dimensional partition must therefore delineate the considerations behind the establishment of these boundaries. In addition to the quest to enable any partition that reflects the desire of the owner of the land, and particularly such that would enable more efficient use of the land's strata, there are various dangers inherent in land partition that could interfere with the ability to utilize the land on all, or some, levels. For example, the interdependency of layers of land stacked upon one another exceeds the interdependency of adjoining pieces of land. Earth's gravity, as well as issues of access to the spaces above or below the surface of Earth, require advance regulation of the relationship between the layers regarding issues like support, access and drainage.[[251]](#footnote-251) This interdependency is influenced by the land's geologic and topographic composition, and the partition therefore requires that an engineer first examine the various aspects of this interdependency such as the distance required between different layers to enable proper usage of each layer.[[252]](#footnote-252) Another risk, pertinent also to the partition of adjoining parcels, is excessive partitioning of the strata, which would lead to coordination issues.[[253]](#footnote-253) Due to all these reasons, the option to create three-dimensional parcels must be restricted by advance planning. Planning errors may result in partitioning that renders it irrevocably difficult to use the land. Moreover, the existing law generally treats all the strata of land as part of single unit. The three-dimensional partitioning of land will introduce into the real estate market new three-dimensional units which are not currently part of the market. There will therefore be room to incorporate this development in urban planning.[[254]](#footnote-254)

A second conceptual problem spawned by the legal recognition of three-dimensional land partitioning relates to the fate of whatever area remains above or below the three-dimensional parcel or parcels. Prior to three-dimensional partition, the status of the remaining area is the same as the rest of the layers of the land. It is the partition that gives rise to the question who will own this area. The solutions proposed for this question can already be found in the annals of the legal doctrine on the extension of property rights in space, and they include allocating the remaining area to whomever owned it prior to the partition, attaching it to one of the three-dimensional strata, expropriating it,[[255]](#footnote-255) or declaring it in the public domain, in similar fashion to the decision rendered in regard to outer space. [[256]](#footnote-256)

The problems enumerated did not impede progress towards recognition of the possibility of three-dimensional land partitioning, but even in the most progressive countries, three-dimensional registration has yet to be actually implemented.[[257]](#footnote-257) One of the reasons for this may be the natural human apprehension towards innovation. Attestations to this apprehension, even fear, can be found in the writings of jurists that supported three-dimensional partition in the early twentieth century.[[258]](#footnote-258) In an article written in 2013, the authors, engineers by training, suggest that one of the reasons for the sluggishness in implementing the three-dimensional land partition is "cultural-cognitive," as they put it, meaning:

"Our cognitive capacity and sense-making regarding land and property representation has (largely) been oriented towards two-dimensional representations for a long time…The tendency for people to fall back on either what they know best, what they are used to, or the response which has become most routinised, is especially prevalent in the face of new and complex situations or technologies."

Thus, it is possible that the intensity of innovation that the three-dimensional partition involves is more daring than customary in land law.

### Assessment of the Legal Innovation

What can be learned about the nature of legal innovation from the legal developments pertaining to the three-dimensional concept of property rights in land that began to emerge towards the end of the nineteenth century? The goal of legal innovation in this area was to redefine the concept of property rights in land. The establishment of limits to the extension of property rights above or below the land's surface, as well as the creation of independent units in condominiums, generally reflected an adaptation of the law to the boundaries formed by reality. Conversely, the notion of creating three-dimensional units across all the land's dimensions pretentiously creates imaginative boundaries, *ex nihilo,* that do not necessarily reflect existing usage but predict future usage. The innovation introduced in these areas was driven by real needs – the mounting usage of the spaces above and below the land's surface as well as the shortage of land in crowded urban areas. Although technological changes have contributed to the emergence of these needs, the incentive for innovation was a real need that stemmed from the usage of the land, not merely from the existence of technology. The legal solutions devised drew their substance primarily from the further development of existing legal solutions, but they also involved the concoction, *ex nihilo*, of legal concepts, and some degree of legal creativity. Innovation was introduced to this field only pursuant to a prolonged, slow and prudent incubation process that moved forward inch by inch; it was not the result of a sudden flash of inspiration. The process was advanced by various lawmakers (attorneys, judges, legislators and academicians) in close conjunction with other disciplines (especially geodesy). The legal innovation in this field addressed the newly emerged needs, but also, in itself, influenced the rate of their emergence.

# Conclusion

 Man envisions ideas and implements them in every area of his life. Innovative development accelerates, especially in technological fields. Consequently, research of the innovation phenomenon developed, in an attempt to investigate the causes and ramifications of innovation and find ways to improve it. Innovation in disparate areas often share similar characteristics. Innovation is not necessarily the result of a sudden flash, but the upshot of an extended process. In many cases, it arises from a real need for a solution, and it generally meets with apprehension towards change. This apprehension tends to mount as innovation increasingly accelerates.

Innovation exists in law as well. The law regulates and encourages other fields of innovation, but also devises its own innovations – it creates legal arrangements, legal institutions, legal procedures, and legal technologies. Legal innovation usually arises from the need to regulate innovation outside the realm of law or from technological or social progress, but sometimes legal innovation is conceived, *ex nihilo*, within the law itself, and then goes on to influence reality.

The scientific branch of innovation research has not accorded much attention to the research of legal innovation perhaps because law is not, by nature, a technological or production industry. Jurists take an interest in new ideas introduced in law, but less so in legal innovation. Notwithstanding, legal innovation has similar characteristics to the innovation in other fields. The field of legal innovation, its motivations, expressions and ramifications, can be researched in much the same way as technological innovation is researched.

In this article I sought to demonstrate this proposition through an analysis of the innovation phenomenon in land law, an ancient field of law which is considered quite conservative in its rate of innovation. Social and technological changes gradually accelerated the pace of innovation in this field as well: computers, digitalization, and the emergence of geographic information systems have boosted the level, accessibility and scope of content of computerized data systems, enhancing the protection of property rights in land, and optimizing the possibilities for their utilization. The capacity for information sharing gave rise to commerce in new products and new commercial arenas. Technology boosted the capacity to register property rights in land electronically, and it now seeks to decentralize this registration. The spatial concept of property rights in land is subject to constant change to the backdrop of the emergence of new usages for the spaces above and below the land's surface as well as the need to optimize the usage of the land's various strata. This article does not pretend to cover all areas of legal innovation in land law.

An analysis of these examples produces several insights into the characteristics of legal innovation. It is usually a reactive form of innovation, spurred by needs or problems outside the realm of law, not necessarily ideas introduced out of nowhere by a theoretician. Reality has always preceded the attention accorded to matters by the law, though in some cases, as in the case of the condominium laws, the legal solution accelerated social processes (urbanization). The propositions to adopt the Blockchain system for land registration are an example of legal innovation arising from technological innovation, not necessarily from a realistic problem that needs to be solved. This is innovation that is still in search of a problem suited to the solution. Legal innovation, in all of the examples, is not the result of a sudden flash of inspiration, but develops from a slow and gradual process. Its development generally reflects the mechanism that creates legal norms: it generally begins with law practitioners (attorneys, clerks) and is only later approved or improved by the creators of institutional norms (judges, legislators, and academicians, in this order). The natural apprehension towards innovation exists in the field of law as well. The pace of legal innovation is accelerating, though it is not in sync with the tempo of technological innovation.

Just as a seemingly conservative field like land law offers insights into the nature and characteristics of legal innovation, there is what to learn about legal innovation from the innovation research in other branches of law, both the ancient ones and the more modern, technology-related ones. The comparison between legal innovation in different branches, in disparate countries and in varying periods can enhance the understanding of innovation processes as well as the capacity to appraise or improve them. Legal innovation can benefit from insights garnered from innovation research in other disciplines, and insights pertaining to legal innovation may contribute to the study of innovation in other disciplines.

1. Richard Rhodes, *Introduction*, Visions of Technology: A century of vital debate about machines systems and the human world 21, 21-24 (Richard Rhodes ed., NY 2000); Gili Drori, Avida Netivi, STEM in Israel: The Educational Foundation for ‘Start-Up Nation’-Preliminary report 3-6 (2013); Saul Singer, Dan Senor, Start-up Nation: The Story of Israel's Economic Miracle x (2009). [↑](#footnote-ref-1)
2. Timothy Butler, James Waldroop, *Job Sculpting – The art of retaining your best people* , 77 Harvard Business Review 144, 148 (1999). [↑](#footnote-ref-2)
3. Gregory N. Mandel, *Left-brain versus right-brain: Competing conceptions of creativity in intellectual property law*, 44 U.C. Davis L. Rev. 283, 288 (2010). [↑](#footnote-ref-3)
4. John F. Duffy *Inventing Invention: A Case Study of Legal Innovation* 86 Tex. L. Rev. 1, 6 (2007) (describing these requirements in the US, Europe and the Far East) [↑](#footnote-ref-4)
5. See, for example, the collection of articles, The Kauffman Task Force on Law, Innovation and Growth, Rules for Growth-Promoting Innovation and Growth through Legal Reform (Kauffman Foundation 2011). [↑](#footnote-ref-5)
6. Jacobellis v. Ohio 378 U.S. at 184, 197 (1964). [↑](#footnote-ref-6)
7. A Google Scholar search on May 6, 2020 produced 9900 items mentioning this combination, only 1,320 of which appeared in periodicals that included the term "law" in their title. For comparison's sake, the term "economic analysis of law" is mentioned in approximately 39,300 items and 6,590 respectively. The number of mentions, of course, provides only a general idea of the level of interest in the field. Ewoud Hondius, *The Innovative Nature of Consumer Law*, 35 J. Consumer Policy 165, 167 (2012) (claiming that studies on legal innovation do not necessarily use the term "innovation"). [↑](#footnote-ref-7)
8. Duffy, supra note 4, at 3 (2007) ("The existing scholarly treatments of legal change are invariably primitive. Legal change is treated as if it is something that just happens…?); Florian Möslein, *Legal Innovation in European Contract Law: Within and Beyond the (Draft) Common Frame of Reference*, European Private Law After the Common Frame of Reference 173, 174-176 (Hans W.Micklitz, Fabrizzo Cafaggi eds. 2010) (reviewing the scant literature on the topic). [↑](#footnote-ref-8)
9. OECD Frascati manual 2015:Guidelines for Collecting and Reporting Data on Research and Experimental Development 59, 64-65, 67, 74-76 (2015), <https://www.oecd-ilibrary.org/docserver/9789264239012-en.pdf?expires=1550502258&id=id&accname=guest&checksum=F51C4BE47D2247EA45EAF7B67A168833>. [↑](#footnote-ref-9)
10. Quill Corp. v. North Dakota, 504 U.S. 298, 301 (1992). search results in database West 6.5.2020 [↑](#footnote-ref-10)
11. Ibid [↑](#footnote-ref-11)
12. Ibid [↑](#footnote-ref-12)
13. [U.S. v. Bownes](https://1-next-westlaw-com.ezproxy.colman.ac.il/Document/Iba9bbd49b68311d9bdd1cfdd544ca3a4/View/FullText.html?listSource=Search&navigationPath=Search%2fv1%2fresults%2fnavigation%2fi0ad604ac00000171e9e76ea31201036a%3fNav%3dCASE%26fragmentIdentifier%3dIba9bbd49b68311d9bdd1cfdd544ca3a4%26parentRank%3d0%26startIndex%3d1%26contextData%3d%2528sc.Search%2529%26transitionType%3dSearchItem&list=CASE&rank=5&listPageSource=bc8d55df0efc5310983204df5890236b&originationContext=docHeader&contextData=(sc.Search)&transitionType=Document&needToInjectTerms=False&enableBestPortion=True&docSource=6f91170978724163a9f0f5f5c450d0ed), 405 F.3d 634, 637 (2005 (("it is no more, and indeed less, of a 'sea change' than numerous other legal innovations scattered across the volumes of the United States Reports and the Federal Reporter"). [↑](#footnote-ref-13)
14. In re DES Cases 789 F.Supp. 552, 561 (1992 (("mass torts prompted the next wave of doctrinal innovation"). [↑](#footnote-ref-14)
15. 499 U.S. 467, 529 (1991 ((Justice Marshall dissenting opinion: "Ironically, the majority seeks to defend its doctrinal innovation on the ground that it will promote respect for the 'rule of law'… Obviously, respect for the rule of law must start with those who are responsible for pronouncing the law"). [↑](#footnote-ref-15)
16. US v. Mckinney, 919 F.2d 405, 421 (7th Cir. 1990); Robert F. Blomquist, *Thinking about Law and Creativity: On the 100 Most Creative Moments in American Law*, 30 Whittier L. Rev. 119, 120 (2008) [↑](#footnote-ref-16)
17. *In Re* Richard Case No. 16-42080-659 (Bankr. E.D. Mo. Oct. 10, 2018). [↑](#footnote-ref-17)
18. John R. Nolon, *Champions of Change: Reinventing Democracy through Land Law Reform*, 30 Harv. Envtl. L. Rev. 1, 2 (2006 (("Our legal system exhibits great resiliency in the face of change"(. [↑](#footnote-ref-18)
19. [Robert C. Ellickson](https://scholar.google.com/citations?user=w6BKe_QAAAAJ&hl=iw&oi=sra), Charles DA Thorland, *Ancient Land Law: Mesopotamia, Egypt, Israel*, 71 Chi.-Kent L. Rev., 321, 324 (1995)‏; Henry Schaffer, Hebrew tribal economy and the JubileeIII–V (New York: G. E. Stechert & Co., 1922). [↑](#footnote-ref-19)
20. *Id*. at 336-37, 366-67, 384. [↑](#footnote-ref-20)
21. Kings 1; 21 (the Naboth the Jezreelite vineyard affair); Ora R. Sheinson, *Lessons from the Jewish Law of Property Rights for the Modern American Takings Debate*, 26 Colum. J. Envtl. L. 483, 499 (2001) (comparing the land laws in ancient Jewish law and in American law). [↑](#footnote-ref-21)
22. Lizabeth Cohen, A Consumers' Republic: The Politics of Mass Consumption in Postwar America 20-24 (New York 2004); Hondius supra note 7, at 167 and onwards (explaining why consumer protections laws are innovative). [↑](#footnote-ref-22)
23. David Marcus, *The History of the Modern Class Action-Part I: Sturm Und Drag 1953-1980*, 90 Wash. U. L. Rev. 587, 600 -604 (2013). [↑](#footnote-ref-23)
24. Liliya Gelemerova, *On the frontline against Money-laundering: the Regulatory Minefield*, 52 Crime, Law and Social Change Journal 33, 34-35 (2009). [↑](#footnote-ref-24)
25. David Marcus, *The History of the Modern Class Action-Part I: Sturm Und Drag 1953-1980*, 90 Wash. U. L. Rev. 587, 600-04 (2013). [↑](#footnote-ref-25)
26. Marsha Garrison, *The Technological Family: What's New and What's Not,* 33 Fam. L.Q. 691, 691 – 692, 701 (1999). [↑](#footnote-ref-26)
27. Oxford Advanced American Dictionary (2011), <https://www.oxfordlearnersdictionaries.com/definition/american_english/innovate?q=innovate> [↑](#footnote-ref-27)
28. Jan Fagerberg *Innovation: A guide to the literature* The Oxford Handbook of Innovation 1, 4 (Jan Fagerberg et al. eds. 2006). [↑](#footnote-ref-28)
29. Frascati manual, *supra* note 9 at 46-48 [↑](#footnote-ref-29)
30. Mark Dodgson et.al The management of Technological Innovation – Strategy and Practice 177-180 (OUP 2008). [↑](#footnote-ref-30)
31. Fagerberg, *supra* note 28 at 9. [↑](#footnote-ref-31)
32. Laura Pedraza-Farina, *The Social Origins of Innovation Failures*, 70 SMU L. Rev. 377, 400 - 410 (2017). [↑](#footnote-ref-32)
33. OECD, Oslo Manual- Proposed guidelines for collecting and interpreting technological innovation data 22-24 (1997); Teresa M. Amabile et al, *Creativity under the gun*, 80 Harvard Business Review 52, 60-61 (2002). [↑](#footnote-ref-33)
34. Mandel, *supra* note 3, at 333-343 (describing differences in concepts of creativity from the perspective of neurobiology, psychology, art work and scientific research). [↑](#footnote-ref-34)
35. Graham Wallace, The art of thought 10, 79 - 80 (London 1926). [↑](#footnote-ref-35)
36. Eugene Sadler-Smith, *Wallas’ Four-Stage Model of the Creative Process: More Than Meets the Eye?* 27 Creativity Research Journal 342, 342 (2015). [↑](#footnote-ref-36)
37. Rex E.Jung et. Al, *The structure of creative cognition in the human brain*, 7 Frontiers in Human Neuroscience 330, 8-11 (2013). [↑](#footnote-ref-37)
38. Brene Brown, Daring Greatly 34 (Gotham Books, 2012). [↑](#footnote-ref-38)
39. Kim A. Taipale, *Technology, Security and Privacy: The Fear of Frankenstein, the Mythology of Privacy and the Lessons of King Ludd,* 7 Yale JL & Tech. 123, 137 (2005). [↑](#footnote-ref-39)
40. Joseph A. Schumpeter, The theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle 86 (1949); Fagerberg, *supra* note 28 at 6,9; Rhodes, *supra* note 1 at 22-23. [↑](#footnote-ref-40)
41. Nuno Garoupa, Thomas S. Ulen, *The Market for Legal Innovation: Law and Economics in Europe and the United States*, 59 Alabama Law Review 1555, 1587 (2008). [↑](#footnote-ref-41)
42. Alvin Toffler, Future Shock 9 – 10 (NY, 1970). [↑](#footnote-ref-42)
43. Galit Nimrod, *Technophobia Among Older Internet Users* 44 Educational Gerontology 148, 149-150 (2018). [↑](#footnote-ref-43)
44. Hanna Arendt, The Human Condition 3 (2nd ed., Chicago 1998); Sofia Ranchordas, *Does Sharing Mean Caring? Regulating Innovation in the Sharing Economy*, 16 MINN J.L. Scr. & TECH. 413, 445 (2015). [↑](#footnote-ref-44)
45. Robert A Edgell, Roland Vogl, *A Theory of Innovation: Benefit, Harm, and Legal Regimes*, 5, Law, Innovation and Technology 21, 22-24 (2013). [↑](#footnote-ref-45)
46. Hsin-Yi Wang et al, *Digital Nativity and Information Technology Addiction: Age Cohort Versus Individual Difference Approaches*, 90 Computers in Human Behavior 1, 2, 6-7 (2019) [↑](#footnote-ref-46)
47. Fagerberg, *supra* note 28 at 7. [↑](#footnote-ref-47)
48. Keith Smith, *Measuring Innovation*, The Oxford Handbook of Innovation 148, 150 (Jan Fagerberg et al. eds. 2006) [↑](#footnote-ref-48)
49. *Id.* at 151 [↑](#footnote-ref-49)
50. Thomas S. Ulen, *Empirical and Experimental Methods of Law: A Nobel Prize in Legal Science: Theory, Empirical Work, and the Scientific Method in the Study of Law*, University of Illinois Law Review 875, 916-917 (2002). [↑](#footnote-ref-50)
51. Giovanni Pascuzzi, *Cognitive Techniques of Legal Innovation*, Law, Development and Innovation 15, 18-20 (Giuseppe Bellantuono, Fabiano Teodoro Lara eds., 2016 ((describing various channels of legal innovation); Andrew Tutt, *A Fragment on Legal Innovation*, 62 Buff. L. Rev. 1001, 1022-1024 (2014) (attorneys as initiators of legal innovation); Stephen Clowney, *Property in Law: Government Rights in Legal Innovations*, 72 Ohio St. L.J. 1, 2-8 (2011) (reviewing the literature that views the government as an initiator of legal innovation, proposing that it grant intellectual property rights in this innovation); Bruce H. Kobayashi, Larry E. Ribstein, *Law as Product and Byproduct*, 9 J.L. Econ. & Pol'y 521, 554-555 (2013) (proposing the endowment of intellectual property rights to private legal innovation enterprises); William D. Henderson, *Innovation diffusion in the legal industry*, 122 Dick. L.R. 395, 400-401 (2018) (defining legal evolution as applied research and recommends learning from other areas of innovation how to accelerate the adoption of its productivity-enhancing innovations). [↑](#footnote-ref-51)
52. Garoupa & Ulen, *supra* note 41 at 1564-1566 [↑](#footnote-ref-52)
53. *Id*. at 1613 [↑](#footnote-ref-53)
54. *Id.* at 1558-1559, 1598-1601 (resource rivalry as a cause of academic innovation); Roberta Romano, *The States as a Laboratory: Legal Innovation and State Competition for Corporate Charters*, 23 Yale J. on Reg. 209, 211, 214 (2006) (competition between countries in attracting companies as an incentive for legal innovation in company law). [↑](#footnote-ref-54)
55. *Id.* at 1609-1610 [↑](#footnote-ref-55)
56. *Id.* at 1565-1566; Lawrence M. Friedman, The Legal System: A Social Science Perspective 276 (1975) (examining the extent of innovation of change in law based on its social ramifications). [↑](#footnote-ref-56)
57. Friedman, *supra* note 56 at 271, "("Jurists…will naturally overestimate the impact of their work"; Garoupa & Ulen, *supra* note 41 at 1558 ("law and economics has been one of the most important developments in North American legal scholarship of the twentieth century "; S. I. Strong *Third Party Intervention and Joinder as of Right in International Arbitration: An Infringement of Individual Contract Rights or a Proper Equitable Measure?* 31, Vand. J. Transnat'l L. 915, 972 (1998) ("The Netherlands is often at the forefront of legal innovations"). [↑](#footnote-ref-57)
58. Ronen Perry, *The Relative Value of American Law Reviews-A Critical Appraisal of Ranking Method*, 11 Va. J.L. & Tech. 1  ,23 (2006) (Measuring citations in legal periodicals, non-legal periodicals, and in supreme court rulings); Garoupa & Ulen *supra* note 41 at 1569-1573 (quotations as a tool for gauging the influence of "law and economy" on the academic legal discourse in the US); Michael R. Heise, *An Empirical Analysis of Empirical Legal Scholarship Production, 1990-2009*, U. Ill. L. Rev. 1739, 1741-1746 (2011) (quotations as a tool for indication of said influence of "empirical legal research"). [↑](#footnote-ref-58)
59. Ronen Perry, *The Relative Value of American Law Reviews: Refinement and Implementation*, 39 Conn. L. Rev 1, 5 (2006) ("The academic quality of a specific article is a function of different variables, such as creativity, innovation…It is impossible not only to measure these variables with scientific precision…"). [↑](#footnote-ref-59)
60. Exodus 34; 27-28 [↑](#footnote-ref-60)
61. Exodus 18; 13-23 [↑](#footnote-ref-61)
62. Judith A. Shapiro, *Shetar's Effect on English Law-A Law of the Jews Becomes the Law of the Land*, 71 Geo. L. J. 1179, 1182-1184 (1983) (Creation of the "promissory note" in the Hebrew Law in the year 500 and its absorption in the Anglo-Saxon Law after the Norman Conquest.) [↑](#footnote-ref-62)
63. Salomon v. Salomon & Co Ltd  [1897] AC 22, 51-54; Francisco Reyes, Erik Vermeulen, *Company Law, Lawyers and "Legal" Innovation: Common Law versus Civil Law*, 28 Banking & Finance Law Review 433, 438, 448 (2013); Ron Harris, *A New Understanding of the History of Limited Liability:*

*An Invitation for Theoretical Reframing*, 26-27, 31-33 (2019), <https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID3547846_code114902.pdf?abstractid=3441083&mirid=1>. [↑](#footnote-ref-63)
64. Duffy *supra* note 8 ("The legal field suffers from such poor incentives for encouraging rigorous development and testing of new law, and even where actors have some incentive, they confront a dearth of tools for accurately measuring the social value of legal innovation" ). [↑](#footnote-ref-64)
65. Claudia Contreras et al, *The Current Impact Factor and the Long-Term Impact Of Scientific Journals By Discipline: A Logistic Diffusion Model Estimation*, 69 Scientometrics 689, 694 (2006). [↑](#footnote-ref-65)
66. Larry A. DiMatteo, *Human capital and the search for originality*, 16 Berkeley Bus. L.J. 267, 277-278, 317 (2019). [↑](#footnote-ref-66)
67. Keith Pavitt, *Sectoral Patterns of Technical Change*, 13 Research Policy 343, 353-365 (1984); Fulvio Castellacci, *Technological Paradigms, Regimes And Trajectories: Manufacturing And Service Industries In A New Taxonomy of Sectoral Patterns of Innovation*, 37 Research Policy 978, 983-991 (2008); Roberta Capello, Camilla Lenzi, *Territorial Patterns of Innovation: A Taxonomy of Innovative Regions in Europe*, 51 The Annals of Regional Science 119, 145-146 (2013). [↑](#footnote-ref-67)
68. Peter Birks, *Equity in the Modern Law: An Exercise in Taxonomy*, 26 U. W. Austl. L. Rev. 1, 3-7 (1996); Ugo Mattei, *Three Patterns of Law: Taxonomy and Change in the World's Legal Systems*, 45 Am. J. Comp. L. 5, 5-7 (1997); Hanoch Dagan, *Legal Realism and the Taxonomy of Private Law*, Structure and Justification in Private Law: Essays for Peter Birks 147, 160-164 (Charles Rickett & Ross Grantham eds., Oxford 2008); Emily Sherwin, *Legal Taxonomy*, 15 Legal Theory 25, 25, 28-31 (2009); Rafał Mańko, *Legal Taxonomy and the Political: A Central European Perspective*, Law, space and the political: An east-west perspective 13, 27-28 (Paulina Bieś-Srokosz et al. eds., Jan Dlugosz University in Czestochowa 2019). [↑](#footnote-ref-68)
69. Some of these studies were mentioned in earlier citations in this article. [↑](#footnote-ref-69)
70. Arthur Lenhoff, *America's Legal Inventions Adopted in Other Countries*, 1 Buff. L. Rev. 118, 120, 124, 128 (1951) (The author lists a series of legal inventions conceived in the US including the written constitution, insurance company surveillance, homestead legislation and the statutory lien; Blomquist *supra* note 16 at 146-152 (ranks the 100 most striking examples of creativity in US law). [↑](#footnote-ref-70)
71. Michal Shur-Ofry et al, *The Diffusion of Legal Innovation—Insights from Mathematical Modeling*, 52 Cornell Int’L. L.J. 313, 318 - 320 (2019) (examining diffusion patterns of legal innovations); Laux, Thomas, *Qualitative Comparative Analysis as a Method for Innovation*

*Research: Analysing Legal Innovations in OECD Countries*, 40 Historical Social Research 79, 98-101 (2015) (proposing a system of analysis for examining the dispersion of the legal innovation regulating equal pay for women in the OECD countries). [↑](#footnote-ref-71)
72. Duffy *supra* note 8 at 3-4 (proposing a similar analysis of the sources of legal innovation) [↑](#footnote-ref-72)
73. John Morley, *The Common Law Corporation: The Power of the Trust in Anglo-American Business History*, 116 Colum. L. Rev. 2145, 2151-2154 (2016). [↑](#footnote-ref-73)
74. Monica M. Gaudiosi, *The Influence of the Islamic Law of Waqf on the Development of the Trust in England: The Case of Merton College*, 136 U. Pa. L. Rev. 1231, 1242-1250 (1988). [↑](#footnote-ref-74)
75. Genesis 23; 18 [↑](#footnote-ref-75)
76. Ellickson, *supra* note 19 at 384-387 Rachel Zelnick-Abramovitz, *Public Registers of Land Sales in Ancient Greece*, Sale and Community; Documents from the Ancient World. Individuals’ Autonomy and State Interference in the Ancient World. Proceedings of a Colloquium Supported by the University of Szeged, Budapest 5-8.10.2012, 41, 62 – 63 (E. Yakab ed., EUT Edizioni Università di Trieste 2015). [↑](#footnote-ref-76)
77. In Vienna (since 1369), Prague (since 1377), Budapest (since 1686), Munich, Hamburg, Bremen and Lübeck (since 1440). Richard R. Powell, Registration of the title to land in The State of New York 287-288 (1938). [↑](#footnote-ref-77)
78. Frederick William Maitland, Domesday book and beyond-Three essays on the early history of England1-4 (Cambridge, 1897). [↑](#footnote-ref-78)
79. Stanhope Rowton Simpson, Land Law And Registration 34-37(Cambridge 1976); Joseph Mitchell Kaye, *A note on the Statute of Enrollments, 1536*, 104 The Law Quarterly Rev. 617, 618 - 619 (1988). [↑](#footnote-ref-79)
80. Richard R. Powell & Patrick J. Rohan Powell on Real Property-Vol. 14, Ch. 82-6 (New York, 1998). [↑](#footnote-ref-80)
81. Robert T. J. Stein & Margaret A. Stone, Torrens Title 17 – 21 (Australia, 1991); Simpson, *supra* note 79 at 68. [↑](#footnote-ref-81)
82. Elizabeth Baigent & Roger J. P. Kain, The Cadastral Map in the Service of the State: A History of Property Mapping 342-344 (Chicago 1984). [↑](#footnote-ref-82)
83. Frederick B. McCall, *The Torrens System - After Thirty Five Years* 10 N.C. L. Rev. 330, 330 (1932); Simpson *supra* note 79 at 77-81. [↑](#footnote-ref-83)
84. J. Leyser, *The Ownership of Flats- A Comparative Study*, 7 Int'l & Comp. L.Q. 31, 31-32 (1958). [↑](#footnote-ref-84)
85. International Encyclopedia of Comparative Law, Vol 6, Ch.5, 6 – 15; Curtis J. Berger, *Condominium: Shelter on a statutory foundation*, 63 Colum. L. Rev. 987, 987, 1001-1002 (1963); Leyser, *supra* note 84 at 33-39. [↑](#footnote-ref-85)
86. Berger, *supra* note 85 at 987. [↑](#footnote-ref-86)
87. Jeremie Gilbert, Indigenous peoples' land rights under international law: From victims to actors 17-18 (2nd ed., 2016); Siegfried Wiessner, *Rights and Status of Indigenous Peoples: A Global Comparative and International Legal Analysis*, 12 Harv. Hum. Rts. J. 57, 61ff. (1999). [↑](#footnote-ref-87)
88. John F. Hart, *Colonial Land Use Law and its Significance for Modern Takings Doctrine*, 109 Harv. L. Rev. 1252, 1252-1253, 1259-1281 (1996); Robert H. Nelson, *Comment A Private Property Right Theory of Zoning*, 11 Urb. Law. 713, 714 -716 (1979). [↑](#footnote-ref-88)
89. Michael F. Reilly, *Transformation at Work: The Effect of Environmental Law on Land Use Control*, 24 Real Prop. Prob. & Tr. J. 33, 33 – 34 (1989). [↑](#footnote-ref-89)
90. William A. Chatterton et al, *Land Information Systems for the Twenty-First Century*, 15 Real Prop. Prob. & Tr. J. 890, 892 - 895 (1980); Report of the Committee on the Improvement and Modernization of Land Records, Real Property Division, American Bar [↑](#footnote-ref-90)
91. Jacek Malczewski, *GIS-based Land-Use Suitability Analysis: A Critical Overview*, 62 Progress in Planning 3, 5-6, 9-13 (2004). [↑](#footnote-ref-91)
92. Martin P. Ralphs, Peter Wyatt, GIS in Land and Property Management 378 (London 2003)**.** [↑](#footnote-ref-92)
93. Here are a few examples: [https://landgr*Id.*com/](https://landgrid.com/) (provides legal and planning information about any area in the US); <https://www.uis.edu/gis/projects/data/> (a list of GIS Datasets for the State of Illinois and the United States; <https://landscape.blm.gov/geoportal/catalog/BLMNational/BLMNational.page> (BLM National Data); <https://geodesy.noaa.gov/NGSDataExplorer/>(National Geodetic Survey Data Explorer); <https://viewer.nationalmap.gov/advanced-viewer/> (USGS National Map). [↑](#footnote-ref-93)
94. Here are a few examples: <https://magic.defra.gov.uk/MagicMap.aspx> provides geographic information about the natural rural, urban, coastal and marine environments across Great Britain); (<https://eservices.landregistry.gov.uk/eservices/FindAProperty/view/MapEnquiryInit.do> ((HM Land Registry service of "Find a property - map enquiry"; (<https://nationalmap.gov.au/> (spatial data from Australian government agencies(; <https://maps.land.vic.gov.au/lassi/> (Victoria's LASSI-Land and Survey Spatial Information; <https://www.geoportal-bw.de/> (GIS of  Baden-Wurttemberg, Germany);

<https://www.landdirect.ie/pramap/> (Irish Property Registration Authority); <https://www.govmap.gov.il/?c=204000,595000&z=0>) (Israel Governmental GIS) <https://www.nadlan.gov.il/> (Israel Governmental Real Estate Portal. [↑](#footnote-ref-94)
95. Google Maps : [https://www.google.co.il/maps/@31.7948163,35.2478105,15z](https://www.google.co.il/maps/%4031.7948163%2C35.2478105%2C15z) ; Google Earth: <https://www.google.com/intl/iw/earth/>. [↑](#footnote-ref-95)
96. Several examples: <https://www.masslandrecords.com/> (Massachusetts Land Records ); <https://www.gov.uk/guidance/register-extract-service> (UK Land Registry's Guidance on Register Extract Service); <https://ecom.gov.il/voucherspa/input/440> (Israel's Land Registry extracts). [↑](#footnote-ref-96)
97. Ralphs & Wyatt, *supra* note 92 at 121 and onwards; Jeremy Speich, *The Legal Implications of Geographical Information Systems (GIS)*, 11 Alb. L.J. Sci. & Tech. 359, 362-370 (2001). [↑](#footnote-ref-97)
98. The World Bank, *Registering Property Methodology- Transparency of Information Index*, in Doing Business-Measuring Business Regulations, <https://www.doingbusiness.org/en/methodology/registering-property>. [↑](#footnote-ref-98)
99. Speich, *supra* note 97 at 365; Kenneth J. Markowitz, *Legal Challenges and Market Rewards to the Use and Acceptance of Remote Sensing and Digital Information as Evidence*, 12 Duke Envtl. L. & Pol'y F. 219, 254 (2002); Andrew C. Wilson et al, *Tracking Spills and Releases: High-tech in the Courtroom*, 10 Tul. Envtl. L.J. 371, 388 (1997)‏. [↑](#footnote-ref-99)
100. Diarmuid Clancy, *From Caveat Emptor towards Full Disclosure-Developments in Ireland*, UNECE Workshop of the influence of land administration on people and business 5 (Croatia, October 2008 ((Technology eliminates the risks associated with *Caveat Emptor*). [↑](#footnote-ref-100)
101. Teresa Scassa, *Geographical Information as 'Personal Information'*, 10 Oxf. Univ. Commonw. Law J. 185, 189-190 (2010)‏. [↑](#footnote-ref-101)
102. *Supra* note 95 <https://www.waze.com/he/livemap> (A free and collaborative smartphone navigation application for smartphones, developed by Israeli startup company "Waze Mobile" and sold to Google in June 2013 ); <https://moovitapp.com/> (A free and collaborative application for navigating public transport developed by the Israeli startup MoovitApp Global LTD and sold to Intel in May 2020); Michal S. Gal and Daniel L. Rubinfeld, *The hidden costs of free goods: Implications for antitrust enforcement*, 80 Antitrust L.J. 521, 536, 550 2016 (analyzing the operating principles of these apps). [↑](#footnote-ref-102)
103. Michal Gal, *The Power of the Crowd in the Sharing Economy*, 13 Law & Ethics of Human Rights 29, 32-33 (2019). [↑](#footnote-ref-103)
104. <https://www.airbnb.com/>; Chad Marzen et al, *The New Sharing Economy: The role of Property, Tort. and Contract Law for Managing the Airbnb Model*, 13 N.Y.U. J. L. & Bus. 295, 298-299 (2017). [↑](#footnote-ref-104)
105. For an example of such a site see <http://www.mls.com/> on technology’s impact on the agency world, see Kimberly R. Goodwin and Sarah E. Stetelman, *Perspectives on Technology Change and the Marketing of Real Estate*, 22 Journal of Housing Research 91, 92 - 93 (2013); Denise Hunter Gravat, The Impact of Digital Marketing Decisions on Market Outcomes in Residential Real Estate 29-49 (DBA Thesis, University of South Florida, 2018). [↑](#footnote-ref-105)
106. Shelly Kreiczer-Levy, Destabilized Property: Property Law in the Sharing Economy 5 (Cambridge 2019). [↑](#footnote-ref-106)
107. Bradley, J Patrick, *Beware-bnb?: Adapting the regulatory approach of community associations to residential sharing & zoning trends*, 53 Real Prop. Tr. & Est. L.J. 373, 379-384 (2019). [↑](#footnote-ref-107)
108. Norrinda B. Hayat, *Accommodating Bias in the Sharing Economy*, 83 Brook. L. Rev. 613, 644 – 645 (2017). [↑](#footnote-ref-108)
109. Marzen et al, *supra* note 104 at 304-311. [↑](#footnote-ref-109)
110. Hayat, *supra* note 108 at 384-387. [↑](#footnote-ref-110)
111. 24 C.F.R. § 1710.14(a)(2); The Land Registration Act 2002 (c. 9), Schedules 1&3 (Eng.); John L. McCormack, *Torrens and Recording: Land Title Assurance in the Computer Age*, 18 Wm. Mitchell L. Rev.61, 69 (at fn. 26)(1992). [↑](#footnote-ref-111)
112. Id, at 67, 80-81. [↑](#footnote-ref-112)
113. Amir Manzoor, E-Commerce: An Introduction 13-15 (2010) (surveying the evolvement of ecommerce since the 1990s). [↑](#footnote-ref-113)
114. See *supra* note 81-83. [↑](#footnote-ref-114)
115. Dale .A. Whitman, *Digital recording of real estate conveyances*, 32 J. Marshall L. Rev., 32, 227, 235 (1999). [↑](#footnote-ref-115)
116. Id; McCormack, *supra* note 111 at 73-74. [↑](#footnote-ref-116)
117. Here are a few examples: <https://legaltemplates.net/> (a free legal forms generator (; <https://ccr.fairfaxcounty.gov/CoverSheet/Coversheet/Create> (Fairfax, Virginia, Land Records Cover Sheet Application); Dale A. Whitman, *Are We There Yet? The Case for A Uniform Electronic Recording Act*, 24 W. New Eng. L. Rev. 245, 258 at *fn.* 562002) the background for the Cover Sheet requiremen). [↑](#footnote-ref-117)
118. *Id*. at 248. [↑](#footnote-ref-118)
119. Haim Sandberg, *Real Estate E-conveyancing: Vision and Risks*, 19 Information & Communications Technology Law 101, 103 (2010). [↑](#footnote-ref-119)
120. Lawrence J. Trautman, *E-Commerce, Cyber, and Electronic Payment System Risks: Lessons from PayPal*, *16* U.C. Davis Bus. L.J. 261, 270, 274-275 (2016). [↑](#footnote-ref-120)
121. See *supra* note 96. [↑](#footnote-ref-121)
122. Sandberg, *supra* note 119 at 104. [↑](#footnote-ref-122)
123. The Land Registration Act 2002, c.9 § 91-95 (Eng.); Sandberg, *supra* note 119, at 107 - 105 ; Michael E. Doversberger, *Conveyancing at a Crossroads: The Transition to E-conveyancing Applications in the US and Abroad* 20 Ind. Int'l & Comp. L. Rev. 281, 287-298 (2010)‏. [↑](#footnote-ref-123)
124. *First digital mortgage signed,* The Law Society Gazzette 9 April 2018, <https://www.lawgazette.co.uk/news/first-digital-mortgage-signed/5065573.article>. [↑](#footnote-ref-124)
125. *HM Land Registry*, Business Strategy 2017-2022 14 (2017) , <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/662811/HM_Land_Registry_Business_strategy_2017_to_2022.pdf> [↑](#footnote-ref-125)
126. Sandberg, *supra* note 119 at 104-105, 107-109; Doversberger, *supra* note 123 at 282-287, 302-307. [↑](#footnote-ref-126)
127. Sandberg, *supra* note 119 at 103, 105. [↑](#footnote-ref-127)
128. Sandberg, *supra* note 119 at 103- 104; Spencer Hale, *Real Property E-Conveyances and E-Recordings: The Solution or Cause of Mortgage Fraud*, 5 OKLA. J.L. & TECH. 44, 1, 25-26 (2009); Doversberger, *supra* note 123. [↑](#footnote-ref-128)
129. Sandberg, *supra* note 119 at 104, 106-109. [↑](#footnote-ref-129)
130. Australian Registrars National Electronic Conveyancing Council (ARNECC), Model Participation Rules 13-15, 43- 46 (December 2018), <https://www.arnecc.gov.au/__data/assets/pdf_file/0003/1426161/model-participation-rules-version-5-clean.pdf>. [↑](#footnote-ref-130)
131. Service Ontario, Guide for the Application for authorization to submit documents for registration in the Electronic Land Registration System (August 2013), <https://files.ontario.ca/electronic_land_reg_application_guide.pdf>. [↑](#footnote-ref-131)
132. The Authority for Land Registration and Regulation, “Digital Services” (Hebrew) <https://www.justice.gov.il/Units/LandRegistration/OnlineServices/Pages/default.asp>. [↑](#footnote-ref-132)
133. Gabriel Brennan, The impact of e-conveyancing on title registration: A risk assessment 61-62 (2015). [↑](#footnote-ref-133)
134. Ry Crozier, *PEXA Beefs Up Security Controls after Home Sale Fraud* Itnew (July 25, 2018), <https://www.itnews.com.au/news/pexa-beefs-up-security-controls-after-home-sale-fraud-495437>. [↑](#footnote-ref-134)
135. Rod Thomas, *Reduced Torrens Protection: The New Zealand Law Commission Proposal for a New Land Transfer Act,* 2011 N.Z. L. Rev. 715, 735 (2011); Hale, *supra* note 128 at 23-24. [↑](#footnote-ref-135)
136. Rouhshi Low, *From Paper to Electronic: Exploring the Fraud Risks Stemming From the Use of Technology to Automate the Australian Torrens System*, 21 Bond L. Rev. 107, 131-132 (2009). [↑](#footnote-ref-136)
137. Lynden Griggs et al, *Accounting for risk: The Advent of Capped Conveyancing Title Insurance,* 24 Austl. Prop. L. J. 371, 372-373 (2016). [↑](#footnote-ref-137)
138. Rosa M. Garcia-Teruel, *Legal Challenges and Opportunities of Blockchain Technology in the Real Estate Sector*, Journal of Property, Planning and Environmental Law 2 (20 January 2020), <https://www.emerald.com/insight/content/doi/10.1108/JPPEL-07-2019-0039/full/pdf?title=legal-challenges-and-opportunities-of-blockchain-technology-in-the-real-estate-sector> [↑](#footnote-ref-138)
139. Avi Spielman, Blockchain: Digitally rebuilding the real estate industry 31-34, 37-40 (MSRED Diss. MIT 2016); Jacques Vos, *Blockchain-based Land Registry: Panacea, Illusion or Something in Between? Legal Interference of Registrars in the E-conveyancing Process*, European Land Registry Association (ELRA) 7th Annual Publication, 4- 7 <https://www.elra.eu/wp-content/uploads/2017/02/10.-Jacques-Vos-Blockchain-based-Land-Registry.pdf>; Joshua A.T. Fairfield, *Bitproperty* 88 S.C. L. Rev. 805, 821-823 (2015); Marco Iansiti, Karim R. Lakhani, The truth about blockchain, 95 Harv. Bus. Rev. 118, 125 (2017). [↑](#footnote-ref-139)
140. Spielman, *supra* note 139 at 43-44; Fairfield, *supra* note 139 at 825-828. [↑](#footnote-ref-140)
141. See *supra* note 81 and accompanying text. [↑](#footnote-ref-141)
142. Fairfield, *supra* note 139 at 840-842. [↑](#footnote-ref-142)
143. Spielman, *supra* note 139 at 33, 43-44; Fairfield *supra* note 139 at 813-816. [↑](#footnote-ref-143)
144. Angela Walch, *The Path of the Blockchain Lexicon*, 36 Rev. Banking & Fin. L.713, 732-734, 753 – 754 (2017). [↑](#footnote-ref-144)
145. Gönenç Gürkaynak et al., *Intellectual Property Law and Practice in the Blockchain Realm*, 34 Computer Law & Security Review 847, 851 (2018). [↑](#footnote-ref-145)
146. Fairfield, *supra* note 139 at 814; Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System (31.10.2008), <https://bitcoin.org/bitcoin.pdf>. [↑](#footnote-ref-146)
147. Fairfield, *supra* note 139 at 831-838. [↑](#footnote-ref-147)
148. Birgit Clark & Ruth Burstall, *Blockchain, IP and the Pharma Industry—How Distributed Ledger Technologies can help secure t* [↑](#footnote-ref-148)
149. Aaron Ricadela, *Blockchain Records Are Forever In Opaque Diamond Market*, Forbes July 12, 2019, <https://www.forbes.com/sites/oracle/2019/07/12/blockchain-records-are-forever-in-opaque-diamond-market/#70760973270b>. [↑](#footnote-ref-149)
150. Scott Reyburn, *Art is Becoming a Financial Product, and Blockchain is Making It Happen*, The New York Times, June 8, 2018, <https://www.nytimes.com/2018/06/08/arts/art-financialization-blockchain.html>. [↑](#footnote-ref-150)
151. Gürkaynak, *supra* note 145 at 854. [↑](#footnote-ref-151)
152. Richard Milne, *Shipping Groups Plot a Course for Digital Collaboration*, Financial Times, November 15, 2018, <https://www.ft.com/content/e699fa06-e81a-11e8-8a85-04b8afea6ea3>. [↑](#footnote-ref-152)
153. Gürkaynak, *supra* note 145 at 861-862. [↑](#footnote-ref-153)
154. John Mirkovitc, Blockchain pilot program-Final report 21-22 (Cook County Recorder of Deeds, Illinois, 30.5.2017), <https://cookrecorder.com/wp-content/uploads/2016/11/Final-Report-CCRD-Blockchain-Pilot-Program-for-web.pdf>; Nicolás Nogueroles Peiró, Eduardo J. Martinez García, *Blockchain and Land Registration Systems*, 6 EPLJ 296, 314 (2017) [↑](#footnote-ref-154)
155. See *supra* note 147 and accompanying text. [↑](#footnote-ref-155)
156. Joshua Weisman, *Restrictions on the Acquisition of Land by Aliens*, 28 Am. J. of Comp. Law 39, 65-66 (1980). [↑](#footnote-ref-156)
157. Amnon Lehavi, *Land Law in the Age of Globalization and Land Grabbing*, Comparative property law: global perspectives 290, 290-294 (Michele Graziadei & Lionel Smith eds., 2017). [↑](#footnote-ref-157)
158. Standard City Planning Enabling Act §8, 13, 14, 17, 21 (U.S. Dept. of Commerce 1928) [↑](#footnote-ref-158)
159. Robert N. Cook, *Land Law Reform: A Modern Computerized System of Land Records*, 38 U. Cin. L. Rev. 385, 387 – 389 (viewing the registry's digitalization as a tool to boost coordination between the various public entities that the land record serves). [↑](#footnote-ref-159)
160. Oleksii Konashevych, *Real Estate Registry on Blockchain: Promise Land or Wishful Thinking?* cointelegraph (13.7.2019), <https://cointelegraph.com/news/real-estate-registry-on-blockchain-promise-land-or-wishful-thinking> [↑](#footnote-ref-160)
161. Spielman, *supra* note 139 at 35; Mirkovitc, *supra* note 154 at 22; Garry Gabison, *Policy Considerations for the Blockchain Technology Public and Private Applications,* 19 SMU Science and Technology Law 327, 345-347 (2016). [↑](#footnote-ref-161)
162. See *supra* note 96. [↑](#footnote-ref-162)
163. Peiró & García, *supra* note 154 at 311. [↑](#footnote-ref-163)
164. Spielman, *supra* note 139 at 42; Gabison, *supra* note 161 at 345 [↑](#footnote-ref-164)
165. Scott Paquette et al, *Identifying the Security Risks Associated with Governmental use of Cloud Computing*, 27 Government Information Quarterly 245, 247 - 251 (2010) (analyzing the government policy for the use of cloud computing and the risks inherent therein). [↑](#footnote-ref-165)
166. Gabison, *supra* note 161 at 344. [↑](#footnote-ref-166)
167. J. David Stanfield et al, Land Registration and Land Fraud in the United States 3-6 (Paper presented to the Seminar on Risk Reduction in Land Fraud, 21 October 2008), <http://www.terrainstitute.org/pdf/Land%20Reg_Fraud_US.pdf>. (In the list enumerating the types of fraud in land registration, registration clerk fraud does not appear). [↑](#footnote-ref-167)
168. Peiró & García, *supra* note 154 at 308; Garcia-Teruel, *supra* note 138 at 10. [↑](#footnote-ref-168)
169. Karen Yeung, *Regulation by Blockchain: The Emerging Battle for Supremacy between the Code of Law and Code as Law* 82 Modern L. Rev. 207, 226-228 (2019). [↑](#footnote-ref-169)
170. Rohan Mark Bennett et al, *Transformations, Transitions, or Tall Tales? A Global Review of the Uptake And Impact Of Nosql, Blockchain, And Big Data Analytics on the Land Administration Sector*, 83 Land Use Policy 435, 441 – 442 (2019); Raymond L Tran, *Portable Reciprocity: A Way Towards a Blockchain Agnostic World to Facilitate Cross-Border Real Estate Transactions*, 53 Real Prop. Tr. & Est. L.J. 447, 466 - 471 (2018). [↑](#footnote-ref-170)
171. Matthias Lehmann, *Global Rules for a Global Market Place? – The Regulation and Supervision of FinTech Providers*, 37 B. U. Int'l L.J (Forthcoming)(Collective action problems as an obstacle to self-regulation of FinTech providers), <https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID3421963_code2610243.pdf?abstractid=3421963&mirid=1> .

 [↑](#footnote-ref-171)
172. Garcia-Teruel, *supra* note 138 at 11-12. [↑](#footnote-ref-172)
173. Gabison, *supra* note 161 at 344. [↑](#footnote-ref-173)
174. Garcia-Teruel, *supra* note 138 at 12-13. [↑](#footnote-ref-174)
175. See *supra* notes 129-132 and text. [↑](#footnote-ref-175)
176. Spielman, *supra* note 139 at 37, Garcia-Teruel*, supra* note 138 at 8-10. [↑](#footnote-ref-176)
177. Victoria L. Lemieux, *Evaluating the Use of Blockchain in Land Transactions: An Archival Science Perspective*, 6 EPLJ 1, 35-37 (2017). [↑](#footnote-ref-177)
178. Emily Crane, *Regulation Without Deflation: Cryptocurrency and its Insider Trading Conundrum*, 51 J. Marshall L. Rev. 797, 804 (2018); Lawrence Trautman, *Virtual Currencies Bitcoin & What Now After Liberty Reserve, Silk Road, and Mt. Gox?*, 20 Rich. J. L. & Tech. 1, 100-101(2014). [↑](#footnote-ref-178)
179. Spielman, *supra* note 139 at 36, 41. [↑](#footnote-ref-179)
180. Spielman., *supra* note 139 at 35-36; Garcia-Teruel, *supra* note 138 at 8; Gabison, *supra* note 161 at 340, 343. [↑](#footnote-ref-180)
181. Peiró & García, *supra* note 154 at 303-305, 310. [↑](#footnote-ref-181)
182. *Id*.. at 306-307. [↑](#footnote-ref-182)
183. *Id*. at 307-309, 313. [↑](#footnote-ref-183)
184. Spielman, *supra* note 139 at 48-49. [↑](#footnote-ref-184)
185. Konashevych, *supra* note 160; Peiró & García, *supra* note 154 at 316-318; Lemieux, *supra* note 177 at 6-19; Ingo Keilitz, Troy Wiipongwii, *Blockchain and International Development: Can Blockchain Technology Be the Solution to Effective Land Registration Systems in Developing Nations*, 9 Wm. & Mary Pol'y Rev. 52, 54 - 58 (2017)‏. [↑](#footnote-ref-185)
186. Mirkovitc, *supra* note 154 at 47; Vermont State Archives and Records Administration, Blockchains for Public Recordkeeping & for Recording Land Records 34-41(January 15, 2020), <https://legislature.vermont.gov/assets/Legislative-Reports/2019-Blockchain-Legislative-Report-VSARA.pdf>. [↑](#footnote-ref-186)
187. See sources, *supra* note 186. [↑](#footnote-ref-187)
188. Christiaan Lemmen, Jacques Vos and Bert Beentjes, *Ongoing Development of Land Administration Standards Blockchain in Transaction Management*, 6 ELPJ 478, 495 – 497 (2017). [↑](#footnote-ref-188)
189. Walch, *supra* note 144. [↑](#footnote-ref-189)
190. Gabison, *supra* note 161 at 345; Garcia-Teruel, *supra* note 138 at 13-15; Spielman, *supra* note 139 at 60; Peiró & García, *supra* note 154 at 319; Lemieux, *supra* note 177 at 48-49. [↑](#footnote-ref-190)
191. In Geodetics there are various models used to describe Earth's shape, generally elliptic and not necessarily spherical. Bernard H. Chovitz, *Modern Geodetic Earth Reference Models*, 62 Eos, Transactions, American Geophysical Union 65, 65-66 (1981). [↑](#footnote-ref-191)
192. John G. Sprankling, *Owning the Center of the Earth*, 55 UCLA L. Rev. 979, 1011, 1024 – 1025 (2008). [↑](#footnote-ref-192)
193. Genesis 11;4. [↑](#footnote-ref-193)
194. Council for Tall Buildings and Urban Habitat, *100 Tallest Completed Buildings in the World by Height to Architectural Top*, The Skyscraper center-Global Tall Building Database of the CTBUH (visited 14.4.2020), <https://www.skyscrapercenter.com/buildings>. [↑](#footnote-ref-194)
195. Martine Drozdz et al, *High-Rise Urbanism in Contemporary Europe*, 43 Built Environment 469, 471 (2018). (Diagram illustrating increase in towers of over 50m in Europe 2000-2017). [↑](#footnote-ref-195)
196. QIN Jing et al, *Evaluation of Three-dimensional Urban Expansion: A Case Study of Yangzhou City, Jiangsu Province, China*, 25 Chin. Geogra. Sci. 224, 229 (2015). (The average building height in Yangzhou in 2012 was 6 to approximately 13m); Markus Schlöpfer et al., *Urban Skylines: building heights and shapes as measures of city size* 14 (2015), [https://arxiv.org/pdf/1512.00946.pdf?](https://arxiv.org/pdf/1512.00946.pdf) (Data on the average building height in 12 large cities in North America in the third Millennium was between 4-10m). [↑](#footnote-ref-196)
197. Haim Sandberg, *Three-Dimensional Partition and Registration of Subsurface Space*, 37 Isr. L. Rev. 119, 123 (2003). [↑](#footnote-ref-197)
198. *Id*, at 123 -124; Sprankling, *supra* note 192 at 982-983, 985-992. [↑](#footnote-ref-198)
199. Lora D. Lashbrook, *The "Ad Coelum" Maxim as Applied to Aviation Law*, 21 Notre Dame L. Rev. 143, 143-145 (1946); Sprankling *supra* note 192 at 983-985; Bava Batra 63b, (a line from the Talmud, one of the religious texts of Judaism, stating that a person selling land must explicitly state in the sales deed that the sale applies "*from the depth of the earth up to the height of the sky.")* [↑](#footnote-ref-199)
200. Relly Victoria Petrescu et al, *History of Aviation-A Short Review*, 1 Journal of Aircraft and Spacecraft Technology 30, 35ff. (2017). [↑](#footnote-ref-200)
201. United Nations Office for Outer Space Affairs, Online Index of Objects Launched into Outer Space (Visited 13.4.2020), <https://www.unoosa.org/oosa/index.html> (9386 objects dispatched to space since 1957); Union of Concerned Scientists, UCS Satellite Database (16.12.2019), [https://www.ucsusa.org/resources/satellite-database (2218](https://www.ucsusa.org/resources/satellite-database%20%282218) satellites were orbiting Earth on the date of publication); Norman Bonnor, *A Brief History of Global Navigation Satellite Systems*, 65 The Journal of Navigation 1, 2ff (2012). [↑](#footnote-ref-201)
202. Bharat Rao et al., *The Societal Impact of Commercial Drones*, 45 Technology in Society 83, 84 – 87 (2016); Robert A. Heverly, *The State of Drones: State Authority to Regulate Drones*, 8 Alb. Gov't L. Rev. 30, 34-37 (2015). [↑](#footnote-ref-202)
203. Kimmo Rönkä et al, *Underground Space in Land-Use Planning*, 13 Tunnelling and Underground Space Technology 39, 39-45 (1998). [↑](#footnote-ref-203)
204. Sprankling, *supra* note 1008-1012, 1029-1032. [↑](#footnote-ref-204)
205. Roderick B. Anderson, *Some Aspects of Airspace Trespass* 27 Journal of Air Law and Commerce 341, 341 (1961). [↑](#footnote-ref-205)
206. Lashbrook, *supra* note 199 at 145-147; United States v. Causby 328 U.S. 256, 261-268 (1945); 49 U.S. Code § 40103 a (2)(2012). [↑](#footnote-ref-206)
207. CFR § 91.119 - Minimum safe altitudes. [↑](#footnote-ref-207)
208. §1, 2 Convention on International Civil Aviation ("Chicago Convention", 7 December 1944 (9th ed. 2006), <https://www.icao.int/publications/Documents/7300_cons.pdf> ;49 U.S. Code § 40103 a (1) (2012). [↑](#footnote-ref-208)
209. NASA, Three Classes of Orbit, <https://earthobservatory.nasa.gov/features/OrbitsCatalog/page2.php> (satellite orbits range from 100 to over 36,000km above the surface of the earth.) [↑](#footnote-ref-209)
210. Bin Cheng, *International Law and High Altitude Flights: Balloons, Rockets and Man-Made Satellites*, 6 Int'l & Comp. 487, 493 (1957). (He foresaw this possibility as early as 1957). [↑](#footnote-ref-210)
211. Treaty on principles governing the activities of states in the exploration and use of outer space including the moon and other celestial bodies (1967), <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html>. [↑](#footnote-ref-211)
212. *Id*., at §1 and §2 of the treaty; Myres S. McDougal, *The Emerging Customary Law of Space*, 58 Nw. U. L. Rev. 618, 628-629 (1963). [↑](#footnote-ref-212)
213. Gbenga Oduntan, *The Never Ending Dispute: Legal Theories on the Spatial Demarcation Boundary Plane between Airspace and Outer Space*, 1 Hertfordshire L. J. 64, 65 – 69 (2003). [↑](#footnote-ref-213)
214. Christopher J Newman, Regulation of artificial satellites, Outer Space Law: Legal Policy and Practice 163, 173 (10-11), (Anal Abul Failat & Anél Ferreira-Snyman eds., 2017). [↑](#footnote-ref-214)
215. Newman, *supra* note 214 at 174; Deborah Housen­Couriel, *Disruption of Satellite Transmissions ad Bellum and in Bello: Launching a New Paradigm of Convergence*, 45 Is. L. Rev. 431, 444-449 (2012); Barbara J. Rowbo, *Airspace-Outerspace? The* *Geostationary Orbit and the Need for a Precise Definition of Outer Space*, 4 NYL Sch. J. Int'l & Comp. L. 115, 121 - 123 (1982). [↑](#footnote-ref-215)
216. Jannat C. Thompson, *Space for Rent: The International Telecommunications Union, Space Law*, *and Orbit/Spectrum Leasing*, 62 J. Air L. & Com. 279, 303 (1996). [↑](#footnote-ref-216)
217. The signatories to the Bogota Declaration were Brazil, Colombia, Congo, Equator, Indonesia, Kenya, Uganda and Zaire. For its background and ramifications see Thompson, *supra* note 216 at 306-308; Rowbo, *supra* note 215 at 123-125; Kelly M. Zullo, *The Need to Clarify the Status of Property Rights in International Space Law*, 90 Geo. L.J. 2413, 2420 – 2421 (2002). [↑](#footnote-ref-217)
218. McDougal, *supra* note 212, at 629; Myres S. McDougal, *Artificial Satellites: A Modest Proposal*, 51 Am. J. Int'l. L. 74, 76 (1957); *Note: National Sovereignty of Outer Space*, 74 Harv. L. Rev. 1154, 1160-1167 (1961). [↑](#footnote-ref-218)
219. Harold Demsetz, *Toward a Theory of Property Rights*, 57 American Economic Review 347, 351- 352 (1967); Garrett Hardin, *The Tragedy of the Commons,*162 *Science* 1243, 1247 (1968); Wian Erlank, *Rethinking Terra Nullius and Property Law in Space*, 18 Potchefstroom Electronic Law Journal 2503, 2515 – 2516 (2015). [↑](#footnote-ref-219)
220. Mejía-Kaiser, Martha, *Out into the Dark: Removing Space Debris from the Geostationary Orbit*, In Proceedings of the IISL Colloquium on the Law of Outer Space, Washington, D.C. 1 – 2 (2019), <https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID3482010_code3412227.pdf?abstractid=3482010&mirid=1>. [↑](#footnote-ref-220)
221. Brian C. Weeden, Tiffany Chow, *Taking a Common-Pool Resources Approach to Space Sustainability: A Framework and Potential Policies*, 28 Space Policy 166, 172 (2012); Philip A. Meek, *The CPR Approach to Space Sustainability: Commentaries on Weeden and Chow*, 28 Space Policy 173, 176 (2012). [↑](#footnote-ref-221)
222. See, *supra* note 202. [↑](#footnote-ref-222)
223. Heverly, *supra* note 202 at 46-47. [↑](#footnote-ref-223)
224. 14 CFR Part 107—Small unmanned aircraft systems, <https://avsport.org/UAS/ground/PART%20107.pdf> (Regularization of flying drones at a maximum altitude of 400 feet, equal to about 120 49m in U.S.C.) (2012) (the Congress' plan for the aviation regularization of this field). [↑](#footnote-ref-224)
225. Heverly, *supra* note 202 at 53-56, 60-61. [↑](#footnote-ref-225)
226. Troy A. Rule, *Airspace in an age of drones*, 95 B.U. L. Rev. 155, 203 – 207 (2015). [↑](#footnote-ref-226)
227. Sandberg, *supra* note 197 at 161. [↑](#footnote-ref-227)
228. W. L. Summers, *Property in Oil and Gas*, 29 Yale L. J. 174, 182 - 185 (1919); Kenneth J. Vandevelde, *The New Property of the Nineteenth Century: The Development of the Modern Concept of Property*, 29 Buff. L. Rev. 325, 354-357 (1980) (analyzing the case law and legislation which at the end of the nineteenth century for the first time enabled distinguishing between property rights in land and property rights in gas and oil). [↑](#footnote-ref-228)
229. 54 USC §320301 (c ((Separation between Federal Ownership of Part of a Parcel Necessary for Proper Care and Management of a Monument from Private Ownership in the Rest of the Parcel); Thomas J. Reed, *Land Use Controls in Historic Areas*, 44 Notre Dame L. Rev. 379, 381-382 (1969). [↑](#footnote-ref-229)
230. United Nations Convention on the Law of the Sea, 21 I.L.M. 1261 (1982), § 76-78. [↑](#footnote-ref-230)
231. Zhi Zhang et al, *Property rights of urban underground space in China: A public good perspective*, 65 Land Use Policy 224, 224 - 225 (2017). [↑](#footnote-ref-231)
232. Zhang et al, *supra* note 231 at 231-232. [↑](#footnote-ref-232)
233. NOP 40-National Outline Plan for the Protection and Development of Subterranean Land - Policy Document (Final Edition to be Presented to the National Council) 37-38 (June 29, 2011)(Hebrew)(Copy reserved by the author). [↑](#footnote-ref-233)
234. CA 119/01, Akunas v. State of Israel, 57(1) P.D. 817, 863 (2003)(Hebrew). [↑](#footnote-ref-234)
235. Stuart S. Ball, *Division into Horizontal Strata of the Landscape above the Surface*, 39 Yale L. J. 616, 618 (n.8), 638 (1930); Russell Denison Niles, *The Rationale of the Law of Fixtures: English Cases*, 11 N.Y.U. L. Q. Rev. 560, 561 - 564 (1934)*;* John Henry Merryman, *Improving the Lot of the Trespassing Improver*, 11 Stan. L. Rev. 456, 480 (1959) (…it is doubtful that any other slogan has been as troublesome as "what is attached to the land becomes part of it"). [↑](#footnote-ref-235)
236. See *supra* notes 228-230 and accompanying text. [↑](#footnote-ref-236)
237. Sandberg, *supra* note 197 at 122; Menachem Klein, “Negotiating Jerusalem: Detailed Summary of Ideas Raised in Track Two”, *Track Two Diplomacy and Jerusalem: The Jerusalem Old City Initiative* 112, 125 ([Tom Najem](https://www.routledge.com/products/search?author=Tom%20Najem) et al eds., Routledge 2017); The White House, *Peace to Prosperity-A Vision to Improve the Lives of the Palestinian and Israeli People,* 16, 18 (Washington January 2020), <https://www.whitehouse.gov/wp-content/uploads/2020/01/Peace-to-Prosperity-0120.pdf> [↑](#footnote-ref-237)
238. Mishna, Bava Metzia 10; 1 ("If a house (the first story) and an upper room (the second story) belonging to two persons (each owning) fell down, the two share in the wood and the stones and the earth". [↑](#footnote-ref-238)
239. The World Band, Urban Development – Overview, <https://www.worldbank.org/en/topic/urbandevelopment/overview> [↑](#footnote-ref-239)
240. Ball, *supra* note 235 at 619-635, 638-645. [↑](#footnote-ref-240)
241. Ball, *supra* note 235 at 635-638 and *supra* notes 84-86 and accompanying text; Gillad Rosen, Alan Walks, *Rising cities: Condominium Development and the Private Transformation of the Metropolis*, 49 Geoforum 160, 163 -164 (2013); 332-333. [↑](#footnote-ref-241)
242. *Id*. at 168; Lei Chen, Mark D. Kielsgard, *Evolving Property Rights in China: Patterns and Dynamics of Condominium Governance*, 2 The Chinese Journal of Comparative Law 21, 21-22 (2014); Douglas C. Harris, *Condominium and the City: The Rise of Property in Vancouver*, 36 Law & Soc. Inquiry 694, 721 (2011) ("Vancouver without condominium would be very different from the city that has emerged "). [↑](#footnote-ref-242)
243. See *supra* note 203 and sources therein. [↑](#footnote-ref-243)
244. Herbert Becker, *Subdividing the Air: A New Method of Acquiring Air Rights*, 9 Chi.-Kent L. Rev. 40, 40, 45 – 47 (1931); Robert R. Wright, *The Model Airspace Act: Old and New Law for Contemporary Land Use Problems*, 1972 Law & Soc. Order 529, 539-544 (1972); James M. Pedowitz, *Transfers of Air Rights and Development Rights*, 9 Real Prop. Prob. & Tr. J. 183, 185, 192-196 (1974). [↑](#footnote-ref-244)
245. Eugene J. Morris, *Air Rights are Fertile Soil*, 1 Urb. Law. 247, 257, 261-263 (1969). [↑](#footnote-ref-245)
246. Wright*, supra* note 244 at 544 on. [↑](#footnote-ref-246)
247. Air Space Act, SNB 1982 c A-7.01 which was replaced by the Air Space Act, RSNB 2011, c 109; Franklin O. Leger, *Air Rights and the Air Space Act*, 34 U.N.B.L.J. 39, 47 - 49 (1985) (The backstory to its legislation involved a multi-story development project called Market Square in Saint John, New Brunswick.) [↑](#footnote-ref-247)
248. Land Law (Amendment No. 33) 5779-2018, §14a, §14e of the Land Law, as amended in *Sefer Ha-Hukim* 80 (Hebrew). [↑](#footnote-ref-248)
249. Peter van Oosterom, *Survey of Israel Three-Dimensional Cadastre and the ISO 19152 - The Land Administration Domain Model-Report 2* (updated version, Israel Survey of Israel & TU Delft, 20 September 2014); <http://mapi.gov.il/ProfessionalInfo/MapiPublications/3D%20Cadastre%20SOI_Report2_v2final.pdf> [↑](#footnote-ref-249)
250. Jantien Stoter et al, *First 3D Cadastral Registration of Multi-level Ownerships Rights in the Netherlands*, Proceedings of the 5th International FIG Workshop on 3D Cadastres 491, 495-497 (2016), <https://pure.tudelft.nl/portal/files/7009259/Paper_27.pdf>. [↑](#footnote-ref-250)
251. Sandberg, *supra* note 197 at 134-135. [↑](#footnote-ref-251)
252. Uri Shoshani et al, *A* “*Multi Layers 3D Cadastre in Israel: A Research and Development Project Recommendations*”, *FIG Working Week* 2005 9 (Cairo 2005), <http://www.gdmc.nl/3DCadastres/literature/3Dcad_2005_04.pdf>. [↑](#footnote-ref-252)
253. Sandberg, *supra* note 197 at 135; Amnon Lehavi , *The Future of Property Rights: Digital Technology in the Real World* 12, 13-16 (2020), <https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID3516096_code352674.pdf?abstractid=3516096&mirid=1> [↑](#footnote-ref-253)
254. Sandberg, *supra* note 198 at 164-166. [↑](#footnote-ref-254)
255. See *id*. chapter D3. [↑](#footnote-ref-255)
256. See *supra* notes 212-219 and accompanying text. [↑](#footnote-ref-256)
257. Efi Diamopoulou et al., *3D Cadastres Best Practices, Chapter 2: Initial Registration of 3D Parcels*, FIG Congress, Istanbul, Turkey 4-17 (2018), [http://www.diva-portal.org/smash/get/diva2:1256072/FULLTEXT02`](http://www.diva-portal.org/smash/get/diva2%3A1256072/FULLTEXT02%60); Davood Shojaei et al, *Moving Towards a Fully Operational 3D Digital Cadastre: Victoria Australia*, 6th International FIG 3D Cadastre Workshop, Delft, The Netherlands 468, (2018), <http://www.gdmc.nl/3dcadastres/literature/3Dcad_2018_25.pdf>. [↑](#footnote-ref-257)
258. Becker, *supra* note 244 at 47 ("The reader will have noticed the phraseology which was employed. It was sought to avoid a subdivision of "'air" or a conveyance of "air." The use of the word "air" by itself was **feared**. The phrase "land, property and space" was preferred";Laird Bell, *Air Rights* , 23 Ill. L. Rev. 250, 263 (1928) (("…if there is anything in the **fear** that a deed of space is a deed of something that is more than ordinarily intangible and incorporeal… ") Author's emphases. [↑](#footnote-ref-258)