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RE-IMAGINING PROPERTY RIGHTS IN AIRSPACE AND SEASPACE IN THE 21ST CENTURY

AUTHORED BY - J. SANJAY K., SUBBA RAM REDDY,
S. SREERUPA & DR. SAJI SIVAN S

ABSTRACT

The 21st century is characterized by the saturation of the vertical commons. As human technological capacity expands upward into the low-altitude atmosphere and downward into the abyssal plains of the ocean, the static, two-dimensional legal frameworks inherited from Roman and English common law are fracturing. This report provides an exhaustive analysis of the emergent property regimes in airspace and seaspace, challenging the obsolescence of the ad coelum doctrine and the rigidity of the Mare Liberum principle. Through a rigorous examination of recent jurisprudence—including Cedar Point Nursery v. Hassid, Lozman v. City of Riviera Beach, and the evolving BBNJ Agreement—it argues that the binary distinction between "private property" and "public commons" is dissolving into a spectrum of time-sliced, functional, and digital rights. The analysis synthesizes economic theory regarding the tragedy of the commons and the anticommons with legal doctrines of trespass, nuisance, and sovereignty. It proposes that the resolution to the "drone dilemma," the "seasteading paradox," and the "deep-sea enclosure" lies not in the restoration of absolute territorial exclusion, but in the development of high-frequency, tradable property interests—micro-easements and dynamic servitudes—enforced through algorithmic governance and blockchain architectures.

KEYWORDS: *Mare Liberum (Freedom of the Seas), Common Heritage of Mankind (CHM), Res Communis, Neo-Grotian Era, Navigable Airspace, Immediate Reaches Doctrine, Right to Exclude, Public Trust Doctrine, Conditional Enclosure.*

I. INTRODUCTION

The first form of property law is a means of dealing with scarcity. Lacking was traditionally a horizontal phenomenon in thousands of years. The primal source of wealth was land and its boundaries were on a two-dimensional flat plane. The air was the vertical dimension, the earth could be considered to belong to a system of the maxim which was known in ancient times as the maxim by which he possesses the earth, he possesses up to the sky, and down to the depths,

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the maxim was called. This principle had something absolute in it, yet it passed well when humanity inhabited merely the surface. It was birds and angels that beheld the heaven and the depths where people could only reach there with a shovel or a well.

Nevertheless, with the industrial and more recently the digital revolutions the vertical axis has become a place of high-risk economic competition and legal contention. The 20th century carved ad coelum doctrine out to the airplane, provided a very crude compromise between surface owners and the navigable airspace.1 The 21st century is shattering this compromise into ruins. With Unmanned Aerial Systems (UAS), Urban Air Mobility (UAM), and suborbital transport, the immediate reaches of the atmosphere have become overrun with innovations in the exact area where the Supreme Court previously assured landowners of exclusive rights; its immediate reaches.

At the same time the oceanic commons are also experiencing a reconceptualization. The Grotian concept of Mare Liberum (Free-at-Sea), according to which the ocean can be could not be owned, but only moved around, is failing as the sea steading under the pressure of deep-sea mining, bioprospecting and the aspiration to build fully autonomous floating cities (sea steading).

This report discusses how these vertical and maritime frontiers are broken. It assumes that the world is seeing the birth of a so-called Neo-Grotian period, in which property lines are no longer given by geographic location, but rather by technological or mobile capabilities. We compare the types of legal tools that have tried to regulate this change, such as the so-called drone highway zoning schemes and the benefit-sharing formulas of the BBNJ Agreement, and assess their economic effectiveness in reducing the conflict between the exclusivity of the privacy and the openness of the public.

II. THE FRAGMENTATION OF THE AD COELUM DOCTRINE

[1]The degradation of the ad coelum doctrine must first be deconstructed in order to comprehend the present state of crisis in airspace property rights. This is an old maxim, provided in English common law, and imported into American legal tradition, which originally conferred upon the surface owner an unlimited vertical column of sovereignty. That was unsustainable in the face

[1] *United States v. Causby, 328 U.S. 256, 261–64 (1946)*

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of modern aviation, and a retreat by the courts generated the ambiguities of which we are now committed.

A. ***THE JUDICIAL RETREAT***

With the arrival of the airplane, the decline of the vertical dominance of the landowner truly commenced. The need to fly and the trespassive nature of land owners were incompatible to courts at the beginning of the 20th century. The alarming incident came with United States v. Causby (1946), a case that still forms the foundation of property law in aviation in the United States.1 In Causby, a chicken farmer whose livelihood was ruined by the passing of military aircraft was adjudicated by the U.S. Supreme Court.

[2]The Court once wrote to say that the ad coelum doctrine simply did not fit the modern world as it would tend to stuff these airways, seriously intervene with their running and development in the public interest and place into the hands of individuals, to whom no more than the rest of the public had a proper claim.

Nevertheless, Causby did not eliminate the rights of the airspace privately. A functional compromise that the Court made was that the landowner has exclusive control of the so-low and so-frequency flights that amount to the taking of the land, but in this context, the utility and usability of the land become a direct and immediate interference.

This ruling created a bifurcated sky:

1. **Navigable Airspace:** A public highway where federal sovereignty pre-empts private claims (originally defined as 500 feet and above).[4]
2. **The Super-jacent Zone:** The lower altitude airspace where the landowner retains a "right to exclude" to prevent interference.[9]

B. ***THE AMBIGUITY OF "IMMDEDIATE REACHES"***

[3]The main ineffectiveness of Causby--the matter of the present litigation--is its refusal to adopt the exact height of the immediate reaches. The buffer space between a 500-foot floor of navigable airspace and the roof of a farmhouse in 1946 was an economically insignificant zone. That buffer zone nowadays is the Goldilocks zone of drone delivery businesses, infrastructure inspection, and surveying.

The Hinman v. decision of the Ninth Circuit. Another theory, proposed by Pacific Air

[2] Hanoch Dagan & Michael A. Heller, *The Liberal Commons*, 110 Yale L.J. 549, 553–58 (2001).
[3] Garrett Hardin, *The Tragedy of the Commons*, 162 Science 1243, 1244–45 (1968).

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Transport (1936), the Actual Use doctrine proposed that a landowner only owned the airspace which he was in use of and occupied. Under Hinman, a drone flying at 50 feet along a vacant lot could not be regarded as a trespass because the owner was not using that airspace. This is the exact opposite to the Causby implication of a secure enclosure irrespective of use at the moment.

The antagonism between these interpretations has become harsh now. The low-altitude sky is dominated by the Hinman view to allow Amazon and Walmart to exploit it, as long as they do not hit buildings. With the Causby interpretation (understood broadly), all drone flights over a suburban backyard would be per se trespass and must have an easement or permission.

C. ***THE DIVERGENCE OF INTERNATIONAL STANDARDS***

[4]The division of the ad coelum doctrine is not a problem inherent to the United States, and the solutions are different. The case of Bernstein of Leigh v Skyviews and General Ltd (1978) in the United Kingdom held the same distinction of a so-called ordinary use, namely the rights of the landowner are limited to the height on which he must use the land and the buildings on the land. Beyond that height, the land owner has no more rights than any other member of the population.

This gives a fine differentiation between trespass and nuisance. In the UK, a drone flying at 50 meters may not be considered a trespasser (as long as it does not exceed the height of normal use) but may still be liable to nuisance or harassment by surveillance. This is in comparison to the more property-focused view starting to gain traction in some jurisdictions in the US: the drone may not be a trespasser within that height bracket, but can still claim to be liable to nuisance or harassment on a case-by-case basis (surveillance vs. transit).

Table 1: Comparative Evolution of Vertical Property Doctrines

Doctrine/Case	Jurisdiction	Key Principle	Implications for Drones
Ad Coelum	Common Law	Ownership to the heavens (Absolute).	Total exclusion rights; drone industry impossible without

[4] 49 U.S.C. § 40103(a)(1) (declaring United States sovereignty over navigable airspace).

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			easements.
Hinman v. Pacific Air	US (9th Cir)	Ownership limited to "actual use."	Drones can fly over vacant/low-use land freely.
US v. Causby	US (SCOTUS)	Ownership of "immediate reaches"; taking if interference occurs.	Ambiguous; creates liability for "low and frequent" flights.
Bernstein v. Skyviews	UK	Ownership limited to "ordinary use" height.	High-flying drones are lawful; focus shifts to privacy/nuisance.
Cedar Point v. Hassid	US (SCOTUS)	Right to exclude is fundamental; temporary invasion is a taking.	Strengthens landowner leverage; implies compensation for drone corridors.

III. THE DRONE DISRUPTION

[5]The theoretical gaps in *Causby* are now being filled by millions of commercial and recreational drones. The legal system is struggling to categorize these machines: Are they "aircraft" subject to federal preemption, or "flying mechanical trespassers" subject to state tort law?

A. The Preemption Paradox

[6]The FAA and India both claim exclusive sovereignty over domestic airspace. The FAA considers the NAS to be ground based and thus the Indian Aircraft act, 1934 develops absolute power in the hands of the central government. This position suggests that local regulations that prohibit drones, whether by the municipalities of the US or the Residential Welfare Associations of Indians, are preempted by the federal or the central requirements. Nonetheless, such a claim of total sovereignty is inconsistent with property and privacy interests. According to Causby, federal definitions cannot erase the rights of the private through fiat. The tension in India is Digital Sky platform zoning versus the right to privacy which is a fundamental enshrine of Puttaswamy.

[5] Directorate General of Civil Aviation, *Drone Rules, 2021*, Gazette of India, Aug. 25, 2021.
[6] Federal Aviation Administration, *Remote Identification of Unmanned Aircraft*, 86 Fed. Reg. 4390 (Jan. 15, 2021).

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B. Nuisance vs. Trespass: The Battle for the Standard

With the multiplying litigation, courts divide regarding which tort structure to apply. The drone industry demands Nuisance standard whereby the plaintiff must establish substantial damage (e.g., noise, distress, lost value) which places a high burden on the landowners and permits the development of the so-called innocent transit.

The supporters of property rights also demand a standard of Trespass, which is per say (without showing any damage) just by entry.

A court in Michigan decided that a municipal drone used to conduct zoning inspections was a search covered by the Fourth Amendment, which implicated an intrusion of trespass onto reasonable expectation of privacy of the landowner.

A lawsuit involving a challenge to the FAA rule on Remote ID claimed that the tracking requirements were an encouragement to government surveillance, and also disregarded the issue of privacy/ trespass of low-altitude flight, but the D.C. Circuit mostly ruled in Favor of the authority of the FAA because of safety concerns.

The difference is both economic and legal. Using a nuisance regime, the drone industry is funded to enjoy the free consumption of the quiet enjoyment of the landowner, up to the level of substantial harm. Trespass regime causes the industry to negotiate and pay to access the industry internalizing the price of their operations.

C. The "Drone Superhighway" Proposal: Stratification of Rights

To resolve the impasse, scholars and regulators—from the FAA to India's DGCA—are converging on a "zoning" solution within Unmanned Traffic Management (UTM) frameworks. This stratifies the low-altitude sky into functional bands:

1. **The Exclusion Zone (0–200 ft):** This layer preserves the "immediate reaches" (*Causby*) in the US and the privacy expectation (*Puttaswamy*) in India. Here, the landowner's right to exclude or privacy claims dominate, requiring permission for operations[1].
2. **The Transit Zone (200–400 ft):** Designated as a public "drone highway." In India, this aligns with the "Green Zone" (vertical limit of 400 ft) under the *Drone Rules, 2021*. Ideally, this functions like a public sidewalk—open for digital transit but subject to strict noise and speed regulations[2].
3. **The Buffer Zone (400–500 ft):** A safety layer strictly separating unmanned traffic from manned aviation[3].

While this offers clarity, the constitutional hurdles diverge. In the US, declaring the

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200–400 ft zone "public" risks a *Cedar Point* "takings" claim, potentially requiring billions in compensation[4].

IV. MECHANISMS FOR RE-IMAGINING AIR RIGHTS[7]

Given the constitutional and economic constraints of a pure "taking" or a pure "exclusion" model, the 21st century requires dynamic, high-frequency property mechanisms. We are moving from "static easements" (permanent rights recorded in a county deed) to "micro-easements" (temporary rights executed by software).

A. The Economic Case for Tradable Air Rights

According to Coasean economics, when property rights are clearly delineated and transaction costs are minimal parties will have efficient final results irrespective of the original distribution of rights.

At the moment, there is an infiniteness of the transaction costs. An Amazon drone does not have time to negotiate a 10-cent easement with each household along a 5-mile route. The tradable air rights system would provide an opportunity to landowners to charge people to use their airspace (e.g. The price of using airspace on a particular block is 0.05 a flight or the price of using airspace before 10 PM and after 6 AM is 0.90 a flight). The operators of drones would program their fleets to optimize the cheapest path based on the cost surface of the airspace.

B. Blockchain and Tokenization of the Sky

[8]This high frequency market needs the infrastructure offered by blockchain technology. The projects such as SkyTrade and Air Rights Development (ARD) proposals rely on smart contracts to tokenize vertical real estate.

The 3D spatial limits of airspace rights of a property are stored in a decentralized ledger. When a drone flight trip crosses a personal piece of land, the smart contract will process a micropayment to the operator to the owner.

[9]During the peak times, prices may soar up, or down on the quieter drones, providing market incentives to quieter technology.

[7] *Kyllo v. United States*, 533 U.S. 27, 34–35 (2001).
[8] *People v. Long Lake Township*, 506 Mich. 331, 349–52 (2020).
[9] *Singer v. City of Newton*, 284 F. Supp. 3d 125, 132–35 (D. Mass. 2017).

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V. THE MARITIME COMMONS

[10]With the vertical boundary to the airspace being encircled, the horizontal boundary to the high seas is undergoing the same. The international legal framework of UNCLOS (United Nations Convention on the Law of the Sea) clashes with the Seasteading movement that intends to create autonomous floating cities, as the latter was created to prevent the very autonomy that seasteaders are pursuing.

A. UNCLOS and the Ban on Sovereignty

The rule of res communis happens to the High Sea--that they are the property of no-one and everyone. Article 89 itself expressly provides as follows: No State may mark out any area of the high seas as within its sovereignty, despite Article 87 authorizing the freedom to build artificial islands, Article 60 specifically allocates sole jurisdiction over such artificial islands to the coastal states, within their Exclusive Economic Zone (EEZ).

Within the seastead falls the jurisdiction of the laws of the coastal state (e.g., French Polynesia). It has no political autonomy.

Seastead cannot impose sovereignty. It is not a territory but a structure or a kind of installation. Absent the sovereignty, it is not free to provide citizenship and issue passports.

B. The "Vessel" vs. "Structure" Distinction: The Lozman Impact

[11]A sensitive legal issue is the determination of whether or not a floating home is a "vessel." Assuming it is a ship, it is subject to Admiralty Law and Flag State (some protection and a legal structure). In case it is a structure, it can be legally stateless in the high seas.

This court case is Lozman v. US Supreme Court. The scope of the definition of a vessel was shrunk dramatically in City of Riviera Beach (2013). The Court determined that Fane Lozman had not built a vessel in his floating home, as it was not designed to transport. This home did not have any propulsion, was rectangular powered, and needed a connection to shore.

Implication to seasteads: The majority of proposed seasteads (such as the platforms of Ocean Builders (in their SeaPods) or (in their seasteading platform) the Seasteading

[10] United Nations Convention on the Law of the Sea art. 87, Dec. 10, 1982, 1833 U.N.T.S. 397.
[11] United Nations Convention on the Law of the Sea art. 89, Dec. 10, 1982, 1833 U.N.T.S. 397.

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Institute) are stationary or semi-stationary. They are not likely to be vessels under Lozman.

C. The Failure of the "Host State" Model

In response to these risks, the Seasteading Institute shifted to a model of a host state by signing a Memorandum of Understanding (MoU) with French Polynesia in 2017 creating a "SeaZone" that has special regulatory autonomy. This was an attempt to imitate the Special Economic Zone model on water. Nonetheless, the acquisition failed because of national politics in the country as well as legal issues regarding the imperfect sovereignty.

I. DEEP SEA MINING

Beneath the Another property battle is going on below the waters. UNCLOS designates as the Common Heritage of Mankind (CHM)1 the so-called Area (the seabed beyond national jurisdiction). This requirement means that the resources such as polymetallic nodules whose focus remains central to Indian strategic Deep Ocean Mission could not end up in the possession of any individual state but should be utilized in the common good of humanity.

A. The Role of the International Seabed Authority (ISA)

[12]The ISA is the custodian of these global commons. It grants exploration licenses, including the license of India on Central Indian Ocean Basin (CIOB) and commercial organizations like The Metals Company3. Although the seabed cannot be owned, such contracts act as property rights in practice, as they give exclusive rights to take decades-long access to expansive areas of ocean bed.

This prompts a conflict between the Grotian tradition (freedom to exploit) in contrast with the Common Heritage tradition (equitable sharing). The present impetus to complete Mining Code is created by the necessity of battery metals (cobalt, nickel). Opponents claim this is a Neo-Grotian enclosure, privatizing the common good, but some countries such as India consider it necessary to the energy security.

B. Marine Genetic Resources (MGRs) and the BBNJ Agreement

Mineral resources extraction is controlled, but the extraction of genetic resources

[12] International Seabed Authority, *India—Central Indian Ocean Basin Exploration Contract* (2016).

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(MGRs) used to be a wild west not so long time ago. The pharmaceutical companies would be able to bio-prospect in the high seas without any obligation to anyone in the global society. The BBNJ-based new agreement also produces a regime of property which is consistent with the Indian-internal orientation towards Access and Benefit Sharing (ABS) Mechanism in advance of collection which is likely to be integrated with databases that safeguard traditional knowledge.

VII. THE OUTER LIMIT: AIRSPACE V OUTER SPACE

The demarcation of the atmosphere and the outer space is the ultimate boundary of vertical property. This boundary, as in Causby, is circumscribed in law.

A. The Delimitation Vacuum and Suborbital Flight

[13]A global agreement does not exist on the point at which airspace (which is under the sovereignty of a state) and outer space (which is free to explore) begin. The standard space marker is the Karman line (100 km), although US government authorities have frequently used 50 miles (about 80 km) as an astronaut wing, and some functionalists believe space commences when orbital mechanics takes over. This ambiguity is exploited by the emergence of sub orbital tourism (Virgin Galactic, Blue Origin). These flights pass over sovereign airspace to the border of space.

[14]When the boundary is pegged too low (e.g. 50 km), states lose sovereignty on the high-altitude surveillance or transport. In the case of very high altitude (e.g. 150 km), Very Low Earth Orbit (VLEO) satellites may technically be infringing national airspace.

A functional definition is becoming more popular with legal academics: an object in orbit is in space; an object that uses aerodynamic lift is in airspace. This prevents the physical ex post facto of fixed lines but generates complicated liability challenges on hybrid cars.

Orbital Debris: The Anti-Commons

[15]In Low Earth Orbit (LEO), property rights are manifesting in reverse: as liability. The "Kessler Syndrome" (cascading debris collisions) is a classic tragedy of the commons.

[13] World Intellectual Property Organization, *Patent Law and Marine Genetic Resources* (WIPO Report, 2022).
[14] International Telecommunication Union, *Orbital Slot Allocation and Spectrum Management* (2021).
[15] Donald J. Kessler & Burton G. Cour-Palais, *Collision Frequency of Artificial Satellites*, 83 J. Geophys. Res. 2637 (1978).

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1. Economic Models**:** New proposals suggest applying "patent-like" incentives to debris removal. An entity that removes debris could be granted tradeable credits or "salvage rights" to the materials.
2. Take-Back Programs**:** Analogous to terrestrial "extended producer responsibility" laws, satellite operators may soon face "deposit-refund" schemes where a bond is posted at launch and refunded only upon successful de-orbiting.[43] This effectively prices the "right to occupy" an orbital slot, transforming LEO from an open-access commons to a regulated leasehold market.

IX. CONCLUSION

This absolute verticality is disappearing in the 21st century kinetic, hyper-connected reality, exposing instead a mature, technocratic web of rights that considers function as a priority over form2. We are also experiencing the emergence of so-called Algorithmic Property a regime in which physical geofencing is phased out in Favor of dynamic geofencing, paper deeds are replaced with smart contracts that are negotiated in high-frequency, and sovereignty is administered by international treaty organizations. This shift is not a theoretical one; already, it is re-formulating the world legal structure, none more evidently in the stratification of the vertical commons that is being done at an alarming pace.

The principle of absolute right of exclusion is weakening in the airspace, which is bound to be substituted by a right of compensation or a statutory licensing. It is anticipated that the Drone Superhighway will become a sort of public trust easement, lit through the private sky via a mash-up of legislative fiat and kind of tokenization. As the West struggles with constitutional implications of such a change according to the Cedar Point constitutional case, India gives an indication of the future via its Digital Sky platform. In this case, the immediate reaches have already been mapped into digital architecture of green, yellow and red zones, in essence becoming a programmable asset under the control of the DGCA. This heralds a worldwide turnaround to the "quiet enjoyment" of land, but no longer maintained by discouraging technology, but by pricing the intrusion with the help of micro-easements and automated compliance.

At the same time the maritime frontier is also receiving a reality check. The romantic, libertarian concept of the autonomous sea stead is being smothered to death by the irresistible legal reality of flag state jurisdiction and the strategic needs of the coastal state. The future of

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ocean habitation is not secession, but in special population model of the Special Ocean Zone-integrated with coastal states, but legally distinct, to reflect the complex "Blue Economy" models being pursued by states such as India. The principle of common heritage is coming to be viewed as a practical tax regime as the Deep Ocean Mission gains momentum in terms of exploration in the Central Indian Ocean Basin, but it was a utopian ideal previously. Regardless of whether this is an abyss polymetallic nodule, or orbital slot in the heavens, more and more of the enclosure is being allowed, but the rent, which is now regulated by the ISA and the new BBNJ Agreement, is amassed to the benefit of the globe. Finally, the 21st century property owner does not possess a portion of the infinite, rather it is a time marked, geofenced and marketable right to utilize it.

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