

Urgency of Developing New Regulatory Norms on Subsurface Ownership and Vertical Depth Boundaries in the National Agrarian Law System

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ABSTRACT

This article examines the urgency of developing new regulatory norms governing subsurface ownership and vertical depth boundaries within Indonesia's national agrarian law system. The study is driven by the absence of explicit legal provisions defining the scope, limitations, and ownership status of underground space, which creates legal uncertainty and potential conflicts in land utilisation, infrastructure development, and urban planning. Utilising a normative juridical method supported by statute, conceptual, and comparative approaches, this research analyses the insufficiency of existing regulations under the Basic Agrarian Law (UUPA), particularly regarding vertical land demarcation and the doctrine of horizontal separation. The findings demonstrate that the current legal framework does not adequately regulate subsurface rights, resulting in normative gaps related to depth limits, administrative procedures, legal protection, and allocation of underground space for public and private interests. The study concludes that Indonesia urgently requires a new normative framework, potentially through the recognition of a distinct Right to Subsurface Space to ensure legal certainty, prevent future ownership disputes, and support sustainable spatial planning.

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INTRODUCTION

Rapid urban population growth in Indonesia has significantly intensified pressure on land availability, particularly in metropolitan areas where horizontal expansion is increasingly constrained. This condition has compelled policymakers and urban planners to explore alternative spatial utilisation strategies, including the systematic use of subsurface space for infrastructure, transportation systems, utilities, and commercial activities. In contemporary urban development discourse, land is no longer understood merely as a two-dimensional surface but as a three-dimensional spatial entity that can be managed vertically, both upward and downward, to achieve efficiency and sustainability in land use (Sorensen & Okata, 2011; Tan & Zhao, 2020).

However, Indonesia's agrarian legal framework has not evolved in parallel with these spatial transformations. The Basic Agrarian Law of 1960 (Undang-Undang Pokok Agraria/UUPA) remains predominantly surface-oriented and does not provide explicit regulation concerning subsurface ownership or vertical depth boundaries. Although the UUPA conceptually acknowledges that land rights extend above and below the surface "as far as necessary for the use of the land," this formulation is functional rather than normative and fails to establish measurable limits of ownership or distinguish between private and public subsurface interests (Harsono, 2008; Sumardjono, 2015). As a result, underground development in Indonesia operates within a legal grey area that undermines certainty in land administration, spatial planning, and infrastructure investment.

From a theoretical standpoint, modern land law scholarship emphasises the importance of vertical land demarcation and the operationalisation of the horizontal separation principle (horizontale scheiding). This doctrine recognises that legal

rights over land may be separated according to spatial layers above, on, or below the surface, rather than being treated as a single, indivisible object (Qiao, 2022; Wicaksono, 2020). In comparative perspective, several jurisdictions such as Japan, Singapore, and South Korea have translated this doctrine into positive law by establishing statutory depth limits and classifying deep subsurface space as part of the public domain. Such regulatory models allow the state to manage underground space independently of surface ownership, thereby reducing overlapping claims and facilitating large-scale underground infrastructure development (Ariga & Zheng, 2017; Tan & Zhao, 2020).

In contrast, Indonesia has yet to adopt a comparable legal approach. The absence of explicit statutory norms governing subsurface ownership has created a normative vacuum with serious legal implications. There is no clear determination of how deep private land rights extend, no recognition of subsurface parcels as independent legal objects, and no comprehensive administrative mechanism for registering underground space within the national land registration system. This condition increases the likelihood of conflicts between surface landowners, developers, and state authorities, particularly in projects involving tunnels, underground utilities, and deep foundations (Hermawan & Hananto, 2021; Hashami & Octariana, 2023). Legal uncertainty is further exacerbated in public–private partnership schemes, where investors require predictable and enforceable rights over subsurface space to secure financing and allocate risk effectively (Hajati, 2018).

Based on these conditions, the central legal problem addressed in this study concerns the absence and ambiguity of regulatory norms governing subsurface ownership and vertical depth boundaries within Indonesia's national agrarian law system. Existing regulations, including Government Regulation No. 18 of 2021, have begun to conceptually recognise underground space as an object of land rights, yet they fail to provide operational standards concerning depth limits, volumetric demarcation, registration procedures, and the allocation of subsurface space for public and private purposes (Hermawan & Hananto, 2021; Abdullah & Purbawa, 2020). This regulatory insufficiency hinders legal certainty and weakens the capacity of spatial planning law to respond to contemporary urban development needs.

To address this problem, this research adopts a normative legal research approach that emphasises doctrinal analysis and legal reasoning. The problem-solving plan involves the use of statutory, conceptual, and analytical approaches to examine existing agrarian and spatial planning regulations, relevant legal doctrines, and comparative regulatory models. Through this method, the study seeks to identify normative gaps and doctrinal inconsistencies while constructing legal arguments for the development of new regulatory instruments governing subsurface ownership and vertical land demarcation (Marzuki, 2005; Hutchinson & Duncan, 2012).

Accordingly, this research aims to achieve three primary objectives. First, it seeks to analyse the adequacy of Indonesia's current agrarian law framework in regulating subsurface ownership and vertical land boundaries. Second, it aims to examine theoretical and comparative perspectives on underground space regulation as a basis for legal reform. Third, it endeavours to formulate normative recommendations for the establishment of a comprehensive legal regime governing subsurface ownership, including the possible recognition of a distinct right to subsurface space, to enhance legal certainty, prevent future land disputes, and support sustainable three-dimensional spatial planning in Indonesia (Qiao, 2022; Tan & Zhao, 2020).

METHODS

This study employs a normative legal research approach, as the central issue examined concerns the absence and ambiguity of legal norms regulating subsurface ownership and vertical depth boundaries within Indonesia's agrarian law system. Normative legal research is particularly appropriate when the objective of the study is to analyse legal deficiencies, inconsistencies, or the need for normative reconstruction, rather than to measure social behaviour or empirical phenomena. This method relies on authoritative legal sources, doctrinal interpretation, and systematic legal reasoning to assess the adequacy of existing regulations and propose normative solutions (Marzuki, 2005; Soekanto & Mamudji, 2011).

The research is conducted through several interrelated analytical approaches. A statutory approach is applied to examine positive law governing land rights and spatial planning, with particular attention to the Basic Agrarian Law (Undang-Undang Pokok Agraria/UUPA), Government Regulation No. 18 of 2021, and other relevant implementing regulations. This approach enables an evaluation of the extent to which existing legislation provides legal certainty regarding subsurface ownership and vertical land demarcation (Harsono, 2008; Hermawan & Hananto, 2021). In addition, a conceptual approach is employed to analyse legal doctrines and theoretical frameworks related to vertical land delineation, the principle of horizontal separation (*horizontale scheiding*), and the juridical status of subsurface space within modern land law (Qiao, 2022; Wicaksono, 2020). An analytical approach is further used to assess normative coherence, identify regulatory gaps, and construct legal arguments supporting the development of new regulatory instruments governing subsurface ownership.

The legal materials used in this study are classified into three categories. Primary legal materials consist of statutes, government regulations, and other binding legal instruments relevant to agrarian law and spatial planning. Secondary legal materials include textbooks, peer-reviewed journal articles, and scholarly commentaries authored by legal experts that discuss land law, underground space regulation, and legal certainty. Tertiary legal materials, such as legal dictionaries and encyclopedias, are utilised to clarify legal concepts and terminology. The collection of legal materials is conducted through a document analysis method, involving a systematic review of legislative texts and doctrinal writings (Ibrahim, 2006; Hutchinson & Duncan, 2012).

All legal materials are analysed qualitatively using a normative juridical method that emphasises doctrinal interpretation, comparative analysis of scholarly opinions, and deductive legal reasoning. Through this analytical process, the study identifies conceptual weaknesses and normative inconsistencies within the existing legal framework and formulates recommendations for the establishment of clearer legal norms concerning subsurface boundaries and proprietary rights. This approach allows the research to contribute to the development of a coherent regulatory framework that enhances legal certainty and supports sustainable three-dimensional spatial governance in Indonesia (Sumardjono, 2015; Tan & Zhao, 2020).

RESULTS AND DISCUSSION

The Impact of the Vacuum of Norm on Legal Certainty in Subsurface Ownership

The absence of a clear and comprehensive legal framework regulating subsurface ownership in Indonesia has created a significant normative vacuum that directly affects legal certainty, predictability, and the governance of underground space. Although the Basic Agrarian Law (UUPA) conceptually recognises that land rights extend both upward and downward “as far as necessary for the use of the land,” this provision lacks operational definitions and cannot function as a robust legal basis for determining vertical ownership limits. Consequently, the scope of private land rights beneath the surface remains vague and inconsistent, a condition that becomes increasingly problematic as rapid urbanisation and infrastructural development intensify the demand for underground construction such as subway tunnels, basements, utility corridors, and drainage systems (Harsono, 2008; Sumardjono, 2015). Legal scholars have consistently noted that Indonesia’s land law framework is not yet equipped to regulate three-dimensional property relationships systematically (Qiao, 2022; Hermawan & Hananto, 2021).

This normative vacuum generates multiple layers of ambiguity. In the absence of statutory depth limits or explicit subsurface rights, landowners cannot ascertain the precise vertical scope of their ownership. The doctrine of horizontal separation, which acknowledges that different legal rights may apply to spaces above and below the surface, has never been fully operationalised within Indonesian positive law, thereby increasing the risk of overlapping claims and underground trespass (Wicaksono, 2020; Hashami & Octariana, 2023). As a result, developers constructing deep foundations or tunnels may unintentionally interfere with subsurface space presumed to be controlled by surface landowners, leading to legal disputes. At the same time, government authorities face uncertainty in determining whether underground space must be acquired, compensated, or merely regulated, due to the absence of a legal distinction between shallow and deep subsurface use (Hermawan & Hananto, 2021).

The normative vacuum also obstructs the development of a three-dimensional (3D) cadastre system. A functional 3D cadastre requires clearly defined legal boundaries for volumetric parcels, which are currently unavailable in Indonesia. Although Government Regulation No. 18 of 2021 introduces underground space as an object of land rights, it does not provide technical standards concerning measurement, mapping, registration, or depth zoning. In contrast, jurisdictions such as Singapore and Japan have adopted explicit statutory demarcations that support detailed underground registration systems (Abdullah & Purbawa, 2020; Ariga & Zheng, 2017). Without similar rules, Indonesia is unable to issue subsurface titles that are legally recognised within the land administration system. As a consequence, underground parcels cannot be registered, transferred, used as collateral, or effectively integrated into spatial planning, significantly limiting their economic and administrative utility (Tan & Zhao, 2020).

Legal risks for investors and developers are also amplified under conditions of normative uncertainty. Financing underground infrastructure projects typically requires formal and enforceable proof of subsurface rights, which Indonesia's legal system is currently unable to provide. Liability issues arising from underground construction such as damage to adjacent structures or interference with existing utilities remain unclear due to the absence of legal norms defining responsibility for subsurface encroachment. As a result, contractual arrangements for underground projects, including build–operate–transfer schemes and public–private partnerships, lack stability and predictability, increasing transaction costs and discouraging investment (Hajati, 2018; Tan & Zhao, 2020).

Furthermore, the normative vacuum intensifies conflict between public and private interests. Unlike legal systems that classify subsurface space beyond a certain depth as part of the public domain, Indonesia leaves this issue unresolved. Consequently, surface landowners, government agencies, and private developers may simultaneously assert authority over the same underground space based on differing legal interpretations. Such overlapping claims elevate the likelihood of litigation and may delay the implementation of strategic national infrastructure projects (Hermawan & Hananto, 2021; Qiao, 2022).

Spatial planning governance is similarly impaired. Although Indonesia's spatial planning regime envisions integrated surface and subsurface zoning, local governments are unable to implement underground zoning policies due to the absence of clearly defined subsurface property rights. Environmental impact assessments (AMDAL) for underground projects also lack standardised criteria concerning permissible depths, geological stability, and environmental risk thresholds. Given the growing importance of underground flood control systems, urban drainage networks, and climate-resilience infrastructure, regulatory uncertainty undermines long-term planning and disaster mitigation efforts (Sugiarto & Winarso, 2019; Afifah et al., 2018).

The normative vacuum further exposes customary and indigenous communities to heightened legal vulnerability. In many customary legal systems, land rights extend beyond the surface to include subsurface elements that hold cultural, spiritual, or communal significance. In the absence of explicit statutory protection, customary communities may be excluded from consultation processes or compensation mechanisms when subsurface land is utilised for development, increasing the risk of dispossession and reinforcing structural power imbalances. This condition runs counter to constitutional guarantees concerning the protection of customary rights (Elvinda, 2021; UUD 1945, Article 18B paragraph (2)).

Environmental governance is likewise weakened by the absence of subsurface regulation. Underground construction poses serious risks, including groundwater contamination, land subsidence, and ecological disruption. However, environmental authorities lack normative guidance regarding depth limits, geological standards, and monitoring obligations. This regulatory gap permits environmentally harmful underground practices to occur without adequate oversight, creating long-term environmental hazards for both ecosystems and human settlements (Sugiarto & Winarso, 2019).

Finally, the normative vacuum contributes to fragmented institutional authority. Multiple ministries and agencies responsible for land administration, spatial planning, mining, public works, and environmental protection exercise overlapping or partial jurisdiction over subsurface space. In the absence of a unified legal framework, coordination

among institutions remains weak, regulatory mandates overlap, and no single authority holds definitive responsibility for subsurface governance. This fragmentation further exacerbates legal uncertainty and diminishes the effectiveness of land administration as a whole (Hermawan & Hananto, 2021; Sumardjono, 2015).

Taken together, the normative vacuum surrounding subsurface ownership significantly undermines legal certainty in Indonesia. Without clear legal norms, vertical boundaries remain ambiguous, registration of underground rights is unattainable, investor confidence declines, public infrastructure development encounters legal obstacles, environmental protection lacks coherence, and vulnerable communities remain insufficiently protected. Legal certainty, an essential pillar of the rule of law, cannot be realised as long as underground space continues to be governed by abstract doctrines and incomplete regulations. Therefore, a coherent legal framework defining subsurface rights, establishing vertical depth limits, enabling a 3D registration mechanism, harmonising institutional authority, and integrating underground governance into national spatial planning is urgently required to ensure that underground development proceeds in an orderly, equitable, and sustainable manner (Qiao, 2022; Tan & Zhao, 2020).

Comparative and Theoretical Perspectives on Subsurface Ownership Regulation

The development of underground space utilisation has fundamentally transformed the traditional conception of land ownership from a two-dimensional to a three-dimensional legal paradigm. Historically, classical property law adhered to the maxim *cuius est solum, eius est usque ad coelum et ad inferos*, which implied that ownership of land extended indefinitely upward to the sky and downward to the centre of the earth. While this doctrine reflected the relatively simple pattern of land use in earlier periods, rapid urbanisation and technological advancement have rendered it increasingly inadequate to accommodate the complex vertical utilisation of land. The expansion of underground transportation systems, utility networks, commercial facilities, and strategic public infrastructure demonstrates that unlimited vertical ownership is no longer compatible with contemporary spatial development. Consequently, numerous jurisdictions have gradually replaced the traditional doctrine with statutory frameworks that define vertical boundaries and establish independent legal regimes governing subsurface space. Japan, Singapore, and South Korea represent prominent examples of countries that have adopted specific legal frameworks regulating underground space in response to land scarcity and increasing urban development demands.

From a theoretical perspective, the emergence of three-dimensional property theory constitutes one of the most significant developments in modern land law. Unlike the conventional approach, which treats land as a horizontal parcel, three-dimensional property theory conceptualises land as a volumetric legal object whose ownership, control, and utilisation may be divided according to measurable spatial dimensions. This approach recognises that proprietary rights need not remain inseparable from a single surface parcel but may instead be allocated independently across different vertical layers. Such a framework seeks to balance the protection of private property rights with the state's responsibility to manage spatial resources efficiently for sustainable development. The practical application of this theory can be observed in Japan through the Act on Special Measures concerning Public Use of Deep Underground (2001), which authorises the government to utilise deep underground space for public infrastructure projects without obtaining consent from every surface landowner, provided that the development serves the public interest and satisfies statutory requirements. This legislation illustrates how three-dimensional property theory has been translated into positive law by establishing clear legal boundaries governing subsurface ownership.

The theoretical foundation of three-dimensional property is closely associated with the principle of legal certainty, which constitutes one of the fundamental objectives of modern land administration systems. Legal certainty cannot be achieved unless the object of property rights is clearly defined. In the context of underground space, ambiguity regarding the vertical extent of land ownership creates uncertainty for landowners, governments, investors, and infrastructure developers alike. Consequently, legal scholars argue that ownership boundaries should no longer be determined solely through horizontal cadastral mapping but should also incorporate volumetric dimensions capable of distinguishing multiple legal interests existing within the same geographical location. Singapore has implemented this approach through the State Lands Act, the Land Titles Act, and related land administration regulations, which enable underground space to be legally separated from surface ownership and registered independently through a three-dimensional cadastral

system. By providing precise spatial boundaries, the Singaporean legal framework facilitates the coexistence of multiple proprietary interests while minimising legal conflicts arising from overlapping land use.

Another theoretical perspective that has significantly influenced subsurface regulation is the principle of horizontal separation (*horizontale scheiding*). Unlike the doctrine of accession, which considers everything attached to or beneath the land as an inseparable component of surface ownership, the principle of horizontal separation recognises that different legal objects may possess distinct ownership status despite occupying the same parcel of land. Originally developed within continental European legal systems, this principle has subsequently been adapted by several Asian jurisdictions to accommodate increasingly complex urban development. South Korea provides a notable example through its Civil Act and various statutes governing underground development, which permit public infrastructure and commercial facilities to exist beneath privately owned land without extinguishing or diminishing the legal rights of surface owners. The Korean experience demonstrates that vertical separation of proprietary rights has evolved beyond a purely theoretical construct into an effective legal mechanism capable of supporting sustainable urban development while preserving legal certainty for all parties concerned.

The theoretical evolution toward vertically differentiated property rights has also been reinforced by the concept of public domain management. Contemporary land law scholars increasingly argue that deep underground space possesses strategic characteristics that distinguish it from ordinary private property. In Japan, deep underground areas that no longer maintain a functional relationship with surface land use may be utilised for public infrastructure projects without substantially interfering with private ownership rights. Singapore has adopted a comparable approach by granting the government broader authority to allocate underground space for the construction of mass rapid transit systems, utility corridors, and other public infrastructure essential to national development. These legal developments reflect a significant paradigm shift from the traditional notion of absolute private ownership toward a more balanced model that reconciles individual proprietary rights with the broader public interest. From the perspective of modern land law theory, this approach embodies the social function of land rights by ensuring that underground space can be managed efficiently, equitably, and sustainably without undermining the legitimate interests of private landowners (Adnan, 2026).

Country	Legal Framework	Vertical Boundary	Independent Subsurface Rights	3D Registration	Public Interest Utilisation
Indonesia	Basic Agrarian Law (Law No. 5/1960); Government Regulation No. 18/2021	Not explicitly regulated	Not specifically recognized	Not available	Limited legal basis
Japan	Act on Special Measures concerning Public Use of Deep Underground (2001)	Explicit statutory depth	Recognized	Available	Strongly regulated
Singapore	State Lands Act; Land Titles Act	Explicit vertical demarcation	Recognized	Fully implemented	Extensive governmental authority
South Korea	Civil Act; Underground Safety Management Act	Regulated through statutory framework	Recognized	Implemented	Integrated with urban development

Table 1: Comparative Regulation of Subsurface Ownership in Selected Jurisdictions
Authors' compilation [source]

Reconstruction for a New Regulatory Framework Governing Subsurface Ownership and Vertical Land Demarcation

The increasing complexity of urban development in Indonesia has revealed substantial weaknesses in the existing legal framework governing subsurface ownership and vertical land demarcation. Although the Basic Agrarian Law of 1960 (UUPA) conceptually recognises that land rights extend upward and downward “as far as necessary for the use of the

land,” this formulation is inadequate for regulating contemporary three-dimensional land use. Its functional character fails to establish measurable vertical boundaries and does not define subsurface parcels as independent legal objects. Consequently, Indonesia’s land law system continues to operate within a predominantly two-dimensional paradigm that is incompatible with the realities of layered infrastructure, underground utilities, subway systems, deep basements, and multi-level engineering works (Harsono, 2008; Qiao, 2022).

Government Regulation No. 18 of 2021 (PP 18/2021) represents an important normative development by formally introducing Ruang Atas Tanah (RAT) and Ruang Bawah Tanah (RBT) as potential objects of land rights. Nevertheless, the regulation remains largely conceptual and lacks detailed mechanisms for implementation. It does not regulate depth limits, technical surveying methods, volumetric mapping standards, or procedures for registering underground parcels within the national land registry administered by ATR/BPN. The absence of these implementing norms prevents subsurface parcels from being registered, transferred, mortgaged, or legally protected in the same manner as surface land, thereby generating legal uncertainty for developers, government authorities, communities, and investors. Without measurable vertical demarcation, the risk of overlapping claims between surface owners and subsurface users remains significant (Hermawan & Hananto, 2021; Abdullah & Purbawa, 2020).

Accordingly, the need for a new regulatory framework governing subsurface ownership is both urgent and multifaceted. First, clear vertical property boundaries must be established. A modern regulatory regime should define the upward and downward extent of land ownership using measurable criteria, such as depth ranges, rather than relying on abstract functional necessity. This approach aligns with comparative legal models. In Japan and Singapore, for instance, subsurface space beyond certain depths is categorised as part of the public domain, allowing the construction of deep tunnels and underground utilities without generating conflicts with surface landowners (Ariga & Zheng, 2017; Tan & Zhao, 2020). Indonesia’s failure to adopt similar statutory clarity undermines legal certainty and complicates land acquisition for underground infrastructure.

Second, Indonesia must develop a three-dimensional (3D) cadastre capable of recording volumetric parcels. A 3D cadastre is essential for registering subsurface property rights with precise spatial coordinates and legal boundaries. Without such a system, volumetric parcels cannot be mapped, certified, or reliably distinguished from surface ownership, leaving no authoritative record to prevent disputes or duplication of rights. The current land administration system is ill-equipped to accommodate stacked ownership or separate subsurface rights, which poses serious obstacles for public infrastructure projects, private development, and local governments implementing spatial planning policies (Abdullah & Purbawa, 2020; Tan & Zhao, 2020).

Third, a new regulatory framework must establish a distinct legal instrument governing subsurface rights. Indonesia could introduce a specific Right to Subsurface Space (Hak Ruang Bawah Tanah), analogous to existing limited real rights such as Hak Guna Bangunan or Hak Pakai, but tailored to underground utilisation. This right should clearly define duration, depth, spatial dimensions, permitted uses, legal obligations, and the relationship between surface and subsurface right holders. The recognition of a distinct subsurface right would also allow underground parcels to function as transferable and mortgageable assets, thereby enhancing investment feasibility for infrastructure and commercial projects (Qiao, 2022; Hermawan & Hananto, 2021).

Fourth, institutional harmonisation is imperative. Currently, multiple ministries and agencies, including ATR/BPN, the Ministry of Public Works and Housing (PUPR), the Ministry of Energy and Mineral Resources (ESDM), the Ministry of Environment and Forestry (KLHK), and local governments, exercise overlapping authority over different aspects of subsurface governance. A comprehensive legal framework must clearly delineate institutional competencies, specifying which authority regulates subsurface parcels, issues titles, supervises safety and environmental impacts, and coordinates inter-agency governance. Fragmented authority has thus far resulted in regulatory inconsistency, delayed permitting, conflicting administrative decisions, and inefficient project implementation (Sumardjono, 2015; Hermawan & Hananto, 2021).

Fifth, environmental and social safeguards must be embedded within the new regulatory framework. Unregulated subsurface construction may lead to groundwater contamination, land subsidence, ecological disruption, and public safety risks. Future legislation must therefore incorporate clear requirements for environmental impact assessments, geological surveys, depth limitations, and continuous environmental monitoring. Equally important is the protection of customary and indigenous communities, whose land tenure systems often encompass subsurface elements imbued with cultural and spiritual significance. Without explicit legal safeguards, these communities face heightened risks of dispossession and marginalisation as underground space is increasingly exploited for development (Elvinda, 2021; Sugiarto & Winarso, 2019).

Sixth, the new framework must provide transparent and effective mechanisms for dispute resolution. Vertical land disputes differ fundamentally from traditional horizontal land conflicts, as they involve volumetric overlaps, underground trespass, liability for subterranean damage, and conflicts between public infrastructure and private ownership. Clear rules governing compensation, expropriation, underground servitudes, and easements are therefore necessary to ensure fairness, reduce litigation, and maintain public trust in land governance institutions (Wicaksono, 2020; Qiao, 2022).

In sum, Indonesia urgently requires a comprehensive regulatory framework governing subsurface ownership and vertical land demarcation. Such a framework must establish measurable vertical limits, introduce a functional 3D cadastre, recognise a distinct subsurface right, harmonise institutional authority, integrate environmental and social safeguards, and provide effective dispute-resolution mechanisms. Without these reforms, underground development in Indonesia will continue to operate under legal uncertainty, constraining national infrastructure development, discouraging private investment, compromising environmental sustainability, and weakening the protection of community rights. A modernised subsurface property regime is therefore not merely a legal refinement but an essential foundation for equitable, efficient, and sustainable spatial governance (Tan & Zhao, 2020; Qiao, 2022).

CONCLUSION

This study demonstrates that Indonesia's existing agrarian law framework remains inadequate to regulate subsurface ownership and vertical depth boundaries in response to the growing use of underground space. Although the Basic Agrarian Law and Government Regulation No. 18 of 2021 acknowledge that land rights may extend above and below the surface, they do not provide clear standards on the legal extent of such rights, measurable depth limits, registration procedures, or the juridical status of subsurface parcels. This creates a normative vacuum that weakens legal certainty, complicates land administration, increases the risk of overlapping claims, and limits the effective use of underground space for infrastructure, utilities, and urban development.

The findings further show that the absence of clear subsurface regulation has broader legal, institutional, environmental, and social consequences. Without explicit vertical demarcation, landowners, developers, and state authorities may assert competing claims over the same underground space. The lack of a three-dimensional cadastre prevents underground parcels from being properly mapped, registered, transferred, or used as collateral. At the same time, fragmented institutional authority, insufficient environmental safeguards, and limited protection for customary communities create further challenges for sustainable and equitable subsurface governance.

Comparative experiences from Japan, Singapore, and South Korea show that effective underground space governance requires clear statutory depth limits, recognition of independent subsurface rights, and a land administration system capable of recording three-dimensional property interests. These models indicate that Indonesia should move beyond a surface-based conception of land rights and develop a vertically integrated regulatory framework that balances private ownership, public interest, investment certainty, environmental protection, and community rights.

Accordingly, this article recommends the development of a comprehensive legal regime governing subsurface ownership and vertical land demarcation. Such reform should include the establishment of measurable vertical boundaries, the introduction of a dedicated Right to Subsurface Space, the implementation of a standardised three-dimensional cadastre, clearer institutional coordination, environmental and social safeguards, and effective dispute-resolution mechanisms. These reforms are essential to ensure that Indonesia's future underground development proceeds with legal certainty, administrative coherence, social justice, and environmental sustainability.

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