



Research Article



## Legal Certainty in Underground Space Utilization: Lessons from Selected Jurisdictions

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**Abstract:** Rapid urbanization, population growth, infrastructure expansion, and land scarcity have encouraged underground space utilization for urban development. However, Indonesia lacks a comprehensive legal framework regulating underground space ownership, utilization, and registration, creating legal uncertainty regarding rights allocation and subsurface development. This study examines the legal challenges and regulatory deficiencies associated with underground space utilization in Indonesia and formulates legal reform recommendations by drawing lessons from comparative legal systems. The study employs normative legal research using statutory, conceptual, and comparative approaches. The analysis focuses on existing Indonesian regulations and evaluates legal arrangements governing underground space in Japan, England, and Germany. The study finds that Indonesia has not established a specific and integrated legal regime capable of regulating underground space utilization effectively. The absence of clear legal provisions has limited legal certainty and hindered the implementation of sustainable underground development. Therefore, this study proposes legal reform through the clarification of vertical property boundaries, the recognition of independent underground space rights, the development of a three-dimensional land registration system, and the harmonization of related legislation. These measures can strengthen legal certainty, improve land governance, and support sustainable urban development in Indonesia.

**Keywords:** Land; Legal Certainty; Underground Space; Urban Development;



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## INTRODUCTION

The development of urban areas in Indonesia over the last two decades has demonstrated a substantial increase in spatial demand. Population growth, rapid urbanization, economic expansion, infrastructure development, public utility provision, and the growing need for housing have intensified pressure on the availability of land in urban regions.<sup>1</sup> This condition has encouraged the government to adopt a spatial planning approach that is no longer exclusively oriented toward horizontal land utilization but also incorporates the vertical dimension through the use of above ground and underground spaces.<sup>2</sup> Within the framework of contemporary spatial planning, underground space is no longer perceived as an economically insignificant area; rather, it has emerged as a strategic spatial resource

<sup>1</sup> Takayuki Kishii, 'Utilization of Underground Space in Japan', *Tunnelling and Underground Space Technology*, 55 (2016), 320–23 <<https://doi.org/10.1016/j.tust.2015.12.007>>

<sup>2</sup> Mária Hámor-Vidó, Tamás Hámor, and Lili Czirok, 'Underground Space, the Legal Governance of a Critical Resource in Circular Economy', *Resources Policy*, 73 (2021), 102171 <https://doi.org/10.1016/J.RESOURPOL.2021.102171>



that can be utilized for mass transportation systems, utility networks, commercial facilities, underground parking, public infrastructure, and integrated urban development.

In Indonesia the need for underground space utilization has become increasingly evident, particularly in metropolitan cities such as Jakarta, Surabaya, Bandung, Medan, and Makassar.<sup>3</sup> Jakarta provides the most prominent example of underground space utilization in Indonesia, as urban land scarcity has driven the development of various underground infrastructure projects.<sup>4</sup> In 2020, the construction of Jakarta MRT Phase 2A officially commenced as a continuation of MRT Phase 1, which had already operated approximately 5.9 kilometers of underground railway lines connecting Lebak Bulus and Bundaran HI. During this phase, the government initiated the development of the Bundaran HI–Kota corridor, which was entirely designed using underground tunnels and stations. The project comprises seven underground stations Thamrin, Monas, Harmoni, Sawah Besar, Mangga Besar, Glodok, and Kota with a total route length of approximately 5.8 kilometers. Between 2021 and 2023, the construction of underground stations and tunnels under MRT Phase 2A continued to progress. The utilization of underground space during this period extended beyond railway infrastructure to include commercial areas, underground pedestrian access, urban utility networks, and the integration of Transit Oriented Development (TOD) zones. Consequently, Jakarta began to adopt a multifunctional underground space concept that integrates public transportation systems with urban economic activity centers.

During the period of 2024–2025, the intensity of underground space utilization increased significantly. The construction progress of Jakarta MRT Phase 2A reached nearly 50 percent by mid-2025 and exceeded 55 percent by the end of 2025. In addition to the development of underground stations, the project also produced a number of new tunnels that form part of the largest underground transportation network in Indonesia. A significant milestone was achieved in 2025 when Jakarta MRT completed the construction of the deepest underground tunnel in Indonesia, located approximately 27–28 meters below ground level and connecting the Harmoni and Sawah Besar areas. Furthermore, Indonesia successfully completed its first stacked tunnel system as part of the Jakarta MRT Phase 2A development. These achievements reflect the increasing scale and complexity of underground space utilization in Indonesia and demonstrate the growing importance of underground infrastructure in supporting sustainable urban development.<sup>5</sup>

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<sup>3</sup> Shana Debrock, Maarten Van Acker, and Han Admiraal, 'Design Recommendations for Sustainable Urban Underground Spaces', *Tunnelling and Underground Space Technology*, 140 (2023) <https://doi.org/10.2788/771635>

<sup>4</sup> Nur Gemilang Mahardika, Ahmad Kushay, and Arief Hasanul Husnan Nasution, 'The Silent Sea: The Legal Lacuna of Sedentary Activities in the Archipelagic Sea Lanes under UNCLOS', *Legality: Jurnal Ilmiah Hukum*, 34.1 (2026), 1–21 <https://doi.org/10.22219/LJIH.V34I1.41899>

<sup>5</sup> G. BurrIDGE and others, 'The Future of 4D Subsurface Modelling: Reflections from a Multi-Sector Conference', *81st EAGE Conference and Exhibition 2019 Workshop Programme*, 2019 <https://doi.org/10.3997/2214-4609.201902008>



Despite the growing demand for underground space utilization, the development of its regulatory framework has not reached a comparable level of maturity.<sup>6</sup> From a normative perspective, Law Number 5 of 1960 concerning Basic Agrarian Principles (the Basic Agrarian Law/UUPA) does not explicitly regulate underground space as an independent object of rights. The UUPA primarily recognizes rights over the surface of the earth as part of land rights, leaving the regulation of the vertical dimension of underground space largely implicit and open to varying interpretations. More specific provisions only emerged through Law Number 11 of 2020 on Job Creation and Government Regulation Number 18 of 2021, which introduced the concepts of above ground space and underground space as objects that may be granted Management Rights (*Hak Pengelolaan*) and Land Rights (*Hak Atas Tanah*).

In addition to Government Regulation Number 18 of 2021, the regulation of underground space is dispersed across various sectoral legal instruments, including Law Number 26 of 2007 on Spatial Planning, Government Regulation Number 21 of 2021 on the Implementation of Spatial Planning, Minister of Agrarian Affairs and Spatial Planning/National Land Agency Regulation Number 18 of 2021 concerning Procedures for the Determination of Management Rights and Land Rights, as well as numerous technical regulations governing spatial utilization conformity and spatial control mechanisms. Nevertheless, these regulatory instruments remain fragmented and have yet to establish a comprehensive legal regime governing underground space. The principal weakness of the current regulatory framework lies in the absence of clear legal provisions concerning the vertical boundaries of land rights, the legal status of underground space as distinct from surface land rights, compensation mechanisms for landowners affected by underground development projects, three-dimensional land registration systems, legal relationships between surface right holders and underground space users, and the allocation of authority between land administration and spatial planning institutions.<sup>7</sup> Although underground space has been formally recognized as an object of utilization, legal certainty regarding who is entitled to control, utilize, and derive economic benefits from such space remains inadequately defined.<sup>8</sup>

The absence of a comprehensive legal regime has the potential to generate significant legal and social consequences.<sup>9</sup> *First*, it increases the likelihood of disputes between land rights holders and underground infrastructure developers. *Second*, it creates investment uncertainty, as business actors are not provided with sufficient guarantees regarding the legal status of the underground space they utilize. *Third*, it may result in overlapping institutional authority among agencies responsible for land

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<sup>6</sup> Bahram Saeidian and others, 'Underground Land Administration from 2d to 3d: Critical Challenges and Future Research Directions', *Land*, 10.10 (2021) <https://doi.org/10.3390/LAND10101101>

<sup>7</sup> Yong Kang Qiao and others, 'Rethinking Underground Land Value and Pricing: A Sustainability Perspective', *Tunnelling and Underground Space Technology*, 127 (2022) <https://doi.org/10.1016/j.tust.2022.104573>

<sup>8</sup> Peng Yu and others, 'Development of Urban Underground Space in Coastal Cities in China: A Review', *Deep Underground Science and Engineering*, 2.2 (2023), 148–72 <https://doi.org/10.1002/DUG2.12034>

<sup>9</sup> Hari Sutra Disemadi and others, 'IPR-Based Sustainable Tourism: Comparative Analysis of Indonesia, Malaysia, and Thailand', *Legality: Jurnal Ilmiah Hukum*, 34.1 (2026), 113–36 <https://doi.org/10.22219/LJIH.V34I1.43454>



administration, spatial planning, and infrastructure development. *Fourth*, it weakens the protection of community rights due to the lack of compensation mechanisms and dispute resolution procedures specifically designed for underground space utilization.<sup>10</sup> In the long term, these conditions may hinder urban infrastructure development and reduce the effectiveness of sustainable development policies.

In contrast to Indonesia, several jurisdictions have developed more mature legal regimes governing space and have provided greater legal certainty for all stakeholders. Japan regulates underground space utilization through the concept of deep underground utilization, which permits the use of underground space at specified depths for public purposes without requiring the consent of all surface landowners, provided that such utilization does not interfere with the normal use of the surface land.<sup>11</sup> This model seeks to balance infrastructure development needs with the protection of private property rights. In the United Kingdom, the regulation of underground space has evolved through a combination of land law, property law, and infrastructure regulations. The British legal system limits the traditional doctrine of vertical ownership (*cuius est solum eius est usque ad coelum et ad inferos*), such that land ownership does not automatically extend to unlimited depths beneath the surface. The state possesses the authority to regulate underground space utilization for public purposes through clearly established licensing, compensation, and land acquisition mechanisms.

Meanwhile, Germany has adopted a more integrated approach through the interaction of land law, spatial planning law, mining law, and registration systems that enable more precise identification and allocation of rights. This framework is supported by a strong commitment to legal certainty, the functional separation of rights based on spatial utilization, and comprehensive mechanisms for protecting landowners affected by underground development activities.<sup>12</sup> A comparison with Japan, the United Kingdom, and Germany demonstrates that the successful governance of underground space depends not merely on the normative recognition of underground space as an object of utilization, but also on the existence of a comprehensive legal regime regulating its legal status, vertical boundaries, registration systems, compensation mechanisms, and dispute resolution procedures. Unlike these jurisdictions, Indonesia continues to face regulatory fragmentation and normative gaps that may impede the development of underground space as an integral component of sustainable urban development. A comprehensive study on legal certainty in underground space utilization in Indonesia is both necessary and timely. A comparative legal approach is particularly important for identifying and formulating an appropriate legal reform model capable of ensuring legal certainty, justice, and

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<sup>10</sup> Kaharuddin and others, 'Implementation of Tax Incentives for Micro, Small, And Medium Enterprises at Special Economic Zone in Indonesia', *Volkgeist: Jurnal Ilmu Hukum Dan Konstitusi*, 7.2 (2024), 263–75 <https://doi.org/10.24090/VOLKSGEIST.V7I2.11056>

<sup>11</sup> Anjar Kususiyanah and others, 'Trends and Landscape of Omnibus Law Research: A Bibliometric Analysis', *Volkgeist: Jurnal Ilmu Hukum Dan Konstitusi*, 7.2 (2024), 219–43 <https://doi.org/10.24090/VOLKSGEIST.V7I2.9633>

<sup>12</sup> Saud H. Alharthi and Hajed A. Alotaibi, 'Harmonising Legal and Sharia Principles in Foreign Investment: The Regulatory Framework of Subsidiaries in Saudi Arabia', *Legality: Jurnal Ilmiah Hukum*, 34.1 (2026), 162–82 <https://doi.org/10.22219/LJIH.V34I1.42145>



sustainable urban development.<sup>13</sup> The urgency of this research stems from the increasing reliance on underground space utilization in Indonesia, which is not accompanied by the existence of a comprehensive and integrated legal framework. Various National Strategic Projects, including the construction of MRT networks, integrated utility corridors, underground tunnels, and Transit Oriented Development (TOD) areas, will increasingly depend on underground space as an alternative solution to urban land scarcity. Without clear legal provisions concerning the legal status of underground space, the vertical limits of land rights, mechanisms for acquiring rights, compensation schemes, and registration systems, the potential for legal disputes among government authorities, investors, and local communities will continue to increase.<sup>14</sup> Regulatory ambiguity may discourage infrastructure investment, undermine the effectiveness of spatial planning policies, and hinder the achievement of sustainable urban development objectives.

Previous studies on underground space have been conducted by several scholars. For instance, Zhang, in his study entitled *Legal Framework of Urban Underground Space in China*, examined the development of the legal framework governing underground space in China and the transition from a two-dimensional (2D) land system to a three-dimensional (3D) land use regime. However, the study remains limited to a single jurisdiction, namely China, and therefore does not provide a comparative assessment of the effectiveness of legal certainty models across different jurisdictions.<sup>15</sup> Hamorvido, in his research entitled *Underground Space: The Legal Governance of a Critical Resource in the Circular Economy*, analyzed the legal governance of underground space as a strategic resource and emphasized the importance of clear ownership rights and regulatory harmonization. Nevertheless, the study primarily focuses on governance and circular economy perspectives rather than on legal certainty models concerning rights to underground space.<sup>16</sup> Furthermore, Elaine Chew examined Singapore's legal reforms concerning the establishment of depth limits on land ownership and the state's authority over subsurface space. However, her analysis is confined to Singapore's legal framework and does not extend to a comparative examination of other jurisdictions.<sup>17</sup> The findings of this comparative analysis are subsequently employed to formulate recommendations for strengthening the regulation of underground space within Indonesia's land law system, with the objective of addressing existing normative gaps and enhancing legal certainty.

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<sup>13</sup> Dinda Aprilia and others, 'Regulatory Model for Tourism Villages in Forest Areas Based on Sustainable Tourism', *Legality: Jurnal Ilmiah Hukum*, 33.1 (2025), 286–306 <https://doi.org/10.22219/LJIH.V33I1.40177>

<sup>14</sup> 'Pembangunan MRT Jakarta Fase 2A Sudah Separuh Jalan, 7 Stasiun Bawah Tanah Siap Terhubung - AyoJakarta.Com' [https://www.ayojakarta.com/metropolitan/03170957/pembangunan-mrt-jakarta-fase-2a-sudah-separuh-jalan-7-stasiun-bawah-tanah-siap-terhubung?utm\\_](https://www.ayojakarta.com/metropolitan/03170957/pembangunan-mrt-jakarta-fase-2a-sudah-separuh-jalan-7-stasiun-bawah-tanah-siap-terhubung?utm_)

<sup>15</sup> Zhi Zhang and others, 'Legal Framework of Urban Underground Space in China', *Sustainability 2020*, Vol. 12, Page 8297, 12.20 (2020), 8297 <https://doi.org/10.3390/SU12208297>

<sup>16</sup> Mária Hámor-Vidó, Tamás Hámor, and Lili Czirok, 'Underground Space, the Legal Governance of a Critical Resource in Circular Economy', *Resources Policy*, 73 (2021), 102171 <https://doi.org/10.1016/J.RESOURPOL.2021.102171>

<sup>17</sup> Elaine Chew, 'Digging Deep into the Ownership of Underground Space Recent Changes in Respect of Subterranean Land Use', 2017 <https://papers.ssrn.com/abstract=3299803>



## METHOD

This study employs a normative legal research method, focusing on the analysis of legal certainty in the utilization of underground space and the formulation of legal reforms to support the development of an underground space legal regime in Indonesia. Normative legal research is utilized to examine the legal norms governing underground space utilization, identify legal gaps and normative conflicts, and assess the extent to which the existing regulatory framework is capable of ensuring legal certainty as conceptualized in Gustav Radbruch's theory of legal certainty. The analysis is conducted on primary legal materials, including Law Number 5 of 1960 concerning Basic Agrarian Principles (Basic Agrarian Law), Law Number 26 of 2007 concerning Spatial Planning, Law Number 2 of 2012 concerning Land Acquisition for Development in the Public Interest, Government Regulation Number 18 of 2021 concerning Management Rights, Land Rights, Condominium Units, and Land Registration, and Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency Number 17 of 2021 concerning Procedures for the Establishment of Management Rights and Land Rights in Above Ground and Underground Spaces. These regulatory instruments are examined to identify legal provisions concerning the legal status of underground space, the vertical boundaries of land rights, the legal relationship between surface land right holders and underground space users, land registration systems, compensation mechanisms, and the distribution of authority among institutions involved in the utilization of underground space.<sup>18</sup>

This research also relies on secondary legal materials, including scholarly literature, legal journals, previous research findings, doctrines of land law, legal certainty theory, and various studies concerning underground space management. Furthermore, the study adopts a comparative legal approach by examining the regulation of underground space in Japan, the United Kingdom, and Germany. Japan is selected due to its specialized regulatory framework governing the utilization of deep underground space through the Act on Special Measures concerning Public Use of Deep Underground 2000. The United Kingdom is selected because of its development of legal certainty through the doctrine of functional ownership and the evolution of property law.<sup>19</sup> Germany is chosen for its successful integration of land law, rights registration systems, and spatial planning through a structured land administration framework. Through the statutory, conceptual, and comparative legal approaches, this study seeks to formulate a model of legal reform for underground space regulation in Indonesia. Such reform includes the clarification of the vertical boundaries of land rights, the establishment of a specific proprietary right over underground space, the development of a three-dimensional cadastre system, the regulation of compensation mechanisms, and the harmonization of institutional authorities in order to ensure legal certainty in the utilization of underground space.

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<sup>18</sup> Bakhromjon Rakhimjonovich Topildiev and others, 'Legal Challenges and Policy Implications for Property Rights Protection in Uzbekistan', *Journal of Human Rights, Culture and Legal System*, 6.1 (2026), 116–46 <https://doi.org/10.53955/JHCLS.V6I1.893>

<sup>19</sup> Mark Van Hoecke, 'Methodology of Comparative Legal Research', *Recht En Methode in Onderzoek En Onderwijs*, 2016 <https://doi.org/10.5553/rem/.000010>



## RESULT AND DISCUSSION

### *Legal Certainty in Underground Space Utilization in Indonesia*

The increasing complexity of urban development and the growing scarcity of available land have necessitated a transformation in spatial utilization patterns, moving from conventional horizontal expansion toward the more intensive use of vertical space.<sup>20</sup> Urbanization data indicate that more than half of Indonesia's population currently resides in urban areas, and this proportion continues to increase annually. In 2024, approximately 58.8 percent of Indonesia's population lived in urban regions, reflecting a continuing trend toward urban concentration.<sup>21</sup> This condition has intensified the need for the utilization of underground space as a solution to land scarcity while simultaneously serving as an instrument for achieving efficient and sustainable urban development.<sup>22</sup> The limited availability of land in urban areas has led to underground space being increasingly regarded as a strategic alternative for supporting sustainable development through the construction of mass transportation systems, integrated utility networks, parking facilities, underground commercial centers, and various other public infrastructures.<sup>23</sup> In this context, underground space is no longer perceived merely as a passive component of land but rather as a spatial resource possessing significant economic value and strategic functions for development.

Rapid expansion in the utilization of underground space has not been matched by adequate developments within Indonesia's land law framework.<sup>24</sup> From a normative perspective the regulation of underground space originates from Article 4(2) of the Basic Agrarian Law (Law Number 5 of 1960), which grants land right holders the authority to utilize the land together with the subsurface and the space above it to the extent necessary for purposes directly related to the use of the land. This provision demonstrates recognition of the vertical dimension of land rights; however, it does not establish clear limitations regarding the scope of control over underground space.<sup>25</sup> The issue becomes more complex because Indonesian agrarian law adopts the principle of horizontal separation, which allows a distinction between land rights and objects or spaces located above or beneath the land.<sup>26</sup> From a doctrinal perspective

<sup>20</sup> Yani Lai and others, 'Review of Constraints and Critical Success Factors of Developing Urban Underground Space', *Underground Space (China)*, 12 (2023), 137–55 <https://doi.org/10.1016/j.undsp.2023.03.001>

<sup>21</sup> 'Indonesia Urban Population (%): 58.8% (2024) Ranked #131 of 217 | Statistics of the World' <https://statisticsoftheworld.com/country/indonesia/urban-population>

<sup>22</sup> Wanjie Hu, Jianjun Dong, Zhilong Chen, and others, 'Linking Underground Space Development with Sustainable Urban Futures: Research Trends and Knowledge Framework', *Tunnelling and Underground Space Technology*, 168 (2026) <https://doi.org/10.1016/j.tust.2025.107227>

<sup>23</sup> Wanjie Hu, Jianjun Dong, Kai Yang, and others, 'Understanding Key Factors Affecting Underground Logistics Systems Adoption and Front-End Planning: A Cross-Sectoral Investigation and Insights into Emerging Mobility Solutions', *Transport Policy*, 164 (2025), 160–77 <https://doi.org/10.1016/J.TRANPOL.2025.02.002>

<sup>24</sup> Uchendu Eugene Chigbu, 'Connecting Land Tenure to Land Restoration', *Development in Practice*, 33.7 (2023), 762–70 <https://doi.org/10.1080/09614524.2023.2198681>

<sup>25</sup> Muhammad Ishar Helmi and others, 'Effectiveness of Criminal Offense Law Regarding Illegal Levies: Reforming Social Organizations within the Indonesian Legal Framework', *Volksgeist: Jurnal Ilmu Hukum Dan Konstitusi*, 7.2 (2024), 411–30 <https://doi.org/10.24090/VOLKSGEIST.V7I2.10882>

<sup>26</sup> Kevin Grecksch, 'Out of Sight – out of Regulation? Underground Space Governance in the UK', *Journal of the British Academy*, 9.S10 (2021), 43–68 <https://doi.org/10.5871/jba/009s10.043>



this principle creates opportunities for underground space to be utilized by parties different from the owners of the surface land.<sup>27</sup> Nevertheless, no regulation currently provides a clear determination of the boundaries of such separation, resulting in uncertainty concerning the legal relationship between surface landowners and underground space users.<sup>28</sup>

More explicit recognition of underground space subsequently emerged through Law Number 26 of 2007 concerning Spatial Planning, which recognizes subsurface space as part of the national spatial framework. Furthermore, Article 146 of Government Regulation Number 18 of 2021 introduced the concept of granting Management Rights and Land Rights over underground space utilized separately from surface land. This regulatory framework was further clarified by Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency Number 17 of 2021, which defines underground space as space located beneath the ground surface whose control, use, and utilization are separated from the surface land parcel. Despite these regulatory developments, the legal framework remains limited to normative recognition and has not yet evolved into a comprehensive underground space legal regime.<sup>29</sup> Consequently the Indonesian legal system continues to face fundamental issues that generate legal uncertainty in the utilization of underground space.

In the context of underground space, these three elements have not been fully realized due to the existence of significant regulatory gaps.<sup>30</sup> The most fundamental legal gap concerns the absence of clear regulations regarding the vertical limits of land rights.<sup>31</sup> The Basic Agrarian Law does not specify the depth to which land rights extend, nor does it determine the point at which the State may grant rights to other parties to utilize underground space.<sup>32</sup> As a result, no clear legal parameter exists to distinguish between subsurface areas that remain part of a landowner's rights and those that may be utilized for public or commercial purposes.<sup>33</sup> Unlike Japan, which has specifically regulated the classification and utilization of deep underground space, Indonesia has yet to adopt a comparable regulatory framework.

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<sup>27</sup> Alexandra M. Gormally-Sutton and Hazel Napier, 'Underground Futures: The Essential Role of the Subsurface in a Net Zero Carbon Future', *Land Use Policy*, 161 (2026), 107871 <https://doi.org/10.1016/j.LANDUSEPOL.2025.107871>

<sup>28</sup> Journal Homepage and others, 'Developing an Ethno-Ecotourism Environmental Education Model for Sustainable Coastal Tourism in Aceh Indonesia', *Jurnal Ilmiah Peuradeun*, 14.2 (2026), 797–820 <https://doi.org/10.26811/PEURADEUN.V14I2.2561>

<sup>29</sup> Bambang Irawan and others, 'Spiritual Ecology Across Faiths: A Comparative Study of GreenSufism in Indonesia and GreenFaith in the United States', *Jurnal Ilmiah Peuradeun*, 14.1 (2026), 51–76 <https://doi.org/10.26811/PEURADEUN.V14I1.1575>

<sup>30</sup> Peter van Oosterom and others, '3D Land Administration for 3D Land Uses', *Land Use Policy*, 98 (2020) <https://doi.org/10.1016/j.landusepol.2020.104665>

<sup>31</sup> Jesper M. Paasch and Jenny Paulsson, '3D Property Research from a Legal Perspective Revisited', *Land*, 10.5 (2021) <https://doi.org/10.3390/LAND10050494>

<sup>32</sup> Dionysia Georgia Perperidou, Konstantinos Sigizis, and Agkronilnta Chotza, '3d Underground Property Rights of Transportation Infrastructures: Case Study of Piraeus Metro Station, Greece', *Sustainability (Switzerland)*, 13.23 (2021) <https://doi.org/10.3390/SU132313162>

<sup>33</sup> Mukhsin Aseri and others, 'Negotiating Authority and Knowledge: Religion, Science, and Politics in the Fatwa Transformations of the Indonesian Ulema Council', *Journal of Islamic Law*, 6.2 (2025), 286–316 <https://doi.org/10.24260/JIL.V6I2.4702>



Indonesian land law also does not recognize a specific proprietary right over underground space.<sup>34</sup> Although Government Regulation Number 18 of 2021 permits the granting of rights over underground space, it continues to rely upon conventional land right constructs originally designed for surface land parcels. In practice, the unique characteristics of underground space allow for layered utilization and simultaneous use by multiple parties at different depths.<sup>35</sup> The absence of a specialized legal right results in uncertainty regarding the scope of authority and legal protection available to underground space users.<sup>36</sup> Similar legal gaps can be observed in the absence of regulations governing the legal relationship between surface landowners and holders of underground space rights. Existing regulations provide no guidance regarding liability where underground activities cause impacts on surface land or structures, including land subsidence, interference with building foundations, or restrictions on land use.<sup>37</sup> Consequently, legal protection for affected parties remains inadequate and creates the potential for disputes.

Another significant issue concerns compensation mechanisms. Unlike the land acquisition regime for public purposes, which is supported by a clear legal framework, the utilization of underground space is not accompanied by regulations specifying the forms, procedures, or standards of compensation for affected landowners.<sup>38</sup> This condition creates the potential for injustice because losses arising from underground activities lack a predictable mechanism for recovery. The legal vacuum is equally evident in dispute resolution and land administration.<sup>39</sup> To date, no specialized dispute resolution mechanism has been established to address conflicts involving underground space. Indonesia's land registration system remains predominantly two-dimensional in nature and is therefore incapable of accurately representing the vertical boundaries of rights.<sup>40</sup> The absence of a three-dimensional *cadastre system* significantly increases the risk of overlapping rights and future spatial utilization conflicts.<sup>41</sup>

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<sup>34</sup> Abdul Kadir Jaelani and others, 'The Impact of Tourism Villages Regulations to Achieve Sustainable Villages Tourism', *Contrarius*, 1.3 (2025), 245–61 <https://doi.org/10.53955/CONTRARIUS.V1I3.217>

<sup>35</sup> Iromi Ilham and others, 'The Challenges and Strategies of Coastal Tourism Development: The Insight from Kampai Island, Indonesia', *Jurnal Ilmiah Peuradeun*, 14.1 (2026), 171–94 <https://doi.org/10.26811/PEURADEUN.V14I1.1357>

<sup>36</sup> Marcin Karabin and others, 'Layer Approach to Ownership in 3D Cadastre in the Case of Underground Tunnels', *Land Use Policy*, 98 (2020), 104464 <https://doi.org/10.1016/J.LANDUSEPOL.2020.104464>

<sup>37</sup> Marco Guerrieri and Matteo Sartori, 'Underground Roundabouts: Analysis of Several Layouts for A Case Study in Urban Area', *The Open Transportation Journal*, 14.1 (2020), 143–53 <https://doi.org/10.2174/1874447802014010143>

<sup>38</sup> Dogus Guler, '3D Modelling of Subsurface Legal Spaces and Boundaries for 3D Land Administration', *Tunnelling and Underground Space Technology*, 152 (2024) <https://doi.org/10.1016/j.tust.2024.105956>

<sup>39</sup> Rohit Ramlakhan and others, 'Modelling the Legal Spaces of 3D Underground Objects in 3D Land Administration Systems', *Land Use Policy*, 127 (2023), 106537 <https://doi.org/10.1016/J.LANDUSEPOL.2023.106537>

<sup>40</sup> Bahram Saeidian and others, 'A Semantic 3D City Model for Underground Land Administration: Development and Implementation of an ADE for CityGML 3.0', *Tunnelling and Underground Space Technology*, 140 (2023) <https://doi.org/10.1016/j.tust.2023.105267>

<sup>41</sup> Hariyanto and others, 'Eco-Governance Fiqh and Urban Waste Management: A Critical Study of Environmental Policy in Yogyakarta', *Journal of Islamic Law*, 7.1 (2026), 247–74 <https://doi.org/10.24260/JIL.V7I1.5167>



These regulatory deficiencies demonstrate that the legal framework governing underground space in Indonesia remains fragmented.<sup>42</sup> The Basic Agrarian Law regulates land rights, the Spatial Planning Law governs spatial utilization, Government Regulation Number 18 of 2021 regulates the granting of rights over underground space, and Ministerial Regulation Number 17 of 2021 establishes administrative procedures. However, these instruments have not been integrated into a single comprehensive legal regime. Such fragmentation gives rise to three principal forms of conflict.<sup>43</sup> *First*, ownership conflicts emerge from the unclear relationship between surface land rights and underground space rights. *Second*, authority conflicts arise because multiple institutions possess regulatory powers over underground space without an integrated coordination mechanism. *Third*, spatial utilization conflicts occur due to the absence of regulations establishing priorities for the use of underground space for different purposes.<sup>44</sup>

The uncertainty surrounding the vertical boundaries of land rights has increased the potential for disputes among landowners, governmental authorities, and holders of underground space utilization permits.<sup>45</sup> This issue is reflected in the development of the Jakarta Mass Rapid Transit (MRT) system, the largest underground infrastructure project in Indonesia. The construction of underground MRT tunnels has generated not only technical challenges but also various legal questions concerning the status of the space traversed by the tunnels, compensation mechanisms for affected surface landowners, the relationship between public interests and private property rights, and the management of commercial spaces integrated with underground transportation facilities. Similarly, the development of integrated utility networks including electricity cables, telecommunications infrastructure, water pipelines, and energy facilities demonstrates the growing demand for underground space utilization.<sup>46</sup> This increasing demand has not been accompanied by the establishment of a legal framework capable of providing certainty regarding legal status, the scope of authority, and legal protection for all stakeholders involved.<sup>47</sup>

These circumstances indicate that the primary challenge in regulating underground space in Indonesia does not merely lie in the absence of regulations but rather in the

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<sup>42</sup> Mika Lehtimäki, 'Legal Structures and Contractual Frameworks in Hybrid Real Estate Development: A Finnish Perspective', *Journal of Property, Planning and Environmental Law*, 18.1 (2026), 1–19 <https://doi.org/10.1108/JPEL-03-2025-0029>

<sup>43</sup> Lanxuan Shen and others, 'Building Information Modelling for 3D Underground Land Administration: Research Challenges and Future Pathways', *Underground Space*, 26 (2026), 235–56 <https://doi.org/10.1016/J.UNDSP.2025.07.005>

<sup>44</sup> Mária Hámor-Vidó, Tamás Hámor, and Lili Czirok, 'Underground Space, the Legal Governance of a Critical Resource in Circular Economy', *Resources Policy*, 73 (2021) <https://doi.org/10.1016/j.resourpol.2021.102171>

<sup>45</sup> Tamás Hámor and others, 'A Good Governance Framework for Strengthening the Enhanced, More Sustainable Use of Underground Resources in Europe', *Tunnelling and Underground Space Technology*, 176 (2026), 107850 <https://doi.org/10.1016/J.TUST.2026.107850>

<sup>46</sup> Yani Lai and others, 'Review of Constraints and Critical Success Factors of Developing Urban Underground Space', *Underground Space*, 12 (2023), 137–55 <https://doi.org/10.1016/J.UNDSP.2023.03.001>

<sup>47</sup> Hamda Sulfinadia and others, 'Negotiating Islamic Inheritance and Customary Law: Functional Legal Pluralism and Matrilineal Pusako Randah in Minangkabau', *Journal of Islamic Law*, 7.1 (2026), 1–30 <https://doi.org/10.24260/JIL.V7I1.3743>



lack of a legal system capable of comprehensively integrating land law, spatial planning, land administration, rights protection, and dispute resolution mechanisms.<sup>48</sup> Accordingly, the realization of legal certainty requires legal reform directed toward the establishment of a comprehensive underground space legal regime.<sup>49</sup> Such reform should include the clarification of the vertical limits of land rights, the creation of a specific proprietary right over underground space, the development of a three-dimensional *cadastre system*, the regulation of compensation mechanisms, and the establishment of specialized dispute resolution procedures.<sup>50</sup> Through these measures, the utilization of underground space can provide legal certainty while simultaneously supporting sustainable urban development.

### ***Legal Certainty in Underground Space Utilization in Several Countries***

Comparative experiences from various jurisdictions demonstrate that the regulation of underground space has become an increasingly important aspect of contemporary urban governance and infrastructure development. In many developed countries, the growing need to accommodate urban expansion and infrastructure demands within increasingly constrained land resources has encouraged the establishment of specialized legal frameworks governing underground space utilization.<sup>51</sup> Unlike Indonesia, where the regulatory framework remains fragmented and continues to generate uncertainty regarding the legal status and governance of underground space, several jurisdictions have successfully developed comprehensive legal regimes that provide a high degree of legal certainty for public authorities, private investors, and affected communities.<sup>52</sup> These experiences suggest that legal certainty in underground space utilization depends not only on the existence of regulatory provisions but also on the clear definition of the legal status of underground space, the delineation of rights between surface and subsurface areas, effective mechanisms for safeguarding public and private interests, integrated land administration systems, and well coordinated institutional arrangements.<sup>53</sup> Therefore, an examination of the legal frameworks adopted in Japan, the United Kingdom, and Germany is essential for identifying the legal principles and institutional mechanisms that may contribute to the development of a more coherent and effective underground space regime in Indonesia.

<sup>48</sup> Kevin Grecksch, 'Out of Sight – out of Regulation? Underground Space Governance in the UK', *Journal of the British Academy*, 9.510 (2021), 43–68 <https://doi.org/10.5871/jba/009s10.043>

<sup>49</sup> Mária Hámor-Vidó, Tamás Hámor, and Lili Czirik, 'Underground Space, the Legal Governance of a Critical Resource in Circular Economy', *Resources Policy*, 73 (2021) <https://doi.org/10.1016/j.resourpol.2021.102171>

<sup>50</sup> Jianqiang Cui and John D. Nelson, 'Underground Transport: An Overview', *Tunnelling and Underground Space Technology*, 87 (2019), 122–26 <https://doi.org/10.1016/j.tust.2019.01.003>

<sup>51</sup> Saeid Emamgholian, Jacynthe Pouliot, and Davood Shojaei, 'A Conceptual Framework for Automatic Modelling and Conflict Detection of 3D Land-Use Regulation Restrictions to Support Issuing Planning Permits', *Land Use Policy*, 137 (2024) <https://doi.org/10.1016/j.landusepol.2023.106972>

<sup>52</sup> Stefano Moroni, 'Property as a Human Right and Property as a Special Title. Rediscussing Private Ownership of Land', *Land Use Policy*, 70 (2018), 273–80 <https://doi.org/10.1016/j.landusepol.2017.10.037>

<sup>53</sup> De Tong, Yuxi Yuan, and Xiaoguang Wang, 'The Coupled Relationships between Land Development and Land Ownership at China's Urban Fringe: A Structural Equation Modeling Approach', *Land Use Policy*, 100 (2021) <https://doi.org/10.1016/j.landusepol.2020.104925>



The selection of Japan, the United Kingdom, and Germany as comparative jurisdictions is based on the fact that these countries have successfully developed underground space utilization as a solution to rapid urbanization, limited urban land availability, and increasingly complex infrastructure demands.<sup>54</sup> In addition to facing challenges that are broadly comparable to those encountered by Indonesia, these jurisdictions have established legal frameworks capable of providing legal certainty in the utilization of underground space.<sup>55</sup> Comparative analysis of these countries is therefore valuable for identifying the legal elements that support legal certainty, particularly with regard to the legal status of underground space, vertical limits of property rights, protection of public rights, land administration systems, and the distribution of authority among state institutions.<sup>56</sup>

Japan is selected because it has adopted a specialized regulatory framework governing the utilization of deep underground space, providing clear delineation between private landownership rights and state authority to utilize underground space for public purposes.<sup>57</sup> The United Kingdom is selected because it has developed legal certainty through the doctrine of functional ownership, which limits the scope of landownership rights according to their practical use and function.<sup>58</sup> Germany is selected because of its successful integration of land law, land registration systems, and spatial planning through a highly structured land administration framework.<sup>59</sup> These jurisdictions represent different yet complementary approaches and collectively provide a comprehensive understanding of underground space governance models that may inform future land law reform in Indonesia. Japan represents one of the most advanced jurisdictions in the development and regulation of underground space.<sup>60</sup> High population density, limited land availability, and the growing demand for public infrastructure in metropolitan areas such as Tokyo and Osaka prompted the Japanese government to develop underground space policies beginning in the 1980s. Prior to the adoption of specialized legislation, the construction of railway tunnels, utility networks, and underground infrastructure frequently encountered obstacles due to the high costs of land acquisition and the difficulty of obtaining consent from

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<sup>54</sup> Takayuki Kishii, 'Utilization of Underground Space in Japan', *Tunnelling and Underground Space Technology*, 55 (2016), 320–23 <https://doi.org/10.1016/j.tust.2015.12.007>

<sup>55</sup> Hong Yuan, Yuan He, and Yuanyuan Wu, 'A Comparative Study on Urban Underground Space Planning System between China and Japan', *Sustain Cities Soc*, 48 (2019), 101541 <https://doi.org/10.1016/j.scs.2019.101541>

<sup>56</sup> Jian Peng and others, 'Factors in the Development of Urban Underground Space Surrounding Metro Stations: A Case Study of Osaka, Japan', *Tunnelling and Underground Space Technology*, 91 (2019) <https://doi.org/10.1016/j.tust.2019.103009>

<sup>57</sup> Olha Zyhrii and others, 'Law and Technology: The Impact of Innovations on the Legal System and Its Regulation', *Social and Legal Studies*, 6.4 (2023), 267–75 <https://doi.org/10.32518/SALS4.2023.267>

<sup>58</sup> Efendi Ibnu Susilo and others, 'Toward a One-Roof System and an Independent Tax Court: Indonesia between the United States and Germany', *Contrarius*, 2.3 (2026), 205–25 <https://doi.org/10.53955/CONTRARIUS.V2I3.291>

<sup>59</sup> Zhi Long Chen and others, 'Present Status and Development Trends of Underground Space in Chinese Cities: Evaluation and Analysis', *Tunnelling and Underground Space Technology*, 71 (2018), 253–70 <https://doi.org/10.1016/j.tust.2017.08.027>

<sup>60</sup> Loretta von der Tann and others, 'Systems Approaches to Urban Underground Space Planning and Management – A Review', *Underground Space (China)*, 5.2 (2020), 144–66 <https://doi.org/10.1016/J.UNDSP.2019.03.003>



surface landowners. These circumstances rendered infrastructure development inefficient and created legal uncertainty regarding the status of underground space.

In response to these challenges Japan enacted the Act on Special Measures concerning Public Use of Deep Underground in 2000. This legislation marked a significant legal milestone by introducing the principle that underground space at certain depths may be utilized for public purposes without requiring the consent of all surface landowners. The rationale underlying this legislation is that underground space beyond a specified depth no longer possesses direct economic value or practical utility for surface landowners. Consequently, the State may utilize such space for public purposes without extinguishing the ownership rights associated with the land above it.<sup>61</sup> A distinctive feature of the Japanese system is the clear separation between surface land rights and the utilization of deep underground space. Accordingly, land ownership is not interpreted as extending indefinitely toward the center of the earth, as contemplated under the classical doctrine of *cuius est solum eius est usque ad inferos*.<sup>62</sup> Instead, the scope of ownership is limited to depths that retain reasonable utility for the landowner. Beyond that threshold underground space may be utilized for public infrastructure projects such as subway systems, utility networks, and transportation tunnels without requiring conventional land acquisition procedures.<sup>63</sup>

From the perspective of legal certainty this regulatory framework offers several advantages.<sup>64</sup> *First*, it clearly defines the boundary between private property rights and state authority in the utilization of underground space. *Second*, it facilitates more efficient infrastructure development by reducing dependence on lengthy land acquisition processes. Third, ownership disputes are minimized because the legal status of underground space is explicitly determined by statute.<sup>65</sup> Consequently, Japan has successfully established a balance between the protection of individual property rights and the promotion of national development objectives. Although the system grants extensive authority to the State, it also provides legal safeguards for landowners.<sup>66</sup> Where the utilization of underground space causes harm or interferes with the use of surface land, landowners are entitled to submit objections and receive compensation

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<sup>61</sup> Anis Mashdurohatun and others, 'Bridging Formal Legality and Living Law Public Prosecutorial Policies to Achieve Justice', *Contrarius*, 2.2 (2026), 110–36 <https://doi.org/10.53955/CONTRARIUS.V2I2.272>

<sup>62</sup> Zhi Long Chen and others, 'Present Status and Development Trends of Underground Space in Chinese Cities: Evaluation and Analysis', *Tunnelling and Underground Space Technology*, 71 (2018), 253–70 <https://doi.org/10.1016/j.tust.2017.08.027>

<sup>63</sup> Fang Le Peng and others, 'A Collaborative Approach for Urban Underground Space Development toward Sustainable Development Goals: Critical Dimensions and Future Directions', *Front Struct Civ Eng*, 15.1 (2021), 20–45 <https://doi.org/10.1007/s11709-021-0716-x>

<sup>64</sup> Lanxuan Shen and others, 'Building Information Modelling for 3D Underground Land Administration: Research Challenges and Future Pathways', *Underground Space*, 26 (2026), 235–56 <https://doi.org/10.1016/J.UNDSP.2025.07.005>

<sup>65</sup> Michael Barker, 'Legal and Administrative Issues in Underground Space Use: A Preliminary Survey of ITA Member Nations', *Tunnelling and Underground Space Technology*, 6.2 (1991), 191–209 [https://doi.org/10.1016/0886-7798\(91\)90066-D](https://doi.org/10.1016/0886-7798(91)90066-D)

<sup>66</sup> F. Zaini, K. Hussin, and M. M. Raid, 'Legal Considerations for Urban Underground Space Development in Malaysia', *Underground Space*, 2.4 (2017), 234–45 <https://doi.org/10.1016/J.UNDSP.2017.11.001>



in accordance with applicable legal provisions.<sup>67</sup> Furthermore, all underground development projects are subject to administrative review and governmental oversight to ensure that underground space is utilized exclusively for public purposes.

Unlike Japan, which regulates underground space through specialized legislation, the United Kingdom has developed legal certainty primarily through judicial decisions and the evolution of property law doctrines.<sup>68</sup> Under traditional English law, the doctrine of *cuius est solum eius est usque ad coelum et ad inferos* initially granted landowners extensive rights over both the airspace above and the subsurface beneath their land. However, the demands of modern development gradually led to limitations on this principle.<sup>69</sup> Significant developments emerged through judicial decisions establishing that landownership rights do not extend indefinitely to unlimited depths.<sup>70</sup> English courts developed the doctrine of *functional ownership*, under which ownership rights extend only to those portions of space that maintain a functional relationship with the use and enjoyment of the land.<sup>71</sup> Underground space at substantial depths may be utilized for public purposes without necessarily constituting an infringement of private property rights.

This approach promotes legal certainty by defining the scope of ownership rights according to their functional and economic significance. The State retains authority to regulate underground space utilization through the planning system, while landowners continue to enjoy legal protection against activities that materially interfere with the use of their land.<sup>72</sup> This framework has enabled the development of major underground projects, including the London Underground railway system, transportation tunnels, and urban utility networks, without generating prolonged legal disputes.<sup>73</sup> From the perspective of legal certainty theory, the British model demonstrates that legal certainty does not necessarily require highly detailed legislation; rather, it may be achieved through consistent legal doctrines, judicial

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<sup>67</sup> Shana Debrock, Maarten Van Acker, and Han Admiraal, 'Design Recommendations for Sustainable Urban Underground Spaces', *Tunnelling and Underground Space Technology*, 140 (2023) <https://doi.org/10.1016/j.tust.2023.105332>

<sup>68</sup> Ying Luo and others, 'Combining Spatiotemporal Interactions of Ecosystem Services with Land Patterns and Processes Can Benefit Sensible Landscape Management in Dryland Regions', *Science of The Total Environment*, 909 (2024), 168485 <https://doi.org/10.1016/J.SCITOTENV.2023.168485>

<sup>69</sup> Absori Absori and others, 'Principle of Ecological Restorative Justice in Corporate Environmental Crimes Policies', *Contrarius*, 2.2 (2026), 87–109 <https://doi.org/10.53955/CONTRARIUS.V2I2.271>

<sup>70</sup> Zhilong Chen and others, 'Exploring Decision-Making Mechanisms for the Metro-Based Underground Logistics System Network Expansion: An Example of Beijing', *Tunnelling and Underground Space Technology*, 139 (2023) <https://doi.org/10.1016/j.tust.2023.105240>

<sup>71</sup> Bo Sun and others, 'Multi-Stakeholders Cooperative Decision Analysis in Underground Logistics System Development: A Methodology Combining Topic Modeling and System Dynamics', *Computers and Industrial Engineering*, 210 (2025) <https://doi.org/10.1016/j.cie.2025.111548>

<sup>72</sup> Zeqi Wang and others, 'Sustainable Urban Development Based on an Adaptive Cycle Model: A Coupled Social and Ecological Land Use Development Model', *Ecological Indicators*, 154 (2023) <https://doi.org/10.1016/j.ecolind.2023.110666>

<sup>73</sup> Yong Kang Qiao and others, 'Rethinking Underground Land Value and Pricing: A Sustainability Perspective', *Tunnelling and Underground Space Technology*, 127 (2022), 104573 <https://doi.org/10.1016/J.TUST.2022.104573>



precedents, and stable administrative practices.<sup>74</sup> Clarity regarding the limits of private property rights and governmental authority constitutes the principal factor supporting underground space development in the United Kingdom.

Germany represents another jurisdiction that has successfully achieved legal certainty in underground space governance through the integration of land law, land registration systems, and spatial planning.<sup>75</sup> Under German law, land ownership generally extends to both the space above and below the land, as provided by the *Bürgerliches Gesetzbuch* (German Civil Code). However, such rights are not absolute and may be restricted by public interests and spatial planning regulations.<sup>76</sup> The primary strength of the German model lies in its highly accurate and integrated land registration system. Rights relating to underground space may be clearly recorded within the land registration system, ensuring that the boundaries of rights are known with certainty by all interested parties. This framework facilitates the vertical separation of rights without creating ambiguity concerning the legal status of the relevant property interests.

Germany also adopts a strong intergovernmental coordination approach. Underground space utilization is not treated solely as a land law issue but as an integral component of the national spatial planning system.<sup>77</sup> Consequently, all underground development projects must conform to spatial planning objectives and broader public interests. This approach creates harmony between development objectives and the protection of individual rights.<sup>78</sup> From the perspective of legal certainty, the German system provides a high degree of security because every right is supported by a clear legal basis, officially recorded within the land registration system, and enforceable through effective judicial mechanisms.<sup>79</sup> Certainty regarding the object of rights, the holder of rights, and the limits of underground space utilization constitutes a fundamental factor underpinning the success of underground space governance in Germany.<sup>80</sup> When compared with Indonesia these jurisdictions reveal

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<sup>74</sup> Ahmad Boutosh, 'Judicial Oversight and the Role of the Comptroller General in Insolvency Disclosure: A Normative Analysis of the Jordanian Companies Act', *Al-Ahkam: Jurnal Ilmu Syari'ah Dan Hukum*, 9.2 (2024), 75–90 <https://doi.org/10.22515/ALAHKAM.V9I2.8559>

<sup>75</sup> Lingxiang Wei and others, 'Optimization of Spatial Layouts for Underground Facilities to Achieve Carbon Neutrality in Cities: A Multi-Agent System Model', *Underground Space (New)*, 19 (2024), 251–78 <https://doi.org/10.1016/j.undsp.2024.03.005>

<sup>76</sup> Qiuxiao Chen and others, 'Evaluation of Underground Space Resources in Ancient Cities from the Perspective of Organic Renewal: A Case Study of Shaoxing Ancient City', *ISPRS International Journal of Geo-Information*, 14.10 (2025) <https://doi.org/10.3390/IJGI14100384>

<sup>77</sup> Kunyang Li and others, 'The Research on the Evaluation Framework and Application of Urban Three-Dimensional (Aboveground and Underground) Regeneration Sensitivity Taking Kunshan Old City in China as an Example', *Tunnelling and Underground Space Technology*, 159 (2025), 106428 <https://doi.org/10.1016/J.TUST.2025.106428>

<sup>78</sup> Ahmad Gelora Mahardika, 'The Implementation of Referendum as a Limitation to Autocratic Legalism in the Formation of the Nusantara Capital City Law', *Al-Ahkam: Jurnal Ilmu Syari'ah Dan Hukum*, 9.2 (2024), 113–29 <https://doi.org/10.22515/ALAHKAM.V9I2.10181>

<sup>79</sup> Joo Hyun Moon, 'Challenges in the Defense Application of Nuclear Energy: Legal and Regulatory Frameworks under the ROK-U.S. Nuclear Cooperation Agreement', *Nuclear Engineering and Technology*, 58.6 (2026), 104204 <https://doi.org/10.1016/J.NET.2026.104204>

<sup>80</sup> Dimitrios Kitsakis and others, 'Exploring the 3 Rd Dimension within Public Law Restrictions: A Case Study of Victoria, Australia', *Land Use Policy*, 85 (2019), 195–206 <https://doi.org/10.1016/J.LANDUSEPOL.2019.03.024>



significant differences in the manner in which legal certainty concerning underground space is established.<sup>81</sup> Japan achieves legal certainty through specialized legislation that explicitly separates surface land rights from the utilization of deep underground space.<sup>82</sup> The United Kingdom develops legal certainty through limitations on ownership rights based on the doctrine of functional ownership and through a robust planning system. Germany emphasizes legal certainty through the integration of land law, land registration systems, and coordinated spatial planning.<sup>83</sup>

Despite employing different approaches, these jurisdictions share several common elements in the construction of legal certainty. *First*, they provide clear legal recognition of the status of underground space. *Second*, they establish a well-defined relationship between private property rights and state authority. *Third*, they offer legal protection mechanisms for affected landowners. *Fourth*, they maintain administrative and registration systems capable of accurately identifying and recording rights. *Fifth*, governmental authority is allocated through clear and coordinated institutional arrangements. In contrast, Indonesia continues to face significant challenges in each of these areas.<sup>84</sup> The regulation of underground space remains dispersed across various sectoral regulations; no definitive vertical boundaries of land rights have been established; a comprehensive three-dimensional cadastre system has yet to be developed; and the legal relationship between surface landowners and holders of underground space rights remains insufficiently regulated.<sup>85</sup> The experiences of Japan, the United Kingdom, and Germany demonstrate that the successful utilization of underground space depends not only upon technical and engineering capabilities but also upon the ability of the legal system to provide certainty regarding property rights, protect public interests, and establish a clear allocation of governmental authority.<sup>86</sup>

#### ***Legal Reform of Underground Space Utilization for Enhancing Legal Certainty in Indonesia***

Persistent legal uncertainty in the regulation of underground space in Indonesia can be attributed to the absence of a comprehensive legal regime governing the legal status of underground space, vertical boundaries of rights, legal relationships among rights holders, registration systems, compensation mechanisms, and dispute resolution

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<sup>81</sup> Didi Nursidi and others, 'Revisiting Coastal Spatial Permitting Regulations toward Sustainable Coastal Zone Management', *Journal of Human Rights, Culture and Legal System*, 6.1 (2026), 285–318 <https://doi.org/10.53955/JHCLS.V6I1.889>

<sup>82</sup> Wanjie Hu, Jianjun Dong, Zhilong Chen, and others, 'Linking Underground Space Development with Sustainable Urban Futures: Research Trends and Knowledge Framework', *Tunnelling and Underground Space Technology*, 168 (2026), 107227 <https://doi.org/10.1016/J.TUST.2025.107227>

<sup>83</sup> Huimin Tan, Jianhua Xu, and Gabrielle Wong-Parodi, 'The Politics of Asian Fracking: Public Risk Perceptions towards Shale Gas Development in China', *Energy Research and Social Science*, 54 (2019), 46–55 <https://doi.org/10.1016/j.erss.2019.03.007>

<sup>84</sup> Dirk Hanschel and Terence Centner, 'Delineating Property Rights in Unconventional Hydrocarbon Resources: Concepts from the United States and Germany', *Energy Research & Social Science*, 20 (2016), 149–57 <https://doi.org/10.1016/J.ERSS.2016.08.004>

<sup>85</sup> Amr ElAlfy and others, 'Scoping the Evolution of Corporate Social Responsibility (CSR) Research in the Sustainable Development Goals (SDGS) Era', *Sustainability (Switzerland)*, 12.14 (2020) <https://doi.org/10.3390/su12145544>

<sup>86</sup> Todd Swanstrom and Jörg Plöger, 'What to Make of Gentrification in Older Industrial Cities? Comparing St. Louis (USA) and Dortmund (Germany)', *Urban Affairs Review*, 58.2 (2022), 526–62 <https://doi.org/10.1177/1078087420975203>



procedures.<sup>87</sup> Although the Basic Agrarian Law, the Spatial Planning Law, Government Regulation Number 18 of 2021, and Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency Number 17 of 2021 have recognized underground space as an object of utilization, these regulatory instruments remain fragmented and have not yet provided the level of legal certainty required under Gustav Radbruch's theory of legal certainty.<sup>88</sup> Consequently, legal reform should be directed toward addressing the normative deficiencies that constitute the primary sources of legal uncertainty.

*First issue* requiring reform concerns the absence of clear vertical limits to land rights under the Basic Agrarian Law. As previously discussed, Article 4(2) of the Basic Agrarian Law merely provides that land rights authorize the holder to utilize the subsurface and the space above the land to the extent necessary for the use of the land concerned. However, the provision does not specify the depth to which land rights extend, nor does it determine the point at which the State may grant rights to other parties for the utilization of underground space.<sup>89</sup> As a result, uncertainty arises regarding the relationship between surface landownership rights and the utilization of underground space for public or commercial purposes.<sup>90</sup> To address this issue, legal reform should be undertaken through the amendment of Article 4(2) of the Basic Agrarian Law by introducing provisions that explicitly define the vertical limits of land control. Such reform may adopt an approach similar to that employed in Japan by distinguishing between underground space necessary for the normal use and enjoyment of land and deep underground space that may be utilized separately for public purposes or strategic national development.<sup>91</sup> This approach would establish a clear legal boundary between surface land rights and underground space rights.<sup>92</sup>

*Second issue* relates to the absence of a specific proprietary right over underground space. Although Article 146(1) and (2) of Government Regulation Number 18 of 2021 permits the granting of Management Rights and Land Rights over underground space utilized separately from surface land, these provisions continue to rely upon conventional land right constructs originally designed for two-dimensional land parcels. Consequently, the existing framework is unable to accommodate the distinctive characteristics of underground space, including multi-layer utilization,

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<sup>87</sup> Ray Galvin, 'An Under-Developed Dimension in Upgrading Energy-Inefficient German Rental Buildings: Corporate Social Responsibility as a Hybrid Form of Governance', *Energy Research & Social Science*, 101 (2023), 103148 <https://doi.org/10.1016/J.ERSS.2023.103148>

<sup>88</sup> Yevheniya Volchko and others, 'Subsurface Planning: Towards a Common Understanding of the Subsurface as a Multifunctional Resource', *Land Use Policy*, 90 (2020), 104316 <https://doi.org/10.1016/J.LANDUSEPOL.2019.104316>

<sup>89</sup> nesia's New Capital City IKN Nusantara: A Multidimensional Conflict Analysis', *Land*, 13.5 (2024), 606 <https://doi.org/10.3390/land13050606>

<sup>90</sup> Jianqiang Cui, Wout Broere, and Dong Lin, 'Underground Space Utilisation for Urban Renewal', *Tunnelling and Underground Space Technology*, 108 (2021) <https://doi.org/10.53292/b09a411e.157eca68>

<sup>91</sup> Alexandra M. Gormally, Nils O. Markusson, and Michelle Bentham, 'The Pore Space Scramble: Challenges and Opportunities for Subsurface Governance', *Geoforum*, 95 (2018), 70–77 <https://doi.org/10.1016/J.GEOFORUM.2018.07.006>

<sup>92</sup> Amir Firmansyah, Suparji, and Pujiono Suwandi, 'Achieving Efficiency with Justice in the Reform of Anti-Corruption Law Enforcement in State-Owned Enterprises', *Journal of Human Rights, Culture and Legal System*, 6.1 (2026), 84–115 <https://doi.org/10.53955/JHCLS.V6I1.898>



simultaneous use by multiple parties at different depths, and its integration with public infrastructure development.<sup>93</sup> Therefore, legal reform should be implemented through amendments to the Basic Agrarian Law and Article 146 of Government Regulation Number 18 of 2021 to recognize a specific proprietary right over underground space (Underground Space Right). Such a right should be defined by a specific spatial volume determined through both horizontal and vertical coordinates, thereby enabling its separation from surface land rights without undermining the protection afforded to surface landowners.

*Third* issue concerns the lack of clarity regarding the legal relationship between surface landowners and holders of underground space rights.<sup>94</sup> Neither Government Regulation Number 18 of 2021 nor Ministerial Regulation Number 17 of 2021 provides detailed provisions governing the respective rights and obligations of these parties where underground activities affect surface land. This normative gap creates the potential for disputes arising from land subsidence, structural damage, interference with building foundations, or restrictions on land use.<sup>95</sup> Legal reform should therefore be undertaken through the inclusion of a dedicated chapter within Government Regulation Number 18 of 2021 regulating the legal relationship between surface land right holders and underground space right holders.<sup>96</sup> Such provisions should address access rights, liability for damage, maintenance obligations, and legal protection mechanisms for each party. Establishing these rules is essential for ensuring certainty regarding the scope of authority and responsibility of all legal subjects involved.

*Fourth* issue relates to the absence of a clear compensation mechanism for underground space utilization.<sup>97</sup> Unlike land acquisition for public purposes, which is comprehensively regulated under Law Number 2 of 2012 concerning Land Acquisition for Development in the Public Interest, there are currently no provisions governing compensation where underground space is utilized without the transfer of surface land rights.<sup>98</sup> Consequently, landowners who suffer losses arising from underground activities lack a clear legal basis for obtaining compensation. To address this deficiency, Government Regulation Number 18 of 2021 should be amended to include specific

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<sup>93</sup> Yun Hao Dong, Fang Le Peng, and Teng Fei Guo, 'Quantitative Assessment Method on Urban Vitality of Metro-Led Underground Space Based on Multi-Source Data: A Case Study of Shanghai Inner Ring Area', *Tunnelling and Underground Space Technology*, 116 (2021) <https://doi.org/10.1016/j.tust.2021.104108>

<sup>94</sup> Bahram Saeidian and others, 'A Semantic 3D City Model for Underground Land Administration: Development and Implementation of an ADE for CityGML 3.0', *Tunnelling and Underground Space Technology*, 140 (2023), 105267 <https://doi.org/10.1016/J.TUST.2023.105267>

<sup>95</sup> Loretta von der Tann and others, 'Systems Approaches to Urban Underground Space Planning and Management A Review', *Underground Space*, 5.2 (2020), 144–66 <https://doi.org/10.1016/J.UNDSP.2019.03.003>

<sup>96</sup> Loretta von der Tann and others, 'Systems Approaches to Urban Underground Space Planning and Management A Review', *Underground Space (China)*, 5.2 (2020), 144–66 <https://doi.org/10.1016/j.undsp.2019.03.003>

<sup>97</sup> Wanjie Hu, Rui Ren, Jianjun Dong, and others, 'A State-of-the-Art Review of Underground Logistics Systems: Research Trends, Application Modes, Planning Approaches, and Future Directions', *Tunnelling and Underground Space Technology*, 162 (2025), 106641 <https://doi.org/10.1016/J.TUST.2025.106641>

<sup>98</sup> Yun Hao Dong, Fang Le Peng, and Teng Fei Guo, 'Quantitative Assessment Method on Urban Vitality of Metro-Led Underground Space Based on Multi-Source Data: A Case Study of Shanghai Inner Ring Area', *Tunn Undergr Space Technol*, 116 (2021), 104108 <https://doi.org/10.1016/j.tust.2021.104108>



provisions governing underground space compensation. Such provisions should regulate the forms of compensation, valuation methodologies, payment procedures, and mechanisms for filing objections. This reform is essential for maintaining a balance between development interests and the protection of individual rights.<sup>99</sup>

*Fifth* issue concerns the absence of a registration system capable of accurately representing the vertical boundaries of underground space rights. Although Article 1(13) of Ministerial Regulation Number 17 of 2021 defines underground space as a space utilized separately from the surface land parcel, the regulation is not supported by a three-dimensional land administration system.<sup>100</sup> Consequently, land registration remains predominantly two-dimensional in orientation and is therefore incapable of adequately preventing overlapping spatial utilization.<sup>101</sup> The experiences of Germany and the United Kingdom demonstrate that legal certainty in underground space governance depends significantly upon the existence of a three-dimensional registration system capable of accurately identifying the object of rights. Accordingly, reform should be undertaken through amendments to Ministerial Regulation Number 17 of 2021 by incorporating provisions concerning a three-dimensional cadastre system that requires the registration of underground space rights based on both horizontal and vertical coordinates and integrates such records into the national land registration system.<sup>102</sup>

*Sixth* issue concerns the fragmentation of authority among institutions responsible for regulating underground space. At present, underground space governance is dispersed across multiple sectors, including land administration, spatial planning, transportation, energy, public works, and public utilities.<sup>103</sup> This fragmentation has resulted in overlapping authority among the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency, regional governments, the Ministry of Public Works, the Ministry of Transportation, and various other sectoral agencies. To address this problem, institutional reform is required through the introduction of cross sector coordination mechanisms within Government Regulation Number 18 of 2021 and the harmonization of such provisions with Law Number 26 of 2007 concerning Spatial Planning. These reforms should establish a clear division of authority, integrated licensing procedures, and a coordinated national framework for underground space

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<sup>99</sup> Yevheniya Volchko and others, 'Subsurface Planning: Towards a Common Understanding of the Subsurface as a Multifunctional Resource', *Land Use Policy*, 90 (2020) <https://doi.org/10.1016/j.landusepol.2019.104316>

<sup>100</sup> Han Admiraal and Antonia Cornaro, 'Why Underground Space Should Be Included in Urban Planning Policy – And How This Will Enhance an Urban Underground Future', *Tunnelling and Underground Space Technology*, 55 (2016), 214–20 <https://doi.org/10.1016/J.TUST.2015.11.013>

<sup>101</sup> Liu Yang and others, 'Repurposing Leftover Transport Infrastructure Spaces: Case Studies from the Netherlands, USA, and China through an Urban Design Governance Lens', *Frontiers of Architectural Research*, 2026 <https://doi.org/10.1016/J.FOAR.2025.10.016>

<sup>102</sup> Katsuhiko Itagaki, 'Legal Consideration on Public Use of Underground Space', *The Japanese Journal of Real Estate Sciences*, 34.2 (2020), 43–50 [https://doi.org/10.5736/JARES.34.2\\_43](https://doi.org/10.5736/JARES.34.2_43)

<sup>103</sup> Loretta von der Tann and others, 'Systems Approaches to Urban Underground Space Planning and Management A Review', *Underground Space*, 5.2 (2020), 144–66 <https://doi.org/10.1016/J.UNDSP.2019.03.003>



governance in order to prevent administrative conflicts in the implementation of development projects.<sup>104</sup>

The proposed reforms demonstrate that the development of legal certainty in underground space utilization requires not only the recognition of underground space as a legal object but also the establishment of a comprehensive legal regime capable of integrating substantive rights, land administration systems, compensation mechanisms, institutional arrangements, and dispute resolution procedures.<sup>105</sup> Drawing upon comparative experiences from Japan, the United Kingdom, and Germany, Indonesia should move beyond fragmented sectoral regulation toward the creation of a coherent and integrated underground space legal framework.<sup>106</sup> Such reforms would provide greater legal certainty, strengthen the protection of property rights, facilitate infrastructure development, and ultimately support sustainable urban development in Indonesia.

**Table 1.** Proposed Legal Reforms for Strengthening Legal Certainty in Underground Space Utilization in Indonesia

No.	Regulation/Provision	Principal Legal Issue	Proposed Reform
1	Article 4(2) of the Basic Agrarian Law	Uncertainty regarding the vertical boundaries of land rights	Clarification of the vertical limits of land rights and classification of shallow underground and deep underground spaces (adopting the Japanese approach)
2	Article 146(1) and (2) of Government Regulation No. 18 of 2021	Absence of a specific proprietary right over underground space	Establishment of an Underground Space Right (HARBT) based on the concept of stratum ownership (adopting the United Kingdom approach)
3	Government Regulation No. 18 of 2021 and Ministerial Regulation of ATR/BPN No. 17 of 2021	Unclear legal relationship between surface landowners and underground space users	Regulation of the rights, obligations, liabilities, and legal protections of the respective parties
4	Government Regulation No. 18 of 2021	Absence of a specific compensation mechanism	Establishment of compensation and indemnification mechanisms for losses arising from underground space utilization (adopting the Japanese approach)
5	Ministerial Regulation of ATR/BPN No. 17 of 2021	Lack of a three-dimensional registration system	Implementation of a Three-Dimensional Cadastre (3D Cadastre) and registration based on vertical coordinates (adopting the German approach)
6	Government Regulation No. 18 of 2021 and Law No. 26 of 2007 on Spatial Planning	Fragmentation of authority and regulatory framework	Establishment of an Integrated Underground Space Legal Framework through regulatory harmonization and cross sectoral coordination

Source: Processed by the author.

Legal reform concerning underground space should not be directed solely toward the creation of new legal norms but also toward the refinement of existing regulatory

<sup>104</sup> Fang Le Peng and others, 'A Collaborative Approach for Urban Underground Space Development toward Sustainable Development Goals: Critical Dimensions and Future Directions', *Frontiers of Structural and Civil Engineering*, 15.1 (2021), 20–45 <https://doi.org/10.1007/S11709-021-0716-X>

<sup>105</sup> Naoto Yokoya, Junshi Xia, and Clifford Broni-Bediako, 'Submeter-Level Land Cover Mapping of Japan', *International Journal of Applied Earth Observation and Geoinformation*, 127 (2024) <https://doi.org/10.1016/j.jag.2024.103660>

<sup>106</sup> Hong Yuan, Yuan He, and Yuanyuan Wu, 'A Comparative Study on Urban Underground Space Planning System between China and Japan', *Sustainable Cities and Society*, 48 (2019) <https://doi.org/10.1016/J.SCS.2019.101541>



provisions. Amendments to Article 4(2) of the Basic Agrarian Law, Article 146 of Government Regulation Number 18 of 2021, and Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency Number 17 of 2021 constitute fundamental measures for addressing the legal issues identified in the preceding analysis. Through these reforms, Indonesia can establish a comprehensive underground space legal regime that provides clear delineation of the vertical boundaries of rights, recognizes a specific proprietary right over underground space, ensures legal protection for both surface landowners and underground space users, develops an integrated three-dimensional land registration system, establishes fair compensation mechanisms, and clarifies the allocation of authority among relevant institutions.<sup>107</sup> The establishment of such a legal framework would enhance legal certainty in the utilization of underground space while simultaneously supporting sustainable urban development and meeting future infrastructure demands.

## CONCLUSION

Based on the analysis of Indonesia's national legal framework, a comparative examination of the legal regimes in Japan, the United Kingdom, and Germany, and the increasing complexity of urban development needs, this study concludes that the principal challenge in the utilization of underground space in Indonesia lies in the absence of a comprehensive and integrated legal regime capable of providing adequate legal certainty. Such legal uncertainty is reflected in the lack of clearly defined vertical boundaries of land rights, the absence of a specific proprietary right over underground space, the insufficient regulation of the legal relationship between surface landowners and underground space users, the lack of an adequate compensation mechanism, the absence of a three-dimensional land registration system, and the continuing fragmentation of authority among relevant institutions. The comparative analysis demonstrates that legal certainty in underground space utilization can be achieved through clear recognition of the legal status of underground space, the establishment of well-defined vertical boundaries of rights, the protection of individual and public interests, the implementation of an integrated land administration system, and effective institutional coordination. Accordingly, legal reform should be directed toward the amendment and harmonization of the Basic Agrarian Law, Government Regulation Number 18 of 2021, and Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency Number 17 of 2021. Such reform should include the clarification of the vertical limits of land rights, the establishment of an Underground Space Right (*Hak Atas Ruang Bawah Tanah/HARBT*) as a distinct proprietary right, the regulation of legal relationships and compensation mechanisms, the implementation of a three-dimensional *cadastre system*, and the development of an integrated legal framework governing underground space. These reforms constitute a strategic step toward enhancing legal certainty, preventing spatial utilization conflicts, protecting the rights of all stakeholders, and supporting sustainable infrastructure development and urban spatial management in Indonesia.

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<sup>107</sup> Stephen Gardiner and Catriona McKinnon, 'The Justice and Legitimacy of Geoengineering', *Critical Review of International Social and Political Philosophy*, 23.5 (2020), 557–63 <https://doi.org/10.1080/13698230.2019.1693157>



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