Л.Н. Гумилев атындағы Еуразия ұлттық университетінің ХАБАРШЫСЫ.
ISSN: 2616-6844. eISSN: 2663-1318

ҚҰҚЫҚ СЕРИЯСЫ/ LAW SERIES/ СЕРИЯ ПРАВО

Халықаралық құқық, халықаралық жеке құқық / International law, Private International Law/ Международное право, международное частное право

IRSTI 10.87.77 https://doi.org/10.32523/2616-6844-2025-153-4-230-243
Scientific article

The Juridification of Outer Space Environmental Governance under the Concept of a Community of Shared Future for Humankind

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Abstract: The systemic dilemma in outer space environmental governance stems from the intrinsic transboundary nature of space activities, the rapid iteration of space technologies, and the global commons character of outer space. These factors have produced structural deficiencies within the existing state-centric international space law regime, manifested in regulatory lag and weak enforceability when confronting compound threats such as orbital debris proliferation, the militarization of outer space, and inequitable allocation of extraterrestrial resources. In response, the concept of a ḷcommunity of shared future for humankind should serve as the normative foundation for both rule reconstruction and institutional innovation. Substantively, a shift toward a responsibility-based model of debris governance and a fair benefit-sharing mechanism for space resources is required to fill gaps in material norms. Procedurally, the establishment of mandatory dispute settlement and independent compliance oversight mechanisms is necessary to strengthen institutional guarantees. This approach helps reconcile national interests with the common interests of humanity, promoting a transition in outer space environmental governance from political commitment to a binding, juridified order. Ultimately, it contributes to the development of a more inclusive, effective, and intergenerationally equitable governance paradigm for outer space.

Keywords: Community of Shared Future for Humankind; Outer Space Environmental Governance; International Space Law; Peaceful Use of Outer Space

Introduction

Contemporary governance of the outer space environment is beset by a systemic crisis arising both from compound security risks generated by rapid technological iteration and the scaling-

Received: 17.11.2025. Accepted: 19.12.2025. Available online: 30.12.2025

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up of space activities, and from structural defects and deep-seated contradictions within the international space law regime. Together, these dynamics constitute the practical impasse of outer space environmental governance.

Outer space environmental security faces a confluence of three major threats: space debris, the weaponization of outer space, and inequitable resource allocation.

First, space debris has evolved into the most pressing physical hazard. The European Space Agency's 2025 Space Environment Report indicates that approximately 54,000 trackable objects larger than 10 cm are in orbit, while an estimated 140 million fragments measure between 1 mm and 1 cm. These high-velocity fragments not only elevate the collision risk for on-orbit spacecraft, but may also trigger cascading debris-generation that renders portions of low Earth orbit irreversibly congested—a phenomenon commonly termed the "Kessler Syndrome." Events such as the 2007 Chinese anti-satellite (ASAT) test and the 2009 Iridium–Cosmos collision both produced substantial debris and exposed the absence of mechanisms allocating responsibility for transboundary and intergenerational environmental harm.

Second, the accelerating trend toward the weaponization of outer space directly undermines the foundational principle of the "peaceful uses" of outer space. The United States formally established the U.S. Space Force in 2019; the Russian Federation continues to test anti-satellite capabilities; and in 2024, China reorganized its military space forces as an independent service branch. Article IV of the Outer Space Treaty (OST) prohibits only the placement in orbit of nuclear and other weapons of mass destruction; it leaves a conspicuous "regulatory vacuum" with respect to conventional space weapons. The Sino-Russian draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT) remains stalled amid great-power rivalry, further illustrating how military-security logics crowd out environmental-security imperatives.

Third, distributive injustice in outer space resources has intensified doctrinal contestation. As lunar and asteroid resource extraction becomes technologically feasible, distributive justice concerns have come to the fore. Through the Artemis Accords and domestic legislation, the United States has promoted "safety zones" and a "whoever extracts, owns" approach—treating space resources in effect as res nullius subject to de facto privatization by technological first-movers. This approach potentially conflicts with the OST's Article II non-appropriation principle and marginalizes developing countries, deepening both a "regulatory deficit" and a "justice deficit" in space governance.

In the face of these threats, the international space law framework centered on the 1967 OST exhibits systemic dysfunction.

First, the existing treaties were concluded during the Cold War with States as the primary regulated actors and did not anticipate the environmental risks posed by commercial mega-constellations (e.g., SpaceX's Starlink), on-orbit servicing, or resource extraction. The OST's principled provisions lack sufficiently specific conduct rules, producing a "governance gap" in which legal development seriously lags technological innovation.

Second, the rules pertaining to outer space environmental governance are dispersed across instruments adopted by bodies such as the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS), the International Telecommunication Union (ITU), and the International Organization for Standardization (ISO). The absence of systemic integration is notable. Soft-law texts—such as UNCOPUOS's Space Debris Mitigation Guidelines—are normatively instructive but lack binding force; their effectiveness depends heavily on voluntary compliance, with weak

monitoring and accountability. Potential tensions also arise between ITU frequency-allocation rules and UNCOPUOS debris-mitigation guidance in the regulation of large low-Earth-orbit constellations.

Third, the 1972 Convention on International Liability for Damage Caused by Space Objects (Liability Convention) primarily addresses direct, immediate harm to the Earth's surface or to aircraft, and adopts a fault-based approach for damage in outer space. It provides no clear principles of attribution or compensation standards for collisions between space objects, indirect harms caused by debris, or long-term cumulative orbital pollution. As a result, victims of transboundary environmental harm encounter significant hurdles in establishing responsibility and obtaining redress.

The current stalemate stems from three mutually reinforcing contradictions.

First, there is a fundamental conflict between State interests and the interests of humankind. States tend to privilege "national first" strategies in space activities: technologically advanced States pre-empt scarce orbital slots and spectrum resources, while developing countries assert claims to development rights and equitable benefit-sharing. Divergent positions on burden-sharing and technology transfer have precipitated a "tragedy of the commons" in space governance.

Second, tensions persist between hard-law deficits and soft-law dilution. Given the high strategic sensitivity of outer space, negotiating new binding treaties entails considerable political costs; States therefore gravitate toward non-binding soft law. Yet soft law is ill-suited to restrain high-conflict activities such as militarization and resource competition, yielding a paradox of "normative abundance and practical scarcity."

Third, military-security and environmental-security logics compete for priority. Major spacefaring powers treat outer space as a "strategic high ground," prioritizing military capabilities to ensure their own absolute security. Environmental security is relegated to a secondary status and frequently compromised by military imperatives, impeding the adoption of robust measures such as mandatory environmental impact assessments and bans on debris-generating ASAT tests that produce long-lived fragments.

Outer space environmental governance thus faces a systemic predicament jointly constituted by compound security threats, structural deficiencies in international law, and profound contradictions in governance logics. This predicament illuminates the limits of the Westphalian, State-centric paradigm when applied to the governance of outer space as a "global commons," and underscores the urgency of introducing new jurisprudential frameworks and governance concepts capable of overcoming these constraints.

Materials and methods

This paper employs a literature analysis method.

Literature analysis method - This paper reviews the existing outer space laws, identifies the deficiencies in the current space laws in terms of norms and procedures, and makes corrections and additions.

Discussion

1 Transcending the Westphalian System

The concept of a community with a shared future for humankind signifies a foundational shift in the value order of international law—from a Westphalian "State-centric" paradigm to

a "humanity-centric" paradigm. By re-configuring the subject structure and value orientation of international law, this concept transcends State-centrism in outer space environmental governance. Traditional international law, grounded in sovereign equality and the primacy of national interests, has revealed structural limitations in governing global commons such as outer space: conflicts between national interests and the interests of humankind have fostered normative fragmentation and the hollowing-out of enforcement mechanisms.

Operationalizing the animating spirit of a community with a shared future for humankind in outer space governance is not only a teleological expansion of the "common interest of all mankind" language in the Preamble of the Outer Space Treaty, but also an active response to contemporary developments. Since 2017, this concept has evolved from a political initiative into a legal principle, appearing in successive UN General Assembly resolutions on outer space and reflected in the Sino-Russian draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT). This evolution is not merely theoretical: it furnishes a normative basis for China's norm-entrepreneurial claims in shaping outer space rules and helps build an international governance consensus oriented toward the interests of humankind as a whole.

2 Elaboration of Core Jurisprudential Principles

The three defining features of the community-of-shared-future concept—common interests, intergenerational equity, and cooperative co-governance—supply a systemic normative content for outer space environmental governance and help fill the value vacuum in the current framework.

First, common interests require that the utilization of outer space resources and the protection of the space environment be directed to the welfare of all humankind, rather than to hegemonic projects of particular States. Although Article I of the Outer Space Treaty articulates the "province of all mankind"/"for the benefit and in the interests of all countries," in practice, this has often been misread as license for the over-expansion of "freedom of exploration and use." Through jurisprudential reconstruction, the community-of-shared-future approach concretizes "common interests" into State obligations—for example, duties to avoid harmful contamination and to promote equitable benefit-sharing. In China's practice, this principle is commonly instantiated through project-sharing mechanisms in international cooperation on the Chinese Space Station and through technological assistance to developing countries under the "Space Information Corridor" of the Belt and Road initiative, thereby translating abstract principles into concrete rights and obligations.

Second, intergenerational equity is placed at the core of outer space governance, requiring effective measures to prevent irreversible harms such as the accumulation of orbital debris and the depletion of orbital resources. While UNCOPUOS's Space Debris Mitigation Guidelines articulate technical standards, their soft-law character has limited implementation. China's debris-remediation experiment with the Shijian-21 satellite, combining domestic legislation and technical services, offers a practical pathway for the "hard-law" consolidation of intergenerational equity.

Third, cooperative co-governance rejects unilateralism and exclusionary rule-clubs, advocating multilateral mechanisms for the coordinated governance of the outer space environment. Article IX of the Outer Space Treaty provides for "international consultations," but lacks procedural guarantees. By advancing the Belt and Road principles of "extensive

consultation, joint contribution, and shared benefits," the community-of-shared-future approach enhances the effectiveness of cooperative governance. For example, China's International Lunar Research Station (ILRS) initiative employs a co-governance architecture to balance participants' interests, standing in sharp contrast to the "club model" associated with the Artemis Accords, and thereby demonstrates a normative advantage in regime competition.

3 Clarifying the Legal Characterization of Outer Space Resources

The legal status of outer space resources is a focal point of doctrinal conflict in space governance. Measured against the common heritage of mankind (CHM) principle, the community-of-shared-future approach offers a jurisprudential critique of res nullius claims and a mediated pathway via a "commons" conception.

Rooted in the Roman-law doctrine of first possession (occupatio), the res nullius view has been embedded in space governance through domestic legislation—such as the United States' Commercial Space Launch Competitiveness Act and Luxembourg's space resources law—thereby advancing a form of "space colonialism" predicated on technological advantage. This position conflicts directly with Article II of the Outer Space Treaty's non-appropriation principle and runs counter to the International Court of Justice's articulation of "concern of humanity as a whole" in its 1996 Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons. Its jurisprudential defects include distributive injustice and the marginalization of developing countries, thereby eroding the justice foundations of global-commons governance.

By contrast, the CHM position (e.g., Article 11 of the Moon Agreement) holds that outer space resources belong to all humankind and that their exploitation must serve common interests. Recent Chinese scholarship has proposed a separation-of-title theory, under which title vests in all humankind while rights of exploration and use may be granted to specific entities through an international mechanism—seeking a balance between equity and efficiency and refining the CHM approach. [1] In addition, a compromise model grounded in res communis (a "negative community" or passive commonality) emphasizes that resources are held in common by all humankind while accommodating development efficiency and benefit-sharing [2], a view that has gained traction in the literature.

These positions have been translated into concrete institutional proposals in China's outer space practice—for example, advocating within UNCOPUOS the establishment of an Outer Space Resources Authority to centralize licensing, environmental standards, and revenue-sharing—thereby demonstrating the community-of-shared-future concept's normative steering power in resource governance.

Results

Confronted with the deep-seated predicament of outer space environmental governance, the concept of a community with a shared future for humankind offers value-based guidance and a jurisprudential foundation for regulatory reconstruction. This Part focuses on three key domains—space-debris governance, allocation of outer space resources, and procedural safeguards—with a view to translating the concept into operational, binding legal rules and proposing concrete frameworks for the rule of law and institutional innovation, thereby advancing a transformation from "State-centrism" to "humanity-centrism" in outer space governance.

1 Space-Debris Governance: A Responsibility Revolution from Mitigation to Remediation

As the most urgent threat to the outer space environment, space debris requires a paradigm shift from "passive mitigation" to "active remediation." Article IX of the Outer Space Treaty (OST) lays down only a principled duty to avoid harmful contamination and lacks specific conduct rules; the Liability Convention, while establishing launching-State responsibility, is confined to a traditional notion of "damage" and does not clearly encompass long-term environmental harms such as debris accumulation and orbital pollution. Accordingly, a systematic revision of the Liability Convention should be pursued: first, explicitly bring debris-generating conduct within regimes of absolute liability or fault-based liability; for traceable debris, impose joint and several liability on launching States; for non-traceable debris, introduce a presumption of liability drawn from international environmental law, apportioning remediation costs among beneficiary States in proportion to orbital use. Second, establish an International Space Debris Governance Fund, financed on a tiered basis by launching States according to launch frequency, orbital occupancy, and GDP-based indicators, to support debris surveillance, R&D, and active removal. The fund's operation may draw on the Polluter-Pays Principle (PPP) first articulated by the OECD in 1972 and reflected in China's 1979 Trial Environmental Protection Law, including the imposition of supplemental environmental levies on high-frequency launchers.

As to standard-setting and hard-law uptake, soft-law instruments should be upgraded into binding obligations. The UNCOPUOS Space Debris Mitigation Guidelines and ISO 24113 should be transformed, via resolution or treaty annexes, into mandatory technical standards. Concretely: (i) require new spacecraft to possess autonomous end-of-life disposal capability (e.g., de-orbit within 25 years of end-of-life); (ii) subject LEO megaconstellations to rigorous ex ante environmental impact assessment (EIA), encompassing collision probability, spectrum interference, and optical interference, with EIA findings as a precondition for launch authorization; and (iii) promulgate technical norms and safety standards for active debris removal (ADR) to furnish a clear legal basis for remediation activities.

At the domestic-law level, China should promptly adopt Regulations on Space Debris Management, establishing a debris-removal bond mechanism and an environmental credit registry for space actors. Specific provisions may include: commercial space operators posting bonds commensurate with launch mass to secure compliance with disposal obligations; maintaining operator environmental credit files with market-access restrictions for non-compliance; and clarifying the legal characterization of ADR and its coordination with OST Article VIII (jurisdiction and control), thereby providing a clear legal basis for technologies such as Shijian-21 debris-removal trials.

2 Allocation of Outer Space Resources: Building a Fair Benefit-Sharing Mechanism

Resource allocation is the core testing ground for implementing the community-of-shared-future concept and directly implicates the practical trajectory of the non-appropriation principle. To address the doctrinal contest between common heritage of humankind (CHM) and res nullius, a theory of separation between ownership and exploitation rights should be affirmed: title to outer space resources vests in all humankind, while exploration and exploitation rights may be granted via an international mechanism to States or commercial entities, conditioned on benefit-sharing. The U.S. model - advanced through the Commercial Space Launch Competitiveness Act and the Artemis Accords ("whoever extracts, owns") - fundamentally conflicts with OST Article II and, in substance, privatizes resources through technological first-mover advantage, lacking jurisprudential justification.

To balance efficiency and equity, an Outer Space Resources Authority (OSRA) should be established under the UNCOPUOS framework, modeled in part on the institutional design of the International Seabed Authority. Its mandate would include: licensing extraction projects; promulgating environmental standards; levying resource royalties/taxes; administering benefit-sharing to ensure participation by developing countries; and supervising operations through environmental oversight. A regime of periodic inspection and review should be instituted to ensure proceduralized and comprehensive governance.

Operationalizing common but differentiated responsibilities (CBDR), developers should be subject to four primary obligations: (i) payment of resource royalties into an international outer space environmental fund; (ii) allocation of a portion of resources (e.g., lunar water) to global public-goods purposes such as scientific research and humanitarian assistance; (iii) transfer of key enabling technologies to developing countries to bridge governance-capacity gaps; and (iv) creation of knowledge-sharing platforms to promote global circulation of space science data.

China can pilot the foregoing through cooperation under the International Lunar Research Station (ILRS). As of 2025, the initiative had attracted responses from 17 countries and over 50 institutions [3]; the June 16, 2021, Sino-Russian ILRS Partnership Guide—based on the principles of equality, openness and integrity [4] - provides a practical template for benefit-sharing in resource development. At the domestic level, China's forthcoming Space Law should codify the CHM character of outer space resources, establish a trusteeship-style national management scheme, set developer qualification and environmental standards, and stipulate benefit-return ratios, thereby furnishing State practice in support of international rule-making.

3 Procedural Safeguards: Toward Compulsory Dispute Settlement and Compliance Oversight

The current space-law regime lacks effective dispute-resolution and compliance-monitoring mechanisms, which severely undermines enforceability. Platforms such as UNCOPUOS rely on voluntary compliance, fueling the "soft-law hollowing"; the Liability Convention's dispute process is highly politicized and inefficient; source attribution for debris is difficult; and cross-border environmental claims are under-institutionalized—producing a "rules without order" impasse.

On dispute settlement, an Outer Space Environmental Disputes Tribunal should be established under UNCOPUOS, forming a multi-tiered system. The mechanism should combine advisory jurisdiction with compulsory arbitration, and allow States, international organizations, and qualified non-governmental entities to bring public-interest environmental actions, particularly regarding transboundary harm and inequitable resource allocation. Procedural design may draw on UNCLOS Annex VII arbitration: maintain a roster of experts in space law, astrodynamics, and related fields; provide expedited procedures for urgent matters; authorize provisional measures; and institute simplified arbitration to enhance efficiency. To secure authority, treaty parties should pre-accept jurisdiction, and revisions to the OST should clarify the binding effect of arbitral awards.

On compliance oversight, a comprehensive system should be instituted with an independent Outer Space Environmental Governance Committee. Its functions would include monitoring national compliance, assessing risk conditions, issuing periodic governance reports and lists of non-compliance, and providing recommendations and policy advice. Repeated violators would face graduated sanctions: initial warnings; subsequent restrictions on launch authorizations; and, in grave cases, technology-export controls or trade measures involving space-related goods and services.

Domestic coordination is equally vital. Through a national Space Law, China should establish an EIA regime for outer space activities, requiring major projects (e.g., megaconstellations) to submit pre-launch assessments covering orbital congestion, collision probability, and optical and radio-frequency interference. A national space-debris surveillance and information-sharing platform should be created, with mandatory interconnection by commercial operators to enable full life-cycle supervision. In addition, a compensation fund for outer space environmental damage should be established to provide remedies for transboundary harm, financed by launch licensing fees, administrative fines, and related sources.

In sum, by coordinating international hard law with domestic soft-law instruments, China can help construct an end-to-end procedural-safeguards regime encompassing monitoring–assessment–arbitration–sanctions, thereby effecting a substantive shift from political commitments to the legalized operation of outer space environmental governance and furnishing institutional guarantees for building a community with a shared future for humankind.

Conclusion

1 The 2024 Security Council Deadlock on Outer Space Draft Resolutions

The 2024 stalemate in the UN Security Council over outer space security draft resolutions epitomizes the contest between a "selective security" paradigm and an "inclusive security" paradigm in space arms control, laying bare a jurisprudential conflict between State interests and the interests of humankind. On 24 April, the United States and Japan tabled a text focused solely on prohibiting the placement in orbit of nuclear and other weapons of mass destruction; the Russian Federation vetoed the draft, characterizing it as "imbalanced, harmful, and politicized." On 20 May, a Sino-Russian draft calling for a comprehensive ban on the placement of any weapons in outer space likewise failed to pass.

At the core lies a divergent reading of the Outer Space Treaty (OST) Article IV "peaceful purposes" principle: the U.S.–Japan draft reflects selective multilateralism oriented to national security, whereas the Sino-Russian draft embodies inclusive multilateralism grounded in the concept of a community with a shared future for humankind, emphasizing the collective-security attributes of outer space as a global commons. As Ambassador Fu Cong, China's Permanent Representative to the United Nations, observed, "the greatest challenge in the outer space domain today is that a certain superpower seeks outer space hegemony, defines outer space as a 'war-fighting domain,' accelerates space force buildup, develops and deploys offensive space weapons, and forges space military alliances—moves that seriously undermine the peaceful character of outer space and heighten risks of miscalculation and conflict." This underscores not only the limits of hegemonic discourse and practice, but also the regulatory deficit in outer space governance amid hard-law shortfalls.

The case study illustrates a vicious cycle of "security-concept competition" and "institution-building stagnation." Although consistent with the purposes and principles of the UN Charter, the Sino-Russian proposal stalled under great-power rivalry, confirming the deeper predicament in which military-security logics suppress environmental-security logics. The implication is clear: only by pursuing inclusive multilateral consultations guided by the community-of-shared-future concept can States bridge divides and construct a rule-of-law order for outer space that reconciles national security with global public interests.

2 Regulatory Challenges of LEO Megaconstellations

The rapid rise of low-Earth-orbit megaconstellations—exemplified by SpaceX's Starlink—exposes structural deficiencies in which international rules lag technological innovation, and confirms the urgency of ex ante environmental impact assessment (EIA) and full life-cycle regulation. As of early 2025, roughly 7,000 Starlink satellites were on orbit, with plans for up to 40,000; such dense deployments significantly exacerbate collision risks, radio-frequency interference, and optical pollution affecting astronomy.

The difficulty is that the current governance framework relies heavily on soft law. UNCOPUOS's Space Debris Mitigation Guidelines lack binding force and accountability; the Liability Convention does not address cross-border liability for debris-related harm; and OST Article VI's "authorization and continuing supervision" duty for private actors remains under-specified—together generating a regulatory vacuum. The U.S. Federal Communications Commission (FCC) has applied relatively permissive standards to constellation approvals, while the European Union's Space Act (2025) introduces monetary penalties [5], yet suffers from limited efficacy absent robust international coordination.

These circumstances point to the necessity of institutional innovation, including:

Ex ante EIA: make congestion risk, collision probability, and spectrum-interference assessments a condition precedent to launch authorization for megaconstellations;

Full life-cycle regulation: build a regime spanning market entry review, on-orbit monitoring, and end-of-life evaluation; establish mandatory third-party insurance and a debris-removal bond for commercial operators;

International standards coordination: through UNCOPUOS, adopt harmonized deployment and operations rules for LEO megaconstellations, including uniform end-of-life disposal capability and data-sharing requirements.

Within the community-of-shared-future framework, this agenda aligns with a risk-prevention principle: only by juridifying technical standards and converting them into binding obligations can we forestall a repeat of the "tragedy of the commons" in the outer space environment.

3 China's Practice and Proposals

Through the Chinese Space Station's international cooperation, the International Lunar Research Station (ILRS), and the "Space Information Corridor," China has translated the principle of "extensive consultation, joint contribution, and shared benefits" into institutional reality, supplying empirical support for the community-of-shared-future concept.

First, the inclusiveness of Space Station cooperation. In partnership with the UN Office for Outer Space Affairs, China has selected the first tranche of international experiments for the Chinese Space Station and is slated to receive the first foreign astronauts in 2026. By December 2024, China had signed nearly 200 cooperation instruments with more than 50 countries and international organizations [6], covering satellite launches, the space station, and deep-space exploration—broad in scope and deep in engagement.

Second, institutional innovation under the ILRS. The ILRS's governance design—anchored in "openness and inclusiveness" and "benefit sharing"—draws on the common heritage of humankind approach: separating ownership and exploitation rights under international coordination; prioritizing lunar water for scientific and humanitarian purposes; and creating benefit-return mechanisms to support capacity-building in developing countries.

Third, governance extension via the Space Information Corridor. Successful initiatives such as the China–Arab Joint Center for Space Debris Observation and the Lancang–Mekong

Earth-Observation Data Cooperation Platform demonstrate how data-sharing and technical assistance can bridge North–South governance gaps, concretizing common but differentiated responsibilities (CBDR) in outer space.

Taken together, these practices show that China is converting vision into rules via legalized pathways. China's relational-governance approach to reshaping cooperation paradigms in outer space goes beyond geo-legal competition and offers a replicable institutional template for the governance of global commons.

Conclusion Remarks

The current international space law regime is plagued by deficiencies such as regulatory lag, weak enforcement mechanisms, and the softening of soft law, rendering it inadequate to address complex threats like space debris, the weaponization of outer space, and inequitable resource allocation. These shortcomings stem from underlying contradictions, including conflicts between national interests and the common interests of humankind, the absence of hard law, and competing security logics. The concept of a Community with a Shared Future for Mankind, by transcending state-centrism and advocating for common interests and intergenerational equity, provides a jurisprudential basis for a paradigm shift in outer space governance, establishing the normative superiority of the Common Heritage of Mankind principle. At the level of rule reconstruction, this article proposes institutional innovations, including a liability revolution in space debris governance, a mechanism for the equitable allocation of space resources, and compulsory dispute settlement procedures. Empirical evidence demonstrates that China, through practices such as space station cooperation, the International Lunar Research Station, and the "Space-based Silk Road," has provided viable models for translating this concept into practice. Based on this, China should play a leading role in the legalization process of outer space environmental governance, through the following specific pathways:

Multilateral Leadership: Promoting the Negotiation and Institutional Construction of an Outer Space Environmental Protection Convention

China should leverage the UN Committee on the Peaceful Uses of Outer Space as the core platform to proactively advocate for the formulation of an Outer Space Environmental Protection Convention, thereby translating the concept of a Community with a Shared Future for Mankind into hard law obligations. Key efforts should focus on promoting three major institutional designs: First, establishing an "Outer Space Resources Administration" to oversee space resource extraction licensing, environmental standard-setting, and benefit-sharing, drawing on the model of the International Seabed Authority to curb unilateral "first-come, first-served" practices. Second, improving the cross-border liability mechanism for space debris damage, amending the Liability Convention to clarify the liability principles for debris generation and removal, and establishing an International Outer Space Environment Remediation Fund, with costs apportioned based on launch frequency and orbital usage. Third, enhancing Transparency and Confidence-Building Measures in outer space activities, promoting the development of a global space traffic management system, and resisting the fragmentation of rules by club models such as the Artemis Accords [7].

Domestic Drive: Establishing a Whole-Chain Regulatory System Centered on the Space Law

China should accelerate the enactment of its Space Law to domesticate its international obligations regarding outer space environmental governance, with key provisions including: First, affirming the "Common Heritage of Mankind" status of outer space resources, establishing a

state trusteeship management system, and clarifying that commercial entities obtain usage rights, not ownership, through "preferential development rights". Second, instituting mandatory standards for space debris mitigation and removal, requiring all launch projects to possess autonomous deorbit capability, and introducing a debris removal deposit system. Third, constructing an Environmental Impact Assessment system for outer space activities, incorporating risks such as orbital congestion and spectrum interference into the assessment scope as a prerequisite for launch licensing[8]. Fourth, establishing a full-cycle regulatory mechanism for commercial space activities, implementing corporate environmental credit evaluation and blacklisting systems, and mandating environmental liability insurance. Furthermore, a National Outer Space Environmental Governance Fund should be established, funded by launch licensing fees and administrative fines, to support debris removal technology R&D and international cooperation.

Differentiated Cooperation: Building a Multi-Tiered "Circle of Friends in Space Governance"

China needs to formulate precise cooperation strategies tailored to different country groups: For technologically advanced Western nations, the focus should be on technical standards coordination and data sharing, such as conducting bilateral dialogues in areas like space debris monitoring and low-Earth orbit constellation deployment. With emerging spacefaring nations, cooperation should be deepened through joint R&D and capacity building, promoting the principles of "Peaceful Use, Equality and Mutual Benefit, and Common Development" embodied in the International Lunar Research Station. For the broad group of developing countries, leveraging the "Belt and Road" Initiative and the Asia-Pacific Space Cooperation Organization, China should provide inclusive support, such as satellite data sharing and the construction of observation centers, to bridge the governance capacity gap. The China-Arab "Joint Space Debris Observation Center" and the "Space-based Silk Road" have already demonstrated that such cooperation is a viable means of strengthening China's discourse power in relevant fields and advancing the concept of a Community with a Shared Future for Mankind from proposal to practice.

Furthermore, in the face of emerging technological challenges such as AI-driven autonomous space systems and the application of digital currencies in resource transactions, China must proactively assess their legal implications, continuously promote conceptual consensus through academic diplomacy and standards export, and intensify research on the legalization of outer space environmental governance in critical areas like the regulation of space militarization and the transnational supervision of commercial space activities. In conclusion, only by adhering to multilateralism and a rule-of-law approach can China lead the construction of an outer space order oriented towards the common interests of humankind, ultimately realizing the vision of an "Environmental Community with a Shared Future in Outer Space."

Contribution of the authors

This paper was finished by two authors equally. The first author finished the first version of the paper, the second author and the corresponding author verified the draft and gave some comments on the paper. The first author finished the form of the paper, and the corresponding author submitted the manuscript to this journal.

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Юридизация управления охраной окружающей среды космического пространства в рамках концепции сообщества общего будущего человечества

Аннотация: Системная дилемма в управлении окружающей средой космического пространства проистекает из неотъемлемого трансграничного характера космической деятельности, быстрого развития космических технологий и характера космического пространства как всеобщего достояния. Эти факторы привели к структурным недостаткам существующего государственно-центричного режима международного космического права, проявляющимся в задержке регулирования и слабой правоприменительной практике при противодействии таким комплексным угрозам, как распространение орбитального мусора, милитаризация космического пространства и несправедливое распределение внеземных ресурсов. В ответ на это концепция сообщества единой судьбы человечества должна служить нормативной основой как для реорганизации правил, так и для институциональных инноваций. По существу, для устранения пробелов в материальных нормах необходим переход к модели управления космическим мусором, основанной на ответственности, и к справедливому механизму распределения выгод от использования космических ресурсов. С точки зрения процедур, для укрепления институциональных гарантий необходимо создание обязательных механизмов урегулирования споров и независимого надзора за соблюдением. Такой подход способствует согласованию национальных интересов с общими интересами человечества, способствуя

переходу в управлении космическим пространством от политических обязательств к юридически обязывающему порядку. В итоге, он способствует развитию более инклюзивной, эффективной и справедливой для всех поколений парадигмы управления космическим пространством.

Ключевые слова: Сообщество общего будущего человечества; Управление космическим пространством; международное космическое право; Мирное использование космического пространства.

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Адамзаттың ортақ болашағының қоғамдастығы тұжырымдамасы аясында ғарыштық қоршаған ортаны басқарудың юрисдикциясы

Аңдатпа: Ғарыштық қоршаған ортаны басқарудағы жүйелік дилемма ғарыштық қызметтің ішкі трансшекаралық сипатынан, ғарыштық технологиялардың жылдам итерациясынан және ғарыштық кеңістіктің жаһандық ортақ сипатынан туындайды. Бұл факторлар қолданыстағы мемлекеттік орталықтандырылған халықаралық ғарыштық құқық режимінде құрылымдық кемшіліктерді тудырды, бұл орбиталық қоқыстардың көбеюі, ғарыштық кеңістікті милитаризациялау және жерден тыс ресурстарды теңсіз бөлу сияқты күрделі қауіптерге тап болған кезде реттеушілік кешігулер мен әлсіз орындаушылықта көрініс тапты. Жауап ретінде, адамзат үшін ортақ болашақ қоғамдастығы тұжырымдамасы ережелерді қайта құру және институционалдық инновациялар үшін нормативтік негіз болуы керек. Материалдық нормалардағы олқылықтарды толтыру үшін жауапкершілікке негізделген қоқыстарды басқару моделіне және ғарыштық ресурстар үшін әділ пайданы бөлісу механизміне көшу қажет. Процедуралық тұрғыдан алғанда, институционалдық кепілдіктерді нығайту үшін міндетті дауларды шешу және тәуелсіз сәйкестікті бақылау механизмдерін құру қажет. Бұл тәсіл ұлттық мүдделерді адамзаттың ортақ мүдделерімен үйлестіруге көмектеседі, ғарыштық қоршаған ортаны басқаруда саяси міндеттемеден міндетті, заңдастырылған тәртіпке көшуді ілгерілетеді. Сайып келгенде, ол ғарыштық кеңістік үшін инклюзивті, тиімді және ұрпақтар арасындағы әділ басқару парадигмасын дамытуға ықпал етеді.

Кілт сөздер: Адамзаттың ортақ болашағының қоғамдастығы; Ғарыш кеңістігін қоршаған ортаны басқару; Халықаралық ғарыш құқығы; Ғарыш кеңістігін бейбіт мақсатта пайдалану

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