Universiteit Leiden
The Netherlands

Conference Report

The 2nd Conference on Earth-Space Sustainability, co-organised by the International Institute of Air and Space Law, the European Research Council (ERC) PlanetStewards Project (Grant Agreement no. 101117483), the Secure World Foundation, and the COST Action FOGOS (CA 23118), was held at Leiden University's Academy Building.[1] As part of the broader Earth-Space Sustainability (ESS) Network, the event brought together an internationally diverse cohort of humanities and social science researchers, legal scholars, policymakers, astronomers, philosophers, and industry practitioners to address some of the most pressing governance challenges of our time. The conference focused on the intertwined futures of Earth and outer space and what emerged was a collective call to move beyond the siloes that have long separated diverse disciplines in their approaches to sustainability governance: to treat Earth-Space as a single, integrated system demanding integrated responses to fragmented issues.[2,3]

[1] See for details and a link to the full programme: https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/events/2nd-conference-on-earth-space-sustainability-law-stewardship-equity.

[2] Yap, X.-S., & Truffer, B. (2022). Contouring 'earth-space sustainability'. Environmental Innovation and Societal Transitions, 44, 185-193. https://doi.org/10.1016/j.eist.2022.06.004

[3] Yap, X.-S., & Kim, R. E. (2023). Towards earth-space governance in a multi-planetary era. Earth System Governance,

INTERNATIONAL INSTITUTE OF AIR AND SPACE LAW

PLANETSTEWARDS

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Opening Remarks: Growing the Earth-Space Sustainability (ESS) Network

The co-chairs of the conference, Tanja Masson-Zwaan (Deputy Director of the International Institute of Air and Space Law, Leiden University)[4], Xiao-Shan Yap (Principal Investigator of the PlanetStewards Project and Co-Chair of FOGOS, Utrecht University)[5], Ian Christensen (Senior Director Private Sector Programs, Secure World Foundation)[6] and Floran Rabitz (Associate Professor and Co-Chair FOGOS, Vilnius University)[7], welcomed the participants and introduced the Earth Space Sustainability (ESS) Network.[8] They highlighted the need for cross-disciplinary exchanges across institutions and disciplines and the importance of sustaining an international community that meets regularly to advance this agenda. A video message from Aarti Holla-Maini, Director of the United Nations Office for Outer Space Affairs (UNOOSA) affirmed the significance of forums like this in shaping the governance of humanity's activities in space.

Opening Panel: Earth-Space Sustainability as a Planetary Challenge of the 21st century

Moderated by Tanja Masson-Zwaan, the opening panel addressed the challenge of Earth-Space sustainability from distinct vantage points: social science, space applications, industry, and astronomy, yet converged on a shared diagnosis: that space governance remains fragmented from the wider sustainability conversation and that this fragmentation is no longer tenable. The panel addressed both political and technical aspects of this matter. Space, it was argued, has long been treated as exempt from the integration of natural and social sciences that has reshaped governance in other domains, yet the decisions being made today about orbital infrastructure, satellite constellations, and the governance of space assets are profoundly social and political in character. It was stressed that those who engage in space activities and related research are political actors, whether they acknowledge it or not. The challenge is to engage actively in reshaping the "de facto governance" emerging from the actions of states and private actors.

It was observed that satellite data is indispensable for monitoring agricultural systems, environmental conditions, and climate variables across the globe, and space sustainability is central to maintaining these capacities. Yet the technology and data that exist are not being integrated into the commercial and business frameworks where they could have the greatest impact. Space, as one panelist put it, should not remain an island. The challenge was framed along three intersecting axes: sustainability *within* space, Environmental, Social, and Governance (ESG) considerations *in* the space sector, and the contribution of space *for* sustainability on Earth.

Translating research into policy and industry action, and asking whether proposed solutions are even legally viable, emerged as a pressing concern. The dual nature of commercial space technologies like

16, [100173]. https://doi.org/10.1016/j.esg.2023.100173

[4] https://www.universiteitleiden.nl/en/staffmembers/tanja-masson-zwaan.

[5] https://www.uu.nl/staff/XSYap.

[6] https://www.tspmi.vu.lt/en/zmogus/florian-rabitz/.

[7] https://www.swfound.org/team/ian-a-christensen.

[8] For more details on the ESS Network: https://www.earthspacesustainability.org/

Starlink, which simultaneously offer global connectivity and degrade scientific observation, particularly for radio telescopes, was mentioned as a source of concern. As private activities in space accelerate, questions about how to deal with existing inequalities become increasingly urgent, and the geopolitical backlash toward the dominance of large actors makes the need for awareness and active governance engagement all the more pressing.

Special Session: Starlight as Nature

"Starlight as Nature", moderated by Xiao-Shan Yap as part of the research programme of the PlanetStewards Project, brought together scholars from history, philosophy, astronomy, and cultural studies to discuss the possibility of defining the night sky and starlight as nature, deserving the same protections as those granted to biodiversity or ecosystems on Earth.[9] Satellite constellations are now responsible for over 10% of light pollution in our skies, with some redirecting sunlight in ways that fundamentally alter what can be observed and experienced from Earth. The session drew a thread between the most ancient of human relationships and some of the most urgent governance challenges of the present moment.

Light pollution degrades the ability of astronomers to conduct science, threatens pollinator populations and other fauna whose lifecycles depend on darkness, and erases navigational and cosmological traditions that have sustained communities across millennia. The discussion invited participants to think of the night sky as a systemic whole, as different cultures have built distinct cosmological frameworks around their connections to celestial bodies. The discussion that followed grappled with the policy implications of these perspectives. The Starlight Declaration of 2007 was invoked as a precedent for treating dark skies as a cultural right, and the court of public opinion, it was argued, will be as important as formal legal mechanisms in determining whether that right will be protected in the future.

Keynote: Orbit, Moon, and the Governance We Choose

In her keynote address, Ulpia-Elena Botezatu (Space Policy Officer at the Romanian Space Agency and Co-Chair of the Action Team on Lunar Activities Consultation at UNCOPUOS) situated the conference within the longer arc of space governance history. Drawing on the analogy of historical figures who shaped the future without knowing they were doing so, she invited participants to consider their own potential legacy: the governance decisions made today, on debris mitigation, on the status of the Moon, on what counts as legitimate authority in outer space, will define the normative landscape for generations. Legitimacy, she argued, is not only a legal question but a social one: the authority of rules depends on whether they are accepted, not merely whether they are formally adopted. Voluntary guidelines, however carefully crafted, are not binding, and the gap between what is recommended and what is practiced remains wide.

Special Session: Commercial Lunar Payloads and Responsible Space Governance

The session on lunar governance addressed how international legal obligations apply to commercial lunar

[9] For more details, see: https://www.planetstewards.eu/ess-conference-2026-reflections.

activities, and whether existing frameworks are adequate to the moment. At the heart of the discussion was the precautionary principle. There was broad agreement that caution is required, but also that caution does not equal prohibition: the principle does not fully prevent activities, it shapes how they are approached. Article IX of the Outer Space Treaty provides relevant anchors, but these remain vague - binding in principle, flexible in practice. The precautionary principle can be approached from two complementary directions: the legal, concerned with regulation and the possibility of contemporary breaches of international obligation, and the philosophical, which asks what values we are ultimately trying to protect.

Some concern was expressed about the possibility that sustainability consistently ranks below exploration in the hierarchy of values driving space development. At some point, the community may need to face the trade-off between progress and preservation. Indigenous perspectives and ways of knowing were raised as a valuable counterweight to purely extractive framings; their relational understandings of celestial bodies, including the Moon, offer a different set of anchors for what responsible governance might look like. The question of legal personhood for celestial bodies was raised and then deliberately set aside in favour of a more immediate argument: rather than waiting for philosophical and legal frameworks to mature, states should be proactive.

Special Session: Tiered Liability and the Future of Space Insurance

The final session of the day addressed a question that is rapidly becoming urgent as Low Earth Orbit grows increasingly congested: how should liability for in-orbit activities be structured to incentivise responsible behaviour? Moderated by Joanne Wheeler (Director, Alden Legal and UK Earth and Space Sustainability Initiative), the session explored the case for a tiered liability approach in which the level of regulatory scrutiny and insurance obligation attached to a space mission is proportionate to its assessed risk to the space environment and to third parties. Bringing together voices from government, incumbent insurers, and a space insurance start-up, it illustrated both the diversity of institutional perspectives on this question and the shared recognition that the current framework is not fit for the scale of activity now underway in Low Earth Orbit.

The second day of the event was structured around parallel paper sessions, keynotes and workshops.

Paper Sessions: The Breadth of the Field

The parallel paper sessions offered a window into the remarkable diversity of research now clustering around Earth-Space sustainability as an emerging field. Across four concurrent tracks, covering environmental sustainability and integrity, commons and data governance, the histories and philosophies of space, and questions of peace, politics, and stability, presenters brought empirical rigour, theoretical ambition, and disciplinary breadth to questions that have too rarely been considered together. Papers ranged from the governance of large satellite constellations and their environmental footprint, to the applicability of maritime law to the orbital commons, to the legal implications of space militarisation and the astropolitics of Starlink in the context of the Ukraine war. What united them was a shared conviction that the governance of space cannot be left to any single discipline, and that the frameworks inherited from the twentieth century are straining under the weight of twenty-first century realities. The

conversations that spilt out of these sessions were enriching in many aspects.

Keynote: Sustainable by Design: Innovating the Future of Space

Andrea Vena, Chief Sustainability Officer of the European Space Agency (ESA), argued that the case for sustainability in space is not merely ethical; it is existential for the sector. An orbital environment degraded by debris, frequency interference, and the accumulation of defunct infrastructure is one in which the space economy cannot function, in which scientific observation becomes impossible, and in which the services that billions of people now depend on, including navigation, communications, and Earth observation, are placed at risk.

The ESA Sustainability Framework reflects this logic: sustainability must be designed into missions from the outset, not retrofitted as an afterthought. This "sustainable by design" philosophy has implications at every level, from spacecraft architecture to mission planning and end-of-life disposal. One of the more striking illustrations was the case of lunar exploration, where the constraints of operating in a remote and resource-scarce environment make circularity not an aspiration but a necessity. The Moon, in this sense, offers a preview of what responsible design thinking looks like when the margin for error is genuinely small.

Vena also spoke about ESA's ClearSpace-1 mission, the first active debris removal mission, developed in partnership with a commercial operator, as a significant step toward treating the orbital environment as something that can and must be actively managed rather than simply used and abandoned. Alongside it, the CAT and RISE missions were presented as further markers of a broader institutional commitment to translating sustainability principles into engineering practice. The message was clear: the future of space is one in which sustainability is not a constraint on innovation but its precondition.

Keynote: Protection of the Dark and Quiet Skies

Federico Di Vruno, Spectrum Manager at the SKA Observatory, brought a perspective to the conference that is easy to overlook precisely because its subject matter is invisible. The radio frequency spectrum, the range of electromagnetic frequencies used for everything from satellite communications to radio astronomy, is a finite natural resource, and like all finite resources, it is subject to the pressures of competing demand, inadequate governance, and the risk of irreversible degradation.

For radio astronomers, the stakes are immediate. The instruments of modern radio astronomy, including the Square Kilometre Array, are among the most sensitive ever built, capable of detecting signals of extraordinary faintness from across the observable universe. That sensitivity is also their vulnerability: radio frequency interference from satellite constellations, terrestrial networks, and even consumer electronics can render entire observation windows unusable. Unlike light pollution, which can be partially mitigated by geography, radio frequency interference respects no such boundaries. A satellite transmitting in a protected frequency band, whether through design, malfunction, or regulatory ambiguity, can compromise observations from anywhere on Earth.

This example exemplifies a broader governance issue: the tragedy of a commons that is simultaneously

global, technically complex, and politically contested. Effective governance requires not only international coordination through bodies like the International Telecommunication Union, but also a shared understanding of what is at stake. The rapid deployment of mega-constellations has outpaced the regulatory frameworks designed to manage interference, and the gap is widening. Sustainability in space must include the electromagnetic environment as well as the orbital one: the two are, in the end, inseparable.

Workshop: A Stewardship Plan for the Moon

As part of the research programme of the PlanetStewards Project, this workshop on 'A stewardship plan for the Moon' – led by Xiao-Shan Yap and supported by Timothy Pape (Bowling Green State University) and Blake Harvey (Utrecht University) – focused on the abstractions of governance theory and the concrete pressures of an environment that is being actively contested. The Moon has become a new territory for scientific, economic, and geopolitical competition on a global scale, and the speed of that transformation has left governance frameworks struggling to keep pace.

The workshop drew on perspectives from Pascale Ehrenfreund (COSPAR), Marjolijn van Heemstra (writer and journalist), Adrien de Sutter (MPIWG), Ulpia Botezatu (UN Action Team on Lunar Activities Consultation), Marco Janssen (Arizona State University), and Mehak Serang (Open Lunar Foundation) to jointly explore what a stewardship plan for the Moon's future might look like. The framing was deliberately ethical: not what states or companies are legally permitted to do on the Moon, but what responsible actors should do, and on what basis. What emerged was a sense that the existing framework, built largely on the 1967 Outer Space Treaty and its principle that the use and exploration of the Moon are the "province of all [hu]mankind," is both indispensable and insufficient. It provides a normative foundation but not the operational guidance needed to manage competing activities in a specific and increasingly congested environment.

Participants engaged in scoring the relevance of a few core governance principles in addressing the increasing utilization of the Moon. Overall, several tensions surfaced that will require sustained attention. The relationship between scientific use and commercial extraction, between the interests of spacefaring nations and those of the broader international community, and between the short-term logic of individual missions and the long-term logic of preservation, are not tensions that any single document or institution can resolve. The conversation about lunar stewardship must be genuinely interdisciplinary, bringing together the technical, legal, ethical, and political dimensions that are too often addressed in isolation.

Workshop: Look Up: Confronting the Ripple Effects of Planetary Defence in the International Community

This workshop was led by Andrea Harrington (Institute of Air and Space Law, McGill University) and facilitated by Arnold Agaba and Martina Elia Vitoloni, also of McGill. "Look Up" was an interactive tabletop exercise in which participants were confronted with a scenario where an asteroid is on a collision course with Earth. The exercise was not designed to produce definitive answers but to expose the complexity of the legal, political, and ethical questions that would be triggered by such a situation, and the degree to which existing frameworks are unprepared for them. Who has the authority to decide on a deflection

mission? Who bears liability if the deflection alters the asteroid's trajectory in ways that harm a different region? What are the obligations of states with early detection capability toward those without? How are decisions made under conditions of radical uncertainty and extreme time pressure?
The exercise made clear that planetary defence is not a technical problem with a governance appendix; it is a governance problem that requires technical inputs. The decisions that matter most are not engineering decisions; they are political and ethical ones, about representation, risk distribution, and the allocation of responsibility across a deeply unequal international community. The exercise generated productive disagreement and, by design, left many questions unresolved. That, in a sense, was precisely the point: the time to expose these disagreements is now, not in the aftermath of a detection event.

The last day of conference continued and concluded the discussions with a mix of keynotes, special sessions, and paper sessions.

Special Sessions: Towards Future Governance

Two concurrent special sessions approached the future of Earth-Space governance from complementary angles. In one session, moderated by Xiao-Shan Yap and Florian Rabitz, the question was whether Earth-Space sustainability governance requires its own independent assessment body capable of synthesizing the full range of scientific, legal, and social dimensions of the field in a way that existing bodies can not. The conversation drew on analogies from fisheries management, environmental impact assessment, and risk-based regulatory frameworks, asking what has worked in comparable domains and whether those lessons can be meaningfully transposed to space. The session featured voices from the Secure World Foundation, the SKA Observatory, COSPAR, the IAF Committee on the Cultural Utilisation of Space, and Open Lunar Foundation. The discussion highlighted both the difficulty and the appeal of this proposal put forward by the PlanetStewards Project. Independent assessment bodies derive their authority from credibility, and credibility in a field as technically complex and geopolitically contested as space governance is hard-won. Yet the alternative, continued fragmentation, with isolated scientific communities, legal bodies, and industry actors each addressing pieces of the puzzle in isolation, was widely seen as inadequate to the scale of the challenge.[10]

The other session focused on environmental integrity and was moderated by Tom Royer (University of Lapland) and Monica Truninger (University of Lisbon). It approached the same landscape from a futures-oriented governance perspective, exploring the discrepancy between how environmental integrity is addressed on Earth compared to in space, and what different governance frameworks might look like if the interconnectedness of the two domains were taken seriously as a starting point rather than as an afterthought.

Keynote: An Embassy for the Moon

Marjolijn van Heemstra, writer, journalist, and dark sky advocate, brought a literary and deeply personal lens to a room of lawyers and scientists. Weaving together colonial history, her Surinamese family roots, and the extractive logic that has driven past cycles of dispossession, she asked whether the rush toward

[10] https://www.planetstewards.eu/ess-conference-2026-reflections

lunar resources represents not a new frontier but a familiar pattern, the same grammar of possession and enclosure, applied now to the one landscape that no flag has yet been able to claim as its own.

She invoked William Blake's engraving "I want! I want!", depicting a lone figure ascending a ladder toward the Moon, as an image of longing that is also an image of hubris. And she gave a name to something that had been present but unarticulated in many of the conference's earlier sessions: "anticipatory grief". The Moon, she argued, is our only truly shared landscape, the one celestial body that every human being on Earth has looked up at with wonder, fear, and meaning. It is now being drawn into an administered, capitalised existence, and something is being lost in that process even before it has fully arrived. This talk was a reminder that the most powerful arguments for Earth-Space stewardship may ultimately not be legal or technical, but moral and poetic, and that before governance frameworks can take hold, something must be felt.

Paper Sessions and Workshop on Science Communication and Policy Engagement

The conference's final parallel paper sessions covered environmental sustainability and integrity, as well as commons, resource, and data governance. Presentations ranged from the legal and ethical dimensions of space agriculture to the implications of lunar waste dumping, and from intergenerational equity in space law to the ancient Indian cosmological foundations that one presenter proposed as a grounding for contemporary Earth-Space governance.

The day closed with a workshop on science communication and policy engagement, organised by Katja Grunfeld (University of Cologne) from FOGOS Working Group 1 and supported by Marieluna Frank, Tom Royer, and Inga Popovaitė, which brought together early-career researchers to explore how the ideas generated over three days might be carried beyond the conference room and into policy processes, public debates, and institutional conversations where they are most needed. It was a gesture toward continuation: the recognition that a conference is not an endpoint but a beginning.

Closing Session

In their closing remarks, the conference co-chairs reflected on the conversations that had taken place, demonstrating that Earth-Space sustainability is a problem that belongs to everyone. They observed that addressing this matter requires everyone's participation: lawyers, humanities scholars and social scientists, astronomers, engineers, politicians, philosophers, and storytellers. What we are ultimately protecting is not just an orbital environment or a frequency band, but a relationship: humanity's oldest and most elemental relationship with the sky above. The governance of Earth-Space sustainability cannot be achieved through any single instrument, discipline, or institution. It requires the kind of cross-disciplinary exchange that the conference was designed to foster and continue. The Earth-Space Sustainability (ESS) Network and the many individual collaborations that seeded across three days will carry these conversations forward. The next generation of researchers, practitioners, and advocates is already in the room.

Conference Rapporteurs: Varvara Kut'yina, Gnanavi Gummadi, Krati Hashwani and Xinji Zhang
LLM candidates in air and space law, Leiden University