LUISS

Research Center for International and Strategic Studies

Research Unit
SPHERE - Space Policy, Humanities, and Exogeography Research Ecosystem

1st SPHERE SPACE POLICY FORUM

7 November 2025

FINAL REPORT

The New Space Age

Integrating Social Sciences and Humanities in Policy-Making

December 2025

Edited by
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Author's note

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The analytical framework and interpretations proposed are the sole responsibility of the author and do not necessarily reflect the positions of the institutions mentioned. The contributions that emerged from the panels have been reworked and integrated into the text without individual attribution to the speakers, with the exception of the institutional opening and closing speeches. Specific citations are reserved for bibliographical references.

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PROGRAMME OF THE 1ST SPHERE SPACE POLICY FORUM

The new space age:
multidisciplinary governance for the future of public policy

7 November 2025, 8:30 a.m.

The Dome, Luiss Campus, Viale Romania 32, Rome

8:30 a.m. – Welcome coffee

9:00 a.m. – Introductory speeches

- Raffaele Marchetti
  Director of the Research Centre for International and Strategic Studies (CISS), Luiss
- Adolfo Urso (video message)
  Minister of Enterprise and Made in Italy
- Angelino Alfano
  President of the Research Centre for International and Strategic Studies (CISS), Luiss
- Alfonso Giordano
  Head of the SPHERE Unit – Space Policy, Humanities and Exogeography Research Ecosystem (CISS), Luiss

9:30 a.m. – Panel I
Space as a strategic domain: challenges for international governance

Speakers:

- Antonino Ali – Professor of International Law, University of Trento
- Massimo Claudio Comparini – Managing Director, Space Division, Leonardo S.p.A.
- Mauro D'Ubaldi – Deputy Secretary General of Defence
- Matteo Lucchetti – Chief Operating Officer, National Competence Centre on Cyber Security CYBER 4.0
- Marcello Spagnulo – Technical-Scientific Expert, Interministerial Committee for Space and Aerospace Policies of the Government

Moderator:

- Raffaele Marchetti – Director of CISS and Professor of International Relations, Luiss

10:15 a.m. – Panel II

Space economy and innovation: the role of public and private policies

Speakers:

- Antonio Bartoloni – Head of the Office for Space and Aerospace Policy, Presidency of the Council of Ministers
- Ezio Bussoletti – President of e-GEOS; Director of the Executive Master's in Space Economy, Luiss Business School
- Alberto Improda – President of the Cross Route Impresa Study Centre
- Francesco Lapenta – Director of the John Cabot University Institute of Future and Innovation Studies
- Luca Rossettini – Chief Executive Officer, D-Orbit – Space Logistics and Orbital Transportation Services
- Ersilia Vaudo Scarpetta – Special Advisor Future Talents, European Space Agency

Moderator:

- Frediano Finucci – Head of Economics and Foreign Affairs Editorial Office, La7 TV News; Training School on Space Journalism, School of Journalism, Luiss

11:00 a.m. – Coffee break

11:30 a.m. – Panel III

The future of humanity beyond Earth: exogeography and policies for the new era

Speakers:

- Gianluca Casagrande – Professor of Space Exploration and Exogeography, European University of Rome
- Ilaria Cinelli – Biomedical Engineer and Analog Astronaut, Aerospace Medical Association
- Mario Cospito – Diplomatic Advisor and Expert on Aerospace Policy, Ministry of Enterprise and Made in Italy
- Marcello Di Paola – Professor of Environmental and Space Philosophy, University of Palermo
- Stefano Pontecorvo – Chairman of Leonardo S.p.A.
- Mario Cosmo – Director of Science and Research, Italian Space Agency

Moderator:

- Eva Giovannini – Journalist, correspondent and presenter, RAI (Italian Public Broadcaster)

12:15 p.m. – Interactive Q&A

Moderator:

- Vittorio Argento – Journalist

12:45 p.m. – Conclusion of proceedings

- Alfonso Giordano – Head of the SPHERE Unit – Space Policy, Humanities and Exogeography Research Ecosystem (CISS); Professor of Exogeography, Astropolitics and Space Economy, Luiss

EXECUTIVE SUMMARY

This summary note summarises the main points of the report for quick reading; details are provided in the following chapters.

CONTEXT AND OBJECTIVES

The 1st SPHERE Space Policy Forum inaugurated a multi-year process of reflection on space policies promoted by the SPHERE Unit of CISS-LUISS. The event brought together institutional, industrial and academic representatives to discuss the challenges of space governance in the new era characterised by the multiplication of actors, the hybridisation of public-private models and the growing pervasiveness of space infrastructure in everyday life.

SPHERE'S THESIS

The report develops a central thesis: the traditionally technocratic approach to space policy – in which the political-strategic dimension was combined with the technical monopoly of engineering sciences, while the social sciences remained confined to ancillary functions – is no longer adequate for the complexity of the current context. SPHERE proposes **multidisciplinary governance of space**, in which technical and scientific (STEM) skills and those of the social sciences and humanities (SSH) engage in structural dialogue in the formulation of public policies.

THE QUADRUPLE FILTER

In support of this proposal, the report presents an analytical tool called the quadruple filter. Each policy option relating to the space domain should be examined according to four dimensions:

- **Technical feasibility**: what is technically possible?
- **Social desirability**: what is socially desirable to do, and for whom?
- **Legal and ethical legitimacy**: what is legally permissible to do?
- **Systemic sustainability**: what is sustainable in the medium to long term?

The filter does not eliminate political discretion, but informs and regulates it, making the *trade-offs* between different dimensions explicit.

THE FIVE CROSS-CUTTING ISSUES

The Forum has identified five recurring areas of tension that cut across the entire space agenda:

1. **Sovereignty vs cooperation**: how to balance competition between powers and multilateral governance;
2. **Fair access to benefits**: who profits from the space economy and who risks being excluded;
3. **Environmental and systemic sustainability**: terrestrial and extraterrestrial impacts of space activities;
4. **Democratic legitimacy**: who sets priorities and through what mechanisms;
5. **Skills and training**: the mismatch between the complexity of decisions and the preparation of decision-makers.

THE SKILLS MAP

The report breaks down the relevant knowledge landscape into three areas:

- **STEM disciplines** (fundamental cognitive infrastructure);
- **Established social sciences** (space law, space policy, space economy, astropolitics, outer space geographies);
- **Emerging socio-humanistic disciplines** (exogeography, astrosociology, space ethics, space humanities). **Exogeography** is proposed as a bridging discipline, capable of integrating material and social dimensions based on the model of physical and human geography.

THE RESULTS OF THE FORUM

The three panels revealed significant convergences:

PANEL I – SPACE AS A STRATEGIC DOMAIN: CHALLENGES FOR INTERNATIONAL GOVERNANCE

- Space as an eminently political domain;
- The crisis of the 1967 regulatory framework;
- The interdependence between space and terrestrial infrastructure;
- The need for a strategic vision that integrates security, technology and cooperation.

Key phrase: 'Either you're at the table, or you're on the menu'.

PANEL II – SPACE ECONOMY AND INNOVATION: THE ROLE OF PUBLIC AND PRIVATE POLICIES

- Innovation as systemic transformation;
- The centrality of public investment;

- The crisis of vertical training models;
- The need for a public administration capable of "delivering" without sacrificing control and reliability.

Key phrase: 'The fundamental question is not only what technologies we want to develop, but what future we intend to build through them'.

PANEL III – THE FUTURE OF HUMANITY BEYOND EARTH: EXOGEOGRAPHY AND POLICIES FOR THE NEW ERA

- Human expansion as a process with high political, regulatory and ethical density;
- Exogeography as a tool for disciplinary integration;
- The extension of the One Health paradigm to space;
- The urgency of anticipating the regulatory dimension of human presence beyond Earth.

Key phrase: 'The question is not only whether boundaries make sense, but whether we are ready to bring a more mature vision to them'.

SUMMARY OF CONVERGENCES

Theme	Emerging convergence
Governance	Recurring theme in all panels, from orbital safety to human expansion
Policy-driven	The space sector is structurally oriented by public choices and regulatory regimes
Hybrid skills	Shared need for profiles capable of combining technical and socio-humanistic knowledge

OUTLOOK

SPHERE intends to continue along three lines:

- **Interdisciplinary research**: consolidation of emerging disciplines, from exogeography to space humanities and their interrelation with STEM
- **Hybrid training**: preparing profiles capable of crossing different disciplinary languages.
- **Institutional and industrial dialogue:** policy advice to support reflection on public and industrial policies.

The report is not a point of arrival, but a common working basis for addressing challenges that affect all of humanity.

INTRODUCTION

This report presents the results of the 1st SPHERE Space Policy Forum, held at LUISS Guido Carli on 7 November 2025. The event inaugurated a multi-year process of reflection on space policies promoted by the SPHERE-Space Policy, Humanities and Exogeography Research Ecosystem Unit of the LUISS Research Centre for International and Strategic Studies (CISS), with the aim of contributing to the national and European debate on space governance in the new era marked by the multiplication of actors, the hybridisation of public-private models and the growing pervasiveness of space infrastructure in everyday life.

The Forum took place in a context of renewed institutional attention to the space sector, recognised as a strategic frontier for economic competitiveness, national security and the international positioning of Italy and Europe. In this context, LUISS sought to provide a space for discussion and debate that would bring together different areas of expertise - technical, scientific, legal, economic, strategic and humanistic - in the belief that the challenges posed by the new space era require approaches that transcend the boundaries of individual disciplines.

While in the 'old space' the political dimension was almost entirely absorbed by strategic competition between opposing blocs, today's governance requires multidisciplinary integration that goes beyond mere engineering efficiency. The thesis that guided the Forum, and which this report develops, is that the traditionally technocratic approach to space policy – dominated by engineering and physical sciences, with the social sciences and humanities in an ancillary position – is no longer adequate for the complexity of the current context. SPHERE proposes multidisciplinary governance of space, in which technical and scientific expertise interacts structurally with economic, legal, sociological, political, historical, geographical, philosophical and anthropological expertise. In support of this proposal, the report presents a four-fold filter for evaluating policy choices: each option is examined according to criteria of technical feasibility, social desirability, regulatory and ethical legitimacy, and systemic sustainability.

The report places particular emphasis on exogeography – the extension of the geographical method to extraterrestrial territories – as an example of a bridging discipline capable of integrating the physical and human dimensions, natural constraints and social constructs. More generally, it recognises that space humanities and emerging socio-humanistic disciplines offer conceptual resources that are still under-exploited for addressing issues that the current regulatory and institutional framework does not fully resolve.

The text is divided into three main parts. Part I reconstructs the conceptual framework, documenting the transition from the 'old space' agency to the new plural space era and introducing the fourfold filter as an analytical tool. Part II presents the five cross-cutting issues that run through the contemporary space agenda and the map of disciplinary skills relevant to addressing them, distinguishing between STEM disciplines, established social sciences and emerging socio-humanistic disciplines. Part III

analyses the content that emerged in the three panels of the Forum, interpreting it through the categories ‘ ‘ developed in the previous parts, and concludes with some working guidelines for research and training that SPHERE will be able to develop further in subsequent stages.

This report is essentially analytical and conceptual in nature. It presents a structured overview of the themes, issues and perspectives that emerged in the Forum and in recent literature, without claiming to exhaust a rapidly changing agenda. The text is intended as a contribution to the public debate on space policy, open to discussion and criticism. Its ideal audience is a broad one: academics engaged in space research, policy-makers involved in the formulation of national and European strategies, public and private sector operators, advanced students and citizens interested in understanding the implications of space choices for contemporary societies and for the future of humanity beyond Earth.

The Forum on 7 November 2025 was a starting point, not an end point. This report is the first public outcome of this process. SPHERE intends to continue the work it has begun, helping to build the skills and networks of dialogue necessary for space governance that is equal to the challenges that lie ahead.

PART I – THE INSTITUTIONAL CONTEXT AND THEORETICAL FRAMEWORK

1 - THE INSTITUTIONAL AND STRATEGIC FRAMEWORK OF THE 1ST SPHERE SPACE POLICY FORUM

The 1st SPHERE Space Policy Forum opened with a series of institutional speeches that defined the political and academic scope of the initiative, legitimising it as a forum for strategic reflection on Italian and European space policies.

The Director of CISS, Raffaele Marchetti, framed the Forum within the University's mission as a bridge between social sciences and major technological challenges. LUISS was presented as a policy-oriented dialogue platform, capable of connecting academic communities, public institutions and private operators on issues of strategic importance. In this perspective, the creation of the SPHERE Unit represents a natural evolution of CISS's vocation: to extend reflection on strategic and international studies to the space domain, recognised as a frontier where issues of security, economics, governance and technological innovation converge. The inaugural Forum was positioned within this framework as the first step in a multi-year process aimed at consolidating LUISS's position in interdisciplinary reflection on space policies.

The Minister for Enterprise and Made in Italy, Adolfo Urso, provided the industrial policy framework for the initiative. In his speech, space was presented as a strategic national asset: critical infrastructure, a technological frontier and a lever of competitiveness for the country as a whole. The Minister emphasised the Government's commitment to providing the sector with a clear and stable regulatory framework that promotes investment, partnerships and technology transfer from research to the market. The emphasis was on the link between the space economy and Italian technology, on the need to build a national system that enhances existing skills - large companies, SMEs, start-ups, universities - and on the European dimension of the challenge: Italian competitiveness depends on the integration of continental supply chains and the creation of European champions capable of guaranteeing strategic autonomy. The priorities identified - regulatory continuity, human capital training, qualified public demand - have outlined an agenda in which the state takes an active role in supporting innovation and growth in the sector.

The President of CISS, Angelino Alfano, concluded the institutional session by placing the Forum in the tradition of research centres as intermediaries between academia, policy makers and economic operators. In this interpretation, strategic study centres are not limited to producing specialist knowledge but also act as a bridge between different disciplines – strategic, legal, economic, technical – and between communities that would otherwise struggle to communicate. The CISS, with its focus on the analysis of international relations and security, finds a natural field of application in the space domain, where its consolidated expertise in strategic studies meets the challenges posed by the new space age. The Forum was presented as a concrete expression of this capacity for integration: an opportunity to compare diverse perspectives on a topic that, by its very nature, requires multidisciplinary approaches.

The institutional interventions thus established the conditions for the legitimacy of the initiative without predetermining its analytical content. The framework outlined - space as a strategic frontier, LUISS as a centre for policy-oriented thinking, CISS-SPHERE as an infrastructure for interdisciplinary dialogue - prepared the ground for the work developed in the subsequent sessions and documented in the following chapters.

The introductory speech by Alfonso Giordano, head of the SPHERE Unit, took up and developed the thesis formulated in the preparatory document for the Forum[1] , presenting the fourfold filter and the map of disciplinary competences as a framework for the work. SPHERE's proposal stems from an observation: space policies have historically been formulated according to a model in which the political-strategic dimension – central during the Cold War as a field of competition between superpowers – was combined with the technical monopoly of engineering and physical sciences, while the social sciences and humanities remained confined to ancillary functions: legitimisation of choices already made, public communication, propaganda.

The thesis put forward is that of multidisciplinary governance of space, understood as the systematic overcoming of the traditional technocratic paradigm. This does not mean denying the centrality of STEM skills but recognising that the formulation of effective public policies requires the structural integration of different types of knowledge: economic, legal, political, sociological, historical, geographical, philosophical, anthropological and cultural. From this perspective, space policies cannot be evaluated solely based on technical feasibility, but must meet multiple criteria involving social desirability, regulatory legitimacy and systemic sustainability.

Giordano proposed a four-fold filter as an analytical tool to guide the Forum's reflection. Every policy option relating to the space domain should be subjected to four fundamental questions: what is technically possible to do (technical feasibility filter); what is socially desirable to do (desirability filter); what is legally and ethically permissible to do (legal and ethical permissibility filter); what is systemically sustainable to do (sustainability filter).

In support of this proposal, Giordano presented a map of the disciplinary skills relevant to space policies, divided into three main areas – STEM disciplines, established social sciences and emerging socio-humanistic disciplines – which will be discussed in more detail in the section dedicated to the skills map.

Within this tripartite division, Giordano attributed to exogeography a role as a bridging discipline and epistemological model. Exogeography extends the traditionally two-sided geographical method to extraterrestrial spaces: geography is, in fact, the only academic discipline that systematically integrates the physical and human dimensions, natural sciences and social sciences. Applied to lunar, Martian or

[1] Available at https://ciss.luiss.it/la-nuova-era-spaziale-una-governance-multidisciplinare-per-il-futuro-delle-politiche-pubbliche/

orbital domains, exogeography offers a language and conceptual apparatus for analysing territoriality, boundaries, resources and settlements beyond Earth, maintaining the tension between physical constraints and social constructions that characterises the geographical tradition. In this sense, it is not just another discipline, but an example of how STEM-Social Sciences and Humanities (SSH) dialogue can generate new fields of inquiry.

International literature confirms the growing demand for interdisciplinary approaches. The ESPI Perspectives 45 report (Daveri and Thiele, 2011) documented the presence of social sciences and humanities in the European space sector, while highlighting its structural limitations: fragmentation, lack of institutionalisation, absence of stable channels of dialogue with technical communities. Other studies (Codignola and Schrogl, 2009; Landfester et al., 2011) represent significant precedents for interdisciplinary reflection but remain episodic initiatives rather than structured programmes. Finally, the UNOOSA Space2030 Agenda (2021) explicitly places space policies within the framework of sustainable development goals, requiring skills that go beyond the scope of engineering sciences.

In line with this approach, the design of the Forum was also explicitly experimental. The three panels were not conceived as single theme round tables composed of homogeneous disciplinary communities, but as spaces for intentional discussion between STEM experts and SSH scholars on concrete issues: orbital security and governance, space economy and public policy, and the future of humanity beyond Earth. The composition of the panels aimed not only to 'cover' the different areas of expertise, but also to create conditions in which technical and socio-humanistic perspectives were called upon to measure themselves against the same objects, making the Forum a first testing ground for the multidisciplinary governance paradigm proposed by SPHERE.

SPHERE proposes itself as an institutional response to this question. The Unit, based at LUISS's CISS, aims to establish a permanent platform for the integration of STEM and SSH in space policy-making. The inaugural Forum on 7 November 2025 represents the first step in a multi-year programme that includes cycles of meetings, publications, research, training and policy advice. The aim is not to replace technical expertise, but to systematically complement it with complementary knowledge, generating more robust policy advice and public policies that are more aware of their social, legal and ethical implications.

In this context, LUISS can count on an educational and research ecosystem that is already active in the space domain. Alongside the research initiatives of the CISS SPHERE Unit, pioneering courses in 'Exogeography, Astropolitics and Space Economy' and 'Deep Tech, Robotics and Space Economy', the Master's in Space Economy at the Luiss Business School, the Master's in Space Law and Geopolitics at the School of Law and the School of Government, the Training Course in Space Journalism at the School of Journalism, and projects on space-driven innovation promoted by the Research Centre on Law and Investments in Future and Earth. These initiatives have produced a first-generation ' ' of hybrid profiles, capable of moving between technical, legal, economic, social and communicative dimensions.

SPHERE acts as the connective tissue of this ecosystem, with the aim of networking these experiences and directing them more systematically towards the multidisciplinary governance of space policies.

2 – From 'old space' to the New Space Era

For over four decades, space activities have been organised according to a model that the literature defines as 'Legacy Space' or 'old space' (Zancan et al., 2024). This configuration, which emerged in the context of the Cold War, had distinctive structural characteristics: the absolute centrality of government agencies, the prevalence of strategic-military logic, the concentration of expertise in a limited number of state actors, and virtually insurmountable barriers to entry for non-governmental entities.

In this paradigm, space was a domain reserved for a few technologically advanced powers. The United States and the Soviet Union, later joined by a limited number of European and Asian countries, held a monopoly on the ability to access and use Earth's orbit and deep space. National space agencies – NASA, Roscosmos, ESA and their counterparts – operated as the sole clients of an aerospace industry that was structurally dependent on public demand. Programmes were funded entirely from state budgets, justified by national security imperatives, geopolitical prestige or fundamental scientific advancement.

The technocratic paradigm that governed this system was based on an implicit assumption: space policies were eminently technical matters to be entrusted to engineers, physicists and the military. When involved, the social sciences performed auxiliary functions – public communication, ex post economic analysis, occasional legal reflection on international treaties – without influencing the formulation of strategies. Space governance was, in essence, governance by technical experts serving politically defined objectives but implemented according to engineering logic.

Since the 2000s, and with marked acceleration in the last decade, this structure has entered a phase of structural transformation. The preparatory document for the SPHERE Forum describes the current context as characterised by a 'plural, pervasive and complex' ecosystem, radically different from the 20th-century agency model. To interpret this transition, a systemic approach has been proposed (Del Canto Viterale, 2023) that highlights how the transition to the new space age requires analytical tools capable of capturing the interdependencies between technological, economic and institutional subsystems.

The first dimension of this transformation concerns the multiplication of actors. Alongside the historical agencies, new state actors have emerged – China, India, the United Arab Emirates, numerous regional powers – which have developed autonomous space capabilities. At the same time, the private sector has taken on an unprecedented role: commercial operators such as SpaceX, Blue Origin, Rocket Lab and a constellation of start-ups in the so-called 'New Space' sector have broken down barriers to entry, drastically reduced launch costs and introduced market-oriented business models. According to OECD

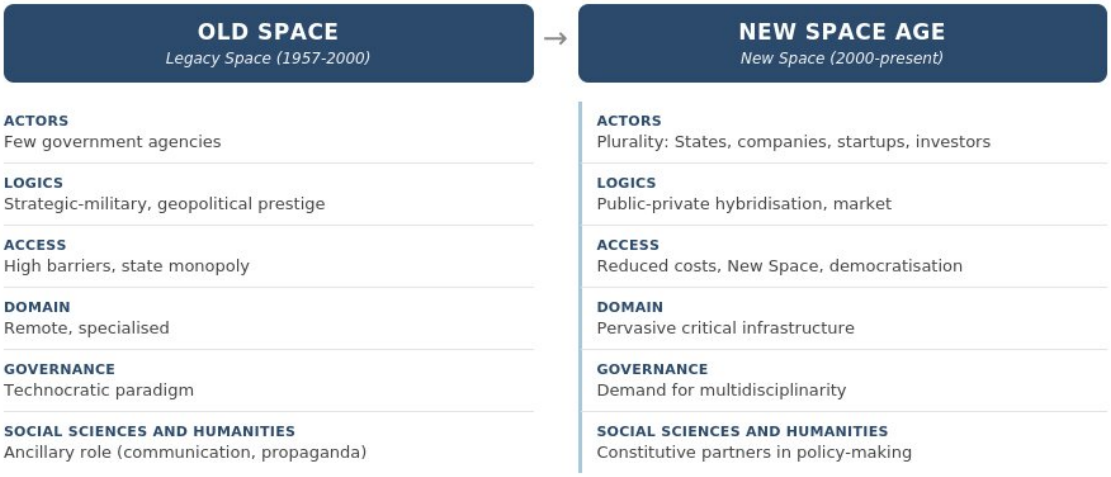
estimates (2019), the global space economy has exceeded $400 billion, with growth rates that make it one of the most dynamic sectors of the world economy.

The second dimension concerns the hybridisation of governance models. The 2011 ESPI report on public-private partnerships (PPPs) in the space sector already documented the emergence of contractual and institutional forms that went beyond the traditional state-market dichotomy. Today, this hybridisation has become the norm: space agencies operate as *anchor tenants* of commercial services, co-invest with private funds, and delegate functions once considered sovereign to commercial operators. The boundary between public and private, between national interest and profit logic, has become porous and negotiable.

The third dimension, perhaps the most relevant in terms of its social implications, concerns the pervasiveness of space infrastructure in everyday life. Telecommunications, satellite navigation, Earth observation, weather forecasting, environmental monitoring, financial services dependent on time synchronisation: space is no longer a remote domain, but a critical infrastructure on which essential functions of contemporary societies depend. The growing dependence of contemporary societies on satellite infrastructure has generated what is referred to (Finucci, 2024) as a new 'great game', in which control of orbital constellations becomes a tool for strategic projection. This interdependence generates unprecedented vulnerabilities – orbital congestion, space debris, intentional interference – and raises issues of security, equity of access and sustainability that transcend the purely technical dimension.

The transition from the 'old space' to the New Space Age is not just a change of scale or actors. It is a qualitative transformation that calls into question the adequacy of the traditional technocratic paradigm. When space was the exclusive domain of a few state agencies, decisions could be made in closed circles, based on relatively homogeneous technical expertise and strategic assessments. The proliferation of stakeholders – governments, businesses, investors, international organisations, civil society, different scientific communities – has fragmented this implicit consensus. Divergent interests, conflicting world views and different time horizons now compete in defining space priorities. At the same time, the pervasiveness of terrestrial fallout has broadened the scope of relevant issues. Space policies no longer concern only what to launch into orbit and how, but who benefits from space services and who is excluded; how to regulate competition between private operators; what rights to recognise for emerging actors; how to distribute the costs of orbital sustainability; what ethical principles to apply to the possible exploitation of extraterrestrial resources. These are questions that require socio-humanistic skills, not as an ancillary function, but as constituent components of the decision-making process.

From the 'Old Space' to the 'New Space Age'



The transition raises questions that technical expertise alone cannot address.

The growing presence of social sciences and humanities in the European space sector at this very stage of transition is no coincidence: the emergence of SSH responds to a functional demand generated by the complexity of the new ecosystem. However, this presence remains fragmented, poorly institutionalised, and lacking stable channels of dialogue with technical communities. The demand for interdisciplinarity currently exceeds the supply of structures capable of satisfying it.

The picture outlined above forms the factual basis for the thesis put forward by the SPHERE Forum. If the New Space Age is characterised by a plurality of actors, hybridisation of models and pervasive impacts, then space policies can no longer be formulated exclusively through the filter of technical and scientific expertise. An approach is needed that systematically integrates different types of knowledge, capable of evaluating policy options not only in terms of engineering feasibility, but also in terms of social desirability, regulatory legitimacy and systemic sustainability.

This need for integration is not new in substance, but it is new in form. Logsdon (2010), reconstructing Kennedy's decision on the lunar goal, had already shown how major space decisions were inherently political even when presented as technical imperatives. What was missing – and what this report proposes – is a framework that makes the integration of different skills explicit and systematic, rather than leaving it implicit or occasional.

This does not, of course, imply a devaluation of STEM skills, which remain indispensable for understanding technical constraints and possibilities. Rather, it implies the recognition that the formulation of effective public policy s requires the integration of complementary perspectives. This thesis is particularly incisively formulated in the work of Nesvold (2023), who documented the ethical challenges of space settlement – labour rights, medical ethics, environmental justice, accessibility – through systematic dialogue with experts in the humanities and social sciences. The central argument

of the volume is that 'the skills of the humanities and social sciences are necessary to support human beings in space': a conclusion that legitimises the thesis proposed here from the outside and confirms its urgency.

The next chapter will articulate this insight in an explicit analytical framework – the fourfold filter proposed by SPHERE – which translates the general principle of multidisciplinary governance into an operational tool for evaluating policy options. The transition documented here, therefore, is not only the context in which the Forum is situated: it is its raison d'être. SPHERE was created as an institutional response to a structural transformation that renders obsolete the technocratic monopoly on space policies and opens space - literally and metaphorically - to the social sciences and humanities.

3 – SPHERE'S FOURFOLD FILTER

The previous chapter documented how the transition to the New Space Age has rendered inadequate the technocratic paradigm that has governed space policies for over half a century. The proliferation of actors, the hybridisation of governance models and the pervasiveness of terrestrial repercussions raise questions that go beyond the scope of engineering and physics. However, recognising a limitation is not the same as proposing an alternative. An analytical framework needs to be developed that translates the general need for interdisciplinarity into an operational tool for evaluating policy options.

To this end, the SPHERE Forum has proposed a conceptual device called the 'quadruple filter'. The basic idea is that every policy decision relating to space should be subject to four sets of questions, corresponding to four distinct analytical dimensions: technical feasibility, social desirability, legal and ethical legitimacy, and systemic sustainability. None of these dimensions can be reduced to the others; each mobilises specific disciplinary expertise; all are necessary for a comprehensive assessment of the available options.

It is worth clarifying the epistemological nature of this tool. The quadruple filter is not a rigid decision-making grid that automatically produces the 'right answer'. Rather, it is an analytical device that makes the trade-offs between different dimensions visible, reveals latent tensions, and forces decision-makers to confront multiple criteria. In this sense, the filter does not eliminate political discretion, but informs and disciplines it, preventing complex choices from being reduced to mere assessments of technical feasibility or economic convenience.

Technical feasibility filter. The first dimension concerns what is technically possible to achieve, given existing physical, engineering and technological constraints. This filter remains indispensable: no policy can ignore an understanding of the capabilities and limitations of available technologies. The error of the technocratic paradigm is not that it has emphasised this dimension, but that it has made it absolute, treating it as not only a necessary but also a sufficient condition for policy formulation. The technical feasibility filter answers the question: what can we do?

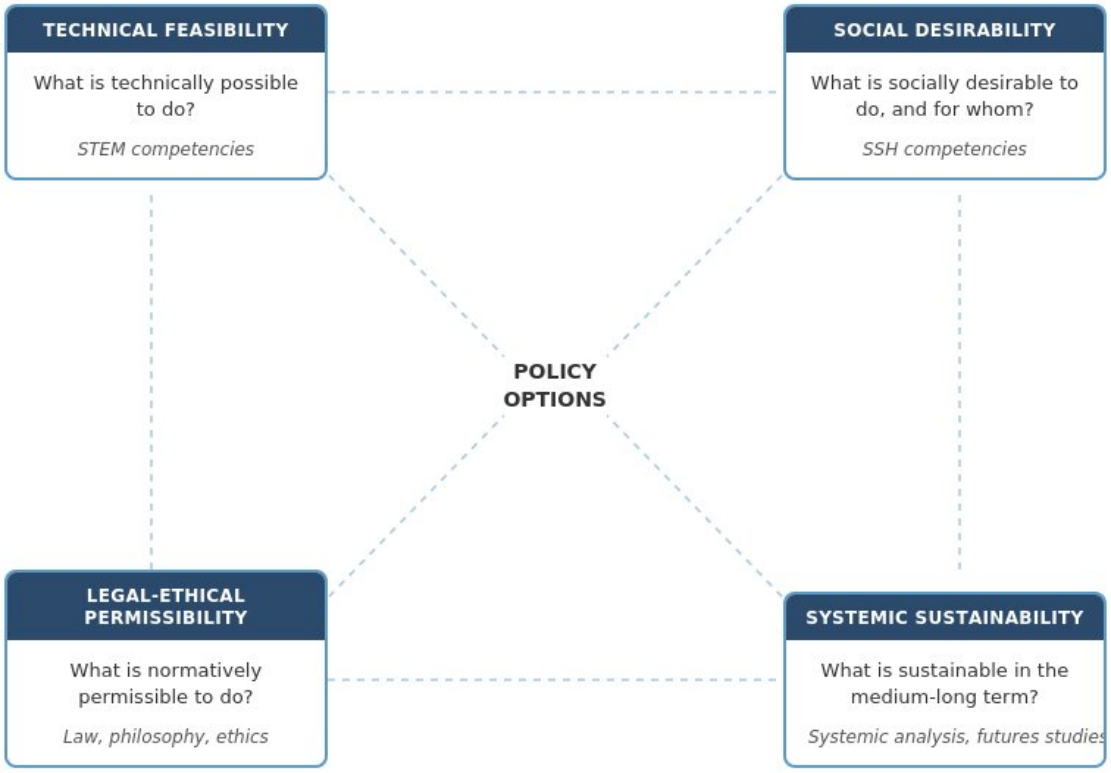
Social desirability filter. The second dimension questions what is socially desirable, beyond mere technical feasibility. Who benefits from a given policy and who bears the costs? How are risks and opportunities distributed among social groups, countries and generations? What are the public perceptions and legitimate expectations of the communities involved? This filter mobilises socio-humanistic skills; it requires analysis of distributive equity and social impact assessments. It answers the question: what do we want to do, and for whom?

Legal-ethical legitimacy filter. The third dimension concerns what is legally permissible, in the dual sense of compliance with current law and compatibility with shared ethical principles. The body of international space law – from the 1967 Outer Space Treaty to subsequent agreements – defines a perimeter of constraints and obligations that policies must respect. As documented in the Handbook of Space Law (von der Dunk and Tronchetti, 2015), this regulatory framework is, however, incomplete and contested, especially on issues such as the appropriation of extraterrestrial resources or liability for damage caused by debris. Positive law is accompanied by ethical issues that the law has not yet codified: the rights of future generations, the moral status of possible extraterrestrial life forms, and the limits of human intervention in planetary ecosystems. The filter answers the question: what are we allowed to do?

Systemic sustainability filter. The fourth dimension assesses what is sustainable in the medium to long term, considering the interdependencies between space and terrestrial systems, the finiteness of orbital resources, and the cumulative effects of human activities beyond the atmosphere. Sustainability is not understood here in an exclusively environmental sense, but in a systemic sense: it includes the ability to maintain over time the conditions that make space activities themselves possible. Orbital congestion, the proliferation of debris, and the degradation of the circumterrestrial environment are threats to the sustainability of the space system as a whole. The filter answers the question: what can we continue to do?

The four filters are interdependent and sometimes in tension. A technology may be feasible but socially undesirable; an activity may be desirable and feasible but legally controversial; a policy may pass the first three filters but be unsustainable in the long term. The quadruple filter does not resolve these tensions, but it makes them explicit, preventing them from being obscured by one-dimensional assessments.

SPHERE's quadruple filter



The filters make trade-offs explicit, informing political discretion without eliminating it

The application of the quadruple filter to concrete cases as listed below illustrates its heuristic capacity.

Mega-satellite constellations. The deployment of constellations consisting of thousands of satellites in low orbit – for global connectivity services – is technically feasible and responds to a real social demand (reducing the digital divide). However, it raises significant questions about the other filters. In terms of lawfulness, the massive occupation of frequencies and orbital slots by a few private operators potentially conflicts with the principle of equitable access to space. In terms of sustainability, the proliferation of objects in orbit increases the risk of collisions and the generation of debris, threatening the future viability of the orbital environment. A purely technical or commercial assessment does not capture these trade-offs.

Space debris and active removal**.** The active removal of space debris is technically complex but not impossible; several agencies and companies are developing operational capabilities. Social desirability is high, given the threat that debris poses to critical infrastructure. However, as has recently been highlighted (Yap, Heiberg and Truffer, 2023), debris governance constitutes a complex socio-technical regime, in which technical issues are intertwined with problems of attribution of responsibility, financing of interventions and international coordination. One study (Nassisi et al., 2020) analysed the

policy prospects for debris mitigation systems, emphasising how the absence of a binding legal regime hinders the adoption of technically available solutions. The filter of legality raises questions about the legitimacy of removing objects belonging to other states; that of sustainability requires solutions that do not generate new risks.

Exploitation of extraterrestrial resources**.** The extraction of resources from the Moon or asteroids is the subject of growing commercial and strategic interest. Although not yet proven on an industrial scale, technical feasibility is considered achievable in the medium term. Its desirability is supported by economic and geopolitical arguments. However, the legal framework is deeply uncertain: the Outer Space Treaty prohibits national appropriation of celestial bodies, but its silence on the commercial exploitation of resources has generated divergent interpretations. The principle of 'common heritage of mankind', invoked by some, is contested by others. Finally, the filter of sustainability raises intergenerational questions: what constraints should be placed on exploitation in order to preserve options for the future?

Planetary protection. Missions with potential biological impact – to celestial bodies that could harbour life forms or returning to Earth with extraterrestrial samples – illustrate the tension between scientific exploration and precaution. The technical feasibility of planetary protection measures is well established; the desirability of astrobiological research is widely recognised. The ethical filter, however, raises questions about the intrinsic value of any extraterrestrial ecosystems and the limits of human intervention.

The fourfold filter formed the conceptual backbone of the SPHERE Forum, guiding its thematic structure. Panel I, dedicated to space as a strategic domain, focused primarily on issues of feasibility and legality: technological capabilities, legal regimes, infrastructure security. Panel II, focused on the space economy, intersected feasibility, desirability and sustainability: business models, distribution of benefits, and the regulatory role of the state. Panel III, oriented towards the human and health dimensions, touched on all four filters, with particular emphasis on social desirability and the sustainability of living conditions in space.

This architecture paves the way for the articulation of the 'five cross-cutting issues' that the next chapter will present. The four-fold filter does not, in fact, exhaust the complexity of space policy making: it indicates the dimensions to be considered, but does not specify the concrete issues to which they should be applied. The five issues – multi-level governance, public-private relations, sustainability, the human dimension and training – represent the substantive agenda that the Forum has identified as a priority, and which the filters help to systematically examine.

PART II – CROSS-CUTTING ISSUES, COMPETENCES AND THE EMPIRICAL CASE

4 – THE FIVE CROSS-CUTTING ISSUES OF THE SPACE AGENDA

The fourfold filter presented in the previous chapter provides a tool for systematically examining policy options according to four analytical dimensions. However, it remains to be specified to which concrete issues this tool should be applied. The New Space Age, with its proliferation of actors, interdependencies and repercussions, generates a virtually unlimited agenda of issues. The SPHERE Forum has made a selection, identifying five cross-cutting issues that span the entire spectrum of space policies and which, by their very nature, cannot be addressed with single-discipline responses. As has been pointed out (Smith, 2021), space exploration raises social issues that require a broader dialogue than that traditionally confined to technical and engineering communities.

The term 'cross-cutting' deserves clarification. These are not five circumscribable technical dossiers, such as the Artemis programme, frequency regulation or the financing of a specific mission. Rather, they are recurring areas of tension that reappear in different contexts: in industrial policy choices as well as in diplomatic negotiations, in the design of orbital habitats as well as in the definition of sustainability standards. Whenever a concrete space policy is discussed, one or more of these tensions emerge, either explicitly or implicitly. The preparatory document for the Forum formulated them as open questions; the introductory speech presented them as the substantive agenda against which to measure the capacity of interdisciplinary dialogue to produce more robust answers than those offered by the traditional technocratic approach.

The first issue concerns the tension between national sovereignty and international cooperation. Space has historically been an arena of competition between powers, where technological capabilities and exclusive access to orbital infrastructure were indicators of status and instruments of geopolitical projection. This logic has not disappeared: the race to return to the Moon, the growing militarisation of Earth's orbit, and the protection of critical space infrastructure testify to the persistence of competitive dynamics. At the same time, the inherently transnational nature of the space domain – where debris from a Chinese satellite can strike an American asset, where frequency interference ignores borders – generates a structural demand for shared rules, operational coordination and multilateral governance. How to balance sovereignty and cooperation is a question that calls into play international law, international relations, political science, political economy, and the outer space geographies, without any of these disciplines being able to claim self-sufficient answers.

The second issue concerns equitable access to the benefits of space activities. The space economy promises global connectivity services, Earth observation for environmental monitoring and emergency management, and positioning data that enable countless terrestrial applications. However, the distribution of these benefits is uneven. The digital divide risks being replicated in the space : those who do not have the infrastructure to access satellite services remain excluded from their benefits. At the same time, the proliferation of mega-constellations raises the risk of the 'enclosure' of the most valuable

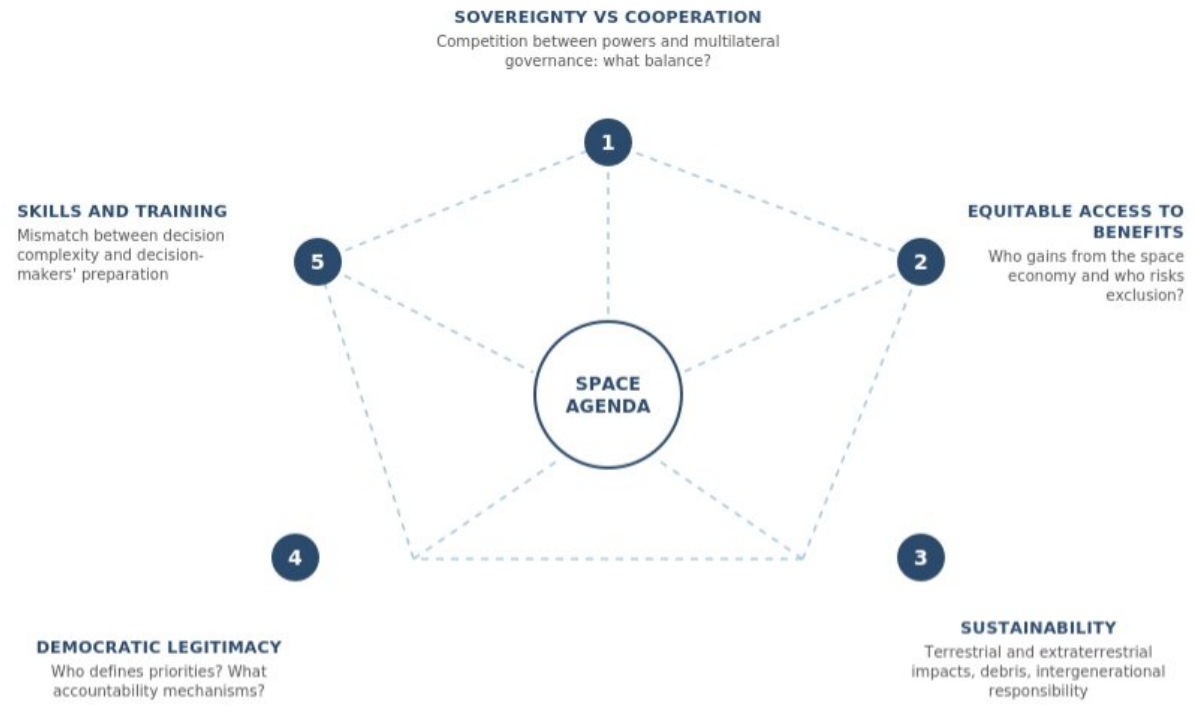
orbits by a few large operators, limiting opportunities for emerging players, countries in the global South, small businesses and scientific communities with limited resources. Analysing this tension requires economic expertise to evaluate business models and market structures, sociological expertise to understand the dynamics of inclusion and exclusion, and legal expertise to examine the regimes governing access to orbital resources.

The third issue concerns environmental sustainability, both on Earth and in outer space. On the terrestrial side, space activities generate impacts – emissions from launchers, consumption of resources for satellite production, end-of-life electronic waste – that must be assessed in the broader context of ecological transition. On the extraterrestrial side, the sustainability of the orbital environment is threatened by the proliferation of space debris and the congestion of increasingly crowded orbits. The structural tensions between capitalist models and sustainability imperatives in the space sector raise questions (McElroy, 2023) about the compatibility between profit-making and intergenerational responsibility. As discussed in the previous chapter on the quadruple filter, systemic sustainability questions the ability to preserve over time the conditions that make space activities possible. This issue mobilises engineering skills for technical mitigation solutions, but also economic skills for incentive mechanisms, legal skills for liability regimes, ethical skills for obligations towards future generations, and geographical skills for analysing the interdependencies between terrestrial and space systems.

The fourth issue concerns the democratic legitimacy and accountability of space decisions. Who defines the priorities of national and European space policies? Through what mechanisms can citizens, scientific communities and non-technical stakeholders influence choices that affect them? The traditional closure of space policy-making within restricted technocratic circles – agencies, industry, the military community – appears increasingly incompatible with the pervasiveness of the repercussions and the plurality of interests at stake. The role of multilateral bodies such as UNOOSA and COPUOS, the transparency of decision-making processes and public consultation mechanisms are becoming central issues for the legitimacy of policies. Analysis requires expertise in political science, democratic theory and organisational sociology, as well as sufficient technical understanding to assess the quality of the information on which decisions are based.

The fifth issue concerns the skills and training of space decision-makers. The complexity of the choices highlighted by the four previous issues generates a demand for professional profiles capable of navigating between different disciplines, integrating technical and social languages, and managing multidimensional trade-offs. The current training of space policy makers – predominantly engineering or, alternatively, purely legal-economic – appears inadequate for this challenge. The SPHERE Forum explicitly raised the issue of the mismatch between the complexity of decisions and the preparation of those who make them, indicating the training of hybrid profiles as a strategic priority. This issue runs through the entire report and will be developed specifically in Part II, dedicated to the map of disciplines.

The five cross-cutting issues



Each spatial policy mobilises one or more of these tensions

The five issues are not distributed exclusively among the Forum sessions but run through them with varying intensity. The tension between sovereignty and cooperation was given special attention in Panel I, dedicated to space as a strategic domain, but it re-emerged in Panel III in relation to space diplomacy and international scientific cooperation. The issue of equitable access to benefits was particularly prominent in Panel II on the space economy, where business models, the regulatory role of the state and the distribution of value generated by commercial activities were discussed. Sustainability was addressed in Panel I – with a focus on debris, infrastructure safety and orbital congestion – and Panel III, where the One Health approach and the design of sustainable habitats extended the concept beyond the purely environmental dimension. Democratic legitimacy emerged across the board whenever rules, standards and priorities were discussed, questioning who has the right to define them. Finally, the issue of skills was an implicit thread running through the entire Forum, becoming explicit in the reflections on training and the role of universities.

These five issues will form the substantive framework through which Part III of the report will examine the contributions of the three panels, identifying convergences, divergences and operational proposals. They will return in the conclusions as an open agenda against which to measure future progress. The fourfold filter tells us how to question policies; the five cross-cutting issues tell us what to question them

about. Together, they define the analytical framework that the Forum has proposed as an alternative to the traditional technocratic approach.

5 – THE SKILLS MAP FOR MULTIDISCIPLINARY GOVERNANCE

The previous chapters have outlined the context (the transition to the New Space Age), the analytical framework (the fourfold filter) and the substantive agenda (the five cross-cutting issues). One operational question remains to be addressed: what disciplinary skills are needed to translate this approach into policy-making practice? The answer cannot be generic. The call for interdisciplinarity risks remaining rhetorical if we do not specify which disciplines should engage in dialogue, on which subjects, and in what ways. The SPHERE Forum has proposed a skills map that responds to this need, articulating the landscape of knowledge relevant to space policy in a tripartite structure, complemented by cross-cutting skills.

It is worth clarifying the nature of this map. It is not an exhaustive catalogue of academic disciplines that can deal with space, nor is it a rigid taxonomy with impermeable boundaries. Rather, it is a heuristic device for thinking about the distribution of skills in space policy making, identifying areas with different degrees of institutional consolidation and different levels of familiarity with the extraterrestrial domain. The map does not prescribe hierarchies of importance but makes visible the plurality of knowledge at stake and the relationships that connect them. Its function is to guide interdisciplinary dialogue, not to replace it with a predetermined scheme.

The first area comprises the STEM disciplines that have traditionally dominated the space sector and continue to form its fundamental cognitive infrastructure. Aerospace engineering, physics, materials science, computer science, artificial intelligence: without these skills, there would be no launchers, satellites, orbital stations or exploration missions. The criticism of the technocratic approach developed in the previous chapters does not imply a devaluation of this knowledge, which remains indispensable for understanding technical constraints and possibilities. Rather, it implies the recognition that they are no longer sufficient on their own. STEM disciplines are called upon to evolve in order to engage in systematic dialogue with the social sciences and humanities, abandoning the claim to self-sufficiency that has characterised the technocratic paradigm. The engineer who designs a mega-constellation must be able to converse with the economist who analyses its market impact, the lawyer who assesses its compliance with international regimes, and the sociologist who studies its implications for equitable access.

The second area brings together the social sciences already established in their application to the space domain. Space law is probably the most structured social discipline in this field: it has reference manuals, specialised journals, recognised academic communities, a body of treaties and interpretative practices on which decades of reflection have accumulated. Alongside space law are space policy and space economy, which analyse public strategies and market dynamics in the sector, respectively. Astropolitics and strategic studies apply the tools of international relations to the extraterrestrial

domain, examining competition between powers, alliances, deterrence and critical infrastructure security. Outer Space Geographies extend the analysis of territorial configurations, flows and spatial inequalities to the orbital and planetary domain. These disciplines constitute the consolidated core of the social sciences of space: they are no longer marginal or ancillary to STEM, but have academic legitimacy, proven analytical tools and channels of communication with decision-makers.

The third area comprises socio-humanistic disciplines in the process of emergence or consolidation, whose relationship with the spatial domain is more recent and whose institutionalisation is still ongoing. Exogeography, which the SPHERE Forum has proposed as a bridge discipline, extends the geographical method in its dual physical and human dimensions to extraterrestrial spaces, offering an epistemological model for the integration of naturalistic and social knowledge. Astrosociology and astroanthropology apply the tools of the social sciences to the study of human communities in spatial contexts, mission crews, future colonies, and collective imaginaries about space. Space ethics and environmental philosophy question the normative foundations of extraterrestrial activities: the moral status of possible forms of life, obligations towards future generations, and the limits of human intervention on planetary ecosystems. Space medicine and the psychology of extreme environments, together with the One Health approach that integrates human, animal and environmental health, address the physical and mental dimensions of human presence beyond the atmosphere. Other space humanities, media studies and cultural studies applied to space analyse representations, narratives and imaginaries that shape public perception and the legitimisation of policies.

This reflection is based on the pioneering work of White (2014), who introduced the concept of *the Overview Effect* to describe the cognitive shift experienced by astronauts when viewing Earth from space. White documents how this experience – the direct perception of the planet's fragility and humanity's interconnectedness – produces profound transformations in individual consciousness and value priorities. The concept, now widely recognised in the literature, provides an empirical basis for understanding why space policies cannot ignore the existential and psychological dimensions of human experience beyond the atmosphere. Many of these disciplines are currently undergoing a phase of structuring: journals are being launched, associations are being formed, and training curricula are being defined. SPHERE aims to contribute to this process by facilitating the integration of this emerging knowledge into policy making.

These three areas are complemented by cross-cutting skills that do not belong to individual disciplines but cut across the boundaries between fields of knowledge. Futures studies offer methodologies for scenario analysis and long-term planning, which are particularly relevant for policies whose effects unfold over extended time horizons. Risk analysis provides tools for assessing the probability and consequences of adverse events, from orbital collisions to accidents during manned missions. Data science applied to public decision-making allows the enormous amounts of information generated by space systems to be processed and transformed into knowledge that can be used by decision-makers.

Science diplomacy and space diplomacy integrate scientific and diplomatic skills in the management of international relations on technologically complex issues.

The map of skills outlined here is not an end in itself. Its function is to guide the training of a new generation of space policy makers, capable of navigating between different disciplinary languages and managing the multidimensional trade-offs that the quadruple filter makes visible. This requirement is intertwined with the need to recognise and value historically invisible contributions: Ghose (2023) has documented how female scientists and astronomers have transformed physics and astronomy while often remaining in the shadows, offering a warning about the selectivity of disciplinary canons and the importance of training that includes plural perspectives. Chapter 3 identified skills and training as one of the five cross-cutting issues of the Forum, pointing out the mismatch between the complexity of decisions and the preparation of those who make them. The map responds to this diagnosis by indicating what decision-makers should be able to read, at least 'in translation': it is not required that every policy maker be simultaneously an engineer, lawyer, economist and philosopher, but that they have sufficient *literacy* to understand the contributions of each discipline and orchestrate dialogue between them.

This objective has implications for the design of training courses. Traditional curricula – engineering or legal-economic – tend to produce single-discipline specialists who are excellent in their respective fields but lack the tools for interdisciplinary dialogue. The map, on the other hand, suggests the need for hybrid profiles, trained through experiences that expose them to multiple areas of expertise. The following chapters of Part II will examine the individual disciplines, looking at the specific contribution that each can make to space policy making.

Established social disciplines applied to space. The previous paragraphs have outlined a map of competences divided into three areas, identifying a consolidated core of social sciences already structured in their application to the space domain. This paragraph explores this core in greater depth, examining the specific contribution of four disciplinary areas: space and international law, space policy and the space economy, astropolitics and strategic studies, and the outer space geographies. This is not an encyclopaedic overview, but rather a focus on the potential that these disciplines offer to the multidisciplinary governance outlined in the previous chapters – a significant potential, albeit still partially under-exploited in decision-making processes.

Space law is the most mature social discipline in its application to extraterrestrial domains. Its fundamental body of law – the Outer Space Treaty (1967), the Agreement on the Rescue of Astronauts (1968), the Liability Convention (1972), Convention on Registration (1975), Moon and Outer Space Agreement (1979) – has established principles that still provide the framework: prohibition of national appropriation, freedom of exploration for the common benefit, peaceful use, state responsibility for national operators. The Handbook of Space Law and the Cologne Commentary on Space Law are the systematic references of a well-established academic community. This internationalist corpus is now complemented by a complementary approach. Zolea (2025) has systematised the space legal landscape

from a comparative private law perspective, analysing how concepts such as property, liability and contracts find extraterrestrial application – urgent issues with the growing commercial presence. However, the regulatory framework inherited from the Cold War has obvious gaps. The regime for resource exploitation remains uncertain: the Outer Space Treaty prohibits the appropriation of celestial bodies but is silent on mining. As documented (Marchisio, 2023), national legal systems fill this gap with unilateral legislation – United States, Luxembourg, United Arab Emirates – raising questions about international consistency. Italy has filled a historical gap with Law No. 89/2025, an evolution explored in depth by Graziani & Zolea (2025). The governance of space debris lacks binding instruments, while the possibility of an agreement for Mars has been explored (Froehlich, 2021). Space law is a well-established but tense discipline.

Space policy and the space economy analyse public strategies and market dynamics in the space sector, respectively. At the European level, the first systematic attempt to define a market-oriented space policy dates back to Communication COM(96) 617, drafted by Ezio Bussoletti on behalf of Commissioner Edith Cresson (European Commission, 1996). The OECD, with its Space Forum and periodical publications such as The Space Economy in Figures, has helped to legitimise the economic analysis of space activities, documenting their growth, market structure and impact on national production systems. Space policy, for its part, studies the role of the state in its many guises: as a regulator that sets standards and authorises operators, as an investor that finances research and infrastructure, and as a partner that co-develops capabilities with the private sector through public-private partnership models. The relationship between national industrial policies and space strategies has become the subject of increasing attention: autonomy of access to space, protection of critical supply chains, and positioning in global value chains are issues in which economic and geopolitical considerations are inextricably intertwined. In the Italian context, the country's role in the space infrastructure economy highlights (Comparini, 2021) the potential of the national supply chain and the conditions for its consolidation within the European framework. The transition from the traditional agency model to the hybrid ecosystem of New Space, discussed in the first chapter, has made these analyses even more relevant, multiplying the actors to be regulated and the governance configurations to be designed.

Astropolitics and strategic studies apply the conceptual tools of international relations to the domain of space. Dolman's work, with his Astropolitik (2002), introduced into the academic debate a geopolitical reading of space that emphasises control of strategic orbital positions, deterrence dynamics, and competition between great powers for dominance of a new high ground. The geopolitical dimension of space exploration has been systematically examined (Spagnulo, 2022; Doboš, 2023), analysing possible power configurations in the solar system and intern n the light of competitive dynamics on Earth. The growing militarisation of orbit, the creation of dedicated space commands in the armed forces of numerous countries, and the development of anti-satellite capabilities have made these studies increasingly relevant to decision-makers. At the same time, the strategic dimension of space is not limited to military competition: it includes development policies, access to technologies, and the distribution of benefits among countries with different levels of capability.

A radically critical position has been articulated by Deudney (2020), who has subjected the premises of space expansionism to systematic scrutiny through the lens of geopolitical theory. Deudney argues that human expansion into space, far from reducing the existential risks to terrestrial civilisation, could increase them: interplanetary anarchy would encourage total conflict, asteroid deflection technology would make possible 'planetary bombs' of incomparably greater power than nuclear arsenals, and the biological diversification of humanity into multiple species would fuel interplanetary wars. The concept of 'astrocide' – the extinction of humanity as a consequence of space expansion – directly challenges the assumption that colonisation guarantees the survival of the species. Regardless of one's opinion on his conclusions, Deudney's work demonstrates that space geopolitics requires serious consideration of systemic risk scenarios that are too often ignored by the dominant discourse.

The outer space geographies extend to the extraterrestrial domain concepts developed for the analysis of terrestrial territorial systems. Territory, boundary, resource, scale, flow: these categories, central to the geographical tradition, find application in the examination of orbits as contested spaces, Lagrangian points as strategic positions, and celestial bodies as potential sites for extraction and settlement. Geography also offers tools for thinking about extraterrestrial space in analogy with other global commons – the open sea, Antarctica, the Arctic – whose governance has required international regimes capable of balancing freedom of access, sovereignty and sustainability. These analogies are not perfect: space has specific physical and legal characteristics. A systematic review (Dunnett et al., 2017) of the 'geographies of outer space' has documented the emergence of a field of research that applies geographical concepts – territory, scale, network, boundary – to the orbital and planetary domain and identified opportunities for development that are still largely unexplored. The growing public relevance of these issues is also evidenced by widely disseminated popular works, such as that of Marshall (2023), who extended the geographical and geopolitical approach already applied to terrestrial contexts to the spatial domain.

These four disciplinary areas do not operate in isolation. A decision on space debris mitigation, for example, is simultaneously a legal issue (who is responsible, what obligations are imposed on operators), an economic issue (who bears the costs, what incentives to structure), a geopolitical issue (how to distribute the burden between established space powers and emerging players), and a geographical issue (how to manage the scarcity of valuable orbits, how to avoid *enclosure* dynamics). Similarly, the regulation of mega-constellations requires legal expertise to define authorisation and liability regimes, economic expertise to assess market impacts and business models, strategic expertise to understand security and dependency implications, and geographical expertise to analyse the spatial distribution of benefits and risks.

The potential of these disciplines for policy making is therefore significant, but still partially underutilised. Decision-making processes tend to involve legal and economic expertise at advanced stages, when technical options have already been defined, rather than integrating them from the outset in the formulation of strategies. Strategic studies inform military and security decision-makers, but

engage less systematically with communities concerned with development, sustainability and equity. Space geography remains an academic niche rather than an operational resource for policy makers. The SPHERE Forum has sought to highlight this gap by proposing multidisciplinary governance in which the established social sciences are not late consultants but constitutive partners in the decision-making process.

The next chapter will complete the picture by examining emerging social and humanistic disciplines – from exogeography to space ethics, from astrosociology to other space humanities – which are further expanding the scope of knowledge relevant to space policy, with varying degrees of institutionalisation but with significant potential for addressing the cross-cutting issues identified in the fourth chapter.

Emerging socio-humanistic disciplines. The previous paragraph examined the established core of social sciences applied to space: law, economics, politics, strategic studies, geography. These disciplines have structured communities, reference manuals, specialised journals and recognised academic legitimacy. This paragraph moves towards a less defined but no less relevant frontier: the social sciences and humanities that are beginning to structure themselves around the domain of space, with varying degrees of institutionalisation and often fragmented bibliographies. These are not cultural embellishments to be added after the fact to technical decisions that have already been made, but potentially structural components of a mature spatial governance capable of addressing the cross-cutting issues identified in the previous chapters.

Exogeography, a discipline with recent epistemological developments, occupies a special position in this landscape. In Italy, Casagrande (2021) laid the foundations for a geographical reflection on extraterrestrial spaces, identifying the challenges that exogeography must face in the face of human presence and activities outside Earth. The SPHERE Forum has proposed it as a bridging discipline, capable of connecting naturalistic and social knowledge in the analysis of extraterrestrial territories. The underlying intuition is that academic geography—unique among traditional disciplines—systematically integrates the physical and human dimensions, studying the interactions between natural environments, social organisations, regulatory regimes, economic practices, and symbolic representations. Extending this two-sided method to spaces beyond the atmosphere means applying the same analytical categories – territory, border, resource, scale, flow – that geography has developed for terrestrial systems to orbits, lunar and Martian surfaces, and Lagrangian points, adapting them to the physical and legal specificities of the extraterrestrial domain.

However, exogeography is not limited to a mechanical extension of pre-existing concepts. It proposes a model for analysing the successive phases of human expansion into space: initial exploration, establishment of temporary outposts, progressive territorialisation with permanent infrastructure, and eventual colonisation. In each phase, physical constraints, legal regimes, socio-economic practices and collective imaginaries interact in specific configurations that require integrated analytical tools. The discipline is still in the process of being structured: canonical references are currently limited to materials produced by SPHERE - preparatory documents, educational programmes, contributions in

preparation - and a small number of pioneering works. Giordano (2025a) proposed the concept of 'orbital thresholds' to analyse the geopolitical evolution of the upper boundary, applying geographical categories to the stratification of orbits and the dynamics of territorialisation of circumterrestrial space. Casagrande (2025) has developed a reflection on the possible geographical perspectives for the beginning of human expansion into space, proposing a conceptual framework for 'looking outside the cradle' of Earth. In a complementary perspective, Giordano (2025b) initiated a reflection on 'demographic exogeography', exploring the implications of migration, settlement and human life beyond Earth through the lens of population geography. This emergency does not diminish its heuristic potential, but it does require caution in distinguishing between what is already established and what constitutes a development agenda.

Alongside exogeography, astrosociology and astroanthropology apply the tools of social sciences to the study of human communities in spatial contexts. The work of Pass (2006) and the Journal of Astrosociology represent attempts to establish a recognisable, albeit still small, academic community. Smith (2019) proposed a systematisation of the 'principles of spatial anthropology', laying the foundations for a science of human settlement in space that integrates biological, cultural and social perspectives. The subjects of investigation include the social organisation of crews on long-term missions, intercultural dynamics in multinational habitats, identity formation processes in isolated environments, and the collective imaginaries that guide expectations and behaviours. The design of space habitats and habitability conditions have been systematically analysed by Häuplik-Meusburger and Bishop (2021), who have integrated architectural, psychological and sociological perspectives. From a more design-oriented perspective, McGuirk, Nahum and Watson (2019) explored the role of design in the collective endeavour of travelling to and inhabiting Mars, documenting solutions for clothing, furnishings, utensils and habitats through prototypes and concepts that translate the imagery of extraterrestrial settlement into concrete forms.

These disciplines question what it means to live, work and build social relationships in conditions radically different from those on Earth, with reduced or absent gravity, prolonged isolation and total dependence on artificial life support systems. The answers are not purely technical: they concern the design of living spaces, the selection and training of crews, the prevention of conflicts and the construction of shared norms. A critical reflection on the ambitions of space colonisation is offered by Weinersmith and Weinersmith (2023), who question the feasibility and desirability of extraterrestrial settlements with a popular but rigorous approach. Although still fragmentary, these research offers resources for policy making relating to orbital stations, lunar bases and possible Martian settlements. Space archaeology is a paradigmatic example of the extension of SSH methodology to the extraterrestrial domain. This emerging discipline studies the material culture of space activities – from the Apollo moon landing sites, now the subject of heritage protection proposals, to orbital debris interpreted as cultural artefacts. Alice Gorman (2019) has systematised the field, demonstrating how archaeology can contribute to the governance of space heritage.

Space ethics and environmental philosophy extended to the extraterrestrial domain raise normative questions that the current legal framework does not address or addresses only partially. What obligations does humanity have towards planetary environments that may harbour life forms, present or past? How can scientific interest in exploration be balanced with the precautionary principle? What rights should future generations be granted in terms of access to extraterrestrial resources that we may exhaust or degrade? How should responsibilities and benefits be distributed among actors with radically asymmetrical technological and economic capabilities? The work of Impey and colleagues (2013), as well as more recent contributions by Chon-Torres (2020) on the ethics of astrobiology, explore these issues using philosophical tools, without claiming to provide definitive answers but structuring the field of legitimate questions. Green (2021) offered a systematic treatment of space ethics, articulating the normative principles that should guide human activities beyond Earth's atmosphere. Impey (2023) extended the reflection to the habitability of exoplanets and the future of humanity, integrating scientific and philosophical perspectives. Nesvold (2023) explored the ethical issues and dilemmas posed by life in space, offering an accessible but philosophically informed reflection on the normative challenges of human expansion. The volume edited by Garasic and Di Paola (2024) brings together contributions on the philosophy of outer space, exploring controversies and speculations that cross the boundaries between ethics, metaphysics and political philosophy. The SPHERE Forum recognised space ethics as a necessary component of the fourfold filter: the criterion of lawfulness is not limited to compliance with positive law but includes compatibility with ethical principles that the law has not yet codified.

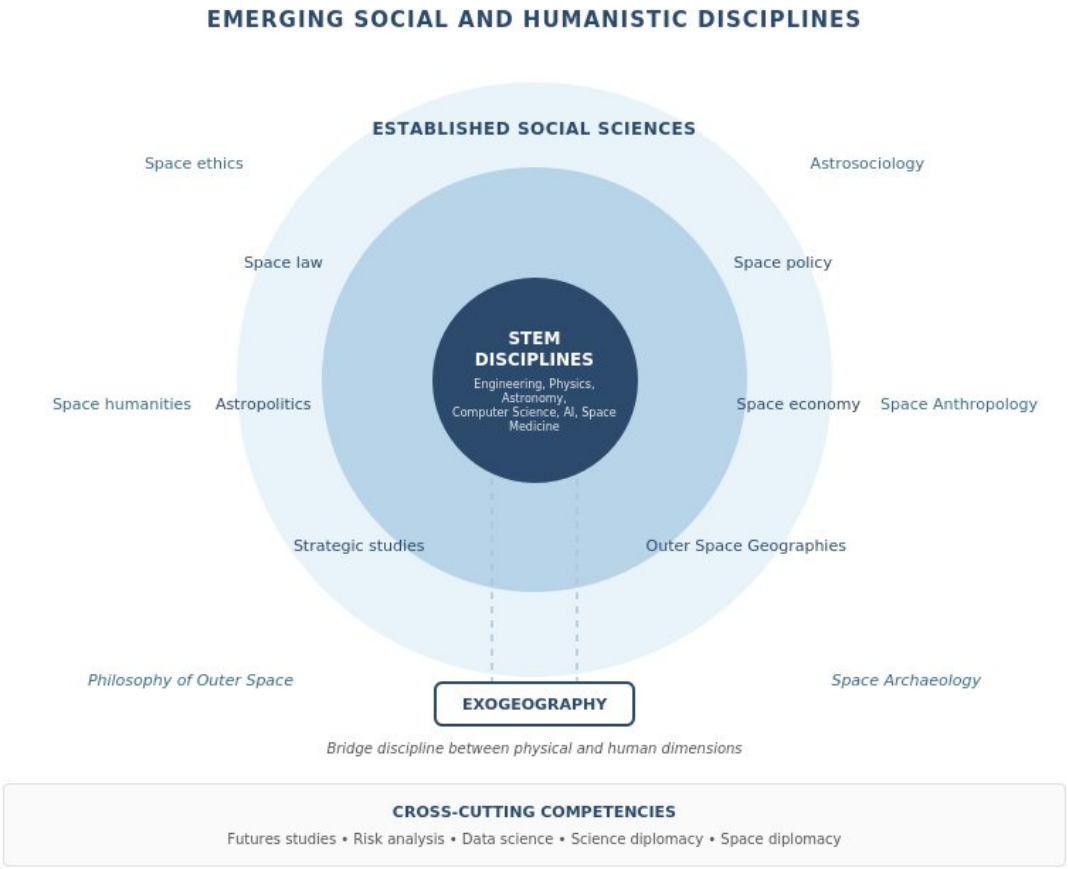
The field of human factors in space, which encompasses various disciplines such as bioastronautics, space agriculture, the psychology of extreme environments, and the physiology of space flight, is an area with well-established roots but undergoing significant conceptual expansion. The work of Krittanawong et al. (2023) documents the emergence of integrated approaches that go beyond the traditional focus on microgravity pathologies to embrace a systemic view of health in space environments. Szocik (2020) edited a volume dedicated to human enhancement for space missions, exploring the ethical and practical implications of the biological and technological modifications necessary for survival in extraterrestrial environments. Cinelli (2023) has documented, thanks in part to 'analogue explorations' (conducted in extreme terrestrial environments), how space operations are a driver of innovation for terrestrial healthcare, highlighting the potential for technology transfer from space medicine to conventional healthcare systems. The extension of the One Health paradigm – which integrates human, animal and environmental health on Earth – to the extraterrestrial domain is an emerging agenda, not yet consolidated in operational protocols but conceptually promising in terms of h . In closed habitats, where every biological component interacts with others and with artificial life support systems, the separation between individual health and ecosystem health becomes unsustainable. Panel III of the Forum devoted significant attention to this perspective, recognising its implications for the design of long-duration missions and for the health governance of future space communities.

Space humanities, media studies and cultural studies applied to space analyse the representations, narratives and artistic productions that shape the public perception of the extraterrestrial domain. Froehlich (2019) has documented how space and popular culture intersect through cinema, music, art, video games, comics, and advertising, showing that the use of space themes varies significantly across different cultural contexts and can convey social commentary on politically sensitive issues. Initiatives such as KOSMICA and dedicated sections in the Routledge Handbook of the Social Studies of Outer Space (Salazar and Gorman, 2023) testify to a growing interest in this dimension. The underlying assumption is that space policies are not formed in a vacuum: they are influenced by collective imaginaries sedimented through decades of literary and cinematic science fiction, institutional communication, scientific dissemination, and contemporary art. The fears, hopes, and expectations of the public condition the legitimacy of policies, the willingness to fund expensive programmes, and the acceptance of risks.

From a more explicitly critical perspective, Boucher et al. (2024) have questioned how terrestrial power structures – of gender, class, ability – are already being projected into extraterrestrial space, proposing feminism as an analytical lens for imagining alternative and more equitable futures. The volume, which brings together reflections, artistic works, and interviews with scientists and astronauts, exemplifies the potential of space humanities to make implicit assumptions visible and to call for governance that is more aware of its cultural premises. Understanding how these imaginaries are formed and transformed is therefore relevant for those who need to build consensus around long-term strategic choices. The ability to translate cosmological complexity into narratives accessible to the general public is demonstrated by works such as those of Vaudo Scarpetta (2023), who has been able to communicate the conceptual revolutions in physics and astronomy with rigour and literary charm, helping to build a widespread space culture.

The common feature of these disciplines is their emergency status: academic communities that are still small, bibliographies that are still being compiled, and initiatives that are often episodic and poorly coordinated. This fragmentation does not invalidate their potential contribution, but it does require structuring work to transform isolated insights into systematic resources for policy making. SPHERE aims to contribute to this process by offering an institutional platform that gives continuity to otherwise scattered research, facilitates dialogue between scholars from different disciplinary backgrounds, and connects theoretical reflection with the operational needs of decision-makers.

Map of disciplinary skills



Part II of the report thus concludes with an overview of competences that goes beyond the established core of the social sciences: multidisciplinary governance of space requires openness towards this socio-humanistic frontier, recognising that the cross-cutting issues identified in Chapter IV – sovereignty and cooperation, equity, sustainability, legitimacy, training – cannot be addressed without the conceptual tools that these disciplines, albeit incomplete, are developing. Part III will show how the Forum panels have already begun to mobilise some of these resources.

6 – FROM THEORETICAL FRAMEWORK TO EMPIRICAL CASE

The first two parts of this report have constructed a conceptual framework for multidisciplinary space governance. The transition from the 'old space' to the New Space Age has highlighted the limitations of the traditional technocratic approach. The fourfold filter has proposed a tool for systematically questioning policy options according to criteria of feasibility, desirability, lawfulness and sustainability. The need for this multidimensional approach is confirmed in the recent analysis by Weinersmith and Weinersmith (2023), who subjected expansionist visions to systematic scrutiny by integrating biology, law, economics, psychology and sociology. The authors – winners of the Royal Society Trivedi Science Book Prize – document how many challenges of space settlement (from human reproduction in microgravity to labour rights in colonies) have been systematically ignored by the dominant discourse,

which focuses solely on technological feasibility. Their chapter 'There's No Labour Pool on Mars' anticipates many of the issues that the fourfold filter proposed in this report allows us to identify.

The five cross-cutting issues identified recurring areas of tension that run through the contemporary space agenda. The skills map articulated the landscape of relevant knowledge, distinguishing between STEM disciplines, established social sciences and emerging socio-humanistic disciplines. It remains to be seen how this theoretical apparatus has been translated into practice: the 1st SPHERE Space Policy Forum was not conceived as a mechanical application of an abstract scheme, but as a laboratory in which to test the capacity of interdisciplinary dialogue to produce more robust analyses and more informed proposals.

The structure of the Forum – three thematic panels – reflects design choices that embody the framework developed in the previous chapters. The tripartite division is neither random nor purely organisational: each panel was constructed to address a specific segment of the space agenda, mobilising different combinations of analytical filters, cross-cutting issues and disciplinary expertise.

Panel I, dedicated to space as a strategic domain, focused on issues of governance, security and regulation of orbital infrastructure. In terms of the fourfold filter, this session mainly intersected technical feasibility – operational capabilities, system vulnerabilities, engineering solutions for risk mitigation – with legal legitimacy – regulatory regimes, international responsibility, gaps in existing law – and systemic sustainability – debris, orbital congestion, preservation of the circumterrestrial environment. Among the five cross-cutting issues, Panel I focused particularly on the tension between sovereignty and cooperation, but also on environmental sustainability and, implicitly, the legitimacy of decision-making processes in the field of space security. In terms of expertise, the session mainly drew on established social sciences – space law, strategic studies, international relations – in dialogue with STEM expertise relating to orbital infrastructure and systems.

Panel II, which focused on the space economy and innovation policies, shifted the focus to market dynamics, the role of the state, and economic governance models in the sector. The fourfold filter was applied with varying emphasis: technical feasibility as a prerequisite for commercial opportunities, social desirability as a criterion for assessing the distribution of benefits, and sustainability as a constraint for business models that do not compromise future operating conditions. The most relevant cross-cutting issues were equitable access to benefits – who gains from the space economy and who risks being excluded from it – and the relationship between market logic and public responsibility. The skills called upon included economics, policy analysis, and innovation management, alongside legal expertise on regulation and geographical expertise on the spatial distribution of production chains.

Panel III, focused on exogeography, space medicine and the ethics of human expansion, addressed the more forward-looking dimension of the space agenda: what it means for humanity to live, work and build communities beyond Earth. All four filters were examined, with particular emphasis on desirability – what forms of social life we want to project into space – and ethical legitimacy – what

obligations we have towards extraterrestrial environments, future generations and possible forms of life (Joseph, 2024). Cross-cutting issues included sustainability extended to the closed ecosystems of space habitats, the legitimacy of choices that will commit humanity to multigenerational horizons, and the development of skills for challenges that are still largely unknown. On a disciplinary level, Panel III provided the greatest visibility for emerging socio-humanistic disciplines – exogeography, space ethics, integrated medicine, the One Health approach – while also engaging in dialogue with the life sciences and engineering expertise on habitat design.

The sequence of the three panels was not arbitrary but followed a dual logic of progression. Spatially, the path led from Earth's orbit – where critical infrastructure, debris and the most immediate safety issues are concentrated – to planetary surfaces and long-term settlement scenarios. Conceptually, the sequence moved from problems that are already partially institutionalised (there are treaties, agencies, markets, liability regimes) to issues that are still largely open, for which there are no established regulatory frameworks or even shared languages. This progression reflects an interpretative choice made by SPHERE: multidisciplinary governance cannot be limited to managing the existing situation but must anticipate challenges that will arise with greater urgency in the coming decades. Panel I addressed the 'here and now' of space policies, which already require operational decisions. Panel II explored the ongoing structuring of the space economy, a rapidly evolving process but one whose trajectory can still be modified. Panel III opened windows onto possible futures, scenarios that seem remote today but will require advance preparation if humanity is to face them with awareness.

The Forum was designed not as a succession of single-discipline presentations, but as an opportunity to bring together different languages. In each panel, the composition of the speakers intentionally brought together diverse profiles: lawyers and engineers, economists and doctors, strategists and philosophers, institutional representatives and academic scholars. This choice reflects the conviction, made explicit in the preparatory document, that multidisciplinary governance is not achieved by adding up separate contributions, but by creating opportunities for discussion in which differences in perspective become visible and, possibly, productive.

Part III of this report analyses the content that emerged from the three panels, comparing it with the hypotheses and questions formulated in the preparatory document for the Forum and reading it through the lens of the theoretical framework constructed in the previous parts. The aim is not to provide a chronicle of the interventions, but rather an analytical reading that uses the Forum as a case study to question the practicability of multidisciplinary governance, verifying where interdisciplinary dialogue has worked, where it has encountered obstacles and where it has opened up avenues that deserve further exploration.

PART III – THE FORUM PANELS

7 – PANEL I: SPACE AS A STRATEGIC DOMAIN

Panel I first discussed the recognition of space as a multidimensional strategic domain, far from the idea of a neutral or merely technical environment. The interventions showed how space today is traversed by dynamics ranging from political management to security, from economic competition to sovereignty, configuring it as an eminently political sphere.

The crisis in the current international regulatory framework was repeatedly mentioned, in particular the inadequacy of the 1967 Outer Space Treaty in a scenario marked by multipolarism, public-private hybridisation, the rise of non-state actors and growing strategic competition. In this context, the competitive management of space also requires specific regulations on the control of foreign investment. Another common theme was the growing interdependence between space and critical terrestrial infrastructure, which makes space essential for national security, defence, cybersecurity and the continuity of essential services.

The debate highlighted the need to strengthen space governance, moving beyond a purely technical vision and recognising the political and strategic nature of space activities. In this perspective, the urgency of developing regulatory instruments capable of governing competition over a collective good was emphasised, limiting inequitable access and controlling foreign investment in sensitive sectors.

It was also highlighted that collaboration between public institutions and private actors, at national and European level, is an essential condition, as no single entity is capable of facing the challenges of the New Space Age alone. Another proposal concerns the adoption of a more realistic and strategic approach by the state, particularly in defence and security, recognising space as an operational domain in a multi-domain logic and accelerating national projection in global competition. In terms of cybersecurity, a structured vision based on three pillars – governance, ecosystem and capabilities – was put forward to ensure the resilience of the space system.

There was broad consensus on the idea that space and its applications can no longer be governed by the regulatory and political frameworks of the past. The speakers agreed on the need for a clear strategic vision that integrates security, technology, governance and international cooperation. There was also agreement on the importance of enhancing national expertise by projecting it at European and global level, in order to avoid loss of technological sovereignty and decision-making capacity. There was also recognition of the central role of cyber security as an enabler of space governance and as a point of connection between space and terrestrial infrastructures.

Among the open issues, the panel discussed the appropriate degree of state intervention: whether it should be limited to creating favourable regulatory frameworks or take a more active and direct role in guiding the development of the space sector. Another topic of debate concerned the management of international competition between state actors, oscillating between the need for cooperation on a

collective good and the growing pressure of national interest logic. The question also remains open as to how to balance the entry and growing weight of private actors with the need to maintain effective public control over defence, security and global governance.

Some speakers emphasised that the main risk is not only that of missing opportunities, but of undergoing a veritable technological colonisation: falling behind in the New Space Age would mean depending on standards set by others, giving up critical autonomy in the cyber and defence fields, and seeing the country's negotiating power in international forums reduced, with repercussions also on future opportunities for new generations.

Among the expressions that summarised the spirit of Panel I were: 'Space is not a neutral environment, but a multidimensional strategic domain'; 'We are experiencing a legal vacuum in which private individuals are moving faster than states'; 'In space competition, the real cost is not only that of moving forward, but above all that of falling behind'; "Either you're at the table, or you're on the menu."

8 - PANEL II – SPACE ECONOMY, INNOVATION AND PUBLIC POLICY

Panel II reconstructed the space economy as a structurally political and strategic sector, in which innovation is seen not only as technological acceleration, but as a transformation of systems, value chains and power relations; it follows that public policies cannot limit themselves to "chasing" the market, but must deal with rapid, complex and multidimensional change, which requires strategic analysis and long-term vision.

In this context, a lexicon has emerged that links development and competitiveness to risk management, with a growing focus on the economic and environmental sustainability of space activities, and which includes security in a broad sense: protection of critical infrastructure, reliability of supply chains, continuity of space services as enabling conditions for any credible industrial trajectory.

A second core theme concerned the role of public investment as a fundamental lever not only for acquiring capabilities and systems, but also for supporting a competitive ecosystem through the purchase of services – explicitly including launch services – placing the public sector within, and not on the margins of, the market architecture.

In terms of skills, the discussion highlighted the crisis in vertical training models: the transformation of the space economy requires profiles capable of integrating technical, economic, regulatory, geopolitical and security dimensions, particularly in public administration, where there is a lack of figures capable of moving quickly between interlocutors and decision-making processes. It was pointed out that threats such as cyber warfare are already a reality and not part of a hypothetical ' ' future; for this reason, continuous training and skills updating, especially in public administration, were described as conditions for national security, not as ancillary elements of space economy policies.

Finally, the panel emphasised that technology 'follows' vision: building the future of space is also a narrative and cultural exercise, in which the decisive question is not only which technologies to develop, but what future we intend to build through them, drawing on the European humanistic tradition and the value of open data and accessible information as the basis for a shared consciousness.

On an operational level, the proposals converged on a redefinition of the public role capable of making government action compatible with the pace of innovation, adopting a more secure and multidisciplinary approach focused on risk management. This involves integrating sustainability, resilience and infrastructure protection from the outset, avoiding these elements being treated as afterthoughts, and using public investment to support capabilities and services in order to strengthen the stability and competitiveness of the ecosystem.

There has been a strong demand for a public administration capable of 'delivering': faster processes, greater flexibility and responsiveness to new needs are considered necessary conditions for keeping pace with structurally faster private actors, without sacrificing control and reliability but realigning administrative tools and timescales with changes in the sector. In this perspective, a real change in administrative philosophy has been called for: the public administration must learn to operate with a focus on delivery and speed, ensuring faster and more flexible processes without sacrificing control and reliability, so as not to become the weak link in value chains that include critical infrastructure and essential services, such as launch services.

On the industrial side, it was proposed to recognise the real heterogeneity of the ecosystem, avoiding indistinct policies that do not differentiate between large companies and start-ups and that risk penalising the most dynamic players. At the same time, emphasis was placed on a problem-oriented and responsible business approach, capable of producing robust solutions in complex and high-risk environments through international teams and varied skills (engineering, business, sustainability, security, regulation, service design).

Finally, in order to make growth sustainable, the need for more readable economic conditions – clear, stable, transparent prices – was highlighted as a prerequisite for planning investments and scaling services, inviting the government not to reduce itself to the role of a mere customer, but to act as a partner that creates conditions and infrastructure for a robust and undistorted market.

The main consensus was on the idea that the space economy requires a paradigm shift: a sectoral approach is no longer sufficient, but an integrated vision is needed that combines competitiveness, security, sustainability and risk management capabilities. Within this framework, there was broad agreement on the centrality of human capital, understood not only as a set of technical skills, but as a critical and transversal capacity, oriented towards the 'big picture' and able to operate in fragmented contexts. A specific Italian vulnerability linked to the ageing of the workforce and brain drain was also highlighted, with the additional constraint that, for reasons of national security, some skills cannot be replaced by importing them from abroad and must therefore be trained and retained within the country.

At the application level, the question of the intensity and form of public intervention remains open: while there is agreement on the need for an enabling role for the state, the panel highlighted the tension between the need to accelerate and make administrative action more effective and the need to preserve adequate levels of control, compliance and reliability in a highly sensitive strategic domain. A further issue concerns the design of policies that support innovation without having a regressive effect on the ecosystem, for example by crushing the most fragile entities with instruments implicitly calibrated to the major players.

Among the phrases that summarised the orientation of Panel II, the following stand out: 'Public policies must start from a full awareness of the rapid, complex and multidimensional change taking place in the space sector'; 'The public administration must be able to respond to new needs more quickly, with greater flexibility and more efficient processes'; "The fundamental question is not only what technologies we want to develop, but what future we intend to build through them."

9 - Panel III - The future of humanity beyond Earth: exogeography and policies for the new era

Panel III interpreted human expansion into space as a profound transformation of the relationship between humanity and extraterrestrial environments, which cannot be reduced to the technical dimension of exploration alone. In this context, exogeography was defined as the continuity of terrestrial geography applied to habitable celestial bodies, useful for interpreting phases and forms of human presence – from exploration to outposts to territorialisation understood as lasting interactions between settlements and infrastructure rather than stable permanence based on the terrestrial model, thus shifting the focus from 'if' to 'how' to design continuous and sustainable interactions in hostile environments.

A second thematic area concerned space medicine, understood as an integrated field in which physical and mental survival depends on the balance of the entire artificial ecosystem that makes life possible. in this perspective, the extension of the One Health philosophy to space was proposed, emphasising that care for the environment and management of systems are conditions for human presence, while there is still a lack of a consolidated ethical dimension, with protocols often lagging behind social, cultural and political impacts.

In this context, some speakers emphasised the role of astronauts not only as technical operators, but also as narrative and diplomatic bridges between the scientific community, institutions and citizens: their experience in space habitats becomes a vehicle for translating complex challenges into understandable stories and for fostering a more mature public culture of space. A third axis intertwined diplomacy, governance and private sector involvement, reaffirming space as a heritage of humanity but in a context of weak regulation and strained diplomacy, where private actors are increasingly influential: here, the figure of the 'space diplomat' emerged as a mediator between states, institutions and private operators.

Finally, the panel introduced an explicitly philosophical and strategic framework: space missions make once abstract issues concrete and impose decisions on the meaning, legitimacy and impact of human actions. The motivations for expansion were interpreted as a combination of different impulses (fear, honour, interest, ideational dimension), which brought us back to the fundamental issue: it is not enough to ask 'how' to expand, but 'why' to do so, with what rules, benefits and responsibilities, warning against the risk of extreme trajectories between a 'Wild West' scenario without common governance and a duopoly of a few dominant powers.

The proposals put forward focused on the need to anticipate, rather than chase, the regulatory and ethical dimensions of human presence in space. This implies designing models of interaction and settlement that are sustainable by definition, incorporating environmental, logistical and social constraints from the outset and recognising exogeography as a tool for integrating technical, scientific and social knowledge, to avoid the 'disciplinary siloing' that reduces the ability to understand the complexity of deep space.

At the same time, the panel proposed viewing space medicine as a platform for operational governance: if survival depends on the balance of the artificial ecosystem, then protocols, medical cooperation and shared standards become structural elements of human presence and its legitimacy. Linked to this vision is the idea of the astronaut as a diplomatic figure, a bridge between citizens and institutions, capable of transforming the space experience into public value, including through the reuse on Earth of knowledge gained in extreme environments.

On a political level, a proposal has been put forward to recognise that the absence or weakness of governance is not simply a void to be filled, but a factor that directly influences the trajectory of the sector: without common rules, competition tends to polarise, producing unbalanced outcomes. This leads to the need to strengthen the role of diplomacy and mediation between the public and private sectors, including through specific figures and skills capable of operating between strategic interests, legitimacy and sustainability.

The most obvious consensus concerned the need to view human expansion as a process with high political, regulatory and ethical density, and not as a mere technological projection. Two ideas converge in this approach: the centrality of multidisciplinary models – exogeography and integrated training – to understand and govern complexity, and the awareness that, without frameworks for cooperation and robust protocols, *deep space* amplifies vulnerabilities and risks, making a structured reflection on sustainability, legitimacy and the distribution of benefits inevitable.

Among the open issues is the balance between visions and interests, i.e. between the strategic and economic drive towards space and the construction of shared governance capable of preventing predatory or overly concentrated outcomes. The panel also highlighted the tension between the speed with which science and technology evolve and the slower pace at which ethical protocols and appropriate social frameworks are consolidated, identifying this gap as the place where operational

practices that are not fully governed can form. A further problematic element concerns the projection of terrestrial logic into space: if tensions on Earth are not managed cooperatively, it seems unrealistic to expect that space – which tends to amplify them – can be governed with greater maturity without a qualitative leap in skills and common vision.

Among the phrases that summarised the Panel III debate were: 'Stable permanence as on Earth is not necessary, but it is essential to plan for continuous and sustainable interactions'; 'Space must be considered a heritage of all humanity'; 'The question is not only whether borders make sense, but whether we are ready to bring a more mature vision to them'.

Panel Matrix vs Quadruple Filter



Each panel went through all the filters with varying intensity, confirming the usefulness of the analytical tool.

CONCLUSIONS

This report has examined the contemporary space agenda with a specific objective: to show that space governance today requires a different approach from that which dominated the first sixty years of the space age. The transition from the 'old space' – agency-based, technocratic, dominated by a few powers – to the new space age – plural, hybrid, pervasive in its terrestrial repercussions – raises questions that technical expertise alone cannot satisfactorily address. The fourfold filter proposed by SPHERE – feasibility, desirability, lawfulness, sustainability – offers a tool for making visible the trade-offs implicit in every policy choice, forcing us to confront criteria that go beyond the engineering dimension. The five cross-cutting issues – sovereignty and cooperation, equitable access to benefits, environmental and systemic sustainability, democratic legitimacy, skills and training – constitute the substantive agenda to which this tool can be applied. The map of disciplinary skills outlined in the report – STEM, established social sciences, emerging socio-humanistic disciplines – indicates which areas of knowledge need to engage in dialogue in order to produce more robust and informed policies.

The 1st SPHERE Space Policy Forum provided the laboratory in which this framework was tested. The three panels addressed the strategic, economic and human dimensions of space policies, mobilising diverse expertise and highlighting the convergences and divergences documented in the previous chapters. In particular, the discussions highlighted three fundamental convergences: the centrality of governance as a cross-cutting issue (from orbital security to the space economy and human presence beyond Earth); the structurally policy-driven nature of the space sector, in which public choices and regulatory regimes guide technological and market trajectories; and the shared need for hybrid skills, capable of combining technical, legal, economic and socio-humanistic knowledge. Alongside these convergences, the differences between the panels indicate varying degrees of maturity and institutionalisation: problems that are already present and urgent in the field of orbital safety, processes currently being structured in the space economy, and scenarios that are partly future-oriented for a stable human presence beyond Earth, where emerging disciplines are called upon to strengthen themselves in order to offer analytical tools that are up to the task of the choices that lie ahead.

The comparison between the panels showed that interdisciplinary dialogue does not eliminate conflicts between different perspectives but makes them explicit and negotiable. This is the added value of a multidisciplinary approach: not the artificial synthesis of irreconcilable positions, but the construction of a space for discussion in which differences become productive. The Forum confirmed that academia, institutions and operators can engage in dialogue on a shared analytical basis, provided that each recognises the limits of their own perspective and the legitimacy of others'.

This work also highlights some lines of development for SPHERE's future activities. In terms of research, this involves exploring the themes that emerged in the Forum in greater depth, contributing both to the consolidation of already established disciplines and to the growth of emerging ones – from exogeography to space humanities, from space ethics to astrosociology. The growth of

interdisciplinary literature on space- s evidence of a demand for reflection that SPHERE intends to intercept and nurture, helping to build bridges between research communities that are still fragmented. In terms of training, the aim is to participate in the preparation of hybrid profiles, capable of crossing different disciplinary languages and managing the complexity of the choices that the space sector imposes. In terms of dialogue with institutions, SPHERE intends to offer analysis and expertise to support reflection on public policies, without claiming to replace decision-makers.

SPHERE sees itself as a permanent laboratory for reflection on space policies, open to contributions from scientific communities, institutions, businesses and civil society. The report presented here is not a point of arrival, but a common working basis on which to build future developments. Space governance is a challenge that concerns all of humanity: addressing it with appropriate analytical tools is the responsibility of those who, today, contribute to preparing the choices of tomorrow.

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