Poland's Evolving Space Law: Assessing Space Debris Mitigation and Remediation in the European Context

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ABSTRACT

The 10th anniversary of the Polish Space Agency in 2024 presents a good opportunity to reflect on the progress made in the area of space law in Poland, particularly concerning the principles, regulations, and recommendations that should be implemented in the national legal framework as well as the organization of the Polish space sector in general. This article focuses on the evolution of space law in Poland, with a particular emphasis on the ongoing efforts to establish a legal framework addressing also space debris mitigation and remediation. These legal developments are presented against the backdrop of broader European efforts in this area.

1. Introduction

Poland has been involved in space activities for many years, dating back to the communist era when in 1970s the Space Research Centre (Centrum Badań Kosmicznych) was established, and the first Polish astronaut, Mirosław Hermaszewski, flew into space in 1978. Significant advancements in the Polish space sector took place after 2012, marked by Poland's accession to the European Space Agency (ESA) and the establishment of the Polish Space Agency (POLSA) in 2014. In the subsequent years, Poland joined various European and international projects and programs, including the European Union Space Surveillance and Tracking EUSST in 2020 and the Artemis Accords in 2021.

As space activities in Poland continue to grow, with an increasing number of space companies and the launch of new space objects, there is an urgent need to ensure that these activities comply with international registration and debris management standards. Current national legal progress significantly lags behind the activities of international organizations such as the United Nations, the European Union, and ESA, in which Poland participates. Rapid adaptation of national laws is essential to sustain and further develop the space industry in Poland and to enable its expansion into global markets. This article also explores the critical role that international cooperation and alignment with global standards will play in the future of Poland's space law and its ability to meet the challenges of an increasingly complex space environment. The article will analyze Poland's efforts in space debris mitigation and remediation within its national legal framework, assessing its alignment with European Union (EU) policies and European Space Agency (ESA) guidelines.

2. Poland's Current Space Law and its Evolution

Poland's space sector has seen a structured development, guided by several key strategic documents and legal frameworks that define the responsibilities and activities of the state in the area of space exploration and utilization. The foundational legal framework is the Act on the Polish Space Agency (POLSA) [1], established in 2014. This act created POLSA, an executive agency responsible for supporting the development of the space industry, coordinating research, and representing Poland in international space cooperation efforts. The agency is tasked with formulating and implementing national space strategies, which include obligations regarding space debris mitigation and environmental protection in outer space while POLSA supervising the entity i.e. the Ministry of Economy is responsible for general space policy [2] . Another significant document is the Polska Strategia Kosmiczna (PSK), or

the Polish Space Strategy (PSK), adopted in 2017 [3] by the Ministerial Council, which outlines the country's goals in the space sector until 2030. The strategy emphasizes Poland's commitment to contributing to the sustainable use of space, in alignment with international standards and European Union (EU) directives. It sets specific objectives for enhancing Poland's capacity to mitigate space debris and engage in active remediation efforts, reflecting the growing recognition of space debris as a critical issue for the safety and sustainability of space activities along with establishment of the National SSA System.

In the efforts to establish a cohesive national framework for Poland's space activities, the Krajowy Program Kosmiczny (KPK), or the National Space Program, has undergone several iterations, most notably versions 0.8 [4] and a subsequent version currently under development. These versions of the KPK were designed to outline strategic objectives for Poland's space sector, including the development of space technologies, enhancement of national capabilities in space situational awareness, and the integration of Poland's space activities within the broader European and international context. Despite these efforts, the KPK has not yet been formally adopted, leaving Poland without a fully ratified national space program to guide its long-term space ambitions. Within these draft versions of the KPK, significant attention is given to the evolution of space law in Poland, particularly in the context of space debris mitigation and remediation. The program drafts emphasize the necessity of aligning Polish space regulations with international standards, including those set by the European Space Agency (ESA) and the Inter-Agency Space Debris Coordination Committee (IADC). The proposed legal frameworks within the KPK underscore the importance of preventing the creation of new space debris, ensuring the safe disposal of satellites, and exploring active debris removal technologies. These provisions reflect Poland's commitment to contributing to the global efforts to maintain the sustainability of the space environment.

However, the lack of formal adoption of the KPK has meant that these legal and strategic initiatives remain unimplemented at the national level, highlighting a critical gap in Poland's ability to effectively manage space debris and ensure the safety and sustainability of its space activities. The evolution of Poland’s space law, particularly in the context of Space Situational Awareness (SSA), is critical for addressing both debris mitigation and remediation. The SSA system, as outlined in the KPK drafts, is essential for real-time tracking and management of space objects, which directly impacts national security and operational safety. Finalizing and adopting the KPK would solidify Poland’s commitment to integrating SSA capabilities into its national framework, aligning with broader EU and ESA strategies, and ensuring active participation in global space governance. This integration is crucial for enhancing space traffic management and contributing to sustainable space operations.

An audit conducted by the Supreme Audit Office (NIK) in 2023 [5] highlighted several areas where Poland's space sector could improve, particularly in implementing international obligations related to space debris mitigation. The audit revealed gaps in the national legal framework concerning the comprehensive management of space debris and recommended stronger enforcement of existing regulations. It also emphasized the need for Poland to enhance its capabilities in space surveillance and tracking (SST) to better manage the risks posed by space debris, aligning more closely with EU and ESA policies.

3. Alignment with European Union (EU) Policies

The legal framework governing the European Union's competencies in the space sector is primarily defined by the Treaty on the Functioning of the European Union (TFEU), with Article 189 serving as the cornerstone [6]. This article delineates the EU's authority to develop a European space policy, implement specific space-related programs, and coordinate efforts among Member States in space-related research, technological development, and exploration. The EU's mandate in this domain is specifically aimed at promoting scientific and technical progress, as well as enhancing industrial competitiveness. A significant development in EU space policy is the establishment of the Union Space Programme for 2021-2027, as defined by Regulation 2021/696 [7]. This comprehensive programme encompasses and expands upon previous flagship initiatives, integrating them into a cohesive framework. The key components of this programme include:

1. Galileo and EGNOS (European Geostationary Navigation Overlay Service) for satellite navigation and positioning;
2. Copernicus for Earth observation;
3. Space Situational Awareness (SSA) for tracking space hazards;
4. GOVSATCOM (Governmental Satellite Communications) for secure satellite communications.

These programmes collectively demonstrate the EU's commitment to developing robust space capabilities across various domains, from navigation and Earth observation to space safety and secure communications.

However, it is crucial to understand that the EU's space competencies are subject to significant limitations. The TFEU outlines space policy as a shared competence between the EU and its Member States, preserving national sovereignty while promoting cooperation. Specifically, Article 189(2) prohibits harmonization of national laws, and Article 346 allows Member States to protect essential security interests, limiting EU intervention in defense-related space activities..

Within these constraints, the EU's role in space policy is multifaceted. It can propose and support space initiatives, facilitate coordination in areas that may benefit from common approaches (such as space safety and space traffic management), and promote international cooperation in space activities. However, it must do so without imposing harmonized regulations across Member States. The EU's contribution to enhancing the resilience and sustainability of European space activities is primarily achieved through coordinating Member States' efforts, supporting research and technological development, and implementing EU-wide programs as outlined in the Union Space Programme.

It is important to note that while the EU plays a significant role in shaping European space policy, the implementation and regulation of many space activities remain within the jurisdiction of individual Member States. The EU's ability to harmonize space policies across Europe is limited by the TFEU, but it can still contribute to creating more coherent approaches through non-binding initiatives, voluntary cooperation mechanisms, and the coordinated implementation of the Union Space Programme.

In conclusion, the legal framework of EU space policy, as defined by the TFEU and further elaborated by Regulation 2021/696, provides the Union with meaningful but carefully circumscribed authority in the space sector. It enables the EU to play a coordinating and facilitating role, while respecting the sovereign interests of its Member States. This framework reflects the complex nature of space policy, which intersects with issues of national security, economic competitiveness, and scientific advancement, necessitating a nuanced approach to governance at the European level.

The European Commission (EC) has underscored the critical challenge posed by space debris in several key documents, highlighting the necessity of robust mitigation and remediation measures to ensure the sustainability and safety of space activities. According to the Space Strategy for Europe 2016 [8], space debris is identified as a significant risk to the long-term viability of space operations. In response, the EC has implemented the Space Surveillance and Tracking (SST) framework, which is designed to monitor space objects, predict and prevent collisions, and mitigate the associated risks to European space infrastructure. This framework, as outlined in the strategy, is intended to evolve into a broader Space Situational Awareness (SSA) service, incorporating additional capabilities such as space weather monitoring and cybersecurity defenses for space assets. Further reinforcing this focus, the European Union Space Strategy for Security and Defence 2023 [9] expands on the need for a consistent EU-wide approach to space security. It emphasizes the development of an EU-wide security framework that would standardize the resilience of space systems across Member States. This framework, most likely supported by the introduction of an EU Space Law, would aim to collectively enhance the protection of space systems and services, addressing threats such as space debris while ensuring the strategic autonomy of the EU in the space domain. In both documents, the EC highlights the importance of international cooperation in addressing space debris. The EU advocates for the promotion of responsible behavior in outer space and the development of global norms and standards to minimize the creation of space debris. This includes efforts to enhance transparency and confidence-building measures, which are crucial to reducing the risks of misperception and unintended conflict in space.

The EC's long-term vision for space debris management, as detailed in these key documents, includes continuous improvements in space debris tracking, the development of mitigation technologies, and the advancement of reusable space technologies and in-orbit services. Those actions, beside main EU space programmes (mainly operational) are also reflected in the EU research and development program called Horizon Europe. These efforts are aimed at ensuring that space remains a sustainable and secure environment, not just for Europe, but for the global community as well.

The European Commission's strategy on space debris, as outlined in pivotal documents likes the "Space Strategy for Europe" and the "European Union Space Strategy for Security and Defence," places a strong emphasis on the mitigation and remediation of space debris. The EC has implemented the Space Surveillance and Tracking (SST) framework as a foundational step towards comprehensive Space Situational Awareness (SSA). Additionally, the

development of an EU-wide security framework, potentially leading to an EU Space Law, is proposed to standardize and enhance the resilience of space systems across Member States. These measures, coupled with the promotion of international cooperation, are central to the EC's vision of maintaining a sustainable and secure space environment, ensuring that space activities can continue safely and responsibly for the benefit of all. The European Commission is actively pursuing the establishment of a comprehensive European Space Law. This potential legislation, as highlighted in the European Union Space Strategy for Security and Defence, aims to create a unified legal framework that would address the safety, resilience, and sustainability of space activities across all Member States. The overarching goal of this initiative is to ensure a safe and sustainable use of space, which is becoming increasingly critical as space traffic grows and the risk of space debris escalates.

A targeted stakeholder consultation was launched by the European Commission in September 2023 to gather input from various actors within the space sector. This consultation, as outlined in the ESPI Yearbook 2023, is intended to shape the EU legislative initiative on space safety, resilience, and sustainability, with the Commission planning to adopt a legislative proposal in 2024-2025 framework. The proposed EU Space Law would introduce common rules and standards for space operations, including stringent measures for collision avoidance, debris removal, and the overall environmental impact of space activities. By establishing such a legal framework, the EU aims to accelerate the development of a resilient and sustainable space infrastructure that can support the long-term needs of European society and the global economy.

4. Europeans Space Agency (ESA) role in space debris domain

The European Space Agency (ESA) is at the forefront of global efforts to mitigate space debris and ensure a sustainable space environment. Through a series of strategic policies, missions, and collaborative programs, ESA has established itself as a leader in addressing one of the most pressing challenges in space operations today. This section provides an overview of ESA’s role in this domain, highlighting its key missions, policies, and the ongoing efforts to mitigate and remediate space debris. ESA's commitment to space debris mitigation is articulated in several foundational documents, including the Zero Debris Charter [10], the ESA Space Debris Mitigation Policy [11], and the ESA Space Debris Mitigation Requirements [12] with overarching goal of achieving a "zero debris" future by 2030/. The Charter emphasizes a collaborative approach, urging all stakeholders to minimize debris generation and to actively work towards space sustainability. The ESA Space Debris Mitigation Policy builds on this by providing a framework for all ESA missions, ensuring that space debris mitigation measures are integrated from the earliest stages of mission design through to the end of mission operations. The policy also aligns ESA’s activities with international guidelines, including those from the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS).

ESA plays a pivotal role in global space debris management through its Space Safety Programme, which encompasses initiatives like the ADRIOS (Active Debris Removal/In-Orbit Servicing) Mission and the CREAM (Collision Risk Estimation and Automated Mitigation) system. These programs are crucial for advancing space debris remediation, not just mitigation. ESA's broader strategy includes fostering international cooperation and setting technical standards that influence national space laws across Europe. Poland’s space law must align with ESA’s Zero Debris Charter and Space Debris Mitigation Policy, ensuring that national legislation supports these initiatives by integrating both debris mitigation and active remediation measures.

Beyond specific missions, ESA’s broader strategy for space debris management includes fostering international cooperation, advancing technical standards, and promoting the development of new technologies. In particular the ESA’s Space Safety Programme, is specifically designed to protect both Earth and space assets from hazards originating in space, including space debris. The program's activities are structured around key areas such as space debris monitoring, mitigation technologies, and the development of a circular economy in space..

ESA’s comprehensive approach to space debris mitigation and remediation demonstrates its leadership in promoting a sustainable space environment. Through ambitious initiatives like the Zero Debris Charter and its Space Safety Programme, ESA is actively working to reduce the risks posed by space debris. These efforts are not only crucial for the safety of current space operations but also set the stage for the sustainable expansion of human activities in space. By leading in the development and implementation of advanced space debris mitigation strategies, ESA ensures that space remains a viable resource for future generations.

5. Expert Insights and Interview

The authors conducted interviews and discussions with individuals involved in various aspects of space legislation in Poland. These included academic lecturers specializing in law, participants in the drafting and implementation of the Polish Space Strategy, and professionals from the domestic space industry. Notably, the interviews gathered insights from former employees of the Polish Space Agency (POLSA), members of Non- governmental organizations, such as Space Sector Professionals Association, and lecturers from Polish universities who focus on space law.

The topics covered in these interviews included the practical challenges of space legislation in the country, the future directions for Polish space law, and issues related to international cooperation in global space governance. Respondents highlighted the challenges in developing space law in Poland, including the lengthy, politically charged process and the lack of expert-led, substantive debate, particularly in integrating technical and legal expertise. This was attributed to the perceived attractiveness of space as a "new and significant" topic, leading to widespread but often superficial involvement. Other challenges identified the scope of space law that should be regulated and concerns about its potential to restrict industry activities. Additionally, participants noted the absence of quantitative and qualitative analyses of the space sector's structure and the impact of regulations, which they felt was a critical gap in the legislative process.

In the context of space debris, it was evident from the interviews that the respondents demonstrated a significantly higher awareness of the challenges associated with this issue. However, when asked to provide specifics or to prioritize aspects of space debris legislation with justifications, only a few individuals possessed a comprehensive understanding of what should be included in the legislative framework and why. This indicates that while the quality of the legislative process remains a challenge, space debris was not entirely marginalized in the discussions. Respondents recognized its importance, yet the depth of understanding and consensus on the specific measures required varied considerably.

Regarding the future evolution of space law, interviewees primarily focused on three critical areas: safety, lunar exploration, and the commercialization of space activities. When asked about the role of space debris within these contexts, particularly the need for remediation efforts, there was a noticeable gap in understanding. Many respondents struggled with defining the issue comprehensively and identifying appropriate technical solutions. This gap suggests that while space debris is acknowledged as a priority, the complexity of the problem is not fully grasped by all stakeholders, especially in terms of integrating it effectively into broader space legislation.

In discussions related to global space governance and international cooperation on space debris, the importance of collaboration with leading spacefaring nations was widely recognized. Respondents highlighted the necessity of engaging with countries such as the United States, the United Kingdom, France, Germany, and other European nations, as well as Japan, South Korea, and Australia. This reflects a broader global consensus on the need for international partnerships to address space debris, yet debates continue on how best to balance national interests with global responsibilities. Key points of contention in these global discussions often revolve around issues such as the distribution of costs for debris removal, the enforcement of international guidelines, and the development of universal standards that accommodate both established and emerging space nations. These debates underscore the complexity of achieving a cohesive global approach to space debris, where national priorities and global needs must be carefully balanced.

6. Results and Discussion

As emerging space nations like Poland seek to establish them in the global space sector, it is critical to develop a robust regulatory framework that addresses both the opportunities and challenges associated with space activities. Specifically, the management of space debris through mitigation and remediation is a key area that requires focused regulatory attention. The analysis, based on various sources including expert interviews, participant observation in the legislative process, and aforementioned document reviews, reveals several issues for considerations, hindering the progress in establishing a comprehensive legal framework for space activities in Poland, among others:

- unclear distribution of responsibilities within the administrative framework: There is a lack of clarity regarding the division of responsibilities among the various stakeholders involved in the development of space law in Poland. This ambiguity has led to inefficiencies and delays in the legislative process;
- lack of proactive regulatory actions: national space authorities has not taken sufficient proactive steps to initiate and advocate for necessary regulations also indicated in NIK audit [5];

- underrepresentation of domain experts in space legislation related bodies: discussions on space law, particularly regarding space sustainability, are often dominated by legal professionals with general expertise, while there is a noticeable underrepresentation of subject matter experts in space sustainability. This imbalance has hindered the development of technically sound regulations.
- deficiency of engineering expertise building-up within national space authorities: it seems that the authorities are concentrating more on space programmatic and financial issues which reflect its unconcern to attract and retain domain-specific engineering experts, which has further limited its ability to contribute effectively to the regulatory process.
- resistance from various interest groups: there has been significant resistance from established interest groups, including scientific institutes and industrial lobbies, which prefer to maintain the status quo. This resistance has stifled efforts to introduce new regulations that would challenge existing power structures.

As a result of these issues, Poland has yet to implement any significant "hard" or "soft" laws governing the space sector, particularly in the areas of space debris mitigation and remediation. This lack of regulatory progress is corroborated by the findings of the Supreme Audit Office (NIK), which highlights the absence of concrete legislation in this critical area.

The current state of Poland's space law presents significant challenges for the country's aspirations in the global space sector. To address these issues, the following actions are recommended:

- establishment of a comprehensive national space law along with guidelines and best practices, which should be harmonized with international standards while providing a legal foundation for all space activities within the country. This law should reflect international treaties obligations as well as UN guidelines for the long-term sustainability of outer space activities. The law should empower the designated entity such to oversee and enforce these regulations.
- establishment of regulatory measures for satellite operators; the regulation is supposed to be imposed on space operators to comply with among other the space debris regulations mitigation through licensing requirements including mandatory debris mitigation plans. This shall also include requirements for end-of-life disposal plans and collision avoidance measures. Enforce the disposal of satellites post-mission, such as deorbiting them or moving them to a graveyard orbit, within a specified timeframe, often within 25 years. Require operators to utilize space situational awareness (SSA) data to actively avoid collisions with other space objects.
- imposing mandatory obligation for public procurements to introduce, beside space debris mitigation also space debris remediation technologies such as serviceability and active debris removal compatibility; in addition in case of commercial entities introducing such technologies should reduce licensing process along with its more favorable conditions.
- authorized entities dealing with licensing shall deliver basic education, training, free tools as well as practical guidelines supporting introducing space debris mitigation and remediation solutions to their products.

To complement the regulatory measures, it is essential to establish an adequate organizational framework, including a designated authority responsible for the space regulatory framework. Specifically, this regulatory body must clearly and unambiguously define the role and responsibilities of the national space authorities. If it is determined that the authority should continue focusing on broad, strategic issues, there may be a need to delegate technical expertise, regulatory authority, and the responsibility for research and development of critical technologies—particularly those with long-term implications—to other organizations. Consequently, the authority for licensing in areas related to space debris, including mitigation and remediation efforts, could be transferred to other institutions (such as aviation authorities). This would ensure that space activities are managed by entities with the appropriate expertise and regulatory capacity, thereby enhancing the effectiveness of national space governance.

Given the current stage of development in Poland's space sector; it seems more prudent to focus on strengthening the role of the space authorities rather than immediately considering a transfer of responsibilities to other institutions. It seems that by empowering space authorities with greater authority and resources, the agency can lead the development of comprehensive space regulations and represent Poland more effectively in international forums. This empowerment should be complemented by incorporating domain experts into discussions on space law, ensuring a balanced representation of legal professionals and technical experts, particularly in critical areas like space sustainability and

engineering. Furthermore, investing in building and retaining technical expertise within space authorities will enhance its capability to contribute to the development of sound regulations.

In parallel, addressing resistance from entrenched interest groups by engaging in constructive dialogue and emphasizing the long-term benefits of regulatory advancements will be essential. If, at some future point, a transfer of responsibilities becomes necessary, it should be executed in a collaborative manner, ensuring that both space authorities and any receiving institution are adequately equipped to manage the transition effectively. This approach will allow Poland to align its national space law with EU and ESA guidelines, strengthen its position in the global space sector, and ensure that it plays a proactive role in international efforts to manage space debris and promote the sustainability of space activities.

7. Conclusions

In conclusion, this article highlights the significant regulatory gaps in Poland's space legal framework, which remain far behind those of other nations despite the establishment of space agency ten years ago. The slow development of comprehensive space regulations poses considerable risks, particularly as space activities, predominantly commercial, continue to increase. This regulatory lag could deter foreign investment in Poland's space sector and exacerbate operational safety risks [13]. The absence of clear responsibility distribution among domestic institutions, a lack of implemented standards and guidelines, and insufficient technical verification mechanisms further compound these challenges.

On a positive note, Polish entities participating in ESA programs are required to adhere to ESA's space debris mitigation and remediation standards, which positively influences their operational practices. However, concerns remain that some space companies operating outside the ESA framework may not comply with these standards. Additionally, while Poland maintains and operates an SSA system, its current use is limited to monitoring objects registered under the EUSST, and it does not extend to the continuous monitoring of public and commercial space activities within the country.

Addressing these regulatory gaps and aligning Poland's space law with European and international standards is essential for mitigating risks, attracting foreign investment, and strengthening Poland's global position. Such actions will ensure that Poland plays a proactive role in managing space debris and promoting sustainable space activities, securing its future in the increasingly competitive global space sector

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