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Legal Challenges When Applying Current Laws to the Use of Space Data

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Abstract

Personal valuable data is gathered on Earth and from outer space. Human activities in outer space generate enormous amounts of data, from satellite imagery and telemetry to scientific experiments. Considering the range of applications that space data can offer, there is a comparable variety in legal aspects connected to their use. This paper reviews the legal challenges when applying current laws to the use of space data. It examined and compared key legitimate and legal relationships between using space data and general data. Analyzing the intersection between the use of space data and general data, the study reveals critical issues regarding the legal basis of space data and finds a challenging threat to privacy and personal data from space data. This research contributes to the dispute by offering regulatory approaches to address the legal challenges.

Keywords

Space Law, Space Policy, Legal Aspects, Space Data

1. Introduction

Space data refers to the information collected from various sources in outer space, such as satellites, telescopes, space probes, and other instruments. It includes satellite imagery and remote-sensing data, astronomical data, space weather data, space-based navigation and communications data, planetary exploration, and more (Climate and Societal Benefits Subcommittee, 2023). Space data classification relies on spacecraft and satellite payloads. Satellite payloads are the instruments, equipment, or satellite systems designed to perform specific functions or tasks. These payloads are the primary reason for launching a spacecraft, and they fulfill the spacecraft's intended mission objectives. The payload can vary depending on the purpose of the spacecraft. It defines the spacecraft's capabilities and the type of data or services it can provide (SatNow, 2024).

Space data and its applications are part of the downstream space sector (Stefoudi, 2024). Earth Observation satellites offer information through imagery. Navigation satellites offer timing and positioning information, and communication satellites allow the circulation of internet traffic. Ground-based and space-based telescopes advance images and other measurements of objects in outer space. They have diverse uses, including civil and commercial purposes. Space data applications are derived for remote sensing data. Space-based high-resolution imagery platforms have been used to collect intelligence, monitor the activities of surrounding borders, and monitor the environment (Dehqanzada & Florini, 2000). Space data can also refer to the way data from outer space are generated and used for large-scale analytics, automation, and prediction (Stefoudi, 2024). The present technological developments in Earth and space observation have stretched the term to enfold data above the images of the Earth taken from outer space, such as characterization from space-based sensors, satellite-based positioning information, and information acquired or transmitted through space technology.

2. Problem Statement

Amidst carrying out the research, Space data represent outstanding civil, commercial, and scientific benefits. The wide difference in data uses and potential from the combination of space and non-space data produces a chance for more accurate information and technology services. The growing number of satellites launched into outer space, continuously uplifting capabilities, the achievement of the development of space data products, and the numerous ecosystems formed by data have come to an increased supply of and demand for information. The varied uses of space data lead to a diverse range of legal considerations. This research focuses on the laws and data policies that are appropriate to the use of space data and general data, the legal challenges of their application, and the regulatory approach to overcome them.

2.1. Scope of Research

This research examines laws and data policies that are applicable to space data and general data, identifies the legal challenges that the use of space data raises, and suggests regulatory and policy solutions to overcome them. To that end, it connects the general framework of international space law with a particular legal discipline of general data.

The purpose of this research is to identify legal aspects of space data and general data and legal challenges when applying current laws to the use of space data, and in consequence, suggest regulatory approaches that can undertake the legal challenges and protect individual and national interests from the use of space data.

2.2. The Concept of Space Data

For the purpose of the research, the concept of space data refers to the data lifecy-

cle that is collected, stored, and transmitted using space technology. The capability of space data conducted from space technology in outer space is as follows.

Television Broadcasting, Radio Communication, and Broadband Internet are satellite services. These services are derived from communication payloads in communication satellites, which carry transponders as their primary payload. Transponders receive signals from Earth, amplify them, and retransmit them back to specific locations on the Earth's surface (SatNow, 2024).

Earth's surface, Atmosphere, Oceans, and Intelligence Data are satellite products. These products are derived from earth observation payloads in earth observation satellites which are equipped with cameras, sensors, and other remote sensing instruments to observe and collect satellite imagery (SatNow, 2024).

Positioning, Navigation, and Timing Information Data, such as those in the Global Positioning System (GPS), Galileo, GLONASS, and BeiDou, are derived from navigation payloads in navigation satellites which carry payloads consisting of atomic clocks and signal transmitters (SatNow, 2024).

Scientific Research Data, such as astronomy, space physics, and other scientific investigations, are derived from scientific payloads in scientific satellites, which are designed to conduct experiments and collect data for scientific research. Payloads may include telescopes, spectrometers, particle detectors, and other scientific instruments (SatNow, 2024).

Earth's Weather and Climate Data are derived from weather and meteorological payloads that carry instruments, including radiometers, spectrometers, and other sensors for measuring atmospheric conditions, cloud cover, and temperature (SatNow, 2024).

Planets, Moon, and Asteroid Data, are derived from interplanetary exploration payloads from space probes and rovers designed for exploration beyond Earth, which carry scientific instruments, cameras, spectrometers, and other tools to study celestial bodies (SatNow, 2024). The legal and policy aspects of data collected by space probes are similar to those legitimized by data collected by satellites.

3. Legal Challenges When Applying Current Laws to the Use of Space Data

Space data's legal framework is a complex mixture of international and national space laws, regional and national legislation, and data policies. International space law constitutes the most relevant field of law concerning activity in outer space by way of its subject and scope (Stefoudi, 2024). Space data and space data applications are acquired through technology that is conducted in outer space and are allowed by satellites that are launched into outer space. Therefore, they fall under the scope of international space law.

3.1. Legal Aspects of Space Data

The term space law is most often associated with the rules, principles, and stand-

ards of international law appearing in the five international treaties and five sets of principles governing outer space developed under the auspices of the United Nations (United Nations Office for Outer Space Affairs, n.d.a). International space law aims to govern how states and private entities behave in outer space. The entailed provisions of international space law that legitimize space data are as follows.

1) Freedom exploration and outer space is a common territory of all

The Outer Space Treaty (OST, 1967), in Article I, legitimated the principle of freedom exploration and that outer space is a common territory of all. According to this, it becomes a settled principle of international law that a State has absolute sovereignty over the airspace above its territory, up to 160 km above the ground (Dempsey & Manoli, 2017). Even so, the State cannot claim sovereignty over the beyond boundary, which is outer space. There are no law violations if data is collected or gathered from one country's territory or international waters. However, the issue becomes tricky when applied to gathering data from another country (Deekshatulu et al., 1995). In the case of space data, it relies on the aforementioned principle. States are committed to the view that they require no consent, including prior consent from other states, to engage in collecting the data from outer space. Likewise, gathering information from outer space rejects the notion of absolute national sovereignty relating to the data process and products resulting from it. In addition, from the international legal perspective, no one or no country can internationally shut over hundreds of satellites in outer space to scan, image, and gather data about what is happening on the Earth's surface presently.

2) Encouraging opportunities for international cooperation to enhance the mutual benefits of space data

The United Nations Remote Sensing Principles (UN. General Assembly, 1987), in Principle XII, has not only implemented the principle of freedom exploration but also stated that outer space is a common territory of all. In addition, it has projected the principle of encouraging opportunities for international cooperation to enhance the mutual benefits of space data of remote sensing. Significantly, this principle reduced the legal obligation of the request for concrete regulation and consultation of the collected data from outer space to become volunteer cooperation upon request.

3) Benefit-sharing from space data

The United Nations Space Benefits Declaration (UN. General Assembly, 1997) has projected the benefit-sharing principle from space data. Professor Frans von der Dunk suggests the principle itself put forward as the basis for any data dissemination policy (Von Der Dunk, 2002). However, it is currently unclear how exactly this benefit-sharing should work. Perhaps benefit-sharing is a common language of international law, as space data can offer enormous benefits for nations and peoples around the world. With the rapid progress of platforms in outer space to collect data and its applications, fears of discrimination and prohibition from free access (to use space data) make way for a vision of mutually beneficial

cooperation. In other words, the benefit-sharing principle was yielded by the idea of shared advantage. It clarifies the terms of free use and access to some extent of space data, including but not limited to satellite imagery, remote-sensing data and positioning, navigation, timing Information data, etc. However, there are differences in detail between the international cooperation models and their implementation. While remote sensing remains uncertain how to provide (sense States) non-discriminatory access to data at a reasonable cost, Global Navigation Satellite Systems (GNSS), which provide satellite-based positioning, navigation, and timing data, have successfully promoted voluntary cooperation on matters of mutual interest in various areas such as road and traffic management, aviation, maritime navigation, precision-farming, humanitarian search and rescue mission, etc. In 2005, the International Committee on Global Navigation Satellite Systems was established under the United Nations system (United Nations Office for Outer Space Affairs, n.d.b). Its mission is to encourage coordination among providers of global navigation satellite systems, regional systems, and augmentations and assist GNSS users with their development plans and applications by facilitating coordination and serving as a focal point for information exchange. GNSS-based Global Emergency Warning Service (European Union Agency for the Space Programme, n.d.) is the framework of cooperation that sends an alert message to smartphones in the alert zone using Satellite Systems. It gives advantages to countries that do not have such a land-based Emergency Warning system. It helps countries be resilient to many types of hazards, from earthquakes to forest fires and terrorist attacks. One observation is that the benefit-sharing principle is not strictly enforceable, and it is based on customary law and State practice, which is open to altered interpretation. Nevertheless, it paves the way for everyone to receive the benefits of space data. Benefit-sharing is the most important principle that has caused different governing norms between space data and general data.

3.2. Legal Relationships between Using Space Data and General Data

The legitimacy of data or information gathering depends on the place from which the data is gathered rather than the nature and location of the data. In the case of space data, the place where data is collected is in outer space. The governing norm of space data is to promote maximizing data collection with hopes of accelerating or spreading space data for the benefit of sharing scientific knowledge (Climate and Societal Benefits Subcommittee, 2023). Otherwise, the governing norm of general data is to encourage minimizing data collection and protecting human privacy.

A key legitimate of space data is to over-collect data from outer space in the hopes of finding something useful, insofar as much of the data could be for the promotion of scientific knowledge (Climate and Societal Benefits Subcommittee, 2023). However, it is important to remark that the over-collected data about nature and geography is reasonable in the pursuit of new scientific knowledge, but the over-collected data about personal and location data of human subjects is not.

The protection of personal data and privacy should be guaranteed when opening any space data (Bu-Pasha & Kuusniemi, 2020).

A key legitimate of general data is to not over-collect data and limit data collection to only what is needed for an intended purpose. The data collector is not supposed to collect other sensitive personal information. Especially if the data subject had not consented to it or if the data is irrelevant to a purpose. According to increased concerns about individual privacy and harm, over-collecting data not only puts such sensitive information about one's life at unnecessary risk of a data disclosure or breach but also violates reasonable privacy expectations and harms human identity (Climate and Societal Benefits Subcommittee, 2023). Therefore, another related key legitimate of general data is to minimize or limit data sharing to only the parties that need the data, or at least with enough transparency to the data subjects for their informed consent.

Although space data provides exciting new possibilities, some space data contains information-related fields of law, such as privacy and data protection, and serious privacy concerns have also been raised (Coffer, 2020). The cases of Google privacy lawsuits are good examples of the analysis of the data protection law and the challenges it will face in handling space data.

Google is an American search engine company founded in 1998. It is now one of the world's most prominent high-technology brands. Google Earth is a mapping service that renders detailed 3D images of various locations on the planet. In 2004, Google bought Keyhole, Inc., partially funded by the Central Intelligence Agency's venture capital arm, In-Q-Tel. Keyhole had developed an online mapping service that Google rebranded in 2005 as Google Earth (Hall & Hosch, 2025). This service lets users find detailed satellite images of most locations on Earth and also can create combinations with various types of other databases, incorporating details such as street names, weather patterns, crime statistics, coffee shop locations, real-estate prices, and population densities into maps created by Google Earth. (Tiwari, 2019). In 2005, concurrent with Google Earth's inception, Google Maps was also born. Google Maps began as a desktop tool for geographical navigation, then evolved into a GPS-based navigational app that provided real-time, turn-by-turn directions and was accessible via mobile devices. Although Google Earth and Google Maps were conceived as separate projects, their parallel development relied on shared technologies, a key principle that would later become the foundation of Google's parent company, Alphabet Inc., a multi-subsidiary operation (Hall & Hosch, 2025). For years, Google Maps has been one of the most used applications on mobile phones, from planning random trips and checking out places to tracking live traffic. Many of these digital maps were created for convenience and sometimes became critical lifesaving tools. For instance, Google Earth and Google Maps provided interactive satellite overlays of the affected region, enabling rescuers to better understand the extent of the damage. Subsequently, many people were curious about how the company could source so much data and build a highly interactive map out of it. One thing that goes without saying is location

tracking, which Google does extensively all the time on millions of Android and iOS devices across the globe. Additionally, Google used a data combination of satellite imagery and Street View to figure out the exact location of roads, water bodies, houses, buildings, etc. It is important to know exactly where the location is in cities that are not well-structured. The collected location data of people, as well as the longitude and latitude number for a particular one, does not help much in this case. Therefore, Google began the Street View project in 2007 with the idea of creating a 360-degree map of the world (Tiwari, 2019). From 2007 to 2010, Google captured over 220 billion images and more than 10 million miles across 100 countries and territories together (Hull, 2024). The data operations team is responsible for managing every aspect of its mapping service, from collecting Street View data and satellite images to checking the accuracy of the information and finding out whether an address is located exactly where it has to be and which machine learning algorithms are hard at work (Tiwari, 2019).

From 2007 to 2010, when Google began the Street View project, many privacy concerns were raised (Electronic Privacy Information Center, n.d.a). First, privacy over many displays exclusively images collected by the Google Street View digital cameras. Google Street View ignored the privacy of millions of people when releasing satellite images of faces, license plates, houses, and addresses until some people sued Google for overlooking their privacy interests by capturing a photo of their home in 2008 (Metz, 2008). Second, privacy over email passwords and email content stored in Wi-Fi transmission data. In 2010, Google was sued by various states in the US for obtaining a vast amount of Wi-Fi data from Wi-Fi receivers that were concealed in Street View vehicles (Google LLC, 2021).

A remark from the cases of Google privacy lawsuits shows that space data and general data have different subjects for data collection. While general data concerns individuals, in contrast, space data may not focus only on individuals. Space data and general data share the same risks and issues of equal access and fairness, trust, and confidence, with the utmost important threat to data being transcendent against harm to individuals, especially to privacy, autonomy, and discrimination.

3.3. Legal Challenges to the Use of Space Data

The challenge when applying international space law to the use of space data is the laws themselves do not enfold the ground-based parts of the data lifecycle and do not design specific rights and obligations for stakeholders involved in space data beyond the existing legitimacy of operation of satellite systems involved in the space data lifecycle.

The Outer Space Treaty (OST, 1967) lacks a particular definition of what constitutes a benefit and whether a benefit-sharing (of space data) constitutes a legal obligation. In addition, there is an absence of national sovereignty in outer space, which poses obstacles to the application of national, regional, and international laws to activities conducted in outer space. The obstacles take into account the complexities of the application of national space law when several States collabo-

rate in space data activities.

To the extent privacy and data protection laws are concerned, space data may include personal data or facilitate their generation and transmission, causing the application of privacy laws. The challenge when applying privacy and data protection laws to the use of space data depends on the public and private actors involved in the space data lifecycle (Stefoudi, 2024). Because privacy and data protection laws do not allow by law for the potential of space technology, it is incompatible with complying with the requirements of consent and lawful processing. Concerning the inability to predict numerous space data uses, the main challenge is how to determine the applicable law and how to balance the freedom to use and explore outer space against the right of States over information concerning their territory. Applying data protection laws to space activities is unwieldy, and space technology challenges the relevance of data protection laws due to their capacity for continuous data collection, which may include personal information.

The case of Google privacy lawsuits such as *Boring v. Google*, 362 Fed. Appx. 273 (3d Cir. 2010) launch the reality that there are no direct international instruments, standards, or guidelines to address the issue concerning or handling the problem that occurs with privacy data gathered or collected from outer space. Google collected integrated databases on both Earth and space systems, which is not obligated to ask for consent under the international legal framework governing data collecting of a State's territory from satellites in the Earth's orbit. To that extent, Google was not found to be illegal, although Google provided the graphic location of personal data. The United States Court of Appeals for the Third Circuit decided that attempts to sue Google for invasion of privacy over its use of residential images in its Google Map program are not likely to succeed (Nissenbaum, 2024). It may be observed that Google began the face-blurring technology that automatically recognizes and blurs faces in Street View photographs as a consequence of national laws and policies, not international space law.

The case of Google privacy lawsuits such as *Ben Joffe v. Google*, No. 11-17483 (9th Cir. 2013) reveals the reality that international space laws are not able to safeguard data of national interests from a combination of Earth and space-based data and to protect human identity from emerging automation technologies, machine learning, and artificial intelligence. In 2007, Google launched its Street View project to capture street-level images from various cities in the US and around the world (Electronic Privacy Information Center, n.d.b). The Street View functionality was accessible on both Google Earth and Google Map programs, and the main sources of data are a combination of Street View camera and satellite imagery. To map roads and buildings, Google uses machine learning to identify them and add the information to their map data. In addition, to increase the accuracy of the information, Google deployed street vehicles with digital cameras to record streets and popular places. It turns out that instead of being equipped only with digital cameras, Google vehicles also concealed Wi-Fi receivers that tapped into homes' unencrypted Wi-Fi networks and collected private data such as emails,

passwords, and other private information from private Wi-Fi networks. Later, Google admitted the data collection was unintentional and a result of computer software errors. It may be observed that the group of Google engineers who built software and embedded it into Street View vehicles has never been the subject of legal proceedings. The reason why Google engineers were never found guilty of committing any cybercrime is that Google claimed it was a machine's fault, not a human fault. It is apparent that through few national legal regimes coercing or punitive legal punishment for the misconduct of big-tech companies, Google's administration and employees do not commit cybercrime although they gathered many customers' private data without consent. These cooperating companies use the customer's data as a product. The most critical point is those companies lean on loopholes in present law to conduct cybercrime. This issue led to another legal challenge when applying cybersecurity (Kosseff, 2018) laws to the use of space data. In the future, the use of space data to conduct cybercrime from one country to another one country according to the capability of cross-border data flow, which refers to the movement of digital information across international borders, allows businesses and individuals to share, store, and process data in different countries (Bannelier & Trotry, 2023) might cause various legal conflicts.

There is a conflict between the laws governing the uses of space data and general data. Space law actively agrees with or gives consent to over-collected data about personal and location data of humans without permission. Privacy and data protection laws, on the other hand, obligate limited data collection. The specific type of personal data that poses the most risk is location data. The Privacy and Electronic Communications Regulations (2003) define location data as any data processed in an electronic communications network or by an electronic communications service indicating the geographical position of the terminal equipment of a user of a public electronic communications service, including data relating to—(f) the latitude, longitude or altitude of the terminal equipment; (g) the direction of travel of the user; or (h) the time the location information was recorded. Location data, to be more specific, is any information collected about the whereabouts of a device or individual, including geo-location data, and is information collected by a network or service about where the user's phone or other device is or was located (Sanford, 2024). Geo-location data is derived through one or a combination of cellular network data, Global Positioning System (GPS) data, and personal area network data.

The relationship between the use of space data in Google privacy lawsuits and the legal applicability and protection of the existing privacy and data protection laws is connected through the different rules to oversee GPS-based location information that belongs to geo-location data (outer space law). After examining the Privacy and Electronic Communications Regulations 2003, it is to be observed that the legal definition of location data (terrestrial law) does not broadly include data collected in outer space such as GPS-based location information. The regulations choose to prevent from prohibiting space data process if the data is anony-

mous or a data collector has the user's consent to use it for a value-added service and the processing is necessary for that purpose (Information Commissioner's Office, n.d.). The Privacy and Electronic Communications ReguSlations 2003 choose to determine that GPS-based location information is created and collected independently of the network or service and includes location information collected at a purely local level.

Anonymization becomes a threat to the privacy-related issues arising from geo-location. Nowadays, geo-location data and its functionality are becoming increasingly essential to daily life. Likewise, many geo-location data services raise privacy concerns from their collection and storage of location information. For instance, Geo-location data and services in mobile apps require collected data everywhere, at any time, and potentially without users' interaction or knowledge. Risks associated with processing geo-location data include unawareness (of data owners) to whom they are transmitting their location, essential data processing information being incomprehensible, and consent for some apps to use location data being invalid (Thomson Reuters, 2012). The General Data Protection Regulation (EUR-Lex, 2016), which came after the Privacy and Electronic Communications Regulations 2003, filled a gap by defining geo-location data as personal data. The General Data Protection Regulation 2016 defines personal data as information relating to an identified or identifiable natural person, and geo-location data falls within this definition.

The use of geo-location data is subject to national and regional data protection and privacy regulations such as the Privacy and Electronic Communications Regulations 2003 in the United Kingdom and the General Data Protection Regulation 2016 in the European Union, which set guidelines for the processing and protection of personal data. There are no specific regulations that govern geo-location universally. The authors are of the view that personal data from the data collected through platforms in outer space can be safeguarded only if multi-stakeholders, both public and private sectors, can build trust and confidence multilaterally.

4. Regulatory Approaches to Address the Legal Challenges

There is an overlapping between the use of space data and general data that has grown with great complexity. The analysis regarding the legal challenges of applying current laws to the use of space data purports different types of action are required, depending on the type of these challenges. Some challenges may give a specified status for a new regulation to address a specific type of activity that has not been previously regulated or to complete gaps in existing regulations. Other challenges can be addressed through the interpretation or enforcement of the current framework or regulatory arrangement on a bilateral level, such as through licenses and contracts. The authors suggest international space law needs new rules. These rules should advise on the optimum application of privacy and data protection laws to space data. The possibility of the most fitting regulatory approach and its associated solution depends on these aspects and on the ability and

preferences of the actors that can implement them. In conclusion, the adoption of an international law obligated to space data will able to resolve significant legal challenges.

Role of Stakeholders

The regulatory approaches are not able to be implemented without a lead main actors, including the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS), States, and private actors. UNCOPUOS has the approving reliability in issues of governance of space activities, including space data. States have the potential to enact most means of solving problems and should consequently be given an important role in addressing the legal challenges. Private actors engaged in space data will implement the proposed solutions depending on whether these actors want to initiate such a procedure and whether they can and have the mandate to do so.

5. Conclusion

The paper set out to address the legal challenges that the use of space data raises. It sorts out the difference in data uses and potential from space and non-space data. Yet, after examining laws and data policies that apply to space data and general data reveals a conflict between the laws governing the uses of space data and general data. Space law chooses to opt in that States require no consent, including prior consent from other states, to engage in collecting the data from outer space. Whereas privacy and data protection laws limit data collection if the data subject does not consent to it. The approaches for taking up the legal challenges and protecting individual and national interests from the use of space data can be determined through three approaches: 1) new regulations, 2) the enforcement of the current framework or regulatory arrangement, and 3) the interpretation of applicable laws. The most important stakeholders who should be involved in clarifying these laws are UNCOPUOS, States, and private actors. UNCOPUOS needs to provide a way to balance the freedom to use and explore outer space against the right of States over information concerning their territory; meanwhile, States need to provide solutions and guidance, and private actors need to decide the applicable law as they both can and should take such action. If there are clear laws on this topic that everyone can adhere to, personally valuable data that is collected from outer space will be able to be secured and kept away from unexpected privacy violations.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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