

# Legal Nature of Remote Sensing of the Earth from Space

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*To ensure the proper functioning of Ukraine as a space nation, one of the important factors is the development of domestic legal opinion and legislation on the outlined issue. And if the topic of the formation of space law in Ukraine appears to be more researched, then its direction, such as remote sensing of the Earth from space, requires a more detailed legal analysis and legislative regulation. Evidence of this is the draft Law of Ukraine "On State Regulation in the Field of Earth Remote Sensing," proposed in 2014, which has not yet been adopted, although its adoption is part of Ukraine's obligations under the Ukraine-EU Association Agreement. In such a case, the issue of researching the legal basis of remote sensing of the Earth from space becomes relevant, where the legal nature of this phenomenon is of primary importance.*

*In the course of the conducted scientific research, the following legal features of remote sensing of the Earth from space were proposed: 1) it is a type of information collection based on the method of observation, which is part of such a management function as monitoring; 2) it is the activity on special space systems or their separate elements operation, as well as the accumulation, processing, integration and distribution of relevant data about the Earth; 3) it is a set of space and informational means that are functionally and organizationally interconnected and ensure proper remote sensing of the Earth from space; 4) the main technical means of remote sensing of the Earth are: radars, lidars, laser altimeters, spectrometers, radiometers, accelerometers, rangefinders, echo sounders, scatter meters, etc.; 5) it is a set of legal relations, the object of which is information necessary for the development of many spheres of human activity: meteorology, ecology, nature management, seismology, prevention of emergency situations of natural and man-made origin, agroforestry improvement activities, in the field of security and defense of the country, etc. The subjects of such legal relations are defined as operators, primary subjects of service provision, secondary subjects of service provision, consumers, as well as a set of authorized controlling authorities. The reasons for the emergence of such legal relations, to which the author includes international and domestic normative acts dedicated to the legal regulation of remote sensing of the Earth, are also revealed; 6) it is a comprehensive institution of space law; 7) is an interdisciplinary science that combines scientific developments in the specifics of space meteorology, geodesy, geology, hydrology, oceanology, earth science, etc.*

*Based on the selected features, the author's definition of the concept of remote sensing of the Earth from space is formulated in the work.*

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## Introduction

The technology of remote sensing of the Earth (hereinafter – RSE) has recently become widespread due to a number of factors: rapid development of international relations; deepening of knowledge about the environment and its individual components, as well as military conflicts in the world.

Remote sensing itself originated back in 1858, when the Earth was filmed from a parachute for the first time, and it was already widely used during the First World War in the form of aerial photography for reconnaissance. During the Second World War, the types of such sensing already included: radars, sonar and infrared enemy detection systems (The origin, 2022).

However, the actual scientific use of RSE began with the launch in 1972 of the first American artificial satellite under the Landsat program.

Since then, the Earth observation satellite market has developed rapidly. Today, more than two dozen countries of the world carry out RSE activities. According to BIS Research, the global market for Earth observation satellite data and services is expected to reach USD 15.90 bln in 2032 (Satellite, 2022).

Such events become the basis for a comprehensive analysis of this phenomenon within the framework of legal science.

The most researched issues in this area include, in particular, the issue of the international legal regime of activities related to RSE, compliance with the principles and norms of international law and the sovereign rights of states when carrying out such activities, historical, economic, and informational aspects of the development of RSE, as well as a comprehensive scientific study of the legal foundations RSE has not yet been conducted in domestic jurisprudence.

In this regard, the purpose of this study will be the legal nature of RSE as a fundamental component of the legal foundations of RSE.

## Discussion

According to DSTU 4220-2003 “Remote sensing of the Earth from space. Terms and definitions of concepts” RSE should be understood as receiving data about the Earth from space using the properties of electromagnetic waves emitted, reflected, absorbed, or scattered by sounding objects.

At the same international level, RSE is considered as the observation and measurement of the energy and polarization characteristics of the own and reflected radiation of elements of the land, ocean and atmosphere of the Earth in various ranges of electromagnetic waves, which contribute to the determination of the location, description of the nature and variability of natural parameters and phenomena, the natural resources of the Earth, the environment, as well as anthropogenic objects and formations (Article 1 of the Convention on the Transfer and Use of Data of the Remote Sensing of the Earth from Outer Space dated 19/05/1978).

In the “Principles relating to remote sensing of the Earth from outer space,” approved by UN General Assembly Resolution 41/65 dated 03/12/1986, RSE means sensing the Earth’s surface

from space using the properties of electromagnetic waves emitted, reflected or scattered by probed objects, with the aim of better management of natural resources, improvement of land use and environmental protection (Principle I).

In the scientific literature, RSE is considered as a type of observation carried out from space using the properties of electromagnetic waves emitted or scattered by probed objects, with the aim of improving the management of natural resources, increasing the efficiency of land use and environmental protection (Malysheva, 2014).

The following questions arise: to which type of activity does the RSE belong, does it act as an independent legal phenomenon, and what is its place in the legal system of law?

In modern understanding, remote sensing of the Earth is considered through a set of measures aimed at obtaining information about any object or process without direct contact with it (Dovhyi et al., 2019), i.e., at a distance (Gibson, 2000).

Based on the given provision, the RSE is a type of information collection.

A feature of RSE that distinguishes it from other types of information collection is that it is conducted by using the method of observation from space, with the automatic satellites or from aboard spacecraft and manned orbital stations for various components of the Earth's environment.

The method of observation serves as the basis of such a legal means of gathering information as monitoring, which is a system of constant observation of phenomena and processes that occur in the environment, society for the purpose of their assessment, control and forecasting, the results of which serve to justify management decisions to ensure security people and objects/subjects, and which can be carried out with the help of electronic and other technical means from land, sea and space stations (Shemshuchenko, 2001).

According to the Preamble of UN General Assembly Resolution 41/65 dated 03/12/1986, its principles relate to the monitoring of the entire surface of the Earth, and therefore may include various types and directions of such monitoring, in particular: ecological (On the approval, 1998); emergency situations (Civil, 2012); fishing vessels (On the creation, 2004); military (On the implementation, 2023) etc.

Hence, RSE from space in its general form is the observation of the Earth, carried out from the most advantageous positions in outer space using the properties of electromagnetic waves that are emitted, reflected or scattered by probed objects (Malysheva, 2014).

Cameras placed on automatic RSE satellites and on board spacecraft and orbital space stations receive high-resolution images of the Earth's surface, the World Ocean, and the Earth's atmosphere. Herewith, energy, polarization and other physical characteristics of own, reflected and scattered radiation of observation objects are measured and fixed (Malysheva, 2019).

Considering the fact that the use of special devices for observation is the basis of the RSE, it can also be treated as the activity of operating the RSE systems or its individual elements, as well as the accumulation, processing, integration and distribution of relevant data, where the RSE system should be understood as a set of space and ground technical and informational means, which are functionally and organizationally interconnected and provide RSE. That is, it is a set of activities that help characterize the nature and/or conditions of phenomena on, above, or below the Earth's surface using observations and measurements from space platforms.

According to Principle I of the UN General Assembly Resolution 41/65 dated 03/12/1986, the "RSE activity" is the operation of space remote sensing systems for the processing, interpretation and distribution of the processed data.

Currently, such measures depend on the emission and reflection of electromagnetic radiation from the surface of the object being studied (In Search, 2024).

Depending on the source of the signal, there are two types of RSE – active and passive (Kohut, 2023).

A feature of the active RSE of the Earth's surface is that the sensors of the devices direct the signal and only after that analyse its intensity. They fully function regardless of the time of day. The following devices are used for this type of RSE:

- radar – a device employing the radar signals to measure the range, with the help of which the distance to the object under study is determined due to their reflection through the emission of radio waves;
- lidar – a device determining the distance to the object under study using light pulses and measuring the intensity of the returned signal, calculated by multiplying the required time by the speed of light;
- laser altimeter – a device that measures height using a lidar;
- range finders – a device that determines the distance using one or two identical devices on different platforms that transmit signals to each other;
- echo sounder – a device that studies weather conditions vertically by emitting pulses;
- scatterometer (reflectometer) – a device used to analyse returned (scattered) radiation.

This type of RSE is actively used in agriculture and forestry, during search and rescue operations, weather forecasting, etc.

In turn, passive RSE devices do not have their own source of energy, which would be directed to the research object or the Earth's surface, so their effectiveness is completely dependent on sunlight.

Such instruments include multi-spectral or hyper-spectral sensors that measure signal intensity using combinations of visible, near, thermal infra-red, and microwave channels.

These include a spectrometer, radiometer, spectroradiometer, hyperspectral radiometer, echo sounder and accelerometer.

One of the most widespread examples of passive RSE is recognized by the Landsat Program, with the help of which for more than 40 years satellites have been collecting and recording data about the planet that are in the public domain and include information that can be used in various industries: geology, cartography, ecology, forestry and agriculture, oceanology, meteorology, etc. (Ridwan et al., 2018).

RSE is widely used in the military sphere as well. Today, the RSE, in particular, allows monitoring of compliance with international agreements on the limitation of strategic weapons, solving other tasks of defence and security of states.

All data received by the satellite are instantly transmitted to receiving ground stations and can be accumulated for further transmission. Such receiving ground stations are located in different places and on different continents.

The information itself, which is obtained as a result of RSE, is defined as “digital files” containing data based on the geographical characteristics of the area.

Such information is processed in various ways, for example, receiving data; preliminary processing; data storage; distribution; analysis of information and use. In the first four cases, the initial stage with the participation of satellites that collect and then transmit information using telemetry, photographs or magnetic recording is discussed. In others, it is about the processing and analysis of received information by special subjects (Report, 1996).

Such subjects of RSE include operators (providers of satellite data), primary subjects of service provision (those that convert satellite data into various types of images), secondary subjects of service provision (those that receive information from primary subjects and make it according to the needs of end users), as well as consumers of RSE information (Malysheva & Hurova, 2020).

The activities of such subjects of space exploration are controlled by specially authorized authorities, represented at the international level by the United Nations Committee on the Peaceful Uses of Outer Space (International, 1959), and at the state level by the State Space Agency of Ukraine (On the approval, 2015).

The experience of advanced countries of the world shows that the use of data received from the RSE is mainly regulated by their domestic legislation.

An example of a special remote sensing management regime is the Canadian Remote Sensing Space Systems Act (2005). The legislation covers space-based remote sensing activities using one or more remote sensing satellites and their operational and data transmission facilities. Compared to the International Principles of Remote Sensing, this regulatory system applies to satellites operating both outside and under Canadian jurisdiction. This mode is aimed at protecting the final data for the creation of which remote sensing was carried out. Although this is an excellent regime for promoting commercial participation in remote sensing, it is somewhat inconsistent with the principles of international cooperation and open data sharing (Smith & Doldirina, 2017).

In turn, the US Land Remote-Sensing Commercialization Act (1984) establishes a closer reflection of these principles, “requiring private remote sensing operators to provide data to all potential users on the same terms.”

The German Satellitendatensicherheitsgesetz (en. Satellite Data Security Act) (2007) (SatDSiG) defines general requirements and regulations for satellite operators and data providers in the primary interests of national security as well as commercial security for sensing data. This structure facilitates large-scale commercial activity. Compared to the United States system, which aims for the “public good” when it comes to the dissemination of data in the national legal system, the German system is more focused on the protection of confidential data, regardless of its public or private funding (Schmidt-Tedd & Kroymann, 2008).

Consequently, the compared systems demonstrate the lack of a uniform international framework for managing information derived from RSE, which creates obstacles to the effective commercial use of data and adversely affects the reliability and authenticity of data for other purposes, such as evidence in court, climate change monitoring and timely response to disasters.

As noted in foreign literature, national regimes often do not exist to promote the goals of international principles, but rather focus on promoting national interests and protecting states from liability (Lee, 2020).

Despite the lack of a unified approach to the use of data obtained through RSE, it can be concluded that RSE is also a set of legal relationships that have a clearly defined purpose, subjects and objects.

The legal basis for the emergence of legal relations with space exploration at the international level is the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 1967, according to which all space activities are carried out for the good and in the interests of all countries, regardless of their level of economic or scientific development. Space activity is carried out by all states without any discrimination, on the basis of equality, with free access to all areas of the celestial bodies.

The member states of this Treaty may carry out such activities according to international law, including with the UN Charter. It states that bear international responsibility for all activities in outer space, including RSE, regardless of whether it is carried out by governmental or non-governmental legal entities. However, the 1979 Convention on the Transfer and Use of Data of the Remote Sensing of the Earth from Outer Space and the “Principles Relating to Remote Sensing of the Earth from Outer Space” approved by UN General Assembly Resolution 41/65 dated 03/12/1986 are recognized as special acts related to satellite remote sensing.

In Ukraine, there is still no special legal act that would regulate the field of remote sensing of the Earth. As a separate coordination and control authority of a specially authorized central authority in the field of space activity, the RSE is defined in the Law of Ukraine “On Space Activity.” The Law of Ukraine “On the National Infrastructure of Geospatial Data” dated April 13, 2020 defines the procedure for the creation, functioning and development of geospatial data, which are collected, including, with the help of RSE.

The draft Law of Ukraine “On State Regulation in the Field of Remote Sensing of the Earth” was approved by Decree of the Cabinet of Ministers of Ukraine No. 657-r dated 28/08/2013, but it has not been approved by the Parliament to this day. In 2021, the Government of Ukraine planned to give impetus to the development of domestic space activities by approving the Concept of the National Targeted Space Program of Ukraine for 2021-2025, however, due to the full-scale invasion of the Russian Federation on the territory of Ukraine, the implementation of this Concept is delayed. In this regard, the current regulations in the field of RSE on the territory of Ukraine are, in particular: DSTU 4220-2003 “Remote sensing of the Earth from space. Terms and definitions of concepts,” DSTU 4758-2007 “Remote sensing of the Earth from space. Data processing. Terms and definitions of concepts,” as well as DSTU 7894-2015 “Remote sensing of the Earth from space. Methodology of data processing. Procedure for development.”

According to the provisions of the UN General Assembly Resolution 41/65 dated 03/12/1986, activities related to environmental protection should be carried out in several areas – management of natural resources; improvement of land use; environmental protection, as well as to promote: protection of the Earth’s natural environment and protection of humanity from natural disasters (Principle X and Principle XI). However, today this activity is not limited only to these areas, but also includes applications in the field of meteorology, geodesy, geology, hydrology, oceanology, earth science and other areas, which gave an impetus to the development of such scientific areas as: space meteorology, space geodesy, space hydrology, space oceanology, space geology, etc. (Zabara, 2018).

Therefore, remote sensing can be considered as an interdisciplinary science, which contains a set of certain scientific knowledge, concepts, ideas about the features of remote sensing in various spheres of public needs.

Within the legal field, RSE is another type of space activity, which is regulated by international “soft law” instruments, as well as some national instruments, in connection with which legal relations regarding RSE constitute a comprehensive institution of space law (Hurova, 2022; Curriculum, 2011).

## **Conclusion**

Having analysed the above, we can draw a general conclusion that remote sensing of the Earth from space is an institution of space law, which consists of a set of legal norms that regulate social relations related to the use of special technologies on space vehicles, with the

help of which observation and collection of information from space about social, ecological and man-made phenomena and processes on Earth in order to substantiate management decisions to ensure international and national security.

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