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Tackling Climate Change by Space Technology: The Pathway of the International Law

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Climate change is one of the most important issues concerning with sustainable development of human beings and a branch of international environment law. Space technology, especially satellite technology, has been recognized as a feasible means to deal with climate change and is being applied more and more widely. Independently or cooperatively, states monitor the elements, process, and effects of climate change through satellite remote sensing, radar and other technologies in order to adapt and mitigate climate change. However, relevant policies and regulations remain at the level of encouraging the application of technology only and leave the blank in regulating the scope and means of the application of them, which might lead confusion and dispute sometimes. Overall, considering the outer space law and the governance rules of climate change issue are two independent branches of international law with respective characters, when designing the pathway for space technologies using in tackling climate change, there is a need for collaboration not only between the two branches, but also among the multi-stakeholders participating in this issue.

Keywords: climate change, space technology, framework convention, international cooperation

Introduction

While the rapid development of human industry and technology has led to economic growth and improved living standards, it has also posed increasingly serious threats and damage to the natural environment and the ecosystems, of which climate change is being one of the most significant impacts. The issue of climate change has already become a common issue for mankind, and with the leading by the United Nations, scientific research, law, and policy are directed to tackle this issue. Space technology, especially satellite technology, provides significant tools for human beings fostering climate adaption and mitigation. From the observations in outer space, the variable indicators of climate can be grasped in a comprehensive manner. Nevertheless, space technology is used for tackling climate change, and laws and policies are still at the initial stage of encouraging the application of technology with the gap of regulation. In other words, the law should not only support the application of space technology in climate change, but also paly the regulatory role in managing the scope, means, and methods of space technology addressing the climate change.

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This article seeks to fill that void by examining the characteristics of the outer space law and climate change law. After introducing the current usage of space technologies in climate change issue and relevant laws and policies, we raise concrete concerns including results sharing, national security, and the balance of private and public interests. We then assess the international rules governing climate change and emphasize considering those features in the regime of outer space law. Finally, we propose four methods to coordinate the application of space technology addressing climate change on international law.

Conditions and Problems of Applying Space Technologies to Tackle Climate Change Issue

Space technology is a heterogeneous scientific concept which is highly specialized, practical and rapidly developing, while the relevant laws and policies are far behind the development of technologies; thus legal problems may appear as a result.

Conditions

The perspective of the technologies. In general, space technologies applied in climate change issues are mainly satellite technologies, especially satellite remote sensing technology and global navigation satellite systems. Ample cases are in practice: the Copernicus programme led by the European Commission plans to develop six Sentinel Expansion missions to help address challenges including climate change (The European Space Agency (ESA), n.d.a). The Tender-X radar mission by the German Aerospace Centre (DLR) applies satellites simultaneously to image Earth's terrain from different angles with unprecedented accuracy (The European Space Agency (ESA), n.d.b), which contributes greatly to climate change issues. Pakistan uses hypertemporal remote sensing techniques, which means long-term, extensively repeated (daily) time series datasets of an area (Ali, 2014, p. 35); such techniques allow for more accurate representation and characterization of land cover and its changes. Whereas satellite techniques have been contributing to meteorological observation, the fact is that only a minority of countries master these techniques. Moreover, data collected by countries lack interoperability; a space-based information platform awaits to be built for sharing satellite images, sensing data, and other information and forming an early warning system.

The perspectives of laws and policies. Most of laws and policies are remaining in the initial stage of encouraging space technologies tackling climate change issues without systematic arrangement and regulation. Taking "Consolidated Draft 'Space2030' Agenda and Implementation Plan" subscribed by the Bureau of the Working Group on the "Space2030" Agenda in 2021 as an example, in the "Overarching Objective 2" part, it strengthened the use of integrated space applications to facilitate the observation of the climate to provide data for the indicators used to track progress in the implementation of the commitments by states parties to the Paris Agreement (UNOOSA, 2021). Even in the "Implementation Plan" part it proposed tools such as the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) and the International Space Climate Observatory; they still remain in design.

As for national laws and policies, representatives are the US and UK which have policies specifically designed for the space technologies using in climate change issue. In October 2021, NASA released Climate Action Plan, which mainly analyzed risks and challenges to NASA's space missions brought by climate change, and adjusted budgets to ensure access to space, response to risks and adapt climate change. UK initiated its first

National Space Strategy in September 2019, which focuses on fighting climate change with space technology and will strive to know how climate change impacts the Earth by using Earth-Observation (EO) technology, including by participating in Copernicus programme of ESA. Both the international and national laws and policies are general and lack of specific arrangement, not to mention regulation, which would result in some problems.

Problems

The most prominent problem is about result sharing. This problem generates between space powers and countries with vulnerable space technologies. It is the fact that countries facing with urgent threats from climate change issues are always weak in space industry; small island countries like Tuvalu are representatives. The increasing temperature of the Earth leads to glacier melting and sea level rising and threatens to submerge small island countries. If the countries mastering space technologies can share the results of Earth-Observation, damages to small island countries can be largely reduced. However, whether the space technology powers can be required to share the climate change information and how to share are practical problems that need specific arrangements.

Besides, remote sensing by satellites may raise countries' concerns about national security, for satellite observation can cover all corners of the world at any time. Rules regulating the boundaries of remote sensing and the handling of information relevant to national security collected via satellites are needed.

Also, as private enterprises become increasingly involved in space activities, countries sometimes rely on their advanced technologies to collect data about climate change. Then controversy may arise over the balance between commercial value and public interest in the ownership of the acquired data.

Status and Characteristics of International Rules for the Governance of Climate Change Issues

Overall, at present under the regime of international law, the outer space law and rules governing climate change belong to different branches and their legal characteristic differ in many perspectives. Therefore, it is necessary to understand the status and characteristics of the rules governing climate change issues to help these two branches align with each other when applying space technologies to tackle climate change.

Adopting the "Framework Convention" Model to Build the International Treaty System

In the regime of climate change, the "framework convention" model is adopted to establish a set of international rules. The conception of framework convention describes a type of legally binding treaty that establishes broader commitments for its parties and leaves a set of concrete targets either to subsequent more detailed agreements (usually called protocols) or to national legislation (Economic Commission for Europe, 2011). Essentially the framework convention serves as an umbrella document, laying down the principles, objectives, and rules of governance of the treaty regime. The framework convention model adopts in the condition that only political will for action is reached without consensus on details.

The framework convention for climate change issues is the United Nations Framework Convention on Climate Change (UNFCCC); the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) and the Paris Agreement are further targeted documents to the convention. The

UNFCCC sets the goal to stabilize the greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system" and proposes five general principles for the parties. The Kyoto Protocol puts quantified emission limitation or reduction commitment of greenhouse gases for the parties. When it comes to the Paris Agreement, specific arrangements for global actions tackling climate change are adopted, including nationally determined contributions (NDCs), long-term strategies, transparency and financial, technical and capacity building support for countries who need support. From the UNFCCC to the Paris Agreement, governance of climate change is not just a political slogan but practical actions.

Multi-stakeholders Participate in the Global Governance of Climate Change

The notion of multi-stakeholder partnerships has been embraced rather widely in the global environmental governance, being designated to solve the increasingly complex challenges that exceed the capabilities of any single sector (Pinkse & Kolk, 2012, p. 178). The sectors in governing climate change include but not limited within different levels of government (national, regional, subnational, and supranational), non-governmental organizations (NGOs), corporations, investors, and civil society. The NGOs and other private sectors are not parties to climate change conventions or other legally binding agreements, thus also called non-party stakeholders. Today, non-party stakeholders are more and more important to the mitigation and adaptation of climate change; they have been instrumental in providing studies, tools, and resources to help governments and other decision makers shape a recovery that addresses challenges that are in their field of vision (UNFCCC, 2020). Also the endorsement of market authority and a set of market mechanisms since the Kyoto Protocol creates opportunities for cross-border cooperation between multi-stakeholders (Andonova, Betsill, & Bulkeley, 2009, p. 58). In a nutshell, multi-stakeholders participating in global governance of climate change is a typical characteristic in this area.

Pathways of International Law for Space Technologies to Tackle Climate Change Issues

As previously mentioned, in the perspective of applying technologies, space technologies are more and more wildly being used for tackling climate change issues while both international and domestic laws and policies lack specific regulation. Therefore, this article proposes the following pathways from the construction of the rules to the implementation of specific ideas.

Promote the Formulation of International Soft Law

In the regime of outer space law, the tendency is that the international community increasingly resorts to and relies upon what are typically referred to as soft law instruments to set out additional principles relating to the exploration and use of outer space (Freeland & Zhao, 2020, p. 413). Beyond the legally binding treaties, soft law instruments can be in the form of resolutions by the UN General Assembly (UNGA) and various guidelines and codes of conduct. The focus on soft law is mainly because in sensitive areas and topics, soft law can help the relative parties reach a consensus without worrying about legal obligations. Similarly, emerging environmental issues are highly complex and sensitive, and urgently require the international community's quick response. Global environmental risks cannot wait for the lengthy process of countries making and ratifying agreements, as

well as sufficient practices and *opinio juris* for establishing customary international law. In this manner, soft law makes great significance.

Therefore, to regulate space technologies applying to climate change issues, promoting the construction of international soft law should be put as a priority. Declarations should be released to set boundaries for using such technologies, especially limiting the utilization of the satellites for military purposes. Nowadays the satellites are generally dual-used ones for both military and civil objectives. Commercial satellites' ability to capture and analyze data and turn it into useful intelligence is known in military speak as tactical space-based ISR (intelligence, surveillance and reconnaissance), and there is an emerging demand for new types of data now being collected by commercial satellites such as radar imagery (Spacenews, 2022). Accordingly, countries need to make declarations to limit their use of data collected by satellites. Also, codes of conduct and guidelines should be formed to direct countries to apply technologies and cooperate with each other.

Enact Specialized International Rules Based on the "Framework Convention" Model

Although soft law has great influence in certain areas, it is the fact that soft law is not law; the propositions of soft law are important and influential, but do not in themselves constitute legal norms (Shaw, 2017, p. 389). In other words, only by turning into hard law can the state parties be bounded as well as restrict their behavior and even their sovereignty (Abbott & Snidal, 2000, p. 422). Considering that the framework convention model has been long-time adopted in governing global climate change and the above-listed advantages of this model, in the cross-field of space technologies usage and mitigating and adapting climate change, framework convention model is also suggested. From general actions in tackling climate change to specific arrangements for applying and limiting space technologies usage, a set of international rules can be developed.

Determine general principles and objectives. Initially, it is necessary for the international community to unanimously approve a framework convention including general principles and overall objectives of applying space technologies to tackle climate change. The overall objectives should align with objectives set by the Paris Agreement. The Paris Agreement sets a goal to limit global warming to well below 2 ℃ and pursue efforts to limit it to 1.5 ℃ by reducing emissions; thus, space technologies should be used to observe climate indicators and collect data and issue alerts. The objectives represent the international consensus that space technologies are encouraged to use in climate change issues.

After setting overall objectives, there should be general principles for countries to take actions. Firstly, it is important to encourage new technologies' development and usage; efforts should be taken in the scope and accuracy of the observation. Then states should cooperate with each other, especially for the countries which are weak in space industry but threatened by climate change tightly. Since climate change is a global issue, no country can stay aloof. Moreover, that states are all equal is the basis of international order thus respecting all the sovereignty should be a basic principle. Last but not the least, when using space technologies in the outer space, both the environment of the earth and the space should be protected without contamination. The general principles are not limited to the four principles as listed above; it needs the joint efforts of the international community to work together to determine.

Provide supporting mechanisms for the application of space technologies. The creation of the Space for Climate Observatory (SCO) dates back to 2017 within the framework of the One Planet Summit, which organized

in Paris at the initiative of President Emmanuel Macron. And it was officially launched in June 2019 when 23 space agencies and international organizations signed the Paris Declaration "Towards a space Climate Observatory" (Space for Climate Observatory, n.d.). The SCO is designed as a world observatory of the climate change and its impacts from Earth-Observation data, in order to monitor climate change, track the impacts of climate change, and help in mitigating and adapting to climate change. The SCO, to some extent, is a hardware facility dealing with climate change issue. Another facility, The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), which is proposed in 2006, is also considered as a tool to contribute to climate change issue (UNOOSA, 2021). Both the hardware and software facilities need supporting mechanisms to play their roles. The supporting mechanisms can be designed align with the phases of implementing space technologies to tackle climate change issue.

The implementation of space technologies to climate change issues mainly focuses on using satellite-based Earth-Observation tools, collecting data of various fields and providing a tool for decision-making on preparedness, adaptation, and resilience to climate change and its impacts. First of all is about the Earth-Observation, and the SCO is indeed an appropriate platform to study and monitor the impacts of climate change, but its smooth operation needs supporting mechanisms. A good example is the International Space Station (ISS), which has been the most politically complex space exploration program ever undertaken (NASA, n.d.). From the launching to construction and operation, the ISS brought together space agencies of the United States, Russia, Europe, Japan, and Canada. There is no doubt that the ISS is an ambitious international collaboration, but the fact cannot be neglected that accidents happened frequently such as air leaking in Russian module (Space.com, 2021), cooling system failing (EXTREMETECH, 2013), and oxygen generator problem (Spaceflight Now, 2006). From the construction to operation and maintenance, a set of mechanism for coordination is necessary, and when accidents happen, timely responses should be distributed. Different participants differ in aspects of finances, technologies, facilities, and so on; also the political positions and relationships between the partners can influence the co-built programmes. Therefore, an authority institution or managing department should establish to coordinate the construction and operation of the SCO and the UN-SPIDER, and balance the interests between the participants.

The data collected by the Earth-Observation are crucial for monitoring and dealing with climate change issues, while there is a dilemma about the usage and conservation of the collected data. On the one hand the Earth-Observation results benefit the human beings as an integral part which calls for the result sharing; on the other hand, since the contributions to the access of data differ between the countries, direct sharing may lead imbalance and the ownership of results needs to be clarified. To deal with the dilemma, similar as the plan to construct and operate the SCO as stated above, the data should be conserved and managed by an authority institution or department. Further a set of mechanism for the management of the data should be designed, and the most important one is the transparency mechanism. From the perspective of tackling climate change issues, relative data should be opened to all the states, especially for states who are urgently threatened by climate change. Moreover, considering that not all the states are able to analyze the collected data, the institution should form a panel of experts to analyze data and provide warning to the countries. Then the institution should conserve and archive the data for a long-time trend analysis. From observation to data conservation, such an institution or

department would play a vital role and supporting mechanisms as stated above would help space technologies smoothly apply in dealing with climate change issues.

Set boundaries to individual countries to collection and distribution of data related to national security. Space-based Earth-Observation is a consolidated capability providing added value to reach information superiority, a crucial enabler for operations in both security and defense domains (Dolce et al., 2020). This proves from the opposite site that data collected by satellites may be related to national security, thus leading countries to concern about setting limitations or enacting regulations. A few of countries have already taken actions in making national Earth-Observation data regulations such as Canada, France, Germany, and so on. In Canada, the Remote Sensing Space Systems Act requires all remote sensing space system operators (whether government, military, or civil) to obtain remote sensing licences prior to operating their satellite systems. More importantly, Canada's Minister of Foreign Affairs has powers to request priority access to data collected by a remote sensing system, to order an interruption of service if necessary to protect national security (Harris & Baumann, 2021). However, not only national security and defense should be considered, but also foreign policy, international relations, and states' international obligations need to be treated prudently. Considered the high-speed of development of space technologies and the active participation of private sectors in space regime, it is necessary to set boundaries to individual countries about collection and distribution of data related to national security on the international level.

On the international level of binding states to collect and distribute the Earth-Observation data, the premise is to clarify the definition of the legal basis for the limitation. In other words, national security is frequently claimed as the foundation of such limitation, but national security is a relatively broad concept which needs to be elaborated how it can affect data collection in this context. Today's national security includes the security of the society, security of the state and the state's participation in international and global security. The post-Westphalian national security implies the state of unhindered implementation, development, enjoyment, and optimal protection of national and state values and interests; both the individual and the collective have no fear of being endangered, instead the sense of serenity, certainty, and control over the future events and developments of importance for the life of society and the state (Mijalković & Blagojević, 2014). International law provides protection of national security by principles such as sovereign equality of the states, non-intervention in matters which fall within national jurisdictions of the states, resolving international disputes between states by peaceful means and so on. Both the connotation of national security and principles under the international law point to the approach of protecting national security, which is the national law. Since the critical interests and state values are naturally and reasonably decided by states, standards for actions violating national security are inconsistent. Data concerned with military affairs or scientific research are confidential; moreover, precise maps of a foreign nation with real-time updates might be seen as surveillance of the nation. To keep the international rules stability, basic principles of the limitations of the collection and distribution of the Earth-Observation data should be set. Types of data which are sensitive and critical to the states that are prohibited to collect or distribute need to be elaborated, and states could make consensus and commitments to not observe and collect data of other countries for military purposes and respect for other countries' national security. Then more detailed regulations can be made to constrain private entities collecting and distributing the Earth-Observation data.

Strengthen Cooperation Between Multi-stakeholders

As has elaborated above, both the legal and practical aspects indicate that the climate change issue needs participation of multi-stakeholders; thus, enhancing of cooperation between the stakeholders is an essential pathway to tackle climate change. From the perspective of actors participating in action of mitigating and adopting climate change, the cooperation can be divided into two levels.

Cooperation at the national level. The calling for the cooperation between nations has been addressed since the emergence of the global governance of the climate change issue. The UNFCC in its Article 3 of principles determined that efforts to address climate change may be carried out cooperatively by interested parties, and lead to sustainable economic growth and development in all parties, particularly developing country parties, and enabling them better to address the problems of climate change. In fact, in climate change regime, the demand for cooperation is substantial and efforts are sustainably taken, such as setting mechanisms like emissions trading and joint implementation under the Kyoto Protocol and listing areas for cooperation like early warning systems, emergency preparedness, and so on under the Paris Agreement. As for the cooperation in tackling climate change by using space technology, the focus is on the technology. The development of space industry varies greatly in different countries; the less developed countries are always more fragile in combating with climate change. It is well-known that the less developed countries need support of funds and technology, but a further step should be considered about how to motive space powers to cooperate. Incentive mechanisms or market mechanisms can be introduced as the motivation, and this needs a joint discussion of the international community.

Cooperation at the sectorial level. From the perspective of sectors participating in space industry, the private sector cannot be ignored. Therefore, cooperation at the sectorial level focus on what between the public sector and the private sector. Generally, the public sector plays the central role in designing plans and policies for the nation's development of space industry and provides regulatory oversight, while the private sector performs actively in the market and is adept at innovation. As for the issue of tackling climate change by using space technology, the issue itself has a public interest in nature, and then it is the task of the public sector to make attractive policies that encourage private entities investing and researching in this area.

The cooperation between the public and private sectors in space regime leads to the problem of leveraging interests and risks. The private entities aim at achieving economic interests in the essence; thus, the frequently used method of cooperation is by signing service contracts. Then the ownership of data should be confirmed by the contract, so as to avoid the data which might be sensitive, to be distributed by the private entity. The leverage of risks is concerned with the liability. Satellites operated by private entities causing collisions or other incidents may possibly lead to the national liability, especially under the control or commands of public sector. In other words, states take responsibility for not only governmental space objects but also private ones. Therefore, states should be prudent with the threshold of private entities participating in space activities. Overall, public sector should encourage private sector's participation as well as fulfill its regulatory obligations during the cooperation.

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