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Intelligent Treaty Systems and The Future of International Law

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ABSTRACT

Ensuring that multilateral regulatory treaties fulfill their stated purposes is important to solving many intractable global problems. Despite immense challenges, the prospects for achieving these aims have improved in recent years with the emergence of what I term Intelligent Treaty Systems (ITS). I define ITS to include five core capacities within treaty regimes: sensing and generating data, gathering and storing data, processing and analysing data, creating models, maps, and visualizations of data, and applying data to targets and indicators. I argue that, taken together, ITS has potential to improve the ability of state parties and relevant stakeholders to manage treaty operations, monitor implementation, and measure and improve treaty performance. These enhanced capabilities may constitute a new basis for treaty implementation and compliance, thus supplementing prevailing explanations of treaty compliance such as managerialism, reciprocity, rational choice, or reputation. Despite this potential, the technologies used in ITS raise significant legal and ethical challenges, which may impede their use in treaty practice. In the final part of the Article, I offer suggestions for future applications of ITS and ways of improving its utility and mitigating some of the potentially negative consequences from its use.

Keywords: Artificial Intelligent, Intelligent Treaty, International Law

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1. BACKGROUND TO THE STUDY

Demands to improve the results from treaties designed to regulate major global problems mount as evidence of global environmental destruction, human rights abuses, and the risk of armed conflict accumulates. Despite significant concerns about the ability of multilateral agreements to help overcome these problems, the prospects for strict adherence to such instruments and strengthening their regulatory impact has potentially been enhanced in recent years through a variety of new technologies. Included are an array of remote sensing and Internet of Things (IOT) tools, high-speed and high-throughput communication infrastructure, enhanced data collection and storage systems, and machine learning tools for data classification and analysis.

Following usage in high-tech circles, I have coined the term Intelligent Treaty Systems (ITS) to refer to the combination of these capabilities. Together these applications and instruments have dramatically improved the ability of treaty secretariats, international organizations, states, research communities, academics, nongovernmental organizations (NGOs), and other stakeholders to: assess background conditions relevant to treaties' purposes and mandates, devise

2. RELATED LITERATURE

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3. See infra-Part II (defining the elements of ITS)
4. See generally THOMAS F. MCINERNEY, STRATEGIC TREATY MANAGEMENT: PRACTICE AND IMPLICATIONS (2015) (describing and analysing the ways in which treaty bodies can use strategic management tools to drive performance improvements in multilateral treaties).
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3. FINDINGS

In recent years, high-tech innovations have transformed many aspects of our world. The influence of technology on business, government, education, healthcare, and our daily lives has been tremendous. It should not be surprising then that these developments are having major effects on all aspects of multilateral treaties. Considering only one aspect of this revolution, that is, the development of artificial intelligence (AI), Sam Altman, chief executive of Open AI, has said that "[t]he AI revolution will be more consequential than the agricultural, industrial and computer revolutions combined. While the precise impact of AI is difficult to assess, it seems clear that international law, as well as society generally, will be substantially affected by these trends. The application of technology to multilateral treaty implementation has been examined by other authors. However, there are notable limitations. Studies in international law have focused on the application of certain types of technology to environmental, human rights, and arms-control treaties, but they generally do not probe the legal and policy issues in any depth. Other studies have considered the implications of big data and remote sensing for international law. Although providing valuable insights, what is missing in these accounts is a view of the full range and ever-increasing power of the technologies being used for treaty-related purposes, as well as the intricate ways in which they interconnect and interact.

Through the concept of ITS we can gain a better view of the complete ecosystems of technology employed in different treaty regimes and the complex workflows that have emerged; providing insights that may contribute to improvements in their design and management. From another perspective, although the understanding of technology's role in international law has lagged adoption, the technologies discussed in this Article are the subject of extensive research in the scientific communities. These studies entail a different limitation: they typically address technical and scientific issues involved in analysing, monitoring, and implementing aspects of multilateral treaties, yet do not generally offer analysis relevant to international law as such. This Article seeks to engage with the scientific and technology communities to understand how they are contributing to international legal processes.

This Article is the first to examine the application of these various technologies to multilateral treaties in an integrated fashion that identifies and traces the intricate workflows, interconnections, and synergies between them. Understood in this way, the innovations occurring are even more impressive. Moreover, while research on applying distinct technologies to specific areas of international law has occurred, there has there been no effort to consider their application to multilateral treaties generally. As I will seek to show, the generic workflows and methods used across diverse treaty regimes are quite similar in the basic processes and tools they use. This finding raises the question of the desirability of maintaining distinctive approaches for specific treaty regimes, or whether some sort of consolidation or common approaches to ITS across diverse fields of international law may be appropriate. The vibrant use of technology for treaty monitoring and implementation that this Article describes stands in contrast to the scepticism often expressed about the status and value of hard-law international agreements.

4. THE ELEMENTS OF INTELLIGENT TREATY SYSTEMS

The notion of Intelligent Treaty Systems derives from studies in computer science and information technology. The notion of intelligent systems generally refers to the complex of multiple interrelating technologies that, taken together, constitute powerful new operating systems for diverse applications. Management consultant Gautam Shroff models intelligence as the outcome of multiple processes, with intelligent systems referring to a series of technological capabilities that involve sensing, learning, connecting, predicting, and correcting.

As framed in this Article, ITS includes an array of technologies, each powerful in its own right, yet delivering more powerful results when integrated. ITS combine multiple technologies to further the abilities of parties and other stakeholders to monitor, manage, and implement multilateral regulatory treaties. In this Article, I will examine treaty regimes in diverse fields to illustrate the specific elements of ITS they employ.

A. Sensing: The first element of ITS, sensing, refers to enhanced capacities for identifying, documenting, and quantifying phenomena in the physical world relevant to treaty purposes. Aside from state reporting, historically, much of the work of monitoring treaty-related issues required direct observations by researchers in the field. As with technology's impact on the wider social world, many of today's observational techniques were unavailable until recently. Admittedly, remote sensing (RS) devices constitute a significant share of the modalities for treaty-related monitoring but are far from the only ones. Today much of the observational work involved in treaty performance monitoring, implementation review, or supporting scientific assessments employ some type of RS technologies. As these technological capabilities increase at a truly exponential pace, their power and utility are growing as well.

The sensing devices available today are becoming vastly more powerful than their predecessors. Key features that make them more powerful include portability, reduced size and miniaturization, improved sensitivity, frequency of measurements, quality of measurements, reduced power use, long-term battery power, connectivity (particularly cellular and Internet), and greater autonomy and functionality. These changes have made monitoring more powerful across many treaty regimes. RS also allows access to sites that otherwise might not be reachable. Distant locations, hazardous areas, and inaccessible sites make RS particularly useful. Not only do these capabilities enable monitoring on a larger scale but they also reduce the potential impact on the environment and matters under observation. Repeated visits by researchers to sites can cause damage to the environment or, depending upon the situation, can be dangerous. RS techniques for many areas of treaty related monitoring can avoid both concerns.

B. Data Collection, Communication, and Storage: Data collection, communication, and storage through information and communication technology is a second core element of ITS. In the treaty context, as in society generally, data flows are increasing exponentially. Overall, global production of data is increasing at a level of fifty to sixty percent per year. The amount of data that can be generated by different sensing technologies can be truly astounding. IOT applications, such as devices for in situ monitoring of species, can generate fifty terabytes of data per year from just one site. Likewise, one private satellite company produces eighty terabytes per day. Biodiversity data housed in the Global Biodiversity Informatics Facility (GBIF) increased 1,150 percent between 2007 and 2020. A major concern with these activities is the environmental risks, although much attention is being devoted to addressing the issue.

Moreover, these trends are accelerating. It is expected that the amount of data being gathered through all IOT applications globally will increase from petabytes to exabytes of data annually. A significant share of the increase is due to the inclusion of data heavy materials such as video, photographs, satellite imagery, and audio materials. For this massive increase in data collected to be usable, storage and computing capabilities must improve correspondingly. Gathering data involves communications systems used to transmit data and the storage systems where they reside. Communications systems include Internet, cellular systems, and RF. Across all elements of ITS, Internet connectivity plays a huge role in transmitting raw data as well as sharing data among research communities. The growth of mobile communications devices with Internet connectivity has been a critical enabler of data transmission. Data obtained through remote-sensing devices rely on a variety of technology and communications infrastructure to gather and store the material.

Off-the-shelf sensor hardware increasingly may include bundled transmission radios and onboard processing capabilities. The sensor devices located in remote areas are connected through communications networks which are in turn linked up to base stations, which transmit data through Internet, satellite, microwave, or cellular networks, or alternatively store the data until it can be recovered at the end of a monitoring period. This data can then be uploaded to cloud servers or retained in stand-alone data centers.

Likewise, for data from space applications, ground stations are an increasingly important component. Data transmitted by EOS is generally in the form of analogy RF signals, which must be converted into digital signals by ground station antennas. The market for these services is developing rapidly alongside the development of the commercial space industry. Previously, ground stations were owned primarily by governments. To address the needs of the rapidly expanding space industry, IT companies have begun offering complete integrated solutions for EOS data capture, server or cloud storage, global transmission through fiber optic networks, and data processing. As in all other aspects of the economy, the business model for satellite services is moving away from fixed to variable costs, with ground station as a service (GSAS) emerging as a product. Already, major IT companies from Amazon Web Services, Microsoft Azure, and others are competing in this market. Across these applications, cloud computing is facilitating data gathering and storage on a variable cost basis and providing highly scalable access to computing and storage for researchers and applications operating in remote locations.

Use of enterprise owned servers is decreasing, yet many historical data are contained in such hardware. These capabilities have been crucial in enabling the use of big data for a range of treaty purposes. Cloud computing offers many benefits, but the simplest way to understand it is that it has made mainframe data storage available to individual users working at a distance. The growth in cloud computing has been a boon for scientific research, including in relation to treaty matters. Collaboration among researchers has been significantly enhanced. Previously, researchers could collaborate through conventional Internet, telephone, or traditional mail applications, however, sharing data and working from the same materials was a much greater challenge. Inevitably, actors would forget something or fail to finish activities crammed into short occasional trips. Today, researchers from all continents can collaborate with others around the world much more effectively. Among these benefits is to facilitate bringing researchers in the Global South into international research networks.

Data can be collected through multiple channels simultaneously and analysis performed jointly. Cloud computing can be done either using private infrastructure consisting of an entity's own hardware or public infrastructure, which involves the use of shared platforms. For many organizations, the latter type of arrangement is preferable. Most of the large cloud computing vendors bundle data and statistical analysis services with their computing and storage products. These include infrastructure as a service, platform as a service, software as a service, and data as a service. An additional benefit of cloud computing is that users can receive information on their preferred devices, including mobile instruments. The information is also available to any user, anywhere, at any time.

C. Data Processing and Analysis: While it might seem that ever larger quantities of data could be an unmitigated good, a common constraint all ITS face is the difficulty of analysing the firehose of data that the sensing-transmission-storage complex generates. Data gathered through IOT used in species monitoring, for instance, may include two orders of magnitude more data than would be gathered by observers in the field in the past. Rapid and exponential improvements in data processing and analysis for learning and identifying connections between data—the third element of ITS—are thus a crucial means of managing these conditions. The use of RS and digital observation tools is tightly connected to data science tools such as machine learning, which is used to process and analyse this data.

Notwithstanding the robust debate about the potential of artificial intelligence, the real workhorse in all of the treaty-related technology described here is machine learning. Data processing involves a fairly standard set of activities used by researchers who study aspects of treaty regimes across a range of different disciplines. These processes can be broken down into three main steps. The first is authentication, whereby data is checked to ensure its validity. The second step involves verification in which data is examined to determine the identity of the object or persons believed to be captured in the data.

Third is a process of classification or coding of the data to assign categories that can be used for subsequent analysis. Tremendous improvements in these processes have become possible in recent years through massive growth in computing power, which has now become widely and economically available through bundled cloud computing services and distributed computing. To analyse gigabyte and even petabyte size datasets, parallel computing algorithms and scalable architecture are needed. In addition, individual software packages, such as the statistical language and ArcGIS, consolidate multiple software packages in single environments and enable multidisciplinary contributions in integrated platforms. The combination of improved computing power and Internet connectivity has facilitated dramatic improvements in machine learning, which is critical to data classification.

Machine learning and its progeny, deep learning, are enabling automation of critical activities, improving efficiency, and increasing data throughput. Historically, classification was carried out manually by researchers or data scientists. One of the biggest challenges facing data science is reducing the amount of human analysis of data. Increasingly, these processes are becoming wholly or partially automated, which is delivering orders of magnitude improvements in the volume of data that can be processed. The automation of data processing and classification can facilitate significant increases in data throughput, quality, and speed. By removing the need for human analysis of data, we can not only gain real-time imaging of occurrences like mass human rights abuses but also crucially real time analysis of patterns and practices. Essentially, machine learning and AI are shortening the time lag between data generation and analysis.

The process of gathering and analysing data proceeds oftentimes in an iterative fashion. One of the benefits of machine learning is that: computer scientists do not hard code rules of action that a system uses to do the exact same thing every time; rather, they give the system the capacity to recognize patterns, trends, or categories in “training” data provided by the programmer and then to use those discoveries to analyse another set of data that has not yet been processed. Moreover, researchers are continuously engaged in processes of identifying better ways of gathering data and analysing the results. Models that have been developed based on available data can be refined and updated as new data, which can be used to train subsequent algorithms, becomes available. These developments suggest that existing capabilities will only improve with time. Similarly, deep learning works by employing computational models composed of stacks of processing layers that are iteratively applied to data to obtain increasingly refined representations of the data. Deep learning enables scaling of machine learning algorithms by automating the process to apply much

5. CONCLUSION

A key theme that emerges from the foregoing discussion is the way in which all of the processes described are viewed ostensibly as value-neutral and objective in nature yet in reality entail value judgements that can influence the outcomes of treaty processes. From the analysis of the role of ITS in the different treaty regimes studied here, it does not appear that there are easy answers to many of the questions raised. While many of the issues are common to all ITS components, the concerns often differ in nature and degree between different treaty regimes. An important question is whether different treaty regimes require sui generis approaches or whether value can be obtained by adopting common standards across different fields.

Given the novelty of ITS and its continued development, we can expect that here, as with society generally, norms and rules governing our increasingly digital societies will continue to evolve in response to new challenges, experience, and better understanding. Ultimately, the value of ITS is to expand the knowledge basis for multilateral treaties, not provide the final answers or definitive truths. At each stage in the processes, judgments must be made about what to measure, how to measure it, how to process the resulting data, how to interpret them, and how to present them.

As the discussion of epistemic considerations above illustrates, our conception of science must accept its limitations judged even on the standards of conventional scientific communities. This understanding does not lead inevitably to a form of relativism, as philosophers such as Jurgen Habermas have shown. In responding to critiques of knowledge by postmodern thinkers, Habermas acknowledged that efforts to define some universal basis for knowledge as epitomized by Immanuel Kant could not be sustained. Knowledge, he argued, is inherently intersubjective and discursive. Only by engaging in deliberation among a wide range of actors can we determine the truth. Hence, the use of ITS must be viewed as not only supporting deliberation and decision making within multilateral treaty regimes, but also the development.

6. RECOMMENDATION

As Part II reflects, ITS affect many aspects of multilateral treaty practice including compliance, implementation, verification, and the knowledge base for assessing and adjusting performance. There may also be ancillary benefits from the use of technology, which, while not the basis for the initial decision to adopt treaties, confer important societal benefits. I would like to focus on specific contributions of ITS including efficiency, better information, and data, continuing technological advancement, stimulation of communities who support and carry out work in furtherance of treaty purposes, and contribution to compliance and regulatory performance. Across the regimes examined, ITS is having important effects on the over all efficiency of the relevant instruments. These enhancements cut across all elements of ITS. Sensing technologies are enabling observations and insights on a scale and scope previously unattainable. Data storage capabilities enable the speedy retention of data and make them available throughout the world almost immediately.

For many applications, the range of data science techniques available to analyse and process these data is providing orders of magnitude improvements on what was possible in the past. Improved data processing facilitates more sophisticated models and user-friendly visualizations for decision making. Collectively, they contribute to improved monitoring of treaty performance against relevant indicators. Overall, as technologies are becoming more powerful, many applications are becoming more user-friendly and accessible to non-technical persons. Together these improvements in efficiency can reduce the amount of effort devoted to taxing mechanical processes, thus conserving researchers' and officials' time for higher valueadded analysis.

Likewise, despite the increase in the power and information available, all of these tasks are being done more cost-effectively, which can conserve resources. Not only are ITS enabling efficiency improvements, but the scope and quality of information being generated by these systems are improving significantly. Increasingly the knowledge base associated with multilateral treaties is truly global. Initiatives like Global Fishing Watch already provide global scale, near-real-time information. Landmine monitoring, while based on national mine action programs, offers broad understanding of mine contamination in nearly all affected countries. Climate change research offers

7. FUTURE WORKS

There are a number of implications for the development of ITS. In addition to addressing some of the potential shortcomings, there are number of steps that can be taken to build on the capabilities that ITS creates. Among these approaches are factoring in ITS in designing multilateral treaties, building infrastructure to enable ITS to support multilateral agreements, intentionally cultivating ITS through strategies and decisions of treaty bodies, taking steps to promote cross-regime interoperability through ITS, and capitalizing on the capabilities ITS enables to achieve more dynamic and responsive governance and regulation. Understanding the capabilities created by ITS is a first step to unlocking its potential.

The regimes studied reflect tremendous progress in building the infrastructure to support ITS. Much of this activity has been carried out through decentralized processes or has emerged through gradual developments within treaty regimes with support from stakeholders. The data infrastructures created for some of the treaty regimes described in this Article provide a view to what may be done in the future. It is unclear what form these initiatives need to take

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