EPICENTERS OF CLIMATE AND SECURITY: THE NEW GEOSTRATEGIC LANDSCAPE OF THE ANTHROPOCENE

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Capturing Climate and Security Risks Through Satellites and Earth Observing Technologies

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Introduction

It has been well documented that climate change is producing rapid physical changes globally.[2] Some of these changes are observable over short periods of time, while others are only discoverable when comparing the current geographical system to that from thousands of years ago, and are, therefore, less obvious.[3] Climate change has altered the underlying fabric of how communities and cultures exist and cooperate with each other, and this is largely through the physical changes that have occurred in a local context.[4] As globalization and increased sharing of the world's resources increases, diminishing resources in certain geographic locations are quickly becoming problematic and proliferating negative consequences globally.[5]

Some of these geographic locations that are experiencing radical physical changes are simultaneously experiencing political economical changes as well. The geopolitical significance of these changes can be significant; some of these local vulnerabilities can create "epicenters," where there are serious implications for global security. Understanding the emerging risks around these epicenters is of the utmost importance, and understanding how to prepare for and mitigate these risks is the responsibility of all stakeholders in the larger, international context. Satellites and Earth Observation technologies are among the best means for observing how the world is climatically and geographically changing, and should be used going forward as a key tool for decision-making by policy-makers and other key stakeholders.

Earth Observation Technology

The first images from space were taken on the sub-orbital V-2 rocket flight launched by the United States in 1946.[6] From then on, taking images of the Earth from space became a national interest. The first satellite to orbit Earth was in 1957, when the Soviet Union launched Sputnik I.[7] The "Space Race" between the United States and the Soviet Union created accelerated "remote sensing" – scanning of the earth by satellite or aircraft to obtain information about it. Increasingly sophisticated remote sensing instruments were created and placed aboard satellites and aircraft to monitor the Earth's surface.

Moving forward to 2017, there are approximately 4,300 satellites orbiting Earth according to an index maintained by the United Nations Office for Outer Space Affairs (UNOOSA). Approximately 380 of these satellites are being used for Earth observation by both the private sector and governments.[8] In addition to satellites, drones - or Unmanned Aerial Vehicles (UAVs) are they are also commonly known - are becoming an increasingly important tool to collect data about the Earth and how it is being used.

Earth Observation (EO) technologies are vitally important to our understanding of the physical changes affecting the world. These EO technologies are primarily used to do three things; first, to collect data that allows constant monitoring of the variation in climate over time. Second, to allow a process of "change detection" to take place, whereby precise measurements of how geographical locations are changing over time. Third, to use satellite and drone observation in near real-time monitoring and precise response to climate-related events. Being able to observe the Earth in such a granular manner allows not only constant monitoring of the changes that might bring about negative consequences, but the collection of vast amounts of data also enables the scientific models that measure climate change to become predictive, thus allowing better planning around future likely changes.

Emergent Risks

Secondary Effects of Climate Change

Climate change has brought about very specific physical changes that satellites and drones are able to detect easily. There are, however, secondary and tertiary effects of climate change that are harder to observe directly. One secondary effect associated with climate change is a global increase in natural disasters. In 2015, the United States National Oceanic and Atmospheric Administration (NOAA) released a report "Explaining Extreme Events of 2014 from a Climate Perspective". In the report, a team of international scientists revealed that 50% of the weather extremes experienced in 2014 were influenced by human activity-related climate change. These events included droughts in Syria, a Himalayan snowstorm in Nepal and extreme flooding in Canada. According to the United Nations Office for Disaster Risk Reduction, 90% of recorded major disasters from 1995 to 2015 were linked to climate and weather, including floods, storms, heat waves and droughts. The prediction for future weather events is unanimous among climate scientists: there will be an increased number of natural disasters, and the severity of these disasters will be heightened.

Another secondary effect of climate change is the impact on available natural resources in a given geographic location. In many instances, climate change has led to either a reduction in or removal of natural resources available to communities or states, thus placing heightened or extreme pressures on regions as harsh resource constraints and degradation sparks domestic instability. Scarcity of food and water poses the greatest hazard. Conflict over food and water scarcity is not new in the age of climate change; however, with the drastic rate of change of global temperatures, these conflicts will become more pronounced and frequent.[9] The effects of some of these conflicts have already been seen; there is substantial academic literature relating the Syrian war to water shortages and the Arab Spring, and particularly the Egyptian Uprising to food shortages.[10]

Both natural disasters and natural resource disturbances are easily observable with EO technologies such as satellites and drones. Natural disasters can be very quickly detected through satellite and drone imagery; they are physical in nature and chaotic in behavior.[11] Using methods of change detection in imagery, which have been implemented for several decades, satellite imagery can very quickly detect a natural disaster. They also can be used in certain stages of the disaster management cycle as outlined by the United Nations Office of Disaster Risk Reduction (UNISDR), namely response, rehabilitation, reconstruction and recovery.[12] Given its ability to collect mass amounts of unbiased data very quickly, especially in conditions that are too dangerous for human data collection, EO data is exceptionally useful for measuring, monitoring and even predicting secondary effects of climate change.

Tertiary Effects of Climate Change

Tertiary effects of climate change are much harder to measure through EO technologies, although satellites do play a very vital role. In this instance, third level effects of resource insecurities and natural disasters are largely intertwined with the downstream effects of socio-economic and geopolitical stresses, which can inevitably lead to human disasters. The United Nations deals primarily with response to humanitarian needs and emergencies resulting from conflict and global challenges from climate change and environmental degradation.[13] Humanitarian disasters are defined as single event or series of events that threaten the health, safety or well being of a community or large group of people.[14] In this instance, famine, the migration of communities and increased conflict are major areas of global concern. It is important to note that these second- and third-level effects often feed into each other and themselves,[15] but to simplify the response to such effects, they usually are treated as independent.

Of these effects, famine and migration are the most difficult to record both on the ground and from aerial EO systems. Satellite imagery has a refresh rate of approximately three days in developed, populated and urbanized areas. However, humanitarian disasters are most prevalent in geographic locations that are not observed by highly refreshed satellites, and thus tracing the movement of people is very difficult when the movement is much faster than the ability of a satellite to capture it. To get around this problem, satellite imagery, and especially imagery captured by drones, has been used to observe refugee camps and surrounding areas of movement. Algorithms have been developed that can take satellite and drone imagery and create an estimate of the camp population, something that is nearly impossible to do on the ground due to the volatility in refugee movements from one camp to another.[16]

A seemingly trivial calculation of a camp's population can have profound effects on both the lives of the refugees in the camp and the economics of disaster management. Knowing, or being able to predict, a camp's population means that there is a streamlining of resources required to sustain the thousands or hundreds of thousands of inhabitants. Satellite imagery has also been used to monitor the impact the settlement of refugees has on natural resources and the quantification of this impact.[17] Lodhi et al use a method of machine learning classification of two images taken in an Afghan refugee camp in northern Pakistan monitoring changes to forest land cover in the area.[18] This reinforces the ability to use satellite data to predict conflict in regions of high numbers of displaced and refugee persons by exploring the fragile relationship between migration and the unexpected tightening of natural resources in states that are already fragile, such as in Pakistan.

Similar to the movement of people, famine and food shortages are difficult to visually detect. Rather than reacting to a famine, satellites (more so than drones) are beginning to be used in a revolutionary way that will predict future food shortages, both globally and within key areas of concern such as epicenters. Within the private sector, U.S.-based TellusLabs is combining decades' worth of satellite imagery and using machine learning to predict economic and environmental future conditions.[19] Within the commodities industry, TellusLabs are working with government agencies to predict crop yields across the United States. Their aim is to expand to international markets and eventually create global grain-supply predictions to locate and prevent weaknesses in the global and local food supply chain.

The United Nations Institute of Training and Research (UNITAR) does food supply chain analysis using satellite images in conflict areas, such as Syria and South Sudan. In an interview, Lars Bromley, the principal analyst for Human Rights and Security at the United Nations Operational Satellite Applications Program (UNOSAT), described the methods undertaken to analyze food stability in regions of unrest: "We have just started a review to look at agricultural production in ISIS-held areas in Syria. Using satellite imagery, we are analyzing how much of the farmland in the area will be able to be harvested in the current growing season. The fear is that, should stability come to the region, there will be food scarcity as farmers have not been able to sow the harvest and even farms that have been sown, have seen their farmers flee the area."

This can be seen in conflict zones globally. He added, "This can be seen in Africa, too. There was a migration of South Sudanese refugees into Uganda who were in search of food security. The conflict there is so serious that the crops couldn't be harvested, and Uganda offered the resources that they badly needed".[20]

Future Recommendations

Earth Observation can provide invaluable global socio-economic, geopolitical insights.[21] As political and economical decision-making become more data-driven, satellites and drones can be valuable tools policy makers should utilize to create sustainable and unbiased policies to reduce the risks that are emerging due to local and global climate change. This new technological landscape, however, is complex and difficult for any one country to navigate alone. There are multiple players across the satellite industry - governments, non-governmental organizations (NGOs) such as the United Nations and the private sector with individual satellite companies distributing different data sources. When it comes to aerial and drone footage, there are complex operational barriers, especially when trying to acquire imagery over hostile zones such as Aleppo in Syria, where a drone or aircraft is likely to come under fire.[22] Trying to collect relevant data from across the multiple sources and integrate it into a format that can be analyzed is challenging. Further, the actual analysis of the imagery is difficult and often requires specially trained engineers to derive relevant analytics and insights from the data.[23] In this context, there are two basic recommendations for policy-makers interested in pursuing this technologically advanced method of mitigating global risks. First, that the collection of data is aggressively pursued where possible. Second, that the international EO community becomes more integrated and that there is end-to-end support for, and across, the stakeholders in the industry. It is vital that in order to pursue a data-driven analysis of climate change implications, the analysis must have enough data to provide accuracy. Many of the methods by which satellites and drones create insights that can be used in these complex scenarios involve machine learning and artificial intelligence. Therefore, it is imperative that the algorithms have enough historical data to "learn" from. This, on a practical level, means that where possible, data from satellites and drones should be taken at any given opportunity and stored so that it can be easily accessed.

To further the second recommendation, the satellite and drone industry is largely fragmented between operations, hardware and software services. There is no single platform from which users can access the highly complex data. There is also the problem of the "digital divide," whereby several governments do not have the same levels of computational access to interpret this heavy data as others. Some countries and agencies, such as the U.S., NASA and the European Space Agency (ESA), provide open-sourced and free data, whereas other private-sector entities such as DigitalGlobe and Planet charge users a fee for accessing the data.

Across the industry, there is a strong need to create an integrated approach at all levels to find an end-to-end solution. This entails a higher level of data integration between the private-sector satellite companies and, even more importantly, a wider range of partnerships among government agencies to allow easier access to this data. One example of a positive approach to collaboration can be seen in the recent Memorandum of Understanding between the South African and Ghanaian governments that laid out the ways in which the two countries would share space-related resources, including EO capabilities, to manage the natural resources that were under duress due to the degradation of the environment caused by climate change.[24]

The concept of sharing spatial capabilities is not new. It is frequently delivered through policy derived by the United Nations Office of Outer Space Affairs, where member states of the United Nations are encouraged to participate and give access of their satellite imagery when possible.[25] These relationships that are created though the United Nations should continue to be strengthened, and the role of the private sector in such partnerships should be highlighted.

Conclusion

As the world moves into a new digital age, policy making should not be left behind. The importance of monitoring, reacting to and predicting climate change-related consequences has never been higher, as evidenced by the current geopolitical phenomena occurring worldwide. The creation of "epicenters" and their ability to have global impacts means that policy-makers are not only encouraged but also required to advance ways in which climate-related problems are dealt with on an international scale. Satellites and drones provide new ways to monitor global changes rapidly and easily, and Earth Observation is fast becoming a tool of national and international security importance. There is much work to be done to create an integrated approach to decision-making from Earth Observation analytics, but the data is readily available to those who seek it, as many do, and use it to prepare for and mitigate against these risks.

NOTES

1 Sinead O'Sullivan is a Research Fellow with the Center for Climate and Security.

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