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NOTE – GEOSPATIAL TECHNOLOGY AS A CONFLICT PREVENTION AND MANAGEMENT TOOL IN UN PEACEKEEPING

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Geospatial Technology as a Conflict Prevention and Management Tool in UN Peacekeeping

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1. Introduction

There is enormous potential for new technologies to improve the effectiveness of UN peacekeeping missions, as they respond to an ever-growing list of tasks in increasingly complex field environments.[1] Much of the recent discussion on the topic of new technologies in peacekeeping has revolved around the use of Unarmed Unmanned Aerial Vehicles (UUAVs) and other cutting-edge aerial technologies.[2] However, the attention on UUAVs has overshadowed another family of technologies that has already enabled peacekeepers to improve their effectiveness for several decades and whose potential grows more promising every year: satellite imagery and geographic information systems (GIS). For an indication of this technology's usefulness in peacekeeping, one needs look no further than Lt. Gen. Daniel Opande, former Force Commander of the UN Mission in Sierra Leone (UNAMSIL), who remarked that "geographic information has been noted to be the soldier's most important weapon – second only to his gun. The mission experienced a lot of operational setbacks initially, because there were no topographical maps for accurate operational planning or orders and hence, it was easy for the Rebels (…) to ambush foreign peacekeepers who knew little about their area of operational responsibilities and had no maps."[3]

The use of geospatial technology for peace and security was popularized by the actor George Clooney after his 2010 visit to Sudan. Together with Enough Project co-founder John Prendergast, he then launched the Satellite Sentinel Project (SSP), which used orbital satellites to document the locations of mass grave sites and razed villages in the Southern Kordofan and Abyei regions. SSP is a strong example of the advances made in this area by nongovernmental actors. A more recent one can be seen in satellite images collected by Amnesty International

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[1] For a detailed discussion of the potential of new technologies in peacekeeping, see Walter Dorn, *Keeping Watch: Monitoring Technology and Innovation in UN Peace Operations* (Tokyo: UNU Press, 2011); Paul F. Diehl, "The Political Implications of Using New Technologies in Peace Operations," *International Peacekeeping* 9, No. 3 (2011): 1-24.

[2] See, for instance, John Karlsrud and Frederik Rosén, "In the Eye of the Beholder? UN and the Use of Drones to Protect Civilians," *Stability: International Journal of Security & Development* 2, No. 2 (2013): 27/1-10, DOI: http://dx.doi.org/10.5334/sta.bo .

[3] UN Cartographic Section, "Geospatial Support for UN Operations," presentation at UNRCC Asia and the Pacific, Bangkok, 2009.

revealing evidence of burned villages in northern Nigeria by Boko Haram militants.[4] Within the UN System, too, entities such as the Office for the Coordination of Humanitarian Affairs (OCHA) and UNICEF have begun to employ geospatial technology to great effect, in such diverse areas as humanitarian assistance, refugee resettlement, food security, and human rights monitoring. Additionally, the sanctions regimes under the auspices of the Security Council's Panels of Experts have employed satellite monitoring for North Korea and Iran to determine the extent of their nuclear weapons development.[5] However, the UN has been slower to harness geospatial technology for peace and security issues in conflict settings. This is particularly true in the context of peacekeeping missions, about which there has been little discussion or prior research on the use of geospatial technology.

The goal of this policy paper is to explore the role of satellite and GIS technologies as a tool for conflict prevention and management specifically in the context of UN peacekeeping missions. Today geospatial analysts at headquarters and in the field actively provide information and analysis to mission management and decision-makers. This paper begins by describing some of the key functions of this technology in contemporary peace operations. It has been shown to help peacekeepers better understand the drivers of conflict on the ground, monitor boundaries and ceasefire lines, improve situational awareness and validate information, document evidence of mass atrocities and other human rights abuses, and inform military planning and the location of troop deployments.

Geospatial technology facilitates these functions by providing peacekeepers with unique information and analytical capabilities. These include the ability to visualize complex information in ways that are simple and communicable; to recognize patterns, relationships, and processes among information and data on the ground; and gather intelligence from remote, inaccessible, and hard-to-reach areas. These and other distinguishing advantages of geospatial technology will be addressed later in the paper.

It is of course important to be attentive to the limitations of these tools. Geospatial technology will not revolutionize conflict prevention, and it is necessary to be aware of what it can and cannot do. To this end, a number of technical and political challenges to the use of geospatial analysis are identified in the following section.

It is of note that these tools have long enabled peacekeepers to improve their operations in a number of areas not directly related to peace and security, such as operational and logistical planning. For instance, by identifying sources of fresh water around which peacekeepers can construct their compounds, and mapping the accessibility (or "trafficability") of roads during

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[4] Amnesty International, "Nigeria: Satellite images show horrific scale of Boko Haram attack on Baga," January 2015, available at www.amnesty.org/en/news/nigeria-satellite-images-show-horrific-scale-boko-haram-attack-baga-2015-01-15 .

[5] See, for instance, United Nations, *Report of the Panel of Experts established pursuant to Resolution 1874 (2009)*, UN Doc. S/2012/422, June 14, 2012.

the wet season.[6] In part because of these operational functions, the Cartographic Section is sometimes associated more closely with logistics and field support rather than conflict prevention and management. The fact that it is located within the Department of Field Support is consistent with this perception.

Understanding the uses of geospatial technology for conflict prevention and management, the conditions under which it is effective, and its associated challenges and limitations is critical to identifying the advantages these tools can bring to peacekeeping. This in turn can provide guidance to decision-makers on when and how to use them, as well as reforms that can bridge the gap between potential and performance. It is also hoped that these findings will complement the report of the Expert Panel on Technology and Innovation in UN Peacekeeping, as well as the Secretary-General's High-level Independent Panel on Peace Operations.[7]

2. Background

Satellite imagery and GIS are separate but interconnected technologies that collectively fall under the label of geospatial technology. Satellite imagery represents images taken of Earth from artificial satellites orbiting the planet. GIS systems use computer software to capture, manage, analyze, and visualize geographic or spatial data and information.[8] Satellite imagery constitutes merely one element of a larger GIS system. GIS analysts use it in conjunction with other geospatially referenced databases containing information such as topographic data, underground water exploration, or conflict tracking. A satellite image may serve as the base map over which other datasets are layered to create a sophisticated and multi-layered product revealing patterns, trends, and relationships among data and information over time.

Unlike UUAVs, satellite imagery has been used in the furtherance of the UN Charter since at least the 1960s. Cartography (the ancestor of modern GIS technologies) has likewise been employed by the UN since 1946, but it wasn't until 1951 that the UN Cartographic Unit was established with four cartographers and one unit chief.[9] Thanks in part to recent technological advances, and following on recommendations from the 2000 Report of the Panel on United Nations Peace Operations (the Brahimi Report), the use of satellite imagery and geospatial technologies has been institutionalized in the UN System to such a degree that peacekeeping

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[6] For an overview of the diverse array of functions served by geospatial technology in peacekeeping generally, see Esri, "UN Uses GIS to Promote Peace and Provide Aid," *ArcNews Online*, Spring 2010, available at www.esri.com/news/arcnews/spring10articles/un-uses-gis.html .

[7] The Secretary-General listed "technological innovation" as one of the areas that may warrant review by the High-Level Independent Panel on Peace Operations. See Ban Ki-moon, "Secretary-General's Remarks at Security Council Open Debate on Trends in United Nations Peacekeeping," New York, June 11, 2014.

[8] Definition according to Esri, a major supplier of GIS software and technology, available at www.esri.com .

[9] In 1946, a single cartographer served under the Presentation Section. Information obtained via email correspondence with UN Cartographic Section official, January 20, 2015.

missions now regularly rely on them. As an example of how "low-tech" geospatial technology is considered, it has been described as "2nd generation conflict prevention" as compared to "3rd generation" and "4th generation" technologies such as crowdsourcing and open-source mobile phones.[10]

How does the UN Secretariat acquire its satellite imagery and GIS data? The United Nations does not own its own satellites in space; there are no white satellites in orbit with the trademark "UN" lettering on the side. Instead, it has agreements with several government and commercial satellite providers, which grant permission for the UN to obtain images captured by their satellites.[11] One of the most popular commercial vendors is Digital Globe, while France and the United States are among the most common government providers. Imagery may also be acquired indirectly through partnerships with other geospatial organizations, ranging from nongovernmental actors (such as SSP) to commercial providers (such as Google Earth), to national geospatial agencies and the European Union Satellite Center, which provides satellite imagery and analysis on theatres of shared concern. It is little known that the UN has a specialized agency, UNOSAT, devoted to providing satellite imagery and analysis to the UN System.[12] UNOSAT was established in 2000 and is located within the United Nations Institute for Training and Research (UNITAR). In 2012, the majority of UNOSAT's clients included OCHA and UN agencies such as UNHCR and UNICEF, which use this information primarily for humanitarian and refugee assistance purposes. Only 6% of the agency's requests for satellite imagery came from DPKO.[13]

Datasets for GIS are similarly acquired through mixed methods. Partnerships with UN agencies, governments, and nongovernmental organizations provide various geological, topographic, or demographic data. Information may also be open-source or acquired via modern techniques such as crowdsourcing and crisis mapping.[14] For cases where a lot of data is missing or unavailable, GIS officers at headquarters and in the field may need to extract or retrieve it themselves, a process which ranges from gathering open-source data from the internet to more complicated collection methods such as aerial photography, remote sensing, and geophysical surveys.[15]

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[10] Francesco Mancini, ed., *New Technology and the Prevention of Violence and Conflict*, New York: International Peace Institute, April 2013, available at www.ipinst.org/publication/detail/396-new-technology-and-the-prevention-of-violence-and-conflict.html .

[11] Unless otherwise stated, information in this section was obtained via interviews with members of the UN Cartographic Section conducted in New York on October 2, December 6, December 13, and December 16, 2014.

[12] Phone interview with UNOSAT official, September 26, 2014.

[13] For UNOSAT's rapid mapping service only. See UN Institute for Training and Research, *UNOSAT Rapid Mapping Service Activity Report 2012*, February 2013.

[14] Crowdsourcing is a process by which data is obtained remotely via contributions from a large number of people, often acting independently, who usually upload this data to the internet. Crisis mapping entails gathering and analyzing data obtained from the public and responders on the ground during a crisis, such as a natural disaster.

[15] The latter scenario is not uncommon in northern Mali and other remote locations where ground survey teams may be tasked with ascertaining data on the locations of roads, rivers, and villages, to name a few.

In the Secretariat, geospatial information is managed by the UN Cartographic Section, which has a mandate to provide geospatial information support to the full range of United Nations operations.[16] The Cartographic Section is situated in the Information and Communications Technology Division within the Department of Field Support. In addition to this presence at UNHQ in New York, there is a GIS Centre located at the UN Logistics Base/Global Service Center in Brindisi, Italy. Operating geospatial technology requires professionally trained geospatial analysts who can understand and interpret satellite imagery, are proficient with GIS software packages and are knowledgeable in feature analysis and data collection methods. The GIS Centre, comprised of approximately 20 staff members, is responsible for providing geospatial support and analysis to field missions, enhancing the geospatial capacity of the field, and serving as a repository for mission geo-databases.[17] Following the release of the Report of the Panel on United Nations Peace Operations in 2000, which recommended that "GIS specialists should be assigned to every mission team, together with GIS training resources,"[18] GIS units became a staple of large field missions. Today GIS units, which act as mission focal points for all geospatial information matters, operate within 15 missions and comprise a total of 130 GIS posts deployed in the field.[19] Responsibilities are shared between the field and the GIS Centre in Brindisi, with the GIS units largely handling in-house requests and the GIS Centre providing heavy-duty geospatial services and training as needed as well as support to missions without a GIS presence, such as most Special Political Missions. As part of the UN's Global Field Support Strategy, the size of the GIS Centre is expected to grow over the coming years as GIS officers from the field are relocated to Brindisi in an effort to save costs and reduce the footprint of GIS.

Within missions, GIS units respond to requests for information from mission management, information analysis cells, and other mission components. Efforts are made to channel all requests for satellite imagery directly through the GIS units; however their location within the mission varies. GIS units may be part of a "Joint GIS" component, which answers to both the administrative arm and the military arm of the mission. The GIS office may also be placed within the chief of staff's office, the electoral or even the engineering component depending on the mandate and composition of the mission in question. GIS cells may closely cooperate with the Joint Mission Analysis Centre (JMAC) or Joint Operations Centre (JOC), and they work closely with other information analysis units when applicable, such as the All Sources Information Fusion Unit (ASIFU) in the UN Mission in Mali (MINUSMA). It is worth noting that

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[16] UN Cartographic Section, "Geospatial information for UN Peace Operations," presentation at the Cambridge Conference, July 22, 2013.

[17] Péter Benicsák, "Overview of the UN Logistics Base/Global Service Center," *Hadmérnök* 7, No. 2 (2012), available at http://hadmernok.hu/2012_2_benicsak.pdf .

[18] UN Panel on Peace Operations, *Report of the Panel on United Nations Peace Operations*, UN Doc. A/55/305, August 2000, p. 43.

[19] These include UNMISS, UNISFA, UNAMID, MINUSMA, MONUSCO, MINURSO, UNIFIL, MINUSCA, MINUSTAH, ONUCI, UNDOF, UNMIL, UNAMA, UNAMI and UNPOS/UNSOA.

the organization of GIS units within missions is currently being streamlined so that GIS components will report to the Communications and Information Technology Section.[20]

3. Utility for Conflict Prevention and Management

The raw data provided by geospatial imagery is what its practitioners call "observables," i.e. vehicles, artillery, camps for displaced persons or armed groups, evidence of damage, or anything else with distinctive features that may be of interest to the analyst. Evidence of conflict can be either the observables themselves or changes in the position, behavior, or condition of the observables over time.[21] The analyst's job consists of interpreting these observables in relation with others, the overall context, and earlier observations in order to recognize changes on the ground, thus extracting actionable information, such as the build-up of a military contingent. Geospatial technology can help a mission fulfill its conflict prevention and management tasks in at least six ways: by offering technical support for boundary demarcation, by supporting mediation efforts, by gathering evidence of atrocities and other human rights violations, by improving situational awareness, by informing force distribution, and by improving conflict analysis.

Technical support for the demarcation of international boundaries – One of the traditional uses of geospatial technology is providing technical assistance and guidance on international boundary issues. Since peacekeepers are now deployed more frequently in internal rather than interstate conflicts, this boundary demarcation function is not as central as it used to be, but the collection of evidence and the interpretation of contested data nonetheless plays a useful role. Such services were instrumental with regard to the Iraq – Kuwait international boundary, and are also provided regarding the Blue Line between Israel and Lebanon and the Green Line in Cyprus, as well as in the context of the conflict between Sudan and South Sudan.[22] After the latter's self-determination referendum in 2011 and before its official accession to independence, geospatial analysis helped monitor the evolution of Sudan military posture and understand whether Khartoum was building up a presence in the disputed areas.

Mediation and ceasefire negotiation – The use of geospatial technology can support mediation efforts within and outside a peacekeeping framework, especially when negotiating ceasefires. The conflicting parties and the mediator must know with precision where to locate ground battle lines and corridors for the safe movement of each side. They need to be able to

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[20] Email correspondence with UN Cartographic Section official, January 20, 2015.
[21] Ben Yunmo Wang et al, "Problems from Hell, Solution in the Heavens? Identifying Obstacles and Opportunities for Employing Geospatial Technologies to Document and Mitigate Mass Atrocities," *Stability: International Journal of Security & Development* 2, No. 3 (2013): 53/1-18, DOI: http://dx.doi.org/10.5334/sta.cn .
[22] UN Cartographic Section, "Geospatial Support for UN Operations."

assess military gains not only in terms of the size of the territory occupied, but also of its specific features, such as the presence of oil fields or other natural resources, and of access points like seaports and airfields. As "[p]arties to the conflict may have different views on the provided figures by the opponent," this data must be verified by a neutral entity so as to "establish a starting position accepted by all parties to the conflict."[23] Each issue negotiated must also be localized with precision, with internal UN guidance emphasizing that ceasefires should specify "geo-locations for lines of disengagement, deployment, assembly points, demilitarized zones and monitoring positions." Such data is indispensable to properly track a ceasefire's implementation and identify potential breaches. For these reasons, it is recommended to mediators that every agreement be accompanied by "[a]greed maps detailing these issues."[24]

Documentation and evidence-gathering – Geospatial technology is better known to the wider public for its use in documenting large-scale violations of human rights and humanitarian law. This has attracted media attention, in particular Amnesty International's "Eyes on Darfur" initiative, and the SSP already mentioned, which revealed potential mass graves in the Sudan and government efforts to conceal the sites. Less well-known is UNOSAT's role in producing timely analysis in 2009 during the Sri Lankan civil war, which documented attacks on civilians by government forces.[25] The agency's work was reviewed by the International Court of Justice for the conflict in Georgia, where imagery of destroyed villages corroborated reports of burnings by the Russian forces. Satellite images have also been reviewed by the International Criminal Court in the case of the DRC, and by the International Criminal Tribunal for the Former Yugoslavia, in support of allegations of war crimes and crimes against humanity.[26] While such recording is typically used after an atrocity has already occurred, it might ultimately have a deterrent effect. It can be argued that if the conflicting parties are aware that their actions are being closely monitored in real time, they might think twice before committing large-scale violations they could be held accountable for in international justice proceedings.[27]

Situational awareness and information-validation – Retrospectively documenting mass atrocities represents only one fraction of the peacekeepers' use of geospatial technology. It is especially used by peacekeepers for its ability to increase situational awareness, thus providing better informed decision making. The transmission of information in a timely manner is indispensable to fulfilling a protection of civilians mandate. By reporting protection issues (such as ethnic cleansing) occurring in remote and inaccessible areas and observing troop buildups and movements in advance, geospatial technology can help peacekeepers assess the human

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[23] UN DPA in collaboration with DPKO's Office of the Military Adviser, *Operational guidance note: Military operational principles for negotiating ceasefire agreements*, June 2, 2006, available at http://peacemaker.un.org/ .
[24] Ibid.
[25] Phone interview with UNOSAT official, September 26, 2014.
[26] Wang et al., "Problems from Hell, Solution in the Heavens?"
[27] Phone interview with UN DPA official, September 3, 2014, and with UNOSAT official, September 26, 2014.

security situation and identify potential threats to civilians.[28] Satellite imagery compiled between the end of December 2013 and mid-January 2014 in South Sudan showed the progressive destruction of the market in the town of Bor and the simultaneous expansion of the IDP population within the nearby UNMISS base, until it was decided to construct a proper IDP camp on the outskirts of the compound.[29]

Ultimately, such information might help peacekeepers deter mass atrocities by denying potential perpetrators the element of surprise.[30] This possibility was demonstrated by the early detection of a military convoy on the road between Juba and Bor. After the crisis broke out in mid-December 2013 and the city of Bor was ransacked, there was a request to monitor a 200-kilometer stretch of road between the two towns. A satellite image taken on January 10, 2014 enabled them to identify a convoy of 300 soldiers and 12 armored vehicles heading towards Bor, as well as the construction of several military checkpoints along the road. This stood in sharp contrast with images taken in 2012, where Bor appeared as a non-militarized village. Given the direction of the convoy, it was identified as belonging to pro-government forces. Only six hours elapsed between the time the image was taken and when its analysis was presented to decision makers at the UN headquarters and in the mission, including the Force Commander, JMAC/JOC, and the senior management group.[31] This shows the ability of geospatial imagery – if transmitted quickly – to improve the situational awareness of peacekeepers, giving them the option to act upon the information received.

Military planning and force distribution – By enhancing situational awareness through the representation of conflict situations and actors on a map to the highest degree of accuracy possible, geospatial technology enables peacekeeping missions to plan for various contingencies and alter force distribution to prevent conflict. Geospatial technology can help peacekeepers assess "force to space ratios," i.e., the amount of security required to manage a given area under a particular set of circumstances.[32] In the case of the African Union – United Nations Mission in Darfur (UNAMID), geospatial analysis showed that "nearly half of all incidents occur more than 100 km from the nearest team site,"[33] a distance that falls beyond the range of most peacekeeping patrols and reveals the need to project a presence at greater ranges from the team sites.[34] Assessing "force to space ratios" through GIS has notably shown its usefulness in the field of electoral assistance and electoral security, tasks which often fall

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[28] Francesco Mancini and Chris Perry, "White Paper: Use of Technology for Conflict Analysis," paper prepared for the Build Peace Conference, April 2014.

[29] Interview with UN Cartographic Section official, New York, December 11, 2014.

[30] Wang et al., "Problems from Hell, Solution in the Heavens?"

[31] Email correspondence with GIS Officer, UN Mission in South Sudan, March 13, 2015; some entities involved are not specified upon request form our interviewees.

[32] Mancini, *New Technology and the Prevention of Violence and Conflict*.

[33] UN Secretary-General, *Special Report on the review of the African Union-United Nations Hybrid Operation in Darfur (UNAMID)*, UN Doc. S/2014/138, February 25, 2014, p. 34.

[34] Interview with UN DPKO official, New York, December 18, 2014.

into the hands of peacekeepers and UN police, and where preventive deployment is required so as to minimize electoral violence. During the 2012 national elections in Timor-Leste, the GIS unit in the UN Transitional Administration (UNTAET) produced a map categorizing zones on a spectrum from "no" to "high" risk, based on where unrest had broken out during the 2006 elections, demographic data, and the location of likely entrepreneurs of violence. This enabled UNPOL to deploy preventively to the high-risk locations.[35] Enhanced situational awareness can also help peacekeepers fight transnational organized crime, an object of increasing concern in contemporary conflicts. A map produced for the UN Stabilization Mission in the DR Congo (MONUSCO) helped peacekeepers focus their patrols to deter smuggling across the border between the DRC and Uganda. The map gathered together in one visual outlet information on illegal crossing points, areas where smuggled goods could be concealed, and potential helicopter landing sites.[36] In addition, satellite imagery and GIS can be used to identify where landmines and unexploded ordnances are located and, based on societal impact survey data, where they are likely to be the most lethal. This helps the UN Mine Action Service focus its demining efforts on areas most in need of urgent rehabilitation in order to protect civilians.[37]

Conflict analysis – Beyond its use for situational awareness, geospatial technology can also increase the accuracy of conflict analysis by improving understanding of the drivers of violence. By overlaying several datasets and tracking changes over time, it makes possible the observation of relationships, patterns, and processes to help make sense of complex situations. This technique was employed in the case of UNAMID, where it confirmed a strong correlation between the locations of traditional migration routes and inter-communal clashes between semi-nomadic groups, yet debunked the assumption that such clashes moved north and southwards in line with seasonal rainfall patterns and the nomads' movements. It was therefore recommended, as part of UNAMID's strategic review, that peacekeepers take into account the locations of the migration routes when planning their patrols, irrespective of the status of the migration season. GIS analysis thus refuted aspects of conventional thinking about conflict dynamics in Darfur, which enabled the peacekeepers to better identify likely hotspots.[38] This is consistent with the finding that combining several datasets offers more predictive power than simply using data of the prior outbreaks of violence.[39]

4. Advantages

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[35] Interview with UN Cartographic Section official, New York, December 11, 2014.
[36] Interview with UN Cartographic Section official, New York, October 2, 2014.
[37] Interview with UN Cartographic Section official, New York, December 11, 2014.
[38] Interview with UN DPKO official, New York, December 18, 2014.
[39] Chris Perry, "Machine Learning and Conflict Prediction: A Use Case," *Stability: International Journal of Security & Development* 2, No. 3 (2013): 56/1-18, DOI: http://dx.doi.org/10.5334/sta.cr .

A number of advantages distinguish geospatial technology from other information-gathering devices used for conflict prevention and management. Scholars have already reflected on the advantages that new technologies can bring to peacekeeping generally, such as lowering its human and financial costs, improving surveillance and monitoring efforts, and allowing for more nimble and less intrusive missions.[40] Instead, this section takes a view towards understanding the advantages of geospatial technology relative to other technologies currently used or being considered by the UN.

Sovereignty – Geospatial technology is perceived as less intrusive than other surveillance devices, therefore making sovereignty constraints less of a limiting factor. Some states have expressed very strong opposition to the use of such technologies. It can be expected that the host government's attitude towards surveillance will depend on whether the findings are used in support of or against its objectives. However, as Paul F. Diehl writes, "[s]tates have shown a greater willingness to accept monitoring of activities from remote sensors or satellites than on-site inspections" as they are less visible to the local population, reducing the possibility of "cultural contamination" and minimizing the appearance of government failure or foreign domination.[41] In addition, there is no sovereignty in space beyond a distance of approximately 100km from sea level, as defined by the Outer Space Treaty of 1967.[42] Since the altitude of orbiting satellites is much higher,[43] they operate beyond a state's territorial airspace and do not require authorization. In contrast, other surveillance technologies may not be permitted by the host government, depending on the Status of Forces Agreement (SOFA), which specifies rules of conduct and sets out the equipment and personnel that can legally be brought into the host country. Because consent is not a limiting factor, this eliminates one of the biggest legal hurdles facing the UN in its use of new peacekeeping technologies.

Technological sophistication – While previous generations of satellites lacked sufficiently advanced optical technology, today's satellites can effectively capture an image from space hundreds of miles away with a high degree of clarity. Commercial satellites are capable of taking medium- and high-resolution images, typically between 0.5 - 1 meters spatial resolution.[44] This makes it comparable to the level of detail captured by aerial reconnaissance. Whereas the latter can capture highly detailed images over a smaller area, satellite imagery can document a much larger area and still observe such signs of conflict as destroyed villages, mass

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[40] See Dorn, *Keeping Watch*; Diehl, "The Political Implications of Using New Technologies in Peace Operations".

[41] Diehl, ibid.

[42] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, United Nations, 1967.

[43] Ann G. Darrin and Beth L. O'Leary, eds., *Handbook of Space Engineering, Archaeology, and Heritage* (Boca Raton, FL: CRC Press, 2009).

[44] Interview with UN Cartographic Section official, New York, October 2, 2014; DigitalGlobe, "Resources: Satellite Information," available at www.digitalglobe.com/resources/satellite-information .

grave sites, the wreckage of exploded ordnances, and tracks in the dirt made by heavy vehicles and transport.

Cost – The cost of satellite imagery varies depending on a number of factors such as the resolution of the image, the time at which it was captured, and other procedural, contractual, and procurement factors. A single satellite image may cost the mission anywhere in the range of $300 for an archived image to $2000 for a newer image. This can be a bargain for a UN peacekeeping mission, in comparison with other means of intelligence gathering such as deploying a helicopter or ground surveillance team, when costs of equipment, labor, fuel, and maintenance are tabulated.

Reach – Another advantage of satellite imagery compared to aerial reconnaissance or ground patrolling is its ability to reach remote and inaccessible areas. This is especially useful in order to gather information when roads are blocked, or when security conditions do not allow the deployment of peacekeepers. This was demonstrated in Abidjan, when the airport was reportedly closed down and the situation was too dangerous for peacekeepers from the UN Mission in Côte d'Ivoire (UNOCI) to investigate. Satellite imagery was able to verify the information, which fed into UNOCI's reporting.[45]

Force requirements – Compared to other technologies and equipment which may be owned and operated by specific country contingents, geospatial analysis is a mission-wide tool that falls under the control of the mission itself. This helps keep the force requirements for use of this technology relatively low. Whereas UUAVs may be brought to the field by specific country contingents (e.g., the Netherlands in MINUSMA) or by commercial contract in which private companies provide their own drone operators (as in the case of MONUSCO), an advantage of geospatial technology is that it is institutionalized within the UN system through the UN Cartographic Section, which has a presence in 15 field missions and can provide geospatial support regardless of the technological sophistication of any one military contingent.

Data visualization - Geospatial technology provides the ability to visualize complex information in ways that are simple and communicable. It is thus increasingly used in the Situation Centre's briefings to UN departments, and in the latter's briefings to the Security Council. In some cases, the data visualization this technology enables has proved more compelling than verbal briefings and word-based reports in catching decision-makers' attention and galvanizing action. Maps used by UNPOS and DPA as part of a Security Council briefing in 2011 revealed the expansion of the Somali transitional government's estimated areas of control over Mogadishu between May 2009 and May 2011. This visual evidence was described as having a game-changing effect on the conflict narrative and the Council's deliberations.[46]

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[45] Interview with UN Cartographic Section official, New York, December 16, 2014.
[46] Phone interview with UN DPA official, September 3, 2014.

5. Challenges and limitations

Despite the myriad advantages geospatial technology can bring to bear on contemporary peacekeeping operations, there are several challenges and limitations that can prevent its use in a given situation and reduce its overall effectiveness. Some of these challenges can be overcome by a combination of technological advancement and reform of policies and practices, while others are more difficult to manage. At least five main challenge areas have been identified: temporal, technical, political, coordination, and mission management challenges.

Temporal challenges – It can be time-consuming to "process" a satellite image or GIS product, the length of which depends on a large number of variables. The amount of time it takes to generate a map turns on the availability of high-quality and reliable data, the complexity of the product in question (as measured by the amount of information or data layers needed), and the number of trained analysts. It also takes about two hours for Cartographic Section officials to access an image after the image has been taken.[47] In the best case scenario, an image can be downloaded from the satellite's server, summarily analyzed, and made available to mission staff within two or three hours. Such a scenario may occur when an "observable" such as a moving vehicle is readily apparent (at least to the trained eye), at which point minimal further analysis is required other than to visually highlight the object in question using computer software.

More often, however, this process takes significantly longer. For complicated GIS products that include multiple data layers such as ground water analysis or the locations of polling stations, weeks might be needed to construct a map (and even longer if data must be extracted from geophysical surveys or other means). The time-consuming nature of data collection and image processing can be at odds with the time-sensitive nature of peacekeeping operations. Complex geospatial analysis is not well-suited for kinetic and up-tempo situations where action often hinges on the swift acquisition of information and intelligence. In cases where peacekeepers are required to intervene in a timely manner to protect civilians or confront spoilers, this timetable poses obvious limitations, and alternative technologies such as UUAVs may be better suited.[48] Future advances in technology will allow for satellite imagery to be processed faster, with satellites tasked to collect images on their own and with highly sophisticated computer software that can automatically detect patterns, in turn facilitating quicker access and distribution of this information across the mission.

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[47] Digital Diplomacy Brownbag seminar, "Opportunities for DPA: One-Stop-Shop for Geospatial Information Services," presentation by the UN Cartographic Section and ensuing discussion, New York, December 5, 2014.
[48] "Getting armed men on a truck and raiding a village or two doesn't take more than a few hours. So the crimes may already have been committed by the time the pictures come in (…). [U]sing UAVs may be more useful and cheaper." Patrick Meier, "Will Using 'Live' Satellite Imagery to Prevent War in the Sudan Actually Work?," *iRevolution.net,* December 30, 2010, available at http://irevolution.net/2010/12/30/sat-sentinel-project/ .

Technical challenges – Sun-synchronous satellites used for surveillance and cartographic purposes are not in unlimited supply. Those that do exist tend to cater to commercial interests or the geostrategic interests of the governments which operate them.[49] Because there are a limited number of satellites in orbit above conflict zones, there may simply be no satellite overhead at the time something noteworthy is occurring. Satellite imagery can only be used to detect "a relatively small portion of possible human rights violations" such as those carried out on a large-scale or accompanying mass atrocities.[50] For instance, during the early stages of the conflict in South Sudan, a relatively small amount of satellite data was available, a reality that gradually changed as the international community paid greater attention to the ensuing conflict.

In addition, because a satellite image is a snapshot representing a particular moment in place and time, it means that this technology is limited to situations where a specific area of interest can be identified in advance. Satellites are not effective at scanning the ground for signs of trouble, making the prospect of catching rebels "red handed" as they commit human rights violations difficult. At least theoretically, armed groups could also avoid detection by keeping a low profile during the hours when satellites regularly pass overhead (usually between 7-10am local time).[51] Another related technical challenge is that satellites can only observe areas that are not obscured by heavy cloud cover, forest canopy, or other climate and topographic impediments.[52] This has made it difficult for satellites to penetrate heavy forest canopy in the eastern DRC and other African tropical regions. In the near future, it is expected that more commercially- and government-owned satellites – with more flexible orbits as well as sophisticated video and sensory capability – will be launched into space, extending both the quantity and quality of images available across an ever-greater number of locations and moments in time. Already radar satellites and remote sensing technology can penetrate cloud cover but at higher cost and requiring more sophisticated technical training than optical imagery[53].

Political challenges – Although technology is more impartial than human monitors in documenting improper movement of troops or ceasefire violations, in reality it is rarely perceived as truly neutral.[54] The use of satellite imagery to corroborate reports on the ground

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[49] Generally speaking the quantity of imagery available is correlated with the level of interest of a particular community in the geographic area in question. Email correspondence with UN Cartographic Section official, January 22, 2015.

[50] Karen T. Litfin, "The Globalization of Transparency: The Use of Commercial Satellite Imagery by Nongovernmental Organizations," in *Commercial Observation Satellites: At the Leading Edge of Global Transparency*, edited by John C. Baker, Kevin M. O'Connell, and Ray A. Williamson (Santa Monica, CA: RAND, 2001), pp. 463–84.

[51] Ibid.

[52] Wang et al., "Problems from Hell, Solution in the Heavens?"

[53] Phone interview with UNOSAT official, September 26, 2014.

[54] Diehl, "The Political Implications of Using New Technologies in Peace Operations."

has proven controversial in the context of politically-charged conflicts. Due to these sensitivities among Member States, the UN has had to tread carefully in its use of this technology. For instance, it has been reluctant to apply it in the case of the Ukraine crisis, likely fearing that this would be perceived as taking sides or taking action without a clear political mandate.[55]

As the UN is often reliant on Member States for satellite data, some parties may question the data itself as well as the accuracy of its analysis and interpretation. Where and when those Member States look with their surveillance sensors and what of that they share with the UN can then provide grounds for critics to question the UN's neutrality. For instance, actors seeking "authoritative information" may doubt the authenticity of the data, especially when they have reason to disagree with the findings. Moscow denied the authenticity of NATO satellite imagery taken in November 2014 showing Russian troop movements along the Ukrainian border. In the case of the Sri Lankan civil war, imagery taken by UNOSAT was dismissed as "fake" by the Colombo government.[56] In the past, data has been misinterpreted or even deliberately manipulated. A famous example concerns former US Secretary of State Colin Powell's briefing before the Security Council in 2003 on the topic of weapons of mass destruction in Iraq, a presentation during which he used satellite imagery to show evidence of Baghdad's possession of such weapons.[57] The allegations later proved to be false. This incident also raises concerns about relying too heavily on actors with vested interests in a conflict for information.

When peacekeeping operations are deployed, political sensitivities may still be a limiting factor. According to one DPA official, satellite imagery is viewed with suspicion among some Member States who worry that this technology is being used for reasons that fall outside the Security Council mandate.[58] For example, they fear that satellites may "reveal the location of military installations … or expose the incompetence or vulnerability of the government."[59] This is related to concerns over confidentiality and privacy issues, with Member States worried that sensitive information acquired may be leaked. All of this can contribute to tensions between the UN and the host country. In addition, the Security Council – with its traditional political culture and methods – has been slow to embrace this technology in its briefings. Some Council members view it with some skepticism and as a "distraction" from traditional means of reporting.[60] The increased objectivity and data-gathering provided by geospatial technology – and what it can potentially reveal about UN actions on the ground – also presents challenges for an organizational culture that is "not predisposed towards critical self-assessment."[61]

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[55] Digital Diplomacy Brownbag seminar, "Opportunities for DPA".
[56] Meier, "Will Using 'Live' Satellite Imagery to Prevent War in the Sudan Actually Work?"
[57] UN Security Council, "Briefing Security Council, US Secretary of State Powell Presents Evidence of Iraq's Failure to Disarm," Press Release No. SC/7658, February 5, 2003.
[58] Phone interview with UN DPA official, September 3, 2014.
[59] Diehl, "The Political Implications of Using New Technologies in Peace Operations," pp. 11–12.
[60] Phone interview with UN DPA official, September 3, 2014.
[61] Email correspondence with UN DPA official, January 5, 2015.

Cooperation challenges – A fourth challenge is cooperation between the UN Cartographic Section and other members of the Secretariat. Given the limitations to this technology, officials requesting geospatial support services will need a carefully considered plan of action and a clear understanding of the utility of geospatial analysis in the context of a particular conflict. Without this collaboration, desk officers may possess unrealistic expectations about what geospatial analysis can do, and they may fail to take steps that can assist geospatial analysts, such as "geocoding" or "geotagging" when reporting incidents of violent conflict. [62] Similarly, it is incumbent upon geospatial analysts to acquire an understanding of the political dynamics of a particular conflict. In the words of one UN Cartographic Section official, the "political team and the GIS team need to speak the same language."[63] Furthermore, geospatial information without a corresponding political narrative can be unhelpful or even misleading, misrepresenting the timeline of events and skewing causal explanations for conflict. Geospatial information should be supported by political analysis when possible to ensure an accurate understanding of the unfolding conflict story.

As such, close collaboration and information sharing between the Mission, DPA, DPKO, the UN Operations and Crisis Centre, and the UN Cartographic Section is required to effectively harness this technology. Lack of awareness of what the UN Cartographic Section and GIS units can do for the Secretariat has been cited by UN officials as an impediment to the successful utilization of this technology.[64] Educating planning officers and coordinating with them in the initial phases of a project will be a strategic challenge, a task made no less difficult by high turnover rates for Secretariat personnel.[65] Fortunately efforts are currently being explored to enhance intra-Secretariat cooperation as well as coordination between agencies, such as a possible memorandum of understanding between UNOSAT and the Cartographic Section of DFS that would allow for closer collaboration.[66] More education for staff on the applications of geospatial analysis is also being envisioned. These include brownbag seminars with the UN Cartographic Section and UNOSAT as part of the "Digital Diplomacy" initiative,[67] developing informal guidance notes on using technology in briefings, and the aforementioned report of the Expert Panel on Technology and Innovation in Peacekeeping.

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[62] Geocoding, or geotagging, is the process of recording the GPS coordinates of where a particular incident occurred so that data can be utilized by GIS software.
[63] Digital Diplomacy Brownbag seminar, "Opportunities for DPA".
[64] Ibid.
[65] Interview with UN Cartographic Section official, New York, December 16, 2014.
[66] Phone interview with UNOSAT official, September 26, 2014.
[67] "The Digital Diplomacy Coalition brings together the diplomatic, international affairs and tech communities to share ideas and best practices to leverage digital for diplomacy." Digital Diplomacy Coalition - New York, available at http://digidiplomats.com/nyc; "DPA needs to embrace Digital Diplomacy and other innovations to help channel ideas and harness new information communication technologies in achieving the Department's objectives." UN DPA, *Strategic Plan*, November 2013, p. 27.

Management challenges in the missions – A fifth challenge is managing the information workflow in the field so that geospatial analysis can find its way into the hands of relevant decision-makers. Gaining better knowledge of a situation does not necessarily translate into appropriate action, and it is only when geospatial analysis contributes to impacting operations on the ground that it can fulfill its conflict prevention and management potential. Because geospatial analysis is primarily provided upon request, the challenge therefore is "to get the tasking right," in the words of one official who was a former GIS Chief in a peacekeeping operation.[68] Although 15 field missions have an active GIS presence, in reality leadership is sometimes not fully cognizant of the potential uses and constraints of geospatial analysis, so much so that there is a disparity between the technology at the mission's disposal and the peacekeepers' exposure to it.

According to another UN official, GIS units in the field have had to combat the impression that they are merely logistical or technical support components, in particular when they do not have a liaison officer in JMAC or JOC.[69] In these cases, geospatial analysis may not be included in the mission's regular intelligence management cycle nor feed into daily political and security briefings. This means that it is not necessarily taken into account by the mission's leadership when making decisions, except for cases where good interpersonal relationships exist.[70] A related problem is the lack of feedback given to GIS officers once they have responded to a specific request. Some of our respondents admitted not knowing what was done with the analysis they had provided once it was forwarded to the relevant mission component. This suggests the need to create a system to evaluate the use of geospatial information at the mission level in order to give feedback to GIS officers and inform the tasking and direction of future geospatial analysis.

The perception of GIS personnel as logisticians may have to do with the fact that the Cartographic Section is nested under the ICT division of DFS at headquarters. While GIS personnel are technically information officers, their direct role in conflict prevention is substantially different from others in the ICT division who provide computer, internet, and communications services. Finding a suitable home for the Cartographic Section has proved difficult in the past: it has been relocated at least half a dozen times, at various instances finding itself under the DFS Logistics Support Division, the Department of Public Information, and the Situation Center. This self-described "branding issue" and "identity crisis" may be muddling the waters and generating further confusion about its conflict prevention potential.[71]

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[68] Interview with UN Cartographic Section official, New York, December 11, 2014.
[69] Interview with UN Cartographic Section official, New York, October 2, 2014.
[70] One former GIS Chief in the field remarked that her proximity to the Chief of Staff's office ensured her analysis and recommendations were well-considered. Interview with UN Cartographic Section official, New York, December 16, 2014.
[71] Ibid.

6. Conclusion

Geospatial technology has wide application and utility for conflict management and prevention. It provides the unique ability to identify relationships, patterns, and processes by overlaying data and tracking changes over time. This makes it a useful tool to increase situational awareness, assess force to space ratios, and improve conflict analysis. In turn, this can help peacekeepers make better informed decisions, including deploying preventively to high-risk locations and, in the best case scenario, denying potential perpetrators the element of surprise. Compared with other information-gathering devices, geospatial technology is valued for its ability to operate more freely from sovereignty constraints; to gather information from remote and inaccessible areas; its relatively low cost; its low force requirements; and the data visualization it allows, which is often more compelling than verbal briefings and word-based reports.

However it will not transform conflict prevention efforts; it must be considered as only one element of a larger toolbox, used to help peacekeepers monitor a situation of concern, cross-check data, and contextualize and refine information, in conjunction with other technologies and traditional reporting methods. Some of the challenges we've identified include the time-consuming nature of data collection and image processing, which does not make it well-suited for the swift acquisition of information and intelligence. In addition, for political reasons, Member States, host governments, or non-state actors may be tempted to question the accuracy of the data or its interpretation. Another major challenge is one that the UN itself must overcome: the seeming lack of awareness of the potential applications and limitations of geospatial technology by relevant staff in the Secretariat and the missions, and the need to ensure such information is both promptly conveyed to and duly considered by senior mission management. The institutional setting, whereby GIS units are often set aside from the missions' regular intelligence management cycle and are perceived as merely logistical support components, may contribute to this problem.

Further research could analyze quantitatively how and under what circumstances peacekeepers use GIS products for conflict prevention and management purposes. This might involve a numerical analysis of the frequency with which GIS products are employed in peacekeeping missions, by whom, and to what effect. It would shed light on the gap between their actual and potential use, and provide solid ground to explore ways to increase mutual understanding and cooperation between GIS officers and decision-makers.