Fragile Transparency

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A fragile transparency: satellite imagery analysis, non-state actors, and visual representations of security

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Abstract

A broad range of non-state actors make use of commercial satellite imagery to monitor global security issues. Questioning the favourable narrative of achieving 'global transparency' through Earth observation, the article unravels the underlying relations between the US government, commercial imagery providers, and other non-state actors. Linking insights from Science and Technology Studies and International Relations, two related arguments are put forward: first, the commercialization of satellite technology and imagery does not dismiss the influence of the state but is conducive of the co-production of shifting actor constellations and related to that, different ideas about transparency and power. Secondly, this leads to a less benign understanding of transparency which emphasizes its contingent emergence, limited scope, and context dependence. This 'fragile transparency' exposes the shifting power relations inherent to commercial satellite imagery and its potential as a political practice to render certain things as visible and threats to international security.

Key words: satellite imagery, visual representation, STS, transparency, international security.

1. Introduction

Satellites, combined with state-of-the-art imaging techniques, offer ordinary humans something heretofore only found among comic-book superheroes: the gift of super sight.

(National Geographic, n.d.)

In recent years, the South China Sea has turned into an area of interest for commercial Earth observation satellites. Chinese land reclamation activities and the construction of radar towers or landing strips are rendered visible by the use of satellite imagery on special interest websites and also in major US newspapers (e.g. Lee 2015; Mufson 2015; Watkins 2015). The Asia Maritime Transparency Initiative (AMTI) is spearheading such efforts and was founded to monitor the ongoing territorial disputes in the South China Sea. In its mission to provide 'objective' information and increase regional transparency, the programme is hosted by the Center for Strategic and International Studies (CSIS), a Washington-based think tank that 'has been dedicated to finding ways to sustain American prominence and prosperity as a force for good in the world' (CSIS 2013). For its ongoing analyses, AMTI relies on

commercial satellite imagery providers, like DigitalGlobe, to oversee this area of also US security interests. Such interests are re-asserted through so-called freedom of navigation operations of US warships that sail within the 12-nautical-mile zone of China's artificial islands and are conceived as a challenge to the country's territorial claims.

In this example, we find a complex network of actors at work that shows how geopolitics are intertwined with the techno-political development of remote sensing, a diverse circle of users and their knowledge claims based on satellite imagery. In this case, a non-governmental organization (NGO) makes claims about enhancing transparency by utilizing commercial satellite imagery in relation to security issues relevant to US policy. Moreover, it is an expression of more general debates about novel opportunities that commercial satellite imagery offers non-state actors in the realm of human rights, nuclear proliferation, or natural disasters. Since the beginning of the new millennium, a broad range of NGOs, companies, advocacy groups, and researchers have become excited about these new possibilities to observe security situations that have been virtually inaccessible before due to political or geographical constraints. At the same time, more commercial imagery providers have been joining the field

and contributing to this enthusiastic discourse in the remote sensing community on the prospects that satellite imagery ostensibly provides 'global transparency' (cf. Olbrich and Witjes 2016). Central to this debate is the assumption that non-state actors' analyses can add to, question, or verify governmental knowledge claims about security-relevant issues (Similar expectations of increased transparency have been articulated in, for instance, debates about the Internet and its implications for democracy. Felt's (2014) study on the nexus of digital health information and socio-technical imaginaries of 'the Internet' shows that although the latter was ascribed transformative influence on governance, business, normative orders, and the way we live, the desired emancipatory transformations did not materialize (see also Castells 2011)). Going further, transparency itself is perceived by the AMTI as a useful tool in global security 'to dissuade assertive behaviour and conflict and generate opportunities for co-operation and confidence-building' (AMTI 2014). Against this background, we suggest that a critical take on the potential of technological innovation for democratic change is required when addressing the connection of transparency and commercial satellite imagery.

In the context of commercial satellite imagery analysis, transparency can be broadly understood as efforts undertaken by mainly non-state actors to increase the visibility of activities taking place in remote areas that are perceived as threatening to international or domestic security. The idea of transparency appears as a central feature among non-governmental satellite imagery analysts, in their belief that making things visible contributes to holding actors accountable for their actions. Against this background, this article suggests a more nuanced understanding of transparency as fragile, often delicate, incomplete, and subject to constant socio-political change. In order to substantiate this argument, we will discuss how the co-production of techno-political changes in satellite technologies and the emergence of new actor constellations redraw questions about transparency and power.

As transparency in international security is strongly linked to vision, the first part of the article presents research from different disciplines on satellite imagery and puts it into the context of the visualization literature from science and technology studies (STS) and security studies, a subfield of international relations. We argue that in particular these two research fields can complement each other in that they place different accentuations on visualization: security studies contribute to the discussion of satellite imagery from a 'visual securitisation' perspective that conceptualizes it as a visual representation that is influential in determining what constitutes a security threat. While this dimension is rarely considered in STS, it provides important insights regarding the role of technology in making visual representations and associated knowledge practices. Based on this discussion, we introduce our theoretical approach that takes up Vertesi's (2014) understanding of visual representations as 'drawing as' from a co-productionist perspective. The empirical part examines how civil society actors represent their work in relation to the techno-political changes of the commercialization of satellite technologies, and how they construct transparency as a guiding principle of their work and a political practice towards more public accountability. In a second step, we investigate the role of government actors in the process of satellite imagery acquisition and distribution, which effectively calls into question the transparency narrative of unprecedented possibilities for non-state actors in security knowledge production. Building on these insights, we then trace the entanglements of the US government with the commercial imagery providers and their implications for civil society actors. We argue that, although they have formed close and consequential relations, they are hitherto invisible in the related discourse on transparency.

2. Non-state satellite imagery analysis: between challenging government positions and 'surveillant witnessing'?

Sometimes blurred, sometimes impressively aesthetic, satellite imagery very easily enters public and political discourses and entails a mode of thinking and reasoning that privileges sight by embodying a 'naturalistic objectivity' (Perkins and Dodge 2009: 2). The sense of materiality and remoteness makes satellite imagery appear as (re-)presenting obvious facts. However, in capturing objects, activities and changes from an allegedly neutral perspective, the socio-political and cultural processes of their production and ways of inscribing meaning often remain invisible. No matter how high the resolution and the quality of the images, they always represent objects that require interpretation; we still need somebody to tell us what the grey squares or green islands on a picture actually mean. Essentially, satellite imagery itself is no more than a 'constellation of signs waiting to be transformed into meaningful symbols' (Olson 1999). When shown in public, it is 'festooned with arrows, captions and claims designed to anchor what is otherwise [...] a blurry and imprecise picture' (Campbell 2007a). This is the result of analysts who construct meaning by detecting and interpreting the imaged objects so that they are ready to be translated into public discourses as a technologically-mediated visual representation of security threats (Jasanoff 2012).

Within the current body of literature on transparency and knowledge-power configurations in the field of satellite imagery from different disciplines, we can identify two main trends: while one group focuses on the democratic potential of commercial satellites with respect to access to and distribution of open-source security knowledge, others are more sceptical about the opportunities it provides for global transparency as well as its political and security implications.

The first group advances the notion that the state increasingly loses its monopoly on satellite imagery as a guarantee for exclusive access to relevant security data (e.g. Livingston and Robinson 2003; Wang et al. 2013; Florini and Dehqanzada 2006; Baker 2001). Research in this stream highlights that the wider availability of and access to satellite imagery leads to a diversification of security knowledge (Baker 2001; Florini and Dehqanzada 2006). Moreover, it is argued that the commercialization of remote sensing allows non-state actors to challenge governmental threat assessments on technical grounds, as opposed to moral arguments and that '[g]reater transparency in international affairs seems likely, if not inevitable' (Livingston and Robinson 2003: 21). Aday and Livingston (2009) make a similar point when they show how satellite imagery was used to pressure the Bush administration to admit to knowing of an Iranian nuclear programme in 2002. As a result, they argue that the advancement of remote sensing technology leads to political power shifts that favour NGOs over state actors. Finally, in a more practical tone, Wang et al. (2013) assess the value of commercial satellite imagery in the hands of non-state actors as a tool to hold perpetrators accountable for human rights violations and mass atrocities. However, they see these efforts as being still largely in the experimental stage and face legal and technical difficulties.

However, there are also more critical accounts on the potential of satellite imagery, in particular in terms of power structures between the observed and the observers. Litfin (2002) ascribes a certain disciplinary power to commercial remote sensing that has a deterring effect on those observed and can open up new possibilities for perceptions of common security and collective identity formation. Shim (2014a,b)

makes the case for the potential of remote sensing to produce specific geopolitical imaginations with reference to night-time satellite imagery of North Korea which appears rather dark between illuminated China and South Korea. In this context, remote sensing works as 'visual spatial imaginaries' (Shim 2014a: 152) that construct North Korea as a foreign, isolated, and secretive place. In a similar fashion, Hong (2013) sees satellite imagery as being located at the intersection of technologies of militarized intelligence, and war and technologies of human rights, as both are used to reify security threats posed by an adversarial country. Questioning the neutral appeal of satellite imagery, Herscher (2014) describes how human rights NGOs have increasingly become entangled with the politics of securitization, collaborating with the state in the production of satellite imagery-based geopolitical knowledge and power. He coins the term 'surveillant witnessing' to refer to a hybrid practice that has emerged at the interface of governmental satellite surveillance and NGO's human rights monitoring practices. Parks also identifies remnants of the state within satellite imagery that she understands as inheriting a military view that 'treat[s] the Earth as a domain of Western vision, knowledge, and control' (Parks 2005: 79). In doing so, she stresses both the remaining powerful position of governments to make claims about what can be seen on the image, but also that there is room for different and challenging interpretations (see also Kurgan 2013).

Despite their different approaches and perspectives on satellite imagery as an instrument to enhance transparency, both groups assume clear boundaries between state/non-state, transparent/secret and private/public (For an analysis of a classified/civilian interaction between the US government and earth science community over secret satellite data of the CORONA satellite reconnaissance program during the 1960s to 1970s, see Cloud (2001)). On the face of it, the structure and dividing lines of these networks of state and non-state actors seem obvious: government analysts and intelligence agencies often work on matters of national security or military interventions and operate within a setting of secrecy. In contrast, analysts of human rights NGOs, universities or think tanks often share an interest in making things public. However, as our empirical analysis will show, these clear-cut categorizations of actors do not hold when investigating their actual practices. In short, they are more fluid, overlapping, context-dependent, and contingent than they appear at first glance. Moreover, as a result of making such strong distinctions between state and non-state actors, the advent of commercial remote sensing is mainly depicted as a zero-sum game in which the state loses its information monopoly to some extent, while NGOs equally gain more influence. Instead, our analysis shows how and in which ways the government plays a decisive role within the complex network of actor-constellations that employ commercial satellite imagery in the context of international security. In particular, the role of commercial providers has not been sufficiently analysed to date. To address these shifting social orders, we suggest understanding the images that satellites transfer down to Earth—and how they become visual representations of security threats—as being part of a finely woven network of technology development, security practices, ideas of transparency, global economic interests, and governmental and civilian surveillance.

2.1 Visualization technologies and the representation of security threats

In the field of security studies, a growing number of scholars acknowledge the role of images in international security politics (e.g. Shapiro 1988; Campbell 2007b; Bleiker 2009; Andersen and Möller 2013;

Shim 2014b). Here, one promising research direction takes images as central to the processes of securitization or de-securitization (e.g. Williams 2003; Campbell and Shapiro 2007; Möller 2007; Hansen 2011; Heck and Schlag 2012). Securitization theory in general refers to the idea put forward by the so-called Copenhagen School that security issues cannot be reduced to pure material characteristics but instead are constructed as a threat by means of language (Waever 1995; Buzan et al. 1998; Buzan and Waever 2003). In short, objects can be securitized through speech acts by particular actors who frame them as threatened, thereby moving from the realm of ordinary politics into a security context which justifies extraordinary measures in order to defend the threatened object, or attack the threatening one. Hansen, in particular, provides an elaborate theoretical understanding of visual securitization as a way in which visual representations influence security practices. According to her, *visual securitisation* is 'when images constitute something or someone as threatened and in need of immediate defence, or when securitising actors argue that images "speak security"' (Hansen 2011: 51). She identifies three crucial differences between words and images: *immediacy* refers to the prompt relation a viewer establishes in the process of looking at an image; *circulability* emphasizes the conditions for the fast distribution of visual securitizations and *ambiguity* highlights uncertainties in the interpretation of an image, as opposed to more explicit speech acts. Against this background, we can understand satellite images as visual representations of sites, places, and objects that "speak security" and as influential elements of security discourses. However, we suggest to also take into account the role of technology and knowledge practices employed for making these representations. Understanding, tracing, and reconstructing these processes has been of continuous interest in STS. Research at the nexus of visuality and materiality questions how 'things are made visible', 'which things are made visible', and investigates 'the politics of visible objects' (Rose and Tolia-Kelly 2012: 4). Similarly, research in this field contends that visualization technologies do not only enhance human visions but rather reconstitute the depicted objects, issues, or processes by making them visible through their own socio-technological arrangements (Ruivenkamp and Rip 2014; for earlier accounts see also Haraway 1989; Latour 1986). In his study on brain images, Dumit draws attention to images as 'fluid signifiers' (Dumit 2003: 10) that easily travel between different contexts, thereby losing and picking up new meanings, allowing them to 'serve different agendas and meanings simultaneously' (Dumit 2003: 4). His concept of mobile and indefinitive visual representation addresses similar features as Hansen's (2011) notions of circulability and ambiguity. Such an understanding of satellite images stresses how they are constructed, and how they travel and acquire various meanings on the way, e.g. when published in media outlets as illustrations of the South China Sea conflict as outlined at the beginning. Moreover, said similarities often remain unaccounted for and suggest that although much of the work in STS is sensitive to the production and circulation of scientific representations, the political and social aspects have only been implicit by comparison to other fields of social sciences (see also Jasanoff 2004). More concretely, we argue that in STS there are only few studies that pay attention to the security dimension of visualization practices. Vogel's analysis (2008) on how visual representations have been employed by security policy actors to create a narrative of threat constitutes a notable exception. Exploring the case of the US biological weapons threat assessment, she traces how images—photos, drawings, and satellite imagery—have been presented as evidence of the existence of biological weapons of mass destruction to the UN Security Council. Although many people viewed the images via

television, newspapers or on various websites, only very few were able to assess their validity. She concludes that this representation of a security threat creates a 'staged public display, but provides limited access to the backstage regions where the display was created' (Vogel 2008: 568) (See also Hilgartner's (2000) work on science and public knowledge). For the purpose of this article, it is particularly this backstage area of knowledge production that is of interest and will be explored in the empirical part. More precisely, we will trace the entanglement of notions of transparency and the actor-network constellation in which satellite images are produced, interpreted, and employed for different purposes.

3. Theoretical approach: a co-productionist view on visual representations

A co-productionist perspective draws our attention to the ways in which knowledge and technological artifacts create and modify social order; equally, it contributes to an understanding of how the production of science and technology itself are shaped by social, political, and cultural factors. As Jasanoff states, '[s]cientific knowledge both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments, and institutions – in short all the building blocks of what we term the social' (Jasanoff 2004). Such a perspective is, in particular, conducive for understanding how techno-scientific knowledge and social order are being created together in the making of identities, institutions, discourses, and representations (Jasanoff 2004: 6). While our analysis also touches upon issues of discourses and institutions, we particularly focus on the notion of making representations, as this provides a promising avenue to address the politics inherent to the imagery itself as well as to the practices of interpretation and construction while travelling from one context to another. We are going to discuss how techno-political changes in the field of satellite technologies and emerging actor constellations are co-productive of each other, thereby leading to new ideas about transparency of security issues. More precisely, we trace these dynamic relationships by focusing on three aspects of representation: the historical and political developments that have shaped a benign transparency narrative of satellite imagery, the knowledge and security practices of involved non-state and state actors, and the emergence of a fluid actor constellation that is co-constitutive of particular notions of transparency.

For a complementary understanding of visual representations, we can turn to Vertesi's (2014) study on how researchers of NASA's Mars Exploration Rover Mission make use of large bulks of images to investigate the red planet. She develops the concept of 'drawing as' to demonstrate that visual representations are a theory-laden, purposeful practice. In this understanding an image cannot be conceived of as a mirroring of perception. Instead, her approach emphasizes the role of expectations and norms in the process of visual construal as such representations rely on a certain recognizability of objects to allow for a context-flexible analysis of the image (Vertesi 2014: 17–21). By using the example of a geochemist, Vertesi lively illustrates that digital image processing is not only about extracting information but also about the representational practices and choices: In her study, one NASA researcher discovers unusual tracks after a robot got stuck in the planet's sandy surface. In the process of digitally manipulating the images and presenting them to colleagues, the scientist not only reveals previously unseen objects, but also produces a representation of a scientific discovery as the tracks lay bare two-toned light soil as an indicator for water (Vertesi 2014:

16). Taking into account the representational choices in the making of image-based knowledge, Vertesi (2014: 20) refers to the mutual relationship of observation and purposeful representation. For the objective of this article, this is a promising approach since it does not reduce visual representations to a result of technical manipulation and inscription but also grasps 'the practical activity of *drawing* a natural object *as* an analytical tool, such that subsequent viewers and image makers will see, represent and interact with that same object the same way' (Vertesi 2014: 31 [emphasis in original]).

Understanding the practices of satellite imagery analysts in this way is a helpful avenue to trace the ways that knowledge is produced through specific, purposeful representational techniques: This includes the concrete choices made by the image interpreters about image selection, which aspects to single out and call to the attention of colleagues, and how to approach the same site from different angles. At the same time, however, Vertesi does not extensively cover the interplay and power dynamics among multiple actors involved in the processes that co-constitute the ways we produce, circulate and make sense of images. By employing a co-productionist perspective that investigates the making of visual representations by a complex actor constellation, we will attend to the representational techniques employed in the backstage regions of security knowledge production and their intimate relation to notions of transparency.

3.1 Empirical material and methods

In order to explore the underlying power relations in the making of visual representations, we have interviewed satellite imagery analysts working on various topics and geographical areas as well as staff from commercial imagery providers. The core of the empirical material comprises thirteen semi-structured expert interviews with active satellite imagery analysts from non-governmental and governmental institutions in the USA, conducted between August 2014 and February 2015, both, in person and via Skype. In light of this material, the analysis focuses on the remote sensing community in the USA as a case study. While the commercialization of satellite technology is certainly a global phenomenon, the USA often takes centre stage in the economic, technological and political development of a large part of the application of commercial satellite imagery by non-governmental actors (Sawyer 2015; Lewis 2002).

The interview sample of eight non-state satellite imagery analysts consists of regular contributors to various security discourses concerning a variety of countries such as Iran, Pakistan, North Korea, or Syria. These analysts are employed at different institutions including private corporations, advocacy groups, NGOs, universities and think tanks, and feature a diverse educational background in engineering, nuclear physics, geography, economics, and political science. Those analysts with degrees in the social sciences, have often worked on issues of disarmament, arms-control, and human rights before taking up satellite imagery analysis as an additional resource for gaining knowledge. In contrast, some members of the group have a military background or were trained as governmental intelligence analysts and now continue doing similar work in a non-governmental or business capacity.

The remaining interviews were conducted with staff from intelligence agencies and international organizations, which use satellite imagery, as well as with staff from commercial satellite imagery providers. All the interviewees are quoted anonymously by mutual agreement. Due to the confidentiality of information, we only quote directly from the interviews with non-state analysts. In order to offer more contextual information, the interview data is complemented by a collection of

official policy documents, international legal code, historic data, and secondary literature on commercial satellite technologies. We used sensitizing concepts as a starting point that guided both the fieldwork and the analysis of the empirical material (Blumer 1954, Charmaz 2006). In accordance with our theoretical focus on visual representation in the context of the commercialization of satellite imagery, we started with the dualist notions of 'transparency vs. secrecy' and 'state actors vs. non-state actors'. However, during the course of the research project, subtle power dynamics among those actors in relation to transparency emerged in the data so that 'networks' and 'collaboration' as well as 'dependencies' became important terms, too. After all interviews were transcribed and stored in a shared database, we developed a coding scheme (Miles and Huberman 1994) using the qualitative data analysis software, Atlas.ti. First, we derived tentative categories such as 'government'; 'classified information'; 'public'; 'collaboration', 'seeing' and 'visibility' that were also informed by the sensitizing concepts and pre-tested for applicability on four interview transcripts by both authors. As a result of that, the categories were annotated and assigned more specific codes that were representative of practices and relations in that particular category. In a second step, we could utilize these codes to identify patterns and accumulations that allowed for identifying and specifying the exchanges and interactions between the different groups of actors involved, their respective notions of transparency, embedded knowledge practices, their role within the network of satellite imagery analysis, as well as the ways they refer to other actors.

4. From top secret to open-source? The commercialization of satellite technologies

Satellite observation has met the interest of the military, commercial, and civilian sectors. A diverse remote sensing community of companies, NGOs, universities, and government organizations uses high-resolution satellite imagery, e.g. in the oil and gas business, to assess the development of nuclear programs, human rights situations or agricultural productivity, or to count cars on parking lots as an indicator of economic activity. In this sense, commercial satellite imagery exhibits dual-use qualities in that it can be utilized for military as well as civilian purposes. Consequently, it attracts a diverse customer base that renders it a valuable product for satellite imagery providers. The most-developed markets for commercial high-resolution imagery are to be found in Europe and the USA. Accordingly, this is also where the providers are located many of the interviewed imagery analysts purchase their material from. With European Airbus Defence and Space and US-based DigitalGlobe, the satellite observation sectors in both markets are dominated by one major corporation. Lately, however, the USA has seen growing competition in commercial Earth observation as global market leader DigitalGlobe has been joined by start-ups such as Skybox or PlanetLabs which also build and launch their own satellites and offer their imagery products for sale. in the process of purchasing satellite imagery, potential customers often can access so-called image libraries to scan through a vast archive of satellite images filtered by location, date, cloud cover, inclination angle, resolution, and other technical features. In 2013, the revenue of the space-based remote sensing market was an estimated USD 1.5 bn and the total number of Earth observation satellites is projected to double by 2021 to more than 300 (OECD 2014: 56). The focus of the article on non-governmental remote sensing in an international security context also evokes the long history of Earth observation satellites when it was predominantly a government domain.

In fact, the benign transparency narrative that surrounds the non-state use of satellite imagery is intricately connected to the techno-political history of satellites and their embedment in Cold War power relations. Many consider 4th October 1957 as the starting point of the satellite era when the first-ever successfully launched artificial satellite, Sputnik 1, was put into orbit by the Soviet Union. Often referred to as the 'Sputnik shock', it had dramatic social and political implications for the USA in that it displayed quite plainly the technological equality of the two opposing blocks. It may be difficult to recall the perceived threats at that time, but 'for the World War II-weary world, it represented the potential for atom bombs to rain down unexpectedly from space anywhere on Earth' (Gabrynowicz 2010: 407).

Although satellite imagery was strongly connected to national security concerns during the Cold War and reserved for government agencies, remote sensing experienced a diversification in usage. The creation of the Landsat programme in the 1970s is illustrative of the opening of remote sensing for non-military applications. This first civil Earth observation programme under the auspices of the National Aeronautics and Space Administration (NASA) has provided remote sensing data for various uses such as economic planning, resource management, or environmental monitoring. However, only a few years after the end of the Cold War, about half a dozen US companies constituted a commercial market for high-resolution imagery. For instance, the largest imagery provider, DigitalGlobe (DG) (Then under the name of WorldView Imaging Corporation), was founded in anticipation of the adoption of the US Land Remote Sensing Act in 1992, which allowed and regulated the licensing of commercial Earth observation services. Satellite imagery experts expected to 'witness a revolution which may forever change the direction of [their] profession' (Fritz 1996: 273). Since then, the US market for commercial high-resolution satellite imagery has consolidated significantly and has experienced various mergers and acquisitions which have left DG as the market leader in the high-resolution satellite imagery segment. The diversification of usage and users of satellite imagery has occurred in accordance with the ongoing development of companies, availability of data, and analytical tools in the remote sensing sector:

> Now you see a lot more uses from different fields, thinking 'what can we do with that imagery', because it's there, it's free, we can use it. Before Google Earth, it was always seen as the prohibitively expensive resource that people don't think about using. (Anonymous Interview with US Satellite Imagery Analyst, 2014)

Moreover, the analyst refers to Google Earth as a breaking point in the transfer of satellite imagery from the secret into the open domain—a precursor of shifting notions of transparency. However, despite Google Earth's public salience and symbolic power for referring to the commercialization of Earth observation, it is often of limited relevance for the remote sensing community that deals with up-to-date security situations and which constitutes the focus of this article.

4.1 Aiming for global transparency: NGOs' usage of satellite imagery

NGOs, like Amnesty International or Human Rights Watch, can be counted among prominent emerging 'imagery activist groups' (cf. Baker 2001) which are making use of the enhancement of geospatial technologies to monitor activities in conflict zones which were previously difficult to access such as Darfur, Nigeria, Syria, and others. In various cases, they enter into a cooperation with other

non-state or commercial actors for access to satellite imagery or for geospatial analytics such as DG or the American Association for the Advancement of Science (AAAS). This suggests that the in-house expertise necessary for sound satellite imagery analysis is not a prerequisite for the use of Earth observation data in human rights advocacy. In a report covering North Korea's political prison camp system, Amnesty International worked with DG in order 'to circumvent the unwillingness of the North Korean authorities to allow human rights investigators access' (Amnesty International 2013: 5). By using a techno-politically enabled detour via outer space, the otherwise denied access was thus enforced on the area of interest.

With increasing frequency, advocacy groups, and also the media, refer to the importance of satellite imagery for transparency of security issues; however, less is known about the process of how they acquire and analyse the respective imagery. The preceding section already implies potential qualifications of the transparency argument in terms of independent and free access to satellite imagery for non-state actors to highlight security and human rights concerns as they see fit. In the following, we analyse NGO practices in relation to commercial satellite imagery in more detail to illuminate broader questions about the changing power configurations regarding non-state actors' access to security knowledge.

The wide and public distribution of satellite imagery and analyses is perhaps the most central issue for non-state actors, whereas state agencies are obviously much more reluctant to share their data and findings with the public. For achieving increased transparency of human rights violations or security threats, making things public is at the core of NGO activities. Moreover, for many analysts, drawing events detected on the ground as potential security threats is a main motivation for their work. In this sense, their notion of transparency does not only refer to the imaged objects and their interpretation, but is also seen as a conscious political practice.

One analyst emphasized this political function of enabling transparency by saying that

> Our point of view is that civil society needs access to information […] in order for those societies to have a voice. If you don't know what's going on […] then society can't have much of a say, it's all left to the privileged decision-makers with access to classified information. (Anonymous interview with satellite imagery analysts, 2014)

In keeping with other analysts, the interviewee conceived satellite imagery as 'a tool to have influence in the public domain' (Anonymous interview with satellite imagery analysts, 2014) thereby buying into some of the assumptions underlying increased transparency as a force for alleviating uncertainty and fostering common understanding (cf. Lord 2006). In effect, using satellite imagery to monitor the human rights situation in North Korea or nuclear activities in Iran were seen as an opportunity to bring about change as a result of shifts in knowledge orders and modifying the relation between information and the public, between secrecy and transparency. Operating on such an understanding, the primary objective envisioned for the use of satellite imagery by non-state actors is to

> raise public awareness of events that relate to human rights or nuclear security, communicating more effectively about these issues by the use of satellite imagery, generates new knowledge in the open domain that has previously only been in the classified domain. (Anonymous interview with satellite imagery analysts, 2014)

Hence, for many non-state analysts, commercial satellite imagery embodies an emancipatory promise located in its potential to overcome the secrecy that has surrounded satellites for the past decades. At the same time, it reinforces the assumption that simply making something visible has virtually direct implications for policy change. This conception of commercial satellite imagery as invoking opportunities to monitor, control, and reveal information implicitly sets those analyses against the ones conducted by state actors. In short, regarding the knowledge–power relations between state and non-state actors, this connects to typical narratives about the core of NGOs' advocacy work.

Non-state analysts critically question the dominant position of states with respect to satellite technology and challenge their reluctance to release more of their available knowledge, for instance about North Korea's nuclear programme and the human rights situation (Anonymous Interviews with Satellite Imagery Analysts 2014; 2015). As outlined above, this lack of information limits the extent to which the general public is able to assess certain political decisions. As a consequence, many analysts from civil society follow a common policy enterprise that puts transparency at its centre. To a great extent, they choose open-source publications to release their analyses and reportedly write for a general audience in order to achieve wider distribution—even though it is believed that most readers are journalists, policymakers, or academics (Anonymous interview with satellite imagery analysts 2014). So, despite the fact that the USA is home to an elaborate and vast private intelligence industry (Priest and Arkin, 2010), which highly values skills and expertise in geospatial analytics, a significant number of analysts choose not to offer their services solely to private businesses, but disseminate their findings in cooperation with NGOs and other civil society actors online and free-of-charge. Furthermore, they are aware of the important role of the media in transferring their results into more widely noticed publications. They see journalists as being attentive towards publications of various satellite imagery analysts. Especially when it comes to security-sensitive topics, such as nuclear programmes or territorial disputes, remote sensing seems particularly compatible with today's news media because it not only caters to the need of a visual experience, but also constitutes a remedy for the secrecy of the intelligence community that only allows for irregular and possibly controlled access (Anonymous interviews with two satellite imagery analysts 2014, 2015).

With respect to governmental imagery intelligence, non-state analysts adopt a peculiar position as they operate on similar technical and analytical terms but, at times, set out to question government information. In doing so, they constitute an unofficial alternative source for governments and the public alike. When it comes to satellite imagery, policymakers have basically two main resources, i.e. their national intelligence infrastructure, and also the work of non-governmental analysts. While the latter is unable to assess the studies of the intelligence community, they nonetheless provide additional options and opinions on the same subject matter and potentially second-guess the conclusions of military analysts without knowing it (Anonymous interviews with three satellite imagery analysts 2014 and 2015). So, in the process of providing security-relevant information to the general public, they coincidentally provide potentially valuable intelligence while attempting to fill in some of the blanks where governments are not willing to act and share information. One case in point is the assessment of the nature and size of nuclear weapons arsenals worldwide. As an open-source

type of data, satellite imagery plays an important part in the creation of 'generally accepted numbers' of weapons per country (Anonymous Interview with US satellite imagery analysts 2014). By virtue of rendering the actual stockpiles visible, public analyses are envisioned to pressure less outspoken governments into voluntarily declaring their capabilities, since open-source information and commercial satellite imagery have practically revealed them anyway. These declarations can then constitute the baseline for further disarmament efforts and a multilateral arms control process (Anonymous Interview with US satellite imagery analysts 2014). This illustrates the potential attributed to commercial satellite imagery as a co-facilitator of 'global transparency' and as a tool to increase pressure on governments through visual representations.

However, when considering the overall distribution of observed countries in available satellite imagery analyses by non-state actors, it is striking that they largely focus on areas concerning US security interests in the widest sense which, arguably, qualifies the global appeal of transparency through satellite technology (cf. Parks 2005). As a matter of fact, despite the opportunities that commercial satellite imagery provides to non-state actors, the US government still plays a significant role pertaining to issues of access and conditions of imagery acquisition. The following section traces some of these lines of influence and relates them to the transparency narrative as developed by the interviewed non-state analysts.

4.2 Government practices to maintain epistemic authority

In an 'ideally commercialised' market for satellite imagery, NGOs would approach sellers, such as DigitalGlobe, and purchase the imagery of interest. However there are quite a few limitations. Acknowledging the dual-use nature of commercial satellite imagery, the US government can intervene in the normal commercial operations of any licensee. In effect, it can demand from the 'licensee to limit data collection and/or distribution by the system during periods when national security or international obligations and/or foreign policies may be compromised, as determined by the Secretary of Defense or the Secretary of State' (NOAA 2006). This policy option is called shutter control in as much as the government can prevent any licensee acquiring or distributing satellite imagery of a specific region based on national interests.

While the policy of shutter control has never been formally executed, the US government implemented a later criticized 'checkbook shutter control' in 2001, during the first 3 months of the war in Afghanistan. Instead of taking the official route of having the Secretary of Defence appeal to the national security interest of the USA, the government used its financial means to purchase all the commercial high-resolution imagery of Afghanistan from October to December. It entered into a multi-million-dollar contract with the then commercial operator, Space Imaging, to prevent anybody else—including the media—from seeing what was happening on the ground and, at the same time, bypassed accusations for violating the freedom of speech and of the press (cf. Parks 2012). Only after the end of the contract did the company regularly release most of the imagery for free purchase. Shutter control constitutes a significant form of intervention in that it grants the government the power to shut down the commercial system of imaging satellites. It can also be understood as a powerful tool of the US government to preserve its epistemic authority effectively determine the permissible degree of transparency by referring to national security reasons.

Once the imagery is acquired, the close relationship between visuality and transparency implies that a higher resolution of commercial Earth imaging satellites can yield considerable political effects. Imagery of a better quality allows non-state satellite imagery analysts an even closer look at what is happening on the ground and means they can discern even smaller objects. The technological progress of remote sensing has indeed led to drastic improvements in terms of spatial and temporal resolution. While in the late 1990s the best non-military imagery provided spatial resolutions of about 1 m to 1.5 m, current commercial satellites can produce panchromatic imagery at a resolution of 0.31 m (The spatial resolution determines the minimum size of an object to be discernible on an image. Accordingly, objects bigger than 0.31 m are potentially recognizable on some commercial satellite images; however, they cannot automatically be identified as this is up to contextual interpretation. The resolution of military spy satellites is believed to be much better and, according to some sources, even usable for facial recognition (Rayner and Harnden 2011)). Discussions about centimetres might seem a little odd, given that most Earth observation satellites are orbiting through space at heights of roughly 400–700 km but when it comes to the analysis of nuclear facilities, details matter in determining the exact operation of that particular plant. At the same time, the growing number of commercial satellites results in more frequent monitoring of areas of interest.

However, technical capabilities are only one part of the equation as the US government exercises its right to determine the quality of resolution free to be sold by commercial providers. For example, all the DigitalGlobe satellites only offer panchromatic imagery of submetre quality and three of them even better than half-a-metre. Until summer 2014, the company was prohibited by federal law from selling or distributing any imagery below a resolution of 0.5 m. As the industry had pushed for a relaxation of this regulation, commercial providers are now allowed to sell panchromatic imagery with a resolution of 0.25 m, and coloured imagery with a resolution of 1 m (Ferster 2014). Even though this probably still cannot compete with the best military spy satellites, this change has had remarkable effects on the size of objects discernible on commercial satellite imagery.

In any case, there are still legal measures available to governments to put certain limits on commercial satellite imagery. Since governments project their ownership claims beyond their physical territory and into space, this puts those countries hosting the most developed and prolific commercial providers in an advantageous position to exert certain kinds of censorship. In this capacity, the USA, and increasingly European governments, are in a position to assert their influence on private imagery companies, obscure public vision and affect global transparency. In other words, despite all the technological innovation, governments still struggle to maintain some of their authority to regulate what is made transparent and what remains hidden from public sight.

5. The complex networks of state, private actors, and civil society

Taking a closer look at the US remote sensing network, governmental agencies are the main customers of the commercial provider, DigitalGlobe. As such, they have a significant influence on the tasking of satellites—this means determining which areas to cover at a certain point of time. Through this privileged access to satellite technologies and resulting imagery, decisions are being made about

what is worthy of being monitored and which issues are given more attention. At this moment, the US military purchases large quantities of commercial high-resolution satellite imagery to complement its national remote sensing system. Moreover, using commercial imagery it becomes easier to share information with other governments or international organizations without revealing its own technical capabilities. In essence, the US government and DG have entered into a dual-dependency. According to its annual report, DG relied on government contracts for about 60 per cent of its revenue in 2014, while the US government would have difficulties acquiring an equivalent quantity of satellite imagery from any other source. The National Geospatial-Intelligence Agency (NGA) processes the bulk of US government purchases and its director, Robert Cardillo, quite plainly describes the relations with the leading commercial imagery provider as a sine qua non for the agency's operation: '[W]e've been in the commercial imagery business for a long time. I have a mission partner called DigitalGlobe. Essentially I can't do my job today without them' (Scott 2015). Following from this, the alleged commercialization of satellite imagery in the USA is arguably carried to a great extent by government contracts and effectively represents an outsourcing of some of its intelligence data gathering to a private company. Going further, DG has also placed employees to sit on-site with its government customers working side-by-side with the government analysts.

This private extension of national intelligence is in line with the strong ties between DG and the US government that goes beyond a mere commercial provision of satellite imagery. Although this close relationship is far from being kept secret from the public—if anything DG uses it for marketing purposes—it barely appears in discourses about how the commercialization of satellite imagery is linked to transparency. DG keeps in mind the needs of its largest customers and has established service level agreements with the US government and Google. As a consequence, they co-determine which areas of the Earth are imaged and, thereby, have an influence on the pool of data available to other non-state actors. NGOs mainly operate on archived imagery because tasking a satellite for a specific collection results in considerably higher costs than using existing imagery. Thus, these entanglements can be understood as one of the key backstage areas of knowledge production. They have repercussions for the remaining remote sensing community and the kind of transparency it can produce. Because it quietly affects the ways in which NGOs decide which areas to cover in their research as in most cases, consumers of freely available or commercial imagery do not know who has tasked the satellite that captured the imagery (see also Kurgan 2013).

Depending on various factors, such as spectral and spatial resolution or time of acquisition, prices for very high-resolution imagery range from about USD 10 to USD 60 per km^2 and often come with minimum order areas of $25 km^2$ for archival material, or at least $100 km^2$ for new tasking collections (see http://www.landinfo.com/prices.htm). These costs cause substantial constraints on the use of satellite imagery in the non-governmental sector and, as the funds of non-state actors often are limited, the decision to buy images is made on a case-by-case basis (Anonymous Interview with US satellite imagery analysts 2014). Accordingly, if a group of non-state actors envisions a larger project based on regular surveillance, i.e. repeated imagery acquisition, it is probably either dependent on a sponsor or a preferential agreement with a commercial imagery provider, which then also introduce their own interests to the network, such as favourable publicity etc. In case of such an agreement, any publication of satellite imagery by an NGO comes with the DG trademark and links the company to humanitarian action, disaster relief, and the monitoring of human rights instead of associations with the US defence and intelligence machinery.

In light of this traditional and ongoing position of remote sensing in the military sector, it can be argued that personal ties matter and have remained strong as former imagery intelligence specialists are still present in the community of non-state analysts. In many cases, they are highly appreciated due to their expertise and inside knowledge regarding both the technical process of analysis as well as the countries of interest (Anonymous Interview with US satellite imagery analysts 2014). They play an important role for non-state actors in acquiring the necessary skills to analyse satellite imagery. In other cases, they go about it in a learning-by-doing fashion, reach out to more experienced analysts or sometimes receive advice from DG where a more stable customer relationship is concerned. These networks seem especially relevant since NGOs often lack institutionalized training and education opportunities in contrast to state or private analysts. As a result, non-state actors do, at times, face a situation in which the increasing quantity of available imagery cannot be duly processed due to a lack of trained analysts (Anonymous Interview with US satellite imagery analysts 2014, 2015).

5.1 Co-developing algorithms: an example of blurring lines between the actors involved

Since the techno-political development and proliferation of remote sensing data is likely to continue, another way of dealing with the mismatch of data and human analysts is to turn to automatic algorithm-based analysis. Indeed, the 2014 annual report accentuates an expansion of DG's portfolio from mere imagery provision to offering a range of products that bring together geospatial big data and analytics. Drawing on its vast archive of satellite imagery, the creation of a platform is envisioned which allows users to perform Big Data analytics on their own in a self-service fashion: such developments point to emerging activities in the field of predictive intelligence for security issues. While predictive analytics are mainly aimed at government and other defence customers, the necessary skills appear to be developed through cooperation with NGOs as well. In an illustrative case, staff from DG's geospatial analytics department collaborated with several organizations and started to document patterns of elephant poaching by, among others, the Lord's Resistance Army (LRA) in the Democratic Republic of the Congo (For the report called *Poachers Beyond Borders*, see www.enoughproject.org/reports/poachers-without-borders (accessed 22 December 2015)). While poaching is believed to finance military activities, local rangers have difficulties in securing their park area of approximately $5000 km^2$. DG analysts supported efforts to become more predictive in fighting poaching and created a pattern profile based on the geospatial information of known poaching locations and extrapolated the result to areas with the highest poaching activity. Using these pattern profiles, analysts were able to predict where future events were more likely to occur and to reduce the area with the highest risks of poaching by 95%, thus allowing for more efficient patrolling by the rangers. DG employed similar predictive analytics to monitor extremist activities in other parts of Africa such as Boko Haram in Nigeria or al-Shabab activities in Somalia. One interviewee familiar with the projects enthusiastically reflected on potential areas of applications:

> So, you can imagine how valuable that type of capability is in terms of military, law enforcement or humanitarian efforts to influence where to apply the limited resources. (Anonymous Interview with commercial provider, 2015)

This quotation is illustrative of the blurred lines between state, civil society and business actors: while the analytical tools have been developed by a private company, they are tested and showcased in a context of animal protection and civil conflict in cooperation with an NGO, and then transferred to its main customer base of governments for application in the field of international security. In effect, it is increasingly difficult to distinguish between the particular actor groups, but there are new actor constellations at work in the remote sensing community which cannot be adequately grasped by simply juxtaposing state and non-state actors.

6. Conclusion

The end of the Cold War, national budget constraints, and expectations of economic benefits have facilitated the transfer of the former military-intelligence technology into the public and private sector. NGOs, advocacy groups, and other non-state actors have embraced commercial satellite imagery as a new opportunity to render visible events in places that otherwise are difficult to access. By that, it is envisioned to increase or add to 'global transparency' of various security issues. However, as was shown in the article, satellite images do not constitute outright 'transparent' windows to the world, but are a product of diverse actor-constellations, political and technological choices, and analytical processes that often remain invisible to the public. This challenges independent access to and analysis of commercial satellite imagery as prerequisites of global transparency as it reveals shifting power dynamics among the involved actors in the backstage area of knowledge production (cf. Vogel 2008). Since satellite imagery as visual representations of security threats are also laden with particular interests and expectations (Vertesi 2014) of those who purchase, analyse and circulate them, this article has investigated how actor-power constellation play out in this field. For instance, limited budgets to purchase specific imagery and a lack of longstanding expertise in analysing it make NGOs partly dependent on the benevolent (or self-interested) cooperation of commercial imagery companies. Moreover, contrary to the dominant narrative, we suggest that the current shifts in the US imaging satellite sector do not exclusively favour nongovernmental actors at the expense of governments' security knowledge authority. Rather, the US government still is an important and powerful player in the area of commercial satellite imagery. As by far the biggest customer and regulator of market leader DigitalGlobe as well as through policies such as shutter control, government actors can still influence the extent to which transparency can be increased by referring to issues of national security. In short, the interplay of the techno-politics of satellite technology and power dynamics in actor constellations is productive of shifting notions of transparency.

Against this background, a binary notion of transparency vs. secrecy is insufficient to address the fundamental changes taking in the satellite technology sector. Rather, we suggest the term 'fragile transparency' to emphasize its contingent emergence, limited scope and, in particular, its context dependence. The notion of fragile transparency exposes the shifting power relations inherent to commercial satellite imagery and its potential as a political practice to render certain things as visible and threats to international security. More concretely, it points to the provisional and temporary character of satellite-based visual representations and their co-constitutive norms and interests: Each satellite image is a specific snapshot of time that assembles a diverse set of actors with differing security and commercial interests, expectations, norms, and claims to epistemic authority. Changes within this satellite-imagery assemblage potentially interfere with what is publicly visible, what constitutes a security threat, under which conditions and for whom. In this sense, fragile transparency does not refer to the bounded technical functionality of remote sensing nor the normative claim that it needs to be reinforced to ultimately achieve global transparency. Rather, it points towards the power dynamics inherent to the practice of Earth observation thereby also opening up spaces of contestation to critically reflect on the visual construal of commercial satellite imagery in international security. Along these lines, the AMTI, which monitors developments in the South China Sea, illustrates the feature of remote sensing to actualize a fragile transparency. Such a perspective highlights the complex actor-constellation behind the initiative and questions the selection of the specific areas of interest, potential overlaps with US security interests and the practices of costly continuous imagery acquisition and analysis.

In this regard, combining insights from STS and international relations, and in particular security studies, has been instructive as they approach visual representations in a similar fashion albeit with different accentuations. Elements of visual securitization (Hansen 2011) such as circulability and ambiguity can also be found in STS accounts of visual representations: They constitute mobile objects that can easily travel between contexts and acquire divergent meanings along the way. More particularly, Vertesi's (2014) approach of 'drawing as' adds the role of expectations and norms among different actors that produce, use, and circulate the images. Reconnecting this insight to Hansen's take on securitization brings certain types of securitizing actors to the fore and links up the practices of visual representation with the construction of security threats. In sum, while STS features a nuanced understanding of visual practices, a combination with the visual securitization literature lends itself to introduce a more explicit security perspective that moves beyond the preoccupation with the production of scientific representations.

To conclude, as fragile transparency alludes to the constant shift of actor constellations and notions of transparency, this has variegated implications for science and technology, and security policy. The increasing reliance of the US government on commercial satellite imagery is reminiscent of broader neoliberal trends towards privatization which puts private companies such as DigitalGlobe in a role once reserved for government actors but without sufficient democratic oversight or legitimacy. While the article has demonstrated the remaining government influence over imagery collection and distribution, the burgeoning technological innovation and international competition from Europe, China and elsewhere raise questions about the future scope and relevance of national regulations for satellite technologies. For non-state actors, the resulting drop in prices and variety of imagery providers might open up the opportunity to become less dependent on certain commercial providers and governments and more confidently follow through with their own goals. Notwithstanding these future developments, visual representations such as satellite imagery are always also the product of purposeful practices and interpretational uncertainties (see also Olbrich and Witjes 2015). This calls for a sense of caution and reflection towards satellite imagery-based knowledge claims, especially when employed in security contexts. Taken together, in light of the projected proliferation of satellite imagery, shifting actor constellations, and the complex process of the visual construction of threats, this article can be understood as a snapshot itself—constituting a starting point for further research on the co-production of techno-political changes in satellite technologies and emerging actor

constellations that dynamically enable different and contingent ideas about global transparency of security issues.

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