1 BEARING WITNESS FROM AFAR

Source: Maxar

"A single image can offer a visual anecdote from a moment and place within a war's complex chronology but says little about the human cost of the damage, let alone the intent behind the damage.

Jamon Van Den Hoek, 2022

Since the late 2000s, commercial satellite imagery has been used to expose and document human-rights abuses and war crimes and, occasionally, to provide humanitarian assistance in crisis situations. Prominent case studies have included Darfur in 2008, South Kyrgyzstan in 2010, Syria in 2017, Burma in 2018, and now also Russia's war against Ukraine.

These efforts can take credit for having raised public awareness of numerous humanitarian crises, and the evidence collected is often deemed irrefutable.

But the use of satellite imagery for documenting violence and war has also drawn criticism. Evidence from Darfur suggests that monitoring the conflict ultimately increased violence by allowing actors to signal their strength or commitment to an issue (Gordon, 2015).

Moreover, images often are fitted into and interpreted through existing political narratives, which may themselves be contested. Skeptics have argued that human-rights remote sensing can be "complicit in (re)articulating dominant geopolitical discourses and established political identities" (Rothe & Shim, 2018).

2 WHEN THERE IS NO GROUND TRUTH

Source: Google Earth (doctored)

“Transparency is never absolute for two reasons. First, photo interpretation is as much art as science, and, second, because even when there is consensus on what an image shows, what it means is often highly contentious.”

Karen T. Litfin, 2002

Since the 2010s, there has been a widely shared expectation—or hope—that broad access to satellite imagery, amplified by social media, will enable the early or timely detection of non-compliance with relevant international agreements. It would become impossible for governments to keep secrets and further enable citizen monitoring.

It’s rare that a single image provides sufficient information for an original analysis that offers new insights.

But sometimes, one image is all there is. And, at other times, whether a specific moment is captured or not captured changes everything. Perhaps a vehicle makes an important delivery or an event occurs that is truly ephemeral in nature.

There are many geographical regions and sites where independent ground truth data remains elusive. “Who decides whether these media are compelling sources or nothing but an artificial view constructed from outer space?” (Rothe & Shim, 2018)

3 CENSORSHIP & DECEPTION

Source: Airbus via Google Earth

"Want to know how to make a satellite imagery analyst instantly curious about something? Blur it out."

Matt Korda, 2018

Google Earth has brought very-high-resolution imagery to the masses. But the imagery can be years old and barely offers a "view" of the world as it is. Outdated imagery on web mapping services is one way to hide things from public view—blurring and pixelating the imagery is another, perhaps naïve approach to shield information. More than anything, it attracts attention.

Regardless, access to up-to-date satellite imagery remains highly uneven, and imagery of particular areas or sites may be even more difficult to obtain—but ultimately it's the high price of purchasing very-high-resolution imagery that prevents broad access for most journalists and researchers today.

Some argue that any attempt to censor or otherwise limit access to satellite imagery—via shutter control, degraded resolution, pixelation, costs, or other methods—is ultimately futile as more providers enter the market and imagery becomes ubiquitous. In such a world, fewer and fewer moments exist, during which an activity on the ground would not be detectable by at least one imaging satellite overhead.

But having reached a level of global transparency, some actors may want to make things invisible again; by using decoys, by operating at night or under clouds, or by mimicking innocuous activities—all of which makes things harder to see.

4 SYNTHETIC & DOCTORED IMAGES

Source: Synthetic imagery generated by Vy Nguyen using Stable Diffusion and various machine-learning methods; Authentic imagery from Google Earth

"How we distinguish reality from the synthetic in our evolving world of thinking machines presents one of the most pressing questions of our time."

Boneh et al., 2021

Satellite imagery is often considered inherently trustworthy because of the expense of creating it. As this imagery is becoming more abundant, its promise of providing ground truth may be one reason why satellite imagery is increasingly used in print and online media. On the other hand, given their low resolution and abstract features, it is relatively straightforward to manipulate satellite imagery or even synthesize imagery from scratch.

Generative AI is fundamentally changing our relationship with all types of media, and it is becoming increasingly difficult to distinguish authentic text, images, video, and audio from content that has been generated artificially.

It's now all but certain that the amount of synthetic media will soon exceed the amount of real media by orders of magnitude. This development poses major challenges, especially when content is created to mislead.

How can we "trust" the authenticity of satellite imagery in an age of misinformation? Digitally signing the data acquired by the satellite, ideally before transmission to the surface, could be one approach to provide assurances of authenticity—but to succeed such an effort would need to overcome the competitive commercial and geopolitical context of imagery production and its use in the media.

SURVEILLANCE & PRIVACY

Source: Airbus

"I also imagine a dystopian not-so-distant future where we can direct very high-resolution satellites to any point on Earth, easily identifying a person's location or activities."

Sarah Parcak, New York Times, 2019

The first imaging satellites, launched in the early 1960s, achieved a ground resolution of about ten meters. When the first commercial high-resolution imaging satellite Ikonos was launched in September 1999, many considered it a geopolitical milestone. Satellite imagery featured in many original newspaper stories at the time, often as a curiosity, but increasingly also to document human-rights violations, environmental disasters, and other events. The resolution of this early imagery was on the order of one meter.

Even over the last few years, the resolution of commercially available imagery has further increased substantially, and the best optical imaging systems achieve a resolution of 30 cm today. This resolution can be further increased using advanced algorithms to achieve an effective resolution of 15 cm.

With imagery of ever increasing resolution becoming available, the policy and ethical questions become: "Who will have access to this data? The police? Politicians looking for dirt on their opponents, or angry spouses with a vendetta? How will this data be used in courts—and who can be trusted to interpret it?" (Parcak, 2019). Is there a path forward based on global guidelines, or is everyone going to find their own strategies to keep their lives private?

6 SEEING PATTERNS OF LIFE

Source: Airbus

"The data sources available to understand pattern-of-life have now mushroomed to such inhuman scales, analysis needs a helping hand from artificial intelligence."

Rebecca Pool (Photonics Focus, 2024)

As the number of imaging satellites has grown, the revisit rates have grown respectively. Satellites of the same fleet can now image the same place on Earth multiple times per day. This can permit "pattern-of-life" analysis, which "systematically evaluates all forms of activity, spatial and temporal, to create a comprehensive assessment of actions and behavior that would otherwise go unidentified by conventional intelligence techniques" (Maxar). With pattern-of-life analysis, some argue, it may become possible to tell stories with satellite imagery and to develop a deeper understanding of the events on the ground.

Vendors advertise "rapid revisit" and suggest many important use cases for this capability, highlighting its importance for coordinating disaster relief, tracking global commerce, and supporting up-to-the-minute reporting on news events.

The deluge of commercial imagery and other open-source information has made it difficult for small investigative teams to process this torrent of data. Advanced machine-learning techniques are becoming indispensable for analyzing this data at scale; ultimately, only government-sponsored efforts may then be able to leverage the potential of near real-time and satellite imagery, undermining the promise of global transparency that such imagery appeared to offer.