Raising standards

The commercial availability of high-resolution satellite imagery brings with it ethical questions, with practitioners increasingly concerned about the lack of professional standards for open-source imagery analysts. **Allison Puccioni** and **Neil Ashdown** examine the evolving debate.

Key points

- The proliferation of commercial satellite imagery and advances in imagery resolution have outpaced efforts by governments and the open-source intelligence community to regulate industry tradecraft and ethics.
- Publishers face numerous ethical dilemmas surrounding the publication of satellite imagery analysis from reputable sources, while less reputable sources are prone to a lack of training, standards, peer review, or deliberate deception.
- Future solutions may include the creation of professional associations to standardise, review, and accredit imagery analysis outputs; wider recourse to conferences and workshops; or formal academic curricula and qualifications.

A session at the quadrennial International Atomic Energy Association Sanctions Symposium in November 2018 showcased the important role that high-resolution commercial satellite imagery analysis plays in monitoring nuclear proliferation. Open-source imagery analysis has enhanced public understanding of nuclear proliferation in territory where access has previously been denied. Moreover, briefings at the symposium highlighted the range of new applications for high-resolution imagery that are being developed by governmental organisations and academic institutes.

Nonetheless, in informal discussions on the sidelines of the symposium, many imagery intelligence (IMINT) practitioners lamented the challenges facing the discipline. These discussions centred on the recognition that – outside governments and militaries – imagery analysis is still at a nascent stage. Moreover, the participants noted that analysts working in open sources faced ethical questions around the publication of imagery analysis in the media that are not faced by analysts working in the classified space, and which therefore lack established bodies of practice that could be used to establish standards for open-source analysts.

Prompted by these concerns, non-profit

The suborbital rocket SQX-1Z carrying three CubeSat miniaturised satellites takes off from the Jiuquan Satellite Launch Center on 5 September 2018 in Jiuquan, Gansu province, China. The proliferation of CubeSats will enable vastly increased earth imaging in the 2020s.

Yang Xiaobo/China News Service/ Visual China Group via GettyImages:1746171

organisations the Stanley Foundation and the One Earth Future Foundation held a follow-up summit, 'The Gray Spectrum: Ethical Decision-Making in Geospatial Analysis', in Boulder, Colorado, in July 2019. The event was attended by established open-source IMINT practitioners, many of whom also attended the symposium (see box on page 11). At this summit, stakeholders in commercial imagery analysis discussed hazards and potential ethical dilemmas associated with the dissemination and publication of analysis of this still relatively new medium.

Maxar Technologies/Getty Images:1746166

An unannotated Maxar Technologies electro-optical image from 25 December 2017, of the Him Shinshar chemical weapons complex outside Homs, Syria – later struck in a US-led coalition operation. Before-and-after imagery enables open-source researchers to carry out tasks such as bomb damage assessment.

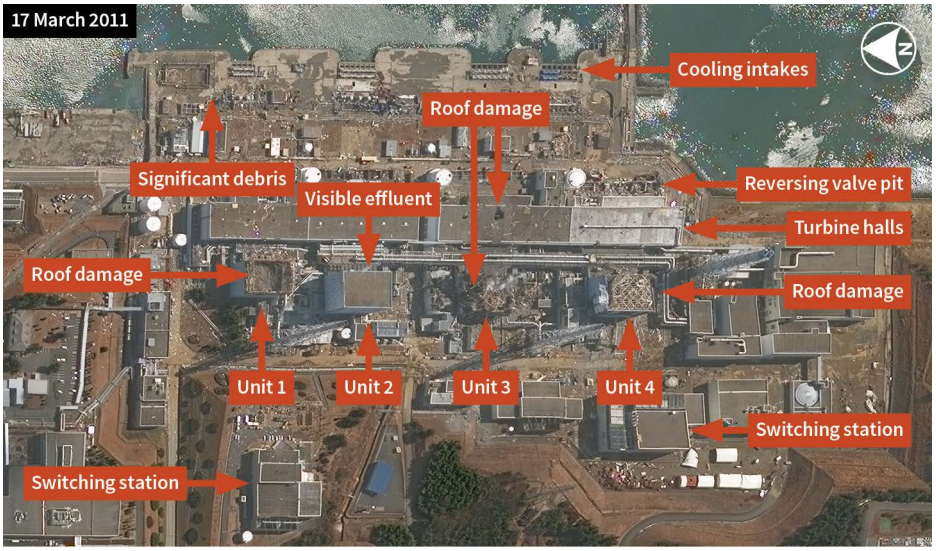
From secrecy to ubiquity

High-resolution imaging satellites were developed in the 1950s, but remained almost entirely inaccessible to the public until the 2000s. Imaging satellites were developed at extraordinary expense by the Soviet Union and the United States, which purposed them to collect technical information about each other's nuclear capabilities. These satellite systems and the imagery that they collected were restricted to the most highly classified intelligence and diplomatic channels.

The tradecraft of interpreting aerial and subsequently space-based reconnaissance imagery has evolved in similar secrecy. Imagery analysis as a practice was formalised along with the widespread systemisation of aerial photographic reconnaissance during the Second World War. Termed "photographic interpretation" in the US and the UK until the 1990s, analysis of remotely sensed images is taught to military and intelligence officials over the course of several months and is practised within a rigid structure of peer review.

Analysis is conducted generally under the auspices of a two-person integrity system in which imagery and geospatial intelligence can only be disseminated after a standardised process of quality control. Since the Second World War, most national militaries and intelligence agencies have collected, processed, analysed, and disseminated imagery analysis entirely through classified channels.

IMINT became a keystone of intelligence for the US military and intelligence communities, and demand continued after Cold War tensions waned in the 1990s. The US government began to solicit commercial solutions to its ever-increasing demand for imagery analysis, and – after decades of



Maxar Technologies imagery captured on 17 March 2011 shows examples of significant damage to the Fukushima Daiichi nuclear plant following the 11 March earthquake and subsequent tsunami.

seeking to ensure that its satellite reconnaissance capabilities remained secret – facilitated the nascent commercial capability to launch and operate high-resolution satellites in the 1990s.

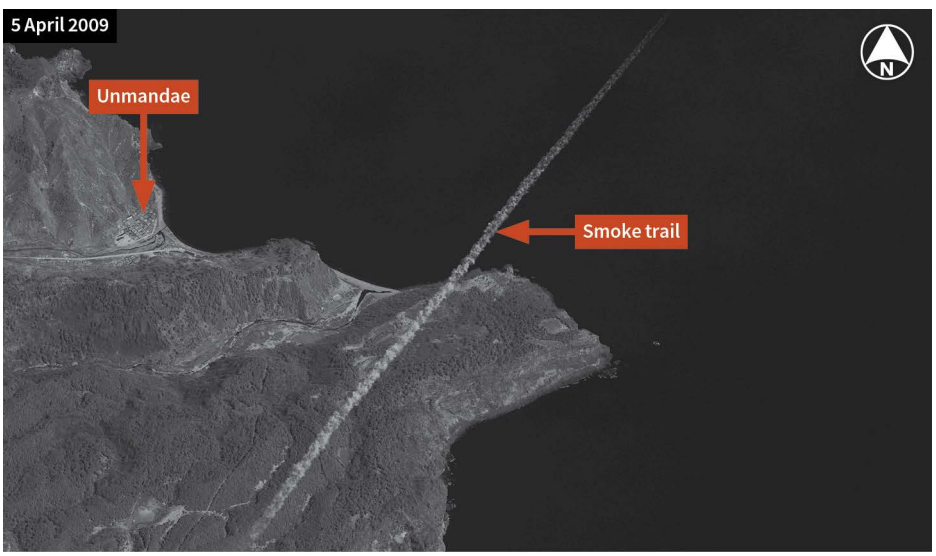
In 1999, the US company Space Imaging launched the first fully commercial high-resolution imaging satellite. In 2010, US and foreign companies operated five commercial high-resolution satellites. By 2019, there were nearly 50 satellites operated by commercial companies in China, France, Germany, Italy, South Korea, Spain, the UK, and the US, and this number is likely to rise to more than 200 in 2020–21.

Commercial satellite companies face legal restrictions including regulation of the resolution that their sensors can collect, limits on the areas of interest over which they can sell imagery, and some restrictions against image purchase from entities based in sanctioned nations. However, the increasing number of countries providing pay-for satellite imagery has diminished the ability of all governments to regulate these restrictions (see box on page 13).

Public awareness of this medium increased alongside the growing number of commercial satellite imagery providers, spurred on by the development of software such as Google Earth. By the late 2000s, the use of imagery was very common in media reporting, and a growing number of outlets provided imagery analysis on a range of military and national security topics. These included academic organisations and commercial entities, as well as non-profit groups and individual analysts.

Some of these open-source imagery analysts have less access to formalised training in imagery analysis, raising questions over the accuracy of some of their imagery analysis. Moreover, some analysts can anticipate fewer negative consequences from publishing incorrect information than others, compounding the challenge around a lack of formal training.

These analysts may also not engage in the same level of pre-publication peer review as their counterparts in national intelligence communities. The lack of training available outside military and intelligence circles and a dearth of practitioners capable of reviewing open-source imagery analysis will potentially create ethical challenges within open-source imagery and analysis.



Maxar Technologies imagery shows the smoke trail of an Unha-2 space launch vehicle launched from Tonghae, approximately 12 kilometres southwest of the coastal village of Unmandae.

Ethical challenges

Open-source imagery analysts face a range of ethical questions around the publication of their material. At the most basic level, open-source imagery analysts face the question of whether to publish satellite imagery and imagery analysis.

Imagery analysts are often the first people outside satellite imagery companies to see newly collected satellite imagery. This imagery can provide timely and detailed understanding of evolving conflicts, natural disasters, and other humanitarian crises. The question of whether to publish such potentially serious information – previously restricted to government agencies and militaries with well-established protocols and the assumption of secrecy – is increasingly falling on open-source practitioners.

One resulting dilemma occurred after a March 2011 earthquake-triggered tsunami led to a nuclear meltdown in the nuclear reactors at the Fukushima Daiichi Nuclear Power Plant near Sendai City in Japan's Fukushima Prefecture. Between 12 March and 15 March 2011, three reactors were severely damaged and released radioactive material. The Japanese government initially minimised the extent of the damage,

reporting only that two reactors had been damaged, and set an immediate zone of evacuation.

The satellite company DigitalGlobe (now Maxar Technologies) imaged the reactor in mid-March 2011 and forwarded the images to several organisations, including *Jane's*. The *Jane's* imagery analyst concluded that there was unequivocal damage to all the reactors, in contrast to the official Japanese government assessment. With a press deadline imminent, *Jane's* had to decide whether to publish this image.

Although media organisations are agents of transparency, publishers weigh the potential for public safety before publication, along with other considerations. A published image of the reactor could potentially have caused panic during an evacuation and possibly would have jeopardised safety more than a lack of full public situational awareness.

Ethical dilemmas are not limited to natural disasters or time pressures on analysts. For example, analysis of weapon systems and platforms is a staple of imagery analysis, including in publications such as *Jane's Intelligence Review*. However, publication of such analysis may effectively help a country to advertise or troubleshoot those capabilities, which may be unethical.

In April 2009, North Korea launched a Space Launch Vehicle (SLV) during the brief overpass window of Maxar Technologies' WorldView-1 satellite. The minutes-long overpass window suggests that North Korea may have timed the SLV launch to align with the collection pass of one of the only commercial high-resolution satellites in existence at that time, enabling the North Korean leadership to actively seek publicity.

Alternatively, publicity attracted by imagery could lead a country to take measures to defeat future imagery collection, either by revealing the technical capability to collect imagery or – more likely – by publicising the existence of a capability that the target country was already aware of. For the open-source analyst, the ethical dilemma in such cases would be whether the benefits of publication outweighed the cost of a potential reduction in the value of satellite imagery for monitoring the area in question.

For example, in 2013, North Korea attempted to conceal a hot water cooling line from its 5 MWe nuclear reactor after imagery-based Western media reports disclosed that the line was active and that liquid effluent had been observed emanating from it. This was a concrete indication that the reactor, a key component to weapons-grade plutonium manufacturing at Yongbyon Nuclear Research Centre, was operational and likely critical.

Tradecraft challenges

These cases centred on ethical questions around publication and assumed that the

Attendees view a Google Earth map of Sentinel Mesa in Monument Valley National Park, on the Utah-Arizona border, as Google Earth unveils a revamped version of its application on 18 April 2017 at an event at New York's Whitney Museum of Art. Google Earth has democratised access to satellite imagery more than any other tool.

Timothy A Clary/AFP/Getty Images:1746170

Maxar Technologies/38 North via Getty Images: 1746165

An electro-optical (EO) satellite image taken of the command centre at the Punggye-ri nuclear test site in North Korea's North Hamgyong Province on 6 July 2019. The image was published by 38North, one of several reputable specialist outlets regularly using commercial satellite imagery to monitor and analyse key sites in North Korea's nuclear and ballistic missile programmes.

underlying imagery analysis was correct. However, in practice, the accuracy of imagery analysis is by no means certain. Erroneous imagery analysis can be published with little of the recourse or rebuke that would occur if disseminated on intelligence channels.

Because there are no formalised academic curricula for imagery intelligence, open-source IMINT practitioners may be less qualified to conduct analysis than individuals with a military or government background (who also may be unable to publicly correct errors because of non-disclosure agreements under official secrets legislations).

There are also examples of deliberate imagery misinterpretation or manipulation to deceive or to misinform the public. In 2014, the investigative journalism organisation Bellingcat determined that Russia's Ministry of Defence had altered high-resolution satellite imagery to argue that Malaysian Airlines Flight 17 (MH17) had been shot down by Ukrainian missiles. According to the Russian authorities, the images showed Ukrainian anti-aircraft missile launchers located within firing range of MH17 on 17 July 2014, the day that it was shot down. The Bellingcat investigation determined that these images were in fact taken before 17 July 2014, and that they had been digitally modified.

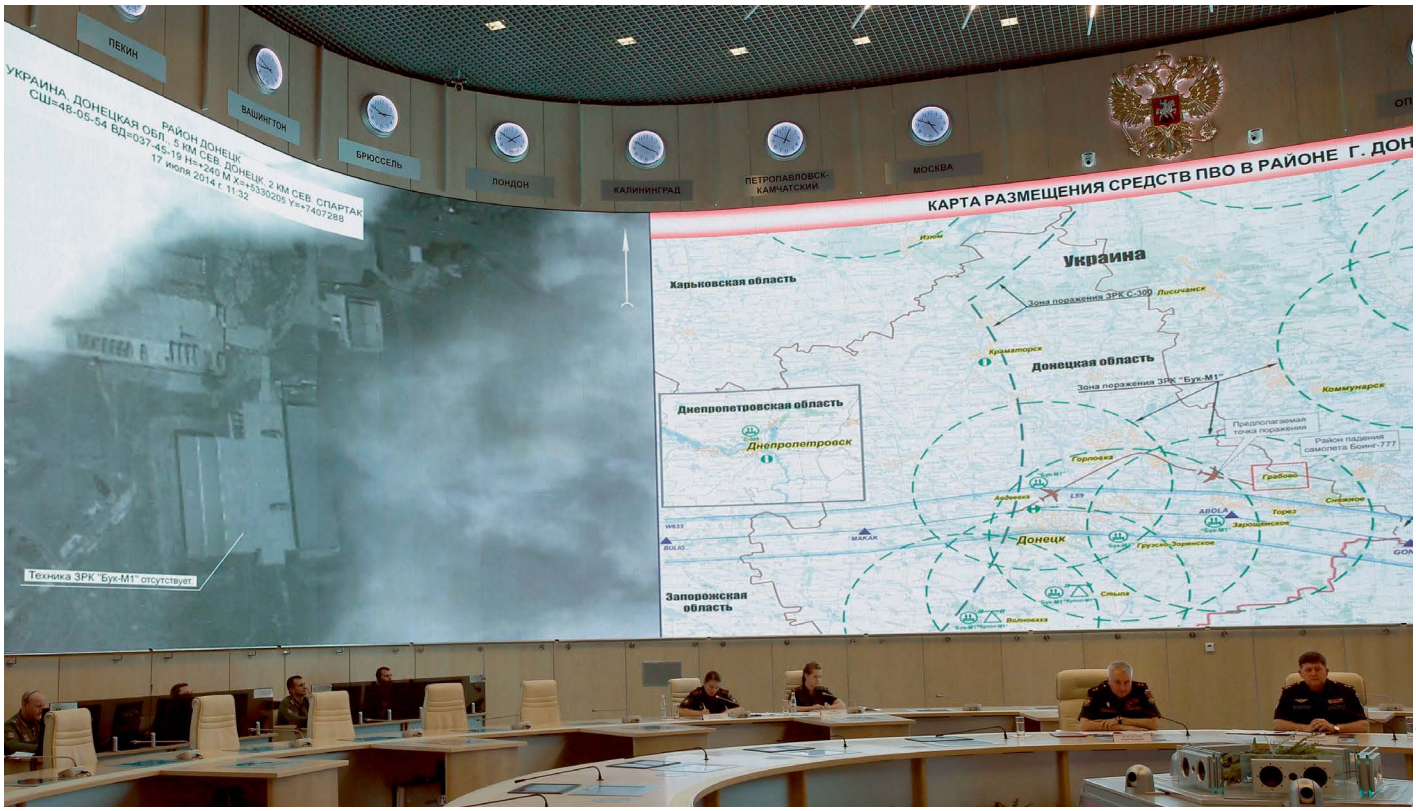
Ethical challenges with respect to research and publishing are by no means unique to imagery analysis. Journalists regularly encounter ethical challenges around the conduct of investigations and publishing their work. In some areas, such as defence and national security journalism, the potential severity of these challenges is recognised and there are structures to support journalists as they make these decisions. In the UK, for example, the Defence and Security Media Advisory (DSMA) Committee provides advice to journalists publishing material with implications for national security.

However, because imagery analysis as a discipline is only slowly emerging from the structured confines of the military and intelligence communities into academic and journalistic communities, analysts do not have the same body of experience to fall back on. Moreover, the exceptional power of imagery analysis as a tool means that the ethical challenges are commensurately serious.

Peer review within open-source satellite imagery analysis is often marred by a shortage of trained practitioners, and at times by inter-organisation competition. The result is a lack of broadly accepted or implemented standards. Similarly, the public is largely unaware of the challenges involved in imagery analysis, and cannot act as discerning consumers of imagery analysis. Satellite imagery is a powerful visual medium, and there is the fallacy that it presents an

Russian Defense Ministry/Anadolu Agency/Getty Images: 1746169

A satellite image used at a press conference on 22 July 2014 in Moscow, Russia, when Lieutenant General Andrey Kartopolov, head of the Main Operations Directorate of the Russian Armed Forces, claimed that a Ukrainian Su-25 fighter was flying to within 2 km of Malaysia Airlines Flight MH17 before it was downed on 17 July 2014 in eastern Ukraine; the use of the image was part of a Russian disinformation campaign that was widely discredited. MH17 was found to have been shot down by a Buk surface-to-air missile.



Russian Lieutenant General Andrey Kartopolov (second right) and Lieutenant General Igor Makushev (right) address journalists in the capital Moscow on 21 July 2014, using a satellite photo that shows one of the sites where they claimed that Buk surface-to-air missile systems operated by the Ukrainian military were reportedly deployed on the eve of the downing of Malaysian Airlines flight MH17. The investigative journalism organisation Bellingcat subsequently determined that the Russian Ministry of Defence had altered high-resolution satellite imagery to argue that MH17 had been shot down by Ukrainian missiles.

objective truth. This assumption belies a lack of understanding of the degree of interpretation involved in professional imagery analysis, and of the capacity for substantive disagreement between practitioners.

The potential for misunderstanding extends to conventional media outlets: editors and fact-checkers who are otherwise knowledgeable are often unable to interrogate satellite imagery analysis and associated material as effectively as they could with other forms of journalism. Moreover, publicly available resources or support for media organisations are lacking; for example, the UK's DSMA Committee might advise against publishing a piece of imagery, but would be very unlikely to comment on the imagery analysis itself.

Establishing standards

The Boulder workshop sought to tackle such issues. It was moderated by the University of Santa Clara's director of the Journalism and Media Ethics programme, Subramaniam Vincent, and the participants examined these issues and sought to formalise standards of practice in their field.

Vincent stressed that ethics arise from agile and changing discourse on standards of right and wrong, as well as continual interrogation of situations as they arise. Although theoretical ethicists may engage in detailed arguments about right-from-wrong, applied ethicists – practitioners in fields such as technology, biology, or journalism – must continuously evaluate decisions in the field and employ such decision-making in their trade.

Vincent told *Jane's* after the event in August 2019, "It may or may not be possible to draw up a code of ethics ... until more experience has been had in the community." However, he argued that building up this experience was necessary for the creation of a professional community, and that "a code of ethics may just emerge alongside this kind of work".

Throughout the workshop, attendees deliberated on how to establish tradecraft standards to ameliorate some of the ethical pitfalls of publishing geospatial analysis. One idea was to establish an association for media-facing imagery analysts, enabling them to exchange ideas and conduct peer review across organisations, disciplines, and regions of expertise. An association of

Stanley Foundation/One Earth Future Foundation summit participants

- James Martin Center for Nonproliferation Studies at the Middlebury Institute, Monterey
- Stanford University's Center for International Security and Cooperation
- Satellite imagery companies including Airbus, Planet, and Maxar Technologies
- Nuclear non-proliferation organisations including the Open Nuclear Network
- Think-tanks including the Center for Strategic and International Studies and the Federation of American Scientists
- Media and investigative journalism organisations including The Diplomat , NK News, Bellingcat, and *Jane's*

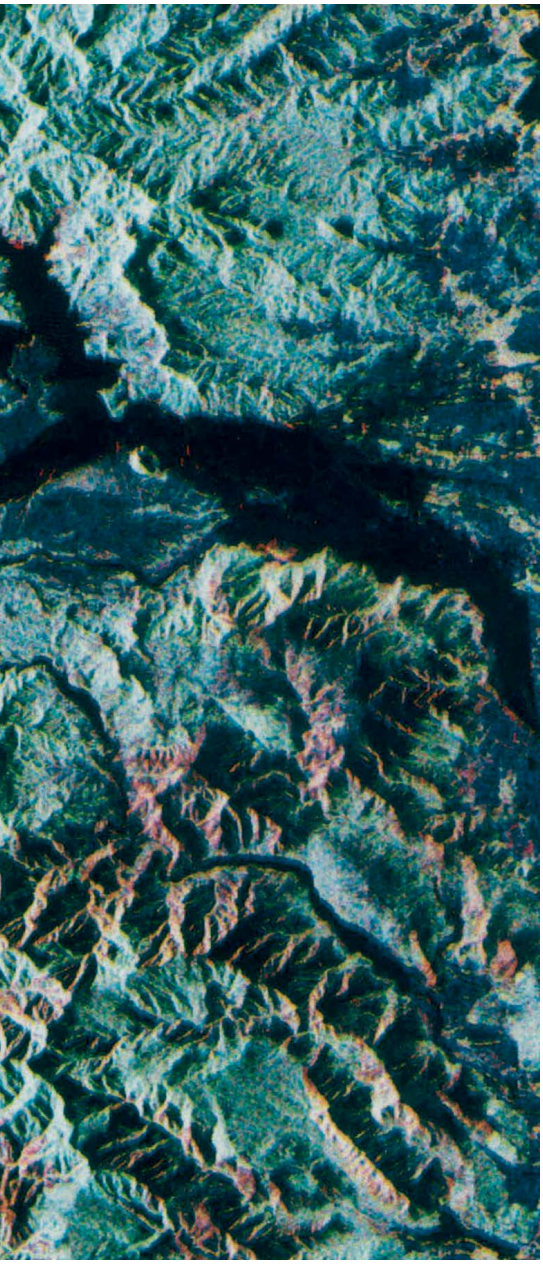
A photo provided by the Jet Propulsion Laboratory (JPL) shows a false-colour composite image of Mount Pinatubo in the Philippines taken by Spaceborne Imaging Radar-C and X-Band Synthetic Aperture Radar (SAR) aboard Space Shuttle Endeavour on 13 April 1994. Later improvements in SAR imagery have enabled open-source researchers to access a powerful tool, but at a cost: SAR imagery is available commercially but not publicly, and requires interpretation by a trained imagery analyst. Imaging Radar/AFP/Getty Images:1746167

practitioners that collects, analyses, and publishes commercial satellite imagery could focus on the standardisation, review, and dissemination of imagery to the media.

Similarly, participants felt that conferences and workshops bringing together junior and senior practitioners with satellite imagery providers, publishers, and academics could serve to exchange tradecraft and build openness regarding active ethical challenges. The creation of a formal system of accreditation for open-source imagery analysts was also proposed, along the lines of similar professional bodies in other fields. Such accreditation could support the standardisation of practices and help news media organisations to evaluate the credibility of imagery analysts.

There was general agreement that ensuring the quality of the imagery analysis would limit the ethical questions around its publication. Although ensuring high standards of tradecraft would not reduce some of the risks around the publication of sensitive imagery analysis, such as in the case of the Fukushima earthquake, it would reduce the likelihood of accidental and deliberate misinterpretation.

Participants also discussed establishing an academic curriculum to formalise the discipline of open-source imagery analysis in a university environment. Although there are long-standardised programmes in geographic information systems – the practice



of exploiting remote-sensing geospatial data that came to prominence with the launch of US and European low-resolution satellites in the 1970s and 1980s – there is currently no openly available degree in analysis of high-resolution imagery.

The increasing availability and decreasing costs of high-resolution imagery and the level of attention that the field attracts suggest that demand for training in imagery analysis is likely to grow.

However, any institution that was planning to offer a programme in high-resolution imagery analysis would have to consider how it would manage the inherent military applications of this skillset, for example in the case of foreign students.

Outlook

The quantity of high-resolution satellite imagery available to the public has increased exponentially since the late 2000s, but the number of established open-source imagery analysts is still small.

As satellite imagery analysis grows in popularity for informing the public on matters of global importance, the disparity between the demand for imagery analysis and the small pool of expertise means that there will be an increasing risk of problems emerging around accidental misinterpretation, deliberate deception, and unregulated transparency.

In the absence of stricter government regulation, the drive for greater oversight may instead emerge from a concerted effort between the satellite companies that provide the data, the institutes and individual practitioners of the tradecraft, and the established media organisations that publish the analysis. These groups will almost certainly seek to retain the decades-honed methods of the original government- and military-derived tradecraft for imagery analysis, and it is likely that there will be efforts to perpetuate this tradecraft, for example through the creation of academic curricula and other training programmes.

However, the Boulder conference participants believed that – to retain the confidence of the public – imagery analysis practitioners would likely have to combine this tradecraft with the adoption of some form of professional ethics or standards, along the lines of the standards of professional journalism.

Jane's assesses that such standards are likely to develop gradually, through events such as future conferences and via experience-sharing between practitioners. However, given the rapid pace of advancement in the satellite industry, it is also possible that technological disruption or other changes in the sector could prompt a rapid re-evaluation of how satellite imagery analysis as a discipline is practised in open sources. ■

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The 'Chinese Bellingcat' scenario

The increasing number of countries putting imagery satellites into space will expose areas currently protected by US law to the kind of scrutiny that has previously been restricted in open sources to states such as China, Iran, North Korea, and Russia.

For example, a Chinese non-governmental organisation using commercially available satellite imagery and other sources such as social media could publish detailed examinations of the deployments and activities of the US military during a future regional conflict.

This kind of analysis would be unprecedented and would draw considerable public attention. It is likely that media organisations and the public would approach expert imagery practitioners to determine the credibility of the analysis. If the analysis appeared to meet the tradecraft standards espoused by IMINT practitioners in their own work, these practitioners might be expected to endorse the quality of the analysis – if not the intent behind its publication.

The emergence of a genuinely independent, open-source imagery analysis community in other countries is not guaranteed. It is possible that the partial diffusion of military and intelligence imagery tradecraft into open sources that has taken place in the UK, the US, and elsewhere will not be permitted in some states. In China, it is questionable whether a group such as Bellingcat could exist genuinely independently of the party-state.

If open-source imagery analysis remained largely confined to a limited group of states and topics, it would further underline the historical and geographic contingency of the open-source imagery boom since the late 2000s.

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