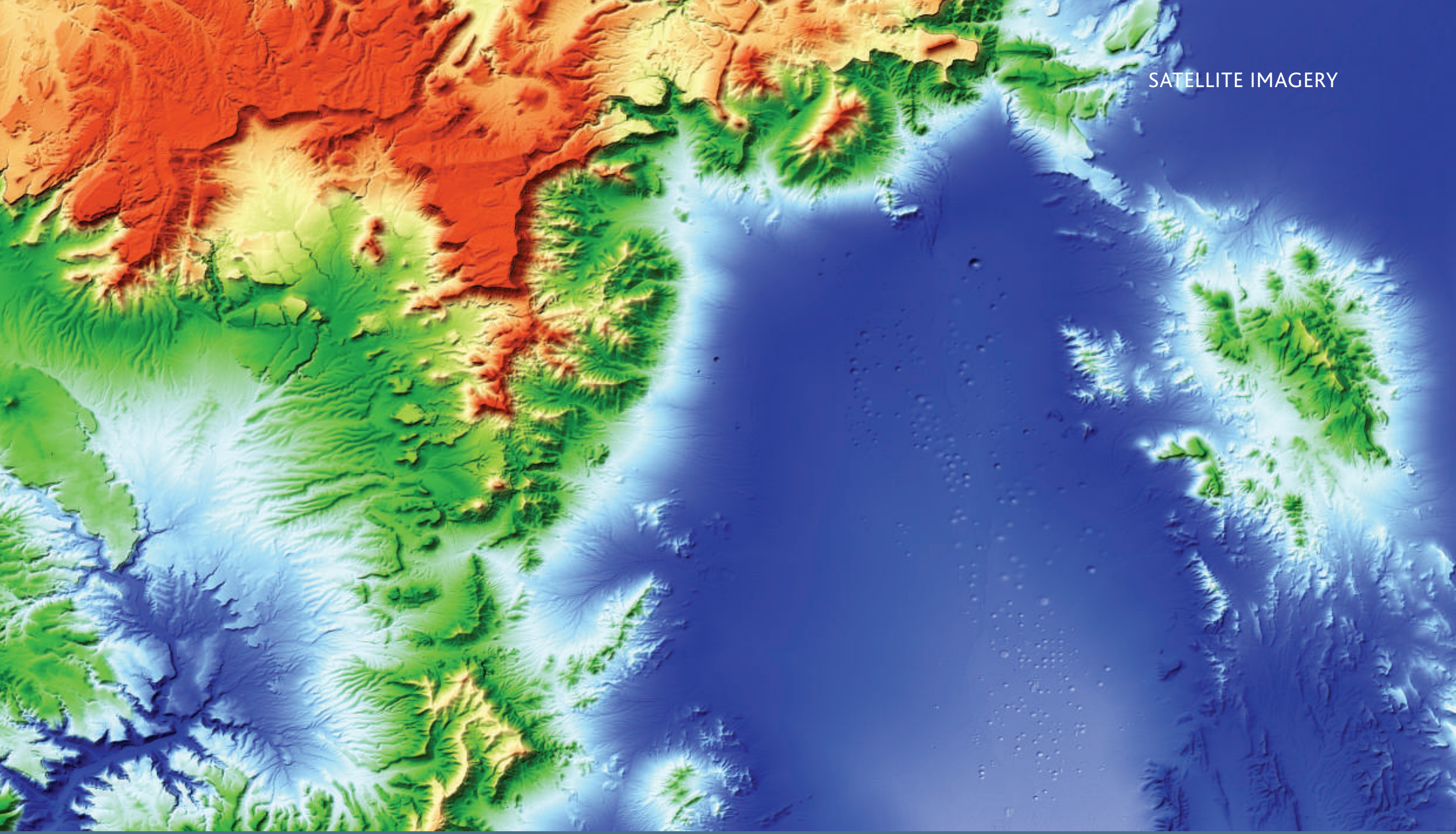


The right imagery for the job

Mountain peaks and valley floors across the globe can now be seen with an accuracy of just one metre thanks to a new 3D map created from radar imagery as part of the TanDEM-X satellite mission. Approximately 150 million square kilometres of land surface were scanned from space by two satellites orbiting in close formation. Imagery © DLR

There has never been such an abundance of satellite imagery and elevation data. It can, however, pose challenges in knowing where to start in selecting the right imagery for the job. NPA Satellite Mapping's Charlotte Bishop reviews the evolution of the market and the options now on offer

When NPA Satellite Mapping was founded 45 years ago it initially focused on the application of satellite imagery for geological exploration before growing to become a leading independent supplier of satellite data and derived solutions to a global client base across a range of market sectors including oil & gas, mining, engineering, environment and defence. It is therefore a fitting moment to look back and consider the numerous 'revolutions' that have occurred within the satellite imagery market and how these changes impact the decisions we can now make in selecting and exploiting the optimum data set.

Lift-off

Most specialists would agree that the first revolution was the launch of Landsat-1, initially known as ERTS-1, in 1972, which was the first commercially available satellite mission.

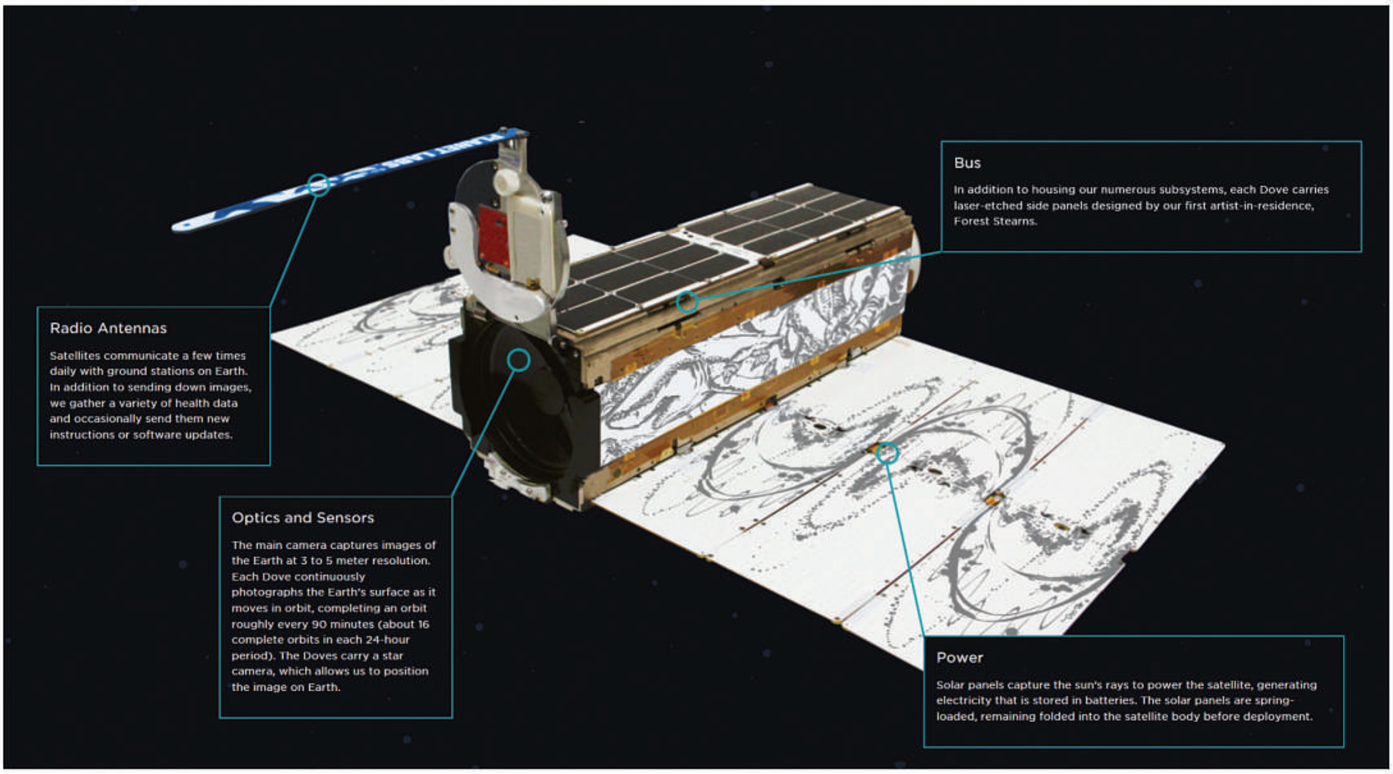
The series is now on its eighth satellite and, with plans for the launch of Landsat-9 in 2023, continues to highlight the value of its medium spatial resolution multi-spectral imagery that is now publicly available. To this day, Landsat still provides the backbone to numerous remote sensing applications thanks to its unrivalled historical archive and fixed 16-day revisit period.

The next revolution was the launch of the first operational Synthetic Aperture Radar (SAR) satellite mission following the success of SEASAT in the 1970s. SAR had the advantage of providing all-weather, day/night imaging capabilities. ERS-1, operated by ESA (European Space Agency), was launched in 1991 and its data acquisition strategy resulted in a significant global archive that continues to be exploited as part of historical assessments. Long-term C-band radar continuity was subsequently provided by ERS-2 (1995), ENVISAT (2002) and, more recently, Sentinel-1A/1B (2014/2016).

Aiming higher

At this early stage, the skies were largely dominated by lower spatial resolution satellite missions but diversity was creeping in with the availability of both optical and radar systems. It wasn't until 1999, and the launch of IKONOS-2, that the first commercial Very High Resolution (VHR) optical satellite successfully reached orbit and imaged the world at a resolution better than a 10 m pixel.

A ground-breaking satellite of its age, it acquired imagery at 80 cm (panchromatic) and 3.6 m (multispectral) spatial resolution and became a workhorse for detailed mapping for the next 16 years.



Planet's constellation of Dove CubeSat small satellites are launched in Flocks to provide a whole-Earth dataset. Image Planet

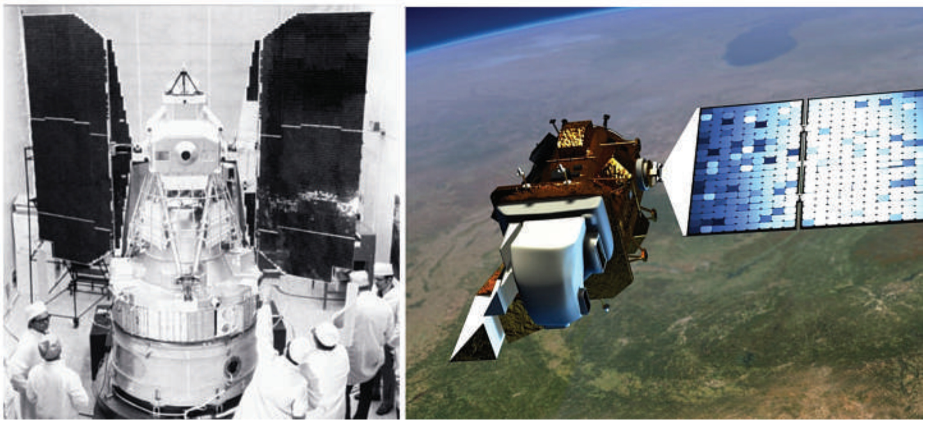
IKONOS-2 marked the start of many similar missions including Quickbird-2, Worldview, Kompsat, and Pleiades, to name but a few.

Another revolution, occurring in parallel with IKONOS-2, focused on increasing the spectral resolution (more spectral bands) of satellites to widen the range of information that could be discriminated from an image. ASTER, launched by NASA in late 1999, was the first satellite with this increased spectral range. Building on the Landsat spectral resolution, it had increased capabilities in the visible, short-wave and thermal portions of the electromagnetic spectrum and is, to this day, unmatched by any other spaceborne multispectral sensor.

Not all the advances were in the optical domain. TerraSAR-X and COSMO-SkyMed, launched within days of each other in June 2007, were the first X-band SAR missions capable of acquiring high spatial resolution data. This technology not only led to daily SAR acquisition capabilities as part of the COSMO-SkyMed constellation but also the generation of the WorldDEMTM global elevation product with a 12m grid derived from TerraSAR-X and its twin, TanDEM-X.

Relaxing the rules

For optical satellites, the next challenge was to improve spatial resolution still further. Worldview-3 was the first - and currently the only - satellite capable of collecting imagery at 30-cm spatial resolution. Launched in 2015, it prompted a relaxation of US Government restrictions by giving the commercial market access to 25 cm resolution imagery (the previous limit being 50 cm). Coupled with the increased spectral capabilities of its visible and shortwave sensor, it offers the balance of highly detailed mapping and increased feature extraction capabilities.



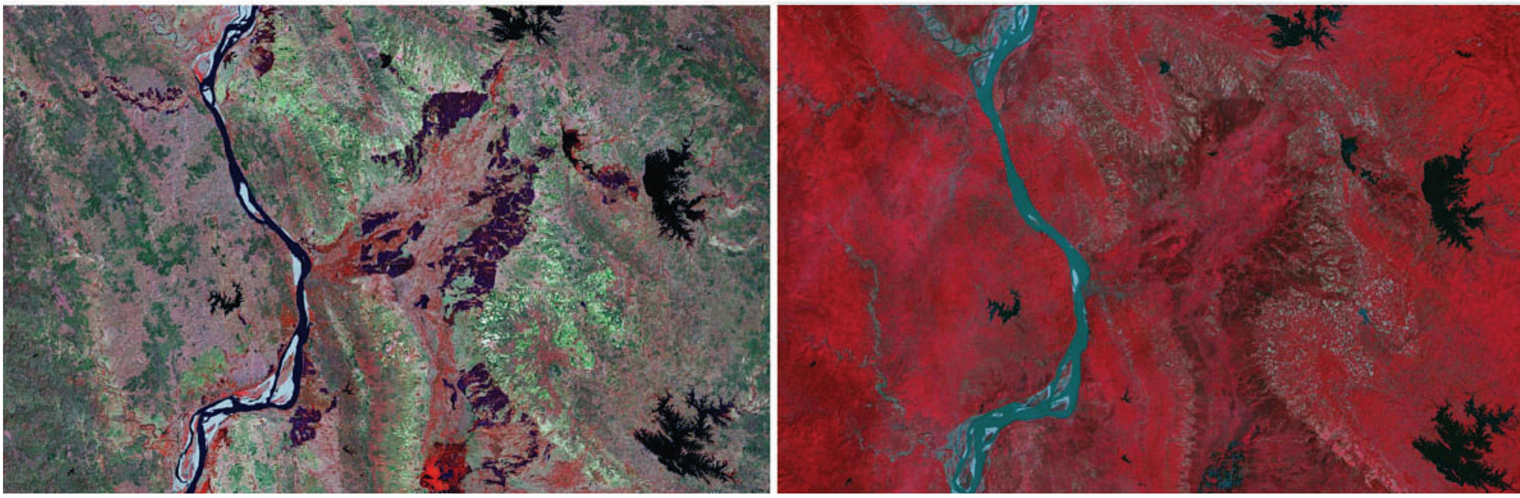
Left: The first Landsat satellite - ERTS-1 and , Right: an artist's impression of the next satellite in the series – Landsat-9. Imagery: NASA

Although not a direct technological advancement, open access data is a revolution in itself and one that has brought significant benefits. The United States Geophysical Survey was the first to make all of its data freely available in the late 2000s leading, in turn, to an exponential increase in the usage of its data. Subsequently, the European Space Agency, with its extensive archive of Synthetic Aperture Radar data, followed suit, setting the baseline for Sentinel. This satellite constellation, with various capabilities, is now providing data quickly and robustly to support the European 'Copernicus' programme. Making data open access not only makes it more accessible, but also encourages research and development. This, in turn, encourages new products and services into the marketplace.

Smallsat boom

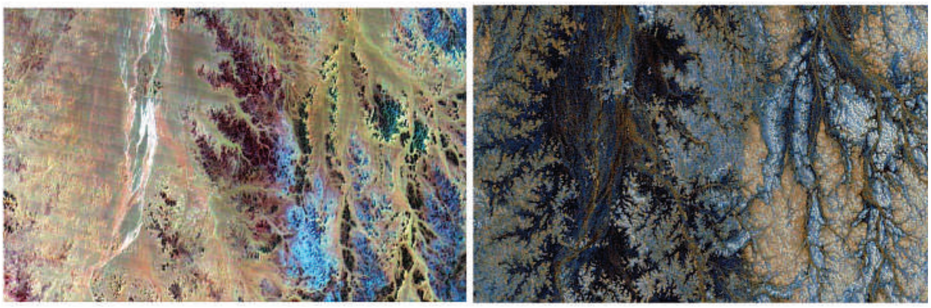
The current revolution is the boom in constellations of small satellites such as Planet's Doves. These missions, typically flown by innovative new operators, seek to improve temporal collection to never-before-seen levels at a fraction of the cost of the larger commercial missions, while also challenging how we ingest and use that data in new and novel ways.

These historical and contemporary satellite imagery revolutions now put us in an enviable position, with many missions, offering numerous, varied capabilities. However, this diversity of options makes for a complex landscape where determining the optimal image purchasing solution can be

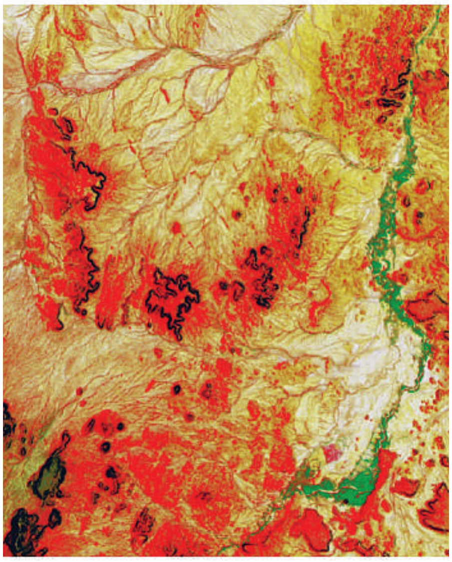


Above left: Dry season imagery over an area showing the variability in land cover. Right: wet season imagery showing the increased extent of vegetation (shown in red). Landsat Imagery ©USGS

Pleiades 50 cm resolution product (left); SPOT-6 1.5 m resolution imagery (right). Pleiades products ©CNES 2013, distributed by Airbus DS and SPOT6 Imagery ©Airbus DS 2013.



Landsat colour composite to highlight geological features in Yemen (left); SIR-C SAR composite imagery over the same area (right). Landsat Imagery ©USGS and SIR-C ©NASA.



Combining optical, SAR and elevation data to assess trafficability. Interpretation ©CGG | NPA Satellite Mapping. Landsat and SRTM Data available from the U.S. Geological Survey, ALOS-1 Palsar data ©JAXA/METI 2009

difficult. It invariably involves a compromise between multiple factors, both technical, economic and intended end use. However, some key considerations can help with the selection. These include the following:

Image timing and date

For some applications, the most recent image may be the most important requirement. In others, a time-series may be required whereby satellite constellations can be exploited for both historical and ongoing monitoring. This can be particularly important in areas that are variable due to seasonal change or undergoing extensive development. For such applications, using a single image may not provide a truly representative view or provide sufficient context for analysis.

Spatial resolution

A 30-cm image will provide an extremely high level of detail but the tradeoff is that it covers only a small area and can be a costly option. Depending on the required mapping scale, a slightly lower resolution, even down to 1.5 m, can provide sufficient detail to derive a 1:10,000 map with the advantage that it covers an area three times the width of a 30-cm image.

Sensor type

Deciding whether to use an optical or SAR sensor, or a combination of both, comes down to a number of factors. An optical sensor, which relies on the reflectance properties of surface features, only operates during the daytime and its applicability can be severely limited in some areas due to cloud cover and haze. SAR, an active sensor, is capable of imaging through clouds during both day and night. In certain situations, SAR can provide some ground penetration, which may also provide useful information on shallow subsurface features.

The 'textural' information from SAR and the 'spectral' information from optical has specific value for different types of projects, and combining them can provide additional insight beyond that available from either used in isolation.

Exciting prospect

Today, we can do far more with satellite data than we ever imagined possible 45 years ago, so what tomorrow could bring is a very exciting prospect. With its extensive applied satellite remote sensing experience, long-term relationships with satellite operators, and independent supplier status, NPA Satellite Mapping offers a simple, impartial entry point into the increasingly complex world of satellite imagery. Selecting the right imagery is the critical first step to unlocking actionable information.

Charlotte Bishop is Remote Sensing Projects Manager with, NPA Satellite Mapping, CGG (http://www.cgg.com/en/What-We-Do/GeoConsulting/NPA)

Nick Smee is CEO of Yotta, the Leamington Spa-based infrastructure asset management specialists (www.yotta.co.uk)

Working together for a better roads network

The challenges facing those who manage our highways infrastructure are already immense and continue to grow. So how can collaboration make a difference? Nick Smee is confident it can, and explains why

The challenges are legion: funding is in general decline; investment in repairs and maintenance looks unlikely to increase for the foreseeable future, and a sizeable proportion of the public feel their local road network is in decline. And all against a backdrop of increasing vehicle numbers and road usage.

To counter these trends, we are seeing the introduction of new technologies such as strategic asset management, an increasing willingness to embrace innovation, and a growing use of predictive analytics. These are positive developments. However, maximising their value could involve a step-change in thinking for those managing our highways.

The Government's five-year programme of work to deliver the £15bn Road Investment Strategy will call for ever-closer collaboration between all those involved

Making more sense

Instead of going it alone, it would make more sense for them to work collaboratively. They need to start tapping into the expertise and enhanced operational efficiencies that working closely with the supply chain, technology solutions providers and academic research departments can bring. This might be to share new concepts and technologies, or to develop formal working partnerships.

While better communication with road users is vital, collaboration and engagement with the wider supply chain and third party technology providers could be just as important in achieving this critical end goal.

Unfortunately, the way that government funding is allocated frequently works against this. The 100% retention of business rates by local authorities means that many councils will be operating in their own devolved areas raising their own money and using it how they see fit.

Broader engagement

At the same time, collaboration is still in its earliest stages across the sector. Providers working with consultants, clients with contractors, contractors working together – these relationships remain patchy and inconsistent. There is a need for broader engagement between councils and the wider supply chain - with asset management technology providers and indeed with academia in the form of university research departments.

The collaborative approach needs to start at the project planning phase. Typically, there is a tendency to first select the team and then decide on the project objectives. But, doing this in reverse is more logical and encourages better collaboration. So starting with the end objective and then selecting the cross-organisational team best placed to achieve the required outcome could be a more sensible move.

Untapped talent

Often, today's asset management projects fail to tap into a broader ecosystem of expertise that draws on talent pools outside the main team. Much can be gained by making use of the expertise and understanding being developed in university research departments; or by working with other authorities to share technology and ideas, or even by closely engaging with government to gain a better understanding of how to tap into new funding sources.

Of course, this all needs a catalyst to make it happen – and this must involve increasing investment in training, finance and skills. But in turn these can be shared out across a selection of councils, all helping to build up best practice across the network.