The **123** Of **AEC**

Renewing the Architecture, Engineering and Construction Industry with Satellite Imagery

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AN OVERVIEW

A reoccurring sustainable issue faced by the Architecture, Engineering and Construction (AEC) industry is that of green buildings. According to a recent report by Grand View Research, the global market for green construction is projected to reach $364.6 billion USD by 2022. The demand for this kind of minimally invasive construction design will not only increase over the next 25 years, but is also set to significantly alter the industry. Combined with population growth, a challenge now exists for AEC professionals to creative innovative designs that are both economical and sustainable long term. Incorporating Very High Resolution (VHR) optical satellite imagery into the planning and development stages of any AEC project can provide solutions.

The use of remote sensing and Geographical Information System (GIS) technology in AEC applications gives enormous benefits over traditional in situ data collection. The data is obtained in a timelier manner, is cost efficient, highly accurate and geospatially reliable.

Furthermore, the combination of data from optical satellites with other socio-economic data provides a crucial link in the total planning process via building information models (BIM), imparting the necessary insights to make effective planning decisions throughout the building's life-cycle.

What is a Building Information Model?

Building Information Model (BIM) is an intelligent 3D virtual model that gives AEC professionals the insight and tools necessary to efficiently plan, design, construct and manage projects. It incorporates multiple forms of data inputs, satellite imagery being one, and is fast becoming a crucial component of any AEC toolkit. The power of BIM is further enhanced when it is combined with a GIS system. This integration of data provides a geospatial context that can be used in infrastructure design to enable efficient workflows and consistent data. Furthermore, BIM facilitates collaboration between the various teams working on a project and acts as one central point to collate and share information.

VHR optical satellite imagery can be an essential tool to monitor site progress, map development portfolios and identify green space. It offers a non-destructive means of providing recurrent information from both a local and global scale. By combining data sources with artificial intelligence and machine learning, further insights can be gained autonomously and in a timelier manner. Advances in these technologies are increasing the affordability for most users, making the exploitation of remotes sensing reliable and profitable.

Other areas whereupon VHR optical satellite imagery can provide benefits include building extraction and delineation, impervious surfaces detection, infrastructure modelling, environmental impact monitoring, urbanisation morphology and 3D modelling.

CASE STUDY

PORT CONSTRUCTION PROGRESS MONITORING

CHALLENGE

Create a viable and practical solution to monitor the progress and environmental impact of a rapidly evolving construction project covering more than 500 km^2 of land and sea area whilst adhering to air restrictions imposed by local government.

SOLUTION

WorldView-2 satellite imagery from sub-sampled mosaics were supplied. The images covered the entire project area with resolution sufficient to track movement of sand, equipment and vessels over time.

RESULTS

The client cost-effectively confirmed work reported by subcontractors aligned with progress shown in the satellite imagery. In addition, the client proved to be in line with the strict environmental guidelines by using archived false-color imagery to show vegetation degradation preceded construction.

WHAT IS VHR SATELLITE IMAGERY?

Very High Resolution (VHR) satellite imagery are images of Earth taken from space in sub-meter resolution – that is every pixel of the image is under one metre in width and height. VHR imagery can be delivered in different combinations of multispectral bands allowing the user to see more detail than possible with the human eye.

EUSI utilises the Maxar WorldView Constellation from their ground station in Munich, Germany to acquire imagery at 30 – 50 cm resolution with rapid revisit. Rapid revisit refers to the ability of the satellites to collect imagery over the same area within a short time frame.

10 M

Suitable for large land area coverage but will not provide any details – for example identifying critical infrastructure

1 M

Provides some level of detail but will hinder detection and identification objectives – markings such as property boundaries or road lines will not be clear

30 CM

The highest amount of detail commercially available and necessary for projects relating to object identification

What can multispectral bands do for me?

The WorldView satellite constellation has 16 multispectral spectral bands that are focused on a part of the light spectrum and sensitive to a particular feature on the ground. By arranging these multispectral bands in various combinations, additional information can be extracted that is invisible to the human eye, such as material composition, building measurements, vegetation health, water depth and roof types.

WHAT SOLUTIONS CAN SATELLITE IMAGERY PROVIDE?

The power of 30 cm resolution imagery in combination with frequent revisits and rapid delivery can be critical for making strategic decisions that decrease inputs while increasing profitability within architecture, engineering and construction. Identifying and assessing profitable development sites relies on current and detailed data. VHR satellite imagery offers visually accurate verification and when combined with other data sources, it provides essential insights to the decision making process.

VHR imagery allows AEC professionals to survey sites from the comfort of the office. The data provides length, width, height, area, and radius of buildings in addition to information surrounding vegetation, ground features, and infrastructure assets. The ability to collect field data before stepping foot on site is invaluable.

Leveraging the extensive archive of data, it is possible to compare before and after images of critical events, as well as monitoring the progress and milestones of development projects.

Time and Cost Savings

Remotely monitor large property portfolios to automatically track changes over time to ensure project is on track. Gain global insights into competitor projects and urban developments

Preconstruction Planning

Assists feasibility and planning stages by scouting potential project sites. Additionally can provide insights into wealth of neighbourhoods to determine profitable development sites

Risk Management

Assess surrounding vegetation encroachment, identify obstruction hazards, plan heavy vehicle access points, determine crane clearance requirements and identify potential onsite dangers

Building Footprints

Structured georeferenced interpretation of the geometric footprint of each building can be extracted from VHR satellite data to verify addresses and points of interest.

3D Modelling

Stereo VHR satellite imagery is used to make 3D models of terrain, vegetation and existing infrastructure. This provides crucial insights to aid development planning.

Feature Extraction

Combining VHR satellite imagery with artificial intelligence, it is possible to produce vector maps that contain features pertinent to your project such as roads, pavements, green space, railways, water and much more.

PAVING THE WAY

PLANNING NEW ENERGY INFRASTRUCTURE

The “Paris Agreement” has created the need for expanded renewable energy infrastructure across Europe. The conventional methods of site selection and planning using registry office maps, manual inspections and aerial photos cannot keep up. Cutting edge methods for efficient site selection and planning that utilise satellite imagery in combination with Artificial Intelligence (AI) and big data processing are currently underway.

The German Aerospace Center (DLR) as well as many other Earth observation and data analytics organisations are aiming to develop processes for finding the ideal locations for new energy infrastructure across the continent. Some of these new highly automated approaches utilising VHR satellite imagery include:

- Detection of suitable infrastructure sites based on current land use maps
- Wind pattern analysis for projected wind farms
- Shade vs. sunlight evaluation for solar farms
- Calculations for total rooftop areas available for solar panels
- Biomass estimations in a given region

Why not just use Google?

Google Maps is one of the most widely used services on the internet and allows high quality data free of charge. Google Earth has significantly lowered the barriers to accessing high resolution satellite images, however it does come with limitations.

- Data is not current and Google has no publicly available schedule of updates
- Populated areas are imaged more frequently than rural or coastal areas
- It is not possible to download geo-referenced images from Google
- Multispectral band combinations cannot be changed to reveal additional insights

HOW DO I GET VHR IMAGERY?

Traditionally VHR satellite imagery could be obtained via an order processing system whereby a user contacts an Earth Observation company. The user either requests a specific area of interest and date from the catalogue or order satellite tasking for a future image to be collected.

This method of obtaining data is useful for users who require infrequent data or who need new collections. For more demanding users who need continuous access to the whole archive catalog, SecureWatch is the smarter and more cost-effective option.

EUSI offers both traditional and cloud-based imagery delivery options combined with personal customer support to guide users to the perfect image.

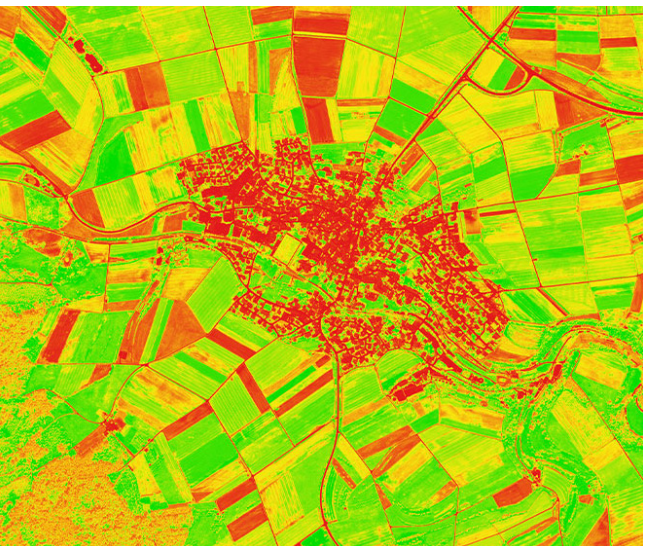
Traditional Order Processing

- Search the catalogue dating back to 1999 or request a new image collection
- Pay for each image upon delivery
- Global coverage – no geographical restrictions, simply define area of interest from available global coverage
- Average delivery in less than 48 hours
- Ability to order imagery with different processing methods (band combinations, pan-sharpening and atmospheric compensation)
- Satellite Tasking – the ability to request a new image collection at specific location
- Smarter model for tailored projects or if new collections are needed

SecureWatch: Cloud-based

- Stream full resolution imagery dating back to the year 1999
- Subscription based service – a yearly price to view, stream and download
- Global coverage – no geographical restrictions, simply define area of interest from available global coverage
- Instant access to imagery via a user friendly web interface or API
- Ability to enhance imagery on screen (band combinations, atmospheric compensation, adding layers and making annotations)
- Set alerts that notify you when new data is collected in your area of interest
- Perfect for customers who need a regular access to archive imagery or integration into software solutions

APPLICATIONS

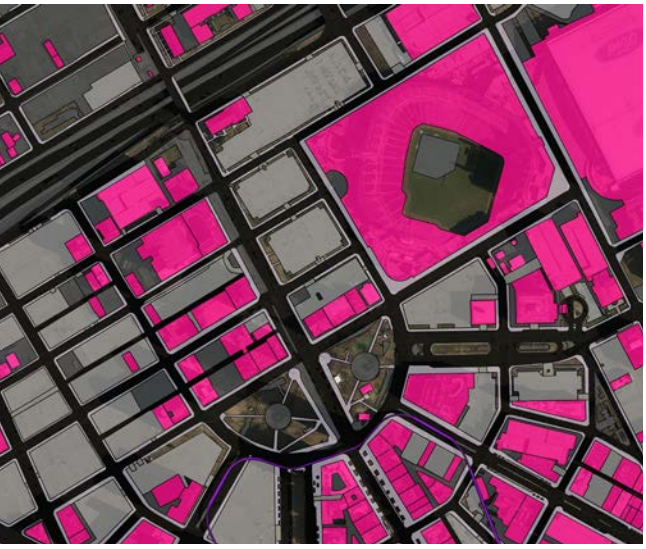


Monitoring Green Space

One of the key components of sustainable building is green spaces. The use of Normalised Difference Vegetation Index (NDVI) from satellite imagery aids in quantifying green spaces. Monitoring these areas is important for change detection to ensure that landscape ecology principles are upheld. For the city of Madrid, VHR satellite imagery derived from WorldView-2 enabled a methodology to be established that takes into account NDVI as well as Fractional Vegetation Cover (FVC). These indices are used to cost effectively measure and monitor plant growth, vegetation cover and biomass production to provide ongoing information for both protecting existing green space and identifying new opportunities.

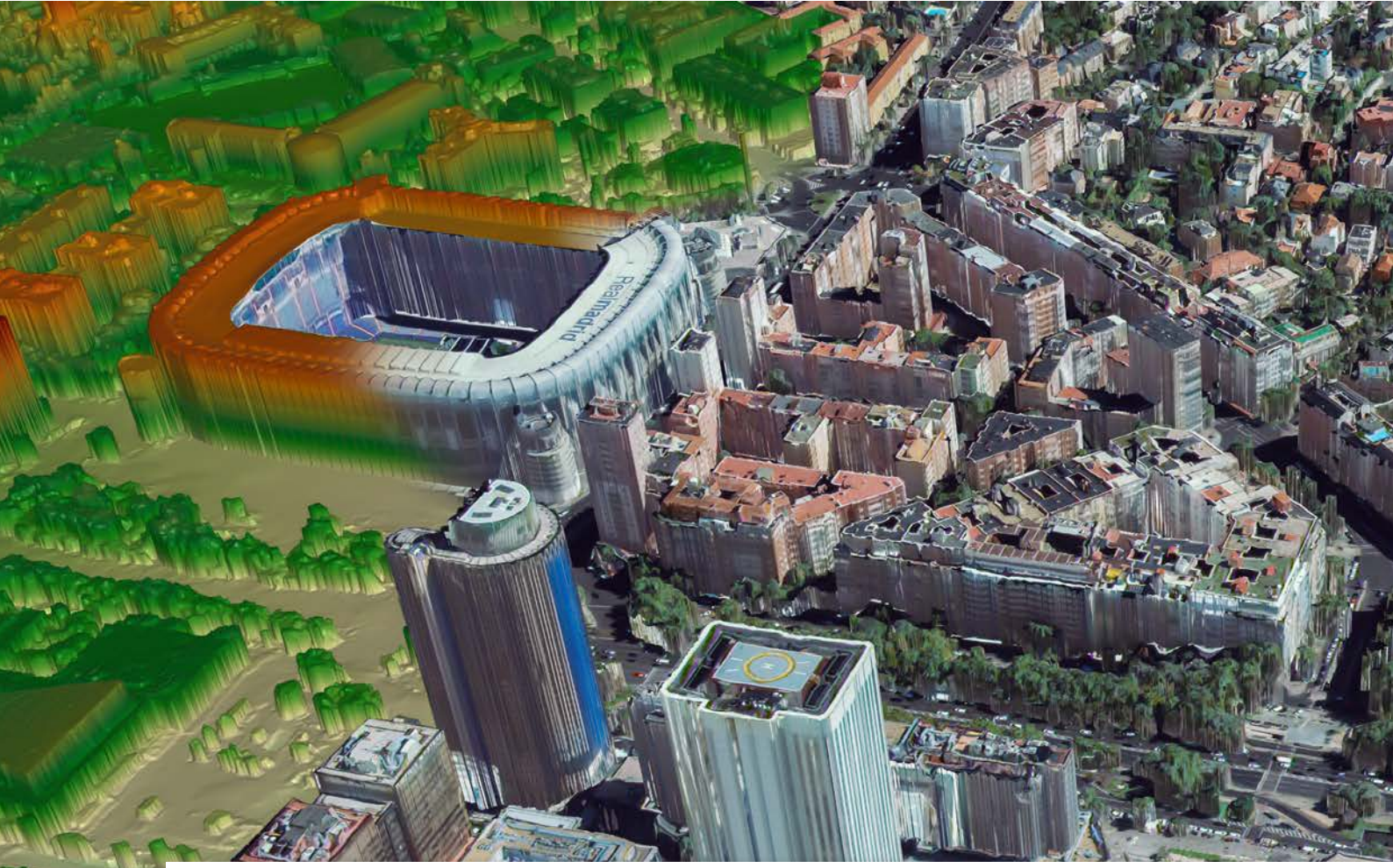
Infrastructure Management

Satellite imagery can be used to monitor the surrounding environment and building assets during the construction phase. The detail in the imagery can provide a clearer understanding of the projects progress, detect risks of natural hazards and mitigate environmental impacts. The imagery offers scalability and reduces the need for on-ground personnel to physically inspect construction sites. This enables enormous cost-savings and provides key insights to decision makers in near-real time for operational risk management as well as asset management.



Road Networks

Transportation systems are pivotal in rapid modernisation. When it comes to AEC, it is necessary to implement a strategic plan to avoid traffic congestion and pollution whilst ensuring interconnectivity of the population and ease of access for all vehicles. Insights into road patterns, width and alignment in addition to items such as dividers, sidewalks and gutters can be obtained from satellite imagery. When combined with land and parcel information, potential sites for new roads and rail infrastructure with the least environmental impact, can be determined.



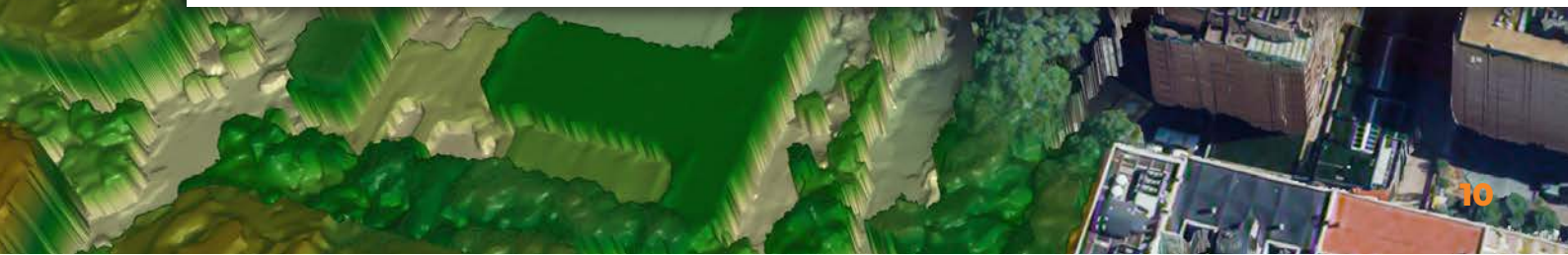
CONSTRUCTION SITE TERRAIN

Utilising Digital Elevation Models (DEM)

The topography and physical features of AEC projects should be considered in the preconstruction planning phase. This influences the layout of temporary facilities, best points of access for heavy vehicles and construction site safety planning. It is widely known that the major cause of delays in any construction project stems from construction site conditions resulting from insufficient preconstruction site surveys. This not only leads to schedule delays but also increases labour costs.

Many technologies that are used for generating digital models of site terrain rely extensively on project site surveys. These technologies are both time-consuming and costly. However 3D representation of a terrain's surface in digital format can be efficiently and cost-effectively generated from triple stereo data acquired through Very High Resolution satellite imagery. The imagery can be collected in a single acquisition and delivered in near-real time to generate a highly accurate Rapid Digital Elevation Model (DEM).

The use of DEM's is critical to making informed decisions in relation to design and planning of preconstruction operations. When taking into account the cost of equipment and data processing of tradition ground surveys, remotely sensed DEM's can cut costs by as much as 10 - 30 %.



CONCLUSION

Seeing The Big Picture From Space

By remotely sensing from their orbits high above the Earth, satellites provide us with much more information than would be possible to obtain solely from the ground.

In particular, Very High Resolution satellite images offer a unique view of what lays in, on and around AEC sites. It provides a cost-effective and simple method of monitoring wide areas both locally and globally, as opposed to using in situ data, and is an indispensable tool for managing the actions and events that impact all phases of the AEC process.

From this data you can gain insights into building typologies, transport networks, vegetation encroachment, development site suitability, asset management and so much more. In addition, the data extracted from satellite imagery is integral to the creation and updating of urban maps to detect major changes in land cover and land use and ensures accuracy of cities for key decision makers at all levels of the AEC process.

The Future of Satellite Imagery

In recent years there has been a surplus of satellite imagery available. Advances in technology have seen data analytics leverage the power of Artificial Intelligence (AI), cloud computing and machine learning.

These advances have a huge potential to disrupt traditional business and provide enormous benefits in the long term. Ultimately the future lies in cloud based multi-source data platforms that have high powered analytics integrated within. SecureWatch is an example of a satellite imagery platform incorporating features pertinent to Earth Observation and providing the user with a tremendous array of analytical tools at their fingertips.

In the past we only had traditional methods of ordering imagery from Earth Observation companies, however the future of satellite imagery lies in the cloud – that is delivery of images via web browser or API.

This interface provides the user with instant access to satellite imagery that can be immediately analysed and manipulated. This is especially important for time sensitive projects. Of course, there will always be a need for traditional data ordering whereupon a project has specific needs and requires direct satellite tasking.

Arming yourself with the right tools is the first step for any AEC professional and one of those tools should be VHR satellite imagery.

About European Space Imaging (EUSI)

Since the launch of the first commercial VHR satellite, we at EUSI have committed ourselves to providing much more than the world's highest quality satellite imagery.

We provide solutions. Utilising our multi-mission ground station at the German Aerospace Center, the team of geospatial experts at EUSI are able to bring together unique partnerships, innovative techniques and tailored services to achieve results for any project.

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