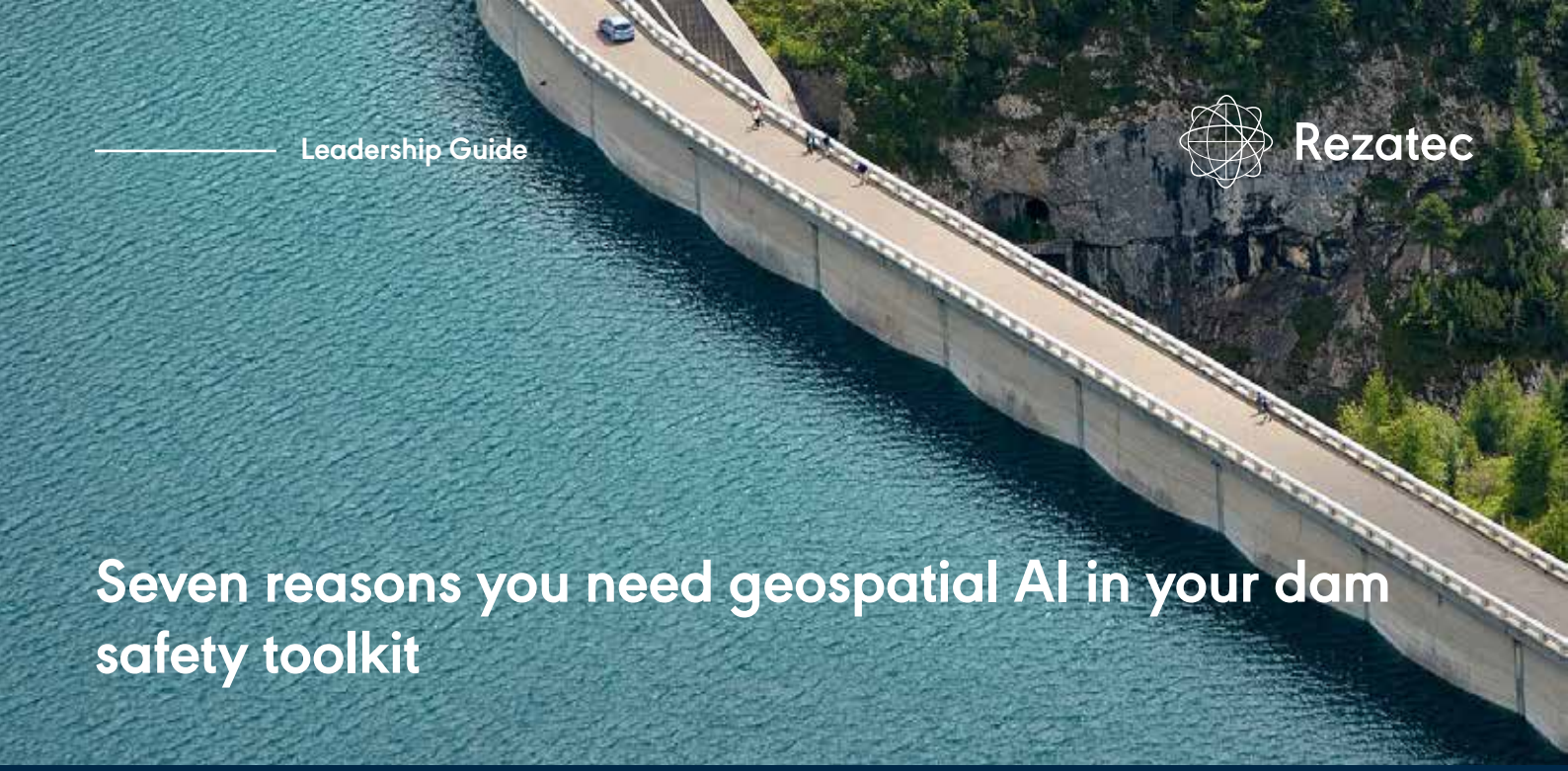

Leadership Guide

Rezatec

Seven reasons you need geospatial AI in your dam safety toolkit

Water SAT - Dam Monitoring

Dam owners are under increasing pressure to maintain the integrity of every dam safely, accurately and cost-effectively. As dam owners around the world are discovering, geospatial AI is a new tool that helps to achieve just that.

For the owners of dams and similar civil structures, managing aging assets is the day-to-day reality of business. Most dams were built decades ago and many are reaching the end of their initial design life. Almost three quarters of the more than 90,000 dams located in the US, for instance, will be more than 50 years old within the next five years.

Dams and embankments are different from many other classes of aging industrial asset though. Given the obvious and far-reaching consequences associated with dam failure and the potential release of millions of tonnes of water, failure of these structures is without doubt an extreme risk event. It's not surprising then that owners and operators of dams and embankment structures are increasingly focused on effective risk assessment as part of a thorough mitigation strategy.

The reality is, however, that operational budgets are increasingly constrained across many asset classes. This puts pressure on the owners who need to maintain the integrity of every dam and hydraulic structure, but without massive increases in costs. In response, many are seeking out more effective and efficient approaches to dam monitoring based on digital technologies.

Today, artificial intelligence is being coupled with new sources of data to create extraordinarily effective tools for dam monitoring. With the availability of data from earth observation satellites, a new class of remote monitoring tools for civil structures that are scalable, accurate and cost-effective is emerging. As the tangible benefits of this approach are being increasingly realised, its uptake by dam owners is growing rapidly. But how does geospatial AI differ from current standard dam monitoring tools – and why do you need geospatial AI in your toolkit?

The evolution of monitoring tools

It's clear that accurate measurements are central to any effective risk assessment. By accurately measuring key predictive indicators for dam structures, such as displacement or seepage, asset owners can direct their limited resources to take early action. Executing a preventative maintenance strategy early typically saves considerable costs in the long run but by identifying potential issues at the earliest possible opportunity, owners can thoroughly investigate any indicative problem before committing significant resources. Given the benefits of more effective monitoring, dam owners and operators have adopted a number of new approaches which they are using to supplement the traditional visual inspections they've used to monitor dams and hydraulic structures for many decades and which are still widely used today.

Topographical surveys

One of the most common approaches to monitoring dam structures is the topographical survey. Moving beyond the simple visual observations used to identify obvious bulges or seepage, a topographical survey relies on precise measurements from identified and exact locations. Topographical surveys use a range of equipment stretching from the high tech such as GPS, 3D scanners and laser measurement tools down to the basic tape measure and theodolite approach. Topographical surveys are certainly accurate and can pick up on very small displacements. However, such surveys are time consuming, labour intensive and require expert staff. These kinds of surveys can present health and safety challenges too. It can be difficult to accurately assess a dam face from the crest, for example, so working from height or challenging access issues emerge. Furthermore, dam structures often serve as roadways and a topographical survey can mean that roads of this kind must be closed to reduce the risk to operatives.

Piezometers & sensors

Another monitoring approach becoming more common is the use of sensors such as piezometers. Pressure-sensitive and submersible, piezometers are used to detect pore water pressure and ground water levels in geotechnical applications such as dams. The results give important data on dam failure indications such as seepage. While piezometers do provide valuable insights into dam structures that may not be obvious from a simple visual inspection, significant effort is required to install these sensors which are fitted in boreholes in the structure. Piezometers can also break and may need replacing. Installation must be handled carefully and any effective measurement requires multiple piezometers deployed in specific and customised locations for each structure.

Piezometers can also break and may need replacing. Installation must be handled carefully and any effective measurement requires multiple piezometers deployed in specific and customised locations for each structure. Piezometers are one of a number of different sensor types that are deployed to monitor dam structures and include those measuring vibration, cracks, tilt and strain gauges. Again, deployment and mitigating health and safety issues can be challenging, as can the interpretation of data which may require expert assessment. But the biggest downside to sensors is that they deliver data at specific locations, which can result in knowledge gaps in those areas between sensors.

Drones

Given the recognised benefits of remote monitoring, dam owners are also adopting drones and UAVs as a way of conducting large-scale observations quickly and with minimal health and safety concerns. It is far simpler to fly a drone along a dam face to inspect a large hole than to send down an individual on ropes, Nonetheless, using a drone as a monitoring tool with only occasional deployment can be expensive. These vehicles can also use lidar, take video and gather other kinds of data, but there are still limitations. For example, when reviewing video footage it can be difficult to gain a 3D perspective from a two dimensional image and they can only get movement readings with an accuracy of 20-30 mm. In addition, there can be restrictions on drone usage, for example if the structure is located near frequently used civil or military airspace.

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Geospatial AI

Satellite observations offer a number of advantages to dam owners looking for remote monitoring solutions – many of which are just not available with more traditional methods. Observations from space clearly eliminate any health and safety risks for ground staff and others and there are no restrictions on the use of satellites because of other air traffic. Additionally, using Synthetic Aperture Radar (SAR) gives satellite observations the edge as they can continue to collect data at night or during bad weather. Satellite data can also be accurate to within a few millimetres, picking up the smallest ground motion.

Orbiting satellites execute detailed surveys on a regular basis, the Sentinel satellites capture a global picture every 6-12 days, for example. Given this global picture has been collected consistently and regularly since 2016, there is a deep archive of data on all ground assets. Another key benefit of satellite data is that is can be combined with other data from sensors or other physical observations to generate a more complete picture of a dam structure and its condition.

Seven reasons to adopt geospatial AI

When incorporating remote monitoring for dam portfolios, owners need to think about the factors that set geospatial AI apart from other tools. There are at least seven advantages that geospatial AI delivers which are just not available with other conventional approaches.

1. Three year historical analysis:

Rezatec's solution begins with a three-year retrospective analysis of the structure by combining archive satellite data with advanced analytics. Dams and hydraulic structures may seem static but they actually experience considerable variation over time, depending on the season or how much water is being retained behind the structure for example. This retrospective view establishes a baseline of normal behaviour for the structure and a key measure in identifying any anomalous behaviour.

2. Multiple data inputs:

According to a recent industry survey, the ability to effectively use siloed data sets is a major concern for dam operators. Geospatial AI can be used across different teams to understand the movement and vegetation across the dam, and even beyond the physical structure to incorporate changes to the surrounding environment. It means that even historical data can be leveraged to gain more precise insights into dam behaviour and deployed to help identify what is normal and what is not for every structure.

3. Clever risk analysis:

Rezatec deploys the most sophisticated machine learning tools and tailored algorithms in its AI approach. These tools combine optical and radar satellite data before interpreting thatinformation to identify potential anomalies in dam behaviour that can indicate a problem. Using machine learning for statistical processing of the various data inputs, Rezatec expertise and clever analysis delivers data-driven risk analysis as a service.

4. Millimetre accuracy:

Using geospatial data and AI, Rezatec's sophisticated processing and analytics is also incredibly accurate, able to pick up movements of just 2-3 mm. Synthetic Aperture Radar employs a phase wave emission which is compared to the phase wave at the same location on a subsequent fly by. Any difference gives a measurement of ground motion over just millimetres of displacement. The proven precision of this dam monitoring technology establishes space-based observation and the AI analysis as a tool that can pick up even the slightest movement and changes which cannot be identified by normal human observation.

5. Identify what's not normal:

By establishing a long-term retrospective analysis, Rezatec's monitoring tool tracks normal movement – the trends, seasonal behaviour and rate of movement – and is primed to identify what is outside this normal baseline and therefore any anomalous ground motion or vegetation. This enables operators to focus their energy and resources on investigating potential problems at the earliest possible opportunity.

6. Frequent data updates:

As satellites travel in regular and fixed orbits they make frequent repeat observations. The European Space Agency's Copernicus Sentinel satellites take repeat observations every 6-12 days depending on location. The data from these observations is available just a few weeks later. This enables Rezatec's dam monitoring tool to be updated every 30 days and means that anomalies are detected quickly to support early investigation and intervention if required.

7. Cost-effective scalability:

Unlike other types of monitoring, geospatial AI is easily scaled to make observations of even the most remote structures or a fleet of assets spread over a wide area or multiple countries, without costs scaling exponentially. Unlike sensors, the size of the structure, its location and accessibility has no impact on costs. In addition, orbiting satellites regularly sweep the entire globe. Extending the risk monitoring service to multiple targets is therefore just a simple matter of extracting the data and executing the appropriate analysis.

The Rezatec solution

Although new technologies and engineering approaches are enabling better monitoring of dam structures not all monitoring solutions are the same. Dam owners need to focus on those tools that can give the earliest possible indications of potential problems across the whole expanse of any structure and across every asset in their dam portfolio.

This enables dam safety leaders to focus on data-led resource deployment while making the most of skilled staff and expertise, even when managing the biggest structures. "Dams are very large assets. That's one of the big challenges we face, making sure that our monitoring is targeted and effective," says Daniel Turnbull, Dam Safety Engineer at the New South Wales-based Hunter Water and a customer of Rezatec's dam monitoring solution.

Ultimately, geospatial AI supplements other technologies such as in-situ sensors and physical inspection observations to build a complete picture of dam risk and with capabilities that far exceed traditional dam monitoring methods. As Turnbull says: "If visual monitoring picks up that there's a potential issue, we're able to refer to satellite monitoring and reveal if there is something measurable to support that theory," However, those capabilities and the tangible benefits they enable are only unlocked through a sophisticated machine learning analysis. With its unique algorithms, Rezatec is the world's leading geospatial provider of AI analytics and offers a new and unique approach to data analysis that delivers the type of business insights that have, until now, not been available. The risk assessment outcomes produced from its analytics engine are presented in an easy-to-use interactive platform that allows dam owners to see any potential issues at a glance. It's not hard to see the reason for the rise of geospatial AI as a remote monitoring tool.

Ready to take a look? Click here to see how the Rezatec solution can support your dam safety objectives

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