Enhancing Natural Disaster Resilience in Transportation Infrastructure Using Kurloo GNSS Monitoring

Presented at the FIG Regional Conference 2024,
14-16 November 2024 in Kathmandu, Nepal

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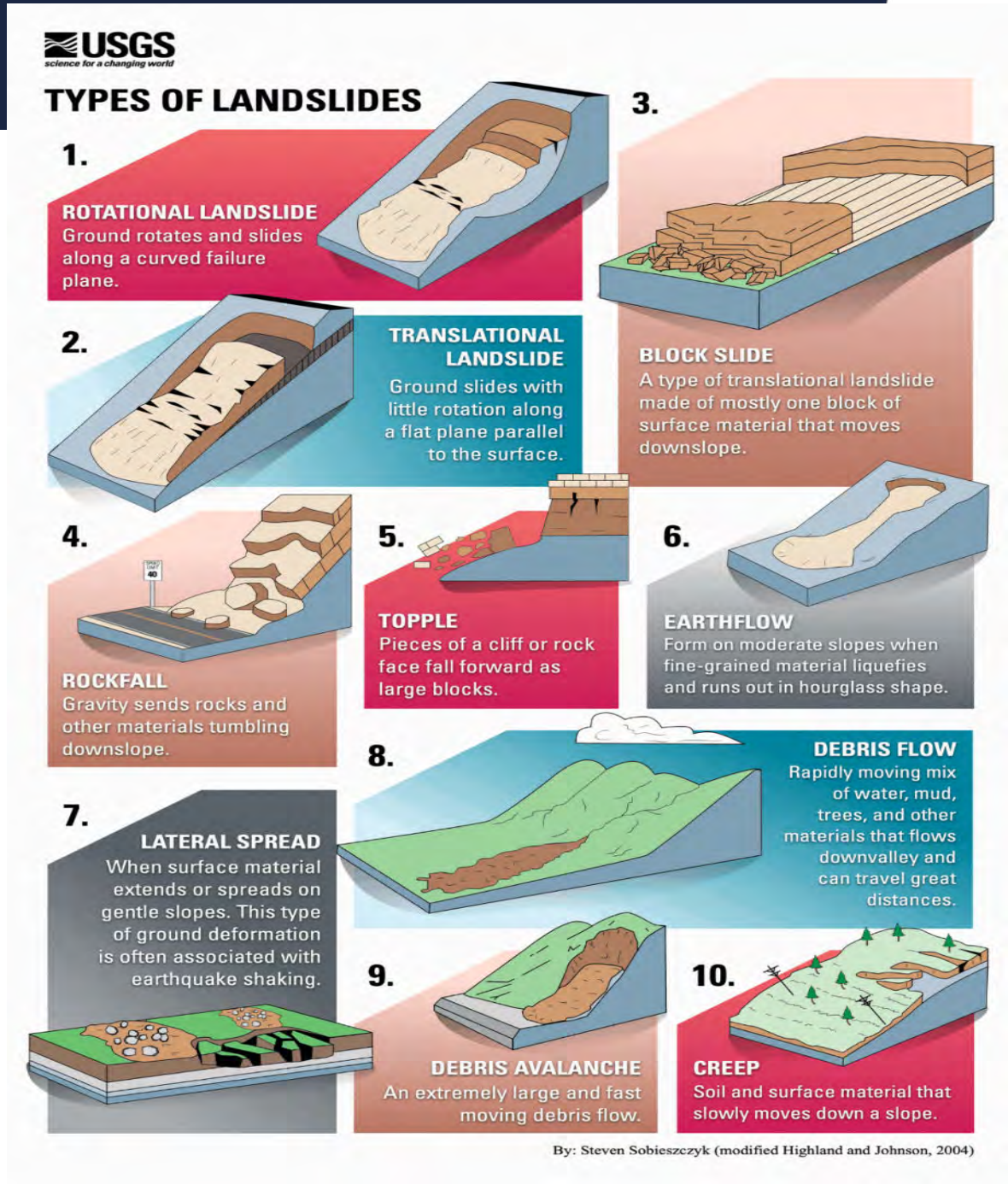
Natural Disasters — Landslides

Influencing Factors...

- Soil
- Rock
- Water & drainage
- Retaining walls
- Construction Practices
- Surface water disposal
- Coastal environment
- Settlements
- *Human activity*
- *Climate change*



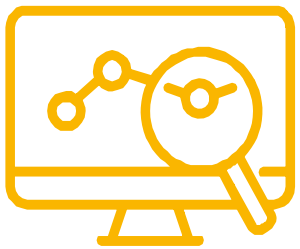
Rail infrastructure damaged by flooding (2022)
Queensland, AUSTRALIA

Road infrastructure collapse by earthquake
USA

Road infrastructure damaged by landslide (2019)
Queensland, AUSTRALIA

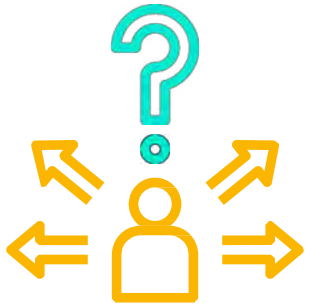
Motivation

Buildings, structures and ground surfaces move all the time



Frequent monitoring is important to assess safety and stability

The current process of monitoring is complicated, expensive and in some cases, a safety risk



Asset and infrastructure managers need to know their assets are safe at any time

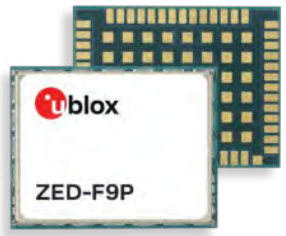
So, we created Kurloo to help manage risk using **precise positioning**- more simply and economically than ever before

Last Generation GNSS Deformation Monitoring System

Prototype developed by Monitum (the team pre-Kurloo)

- Expensive positioning device (custom designs)
- Bulky and challenging to deliver, install and operate
- Remotely configurable - when comms available
- Accuracy XYZ displacement daily at 5-10mm (relative precision)
- Limited access to data
- Semi-automated downloading and processing
- Limited access to results and interpretations

Opportunity

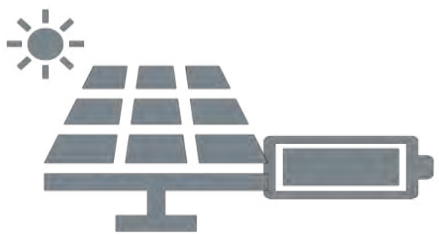


Low cost
GNSS chips

aws

Cloud computing

Low power integrated
modems



Solar & battery
technology

Advanced manufacturing
processes

The Goal

Make precise positioning more accessible, to more people, in more places, more often.

- ✓ Low unit cost positioning device (mass deployable)
- ✓ Compact and simple to install and operate
- ✓ Remotely operated and configurable
- ✓ Accuracy XYZ displacement daily at 2-5mm daily (relative precision)
- ✓ Unlimited 24h online access to results
- ✓ Fully automated processing

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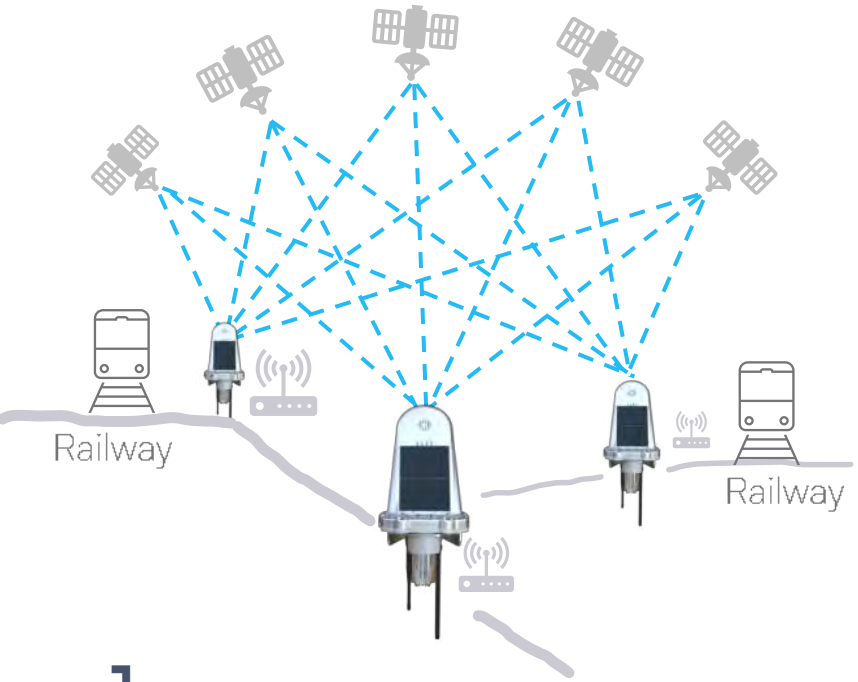
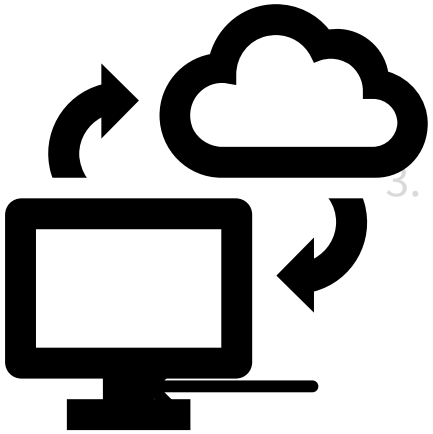
Kurloo Service Overview



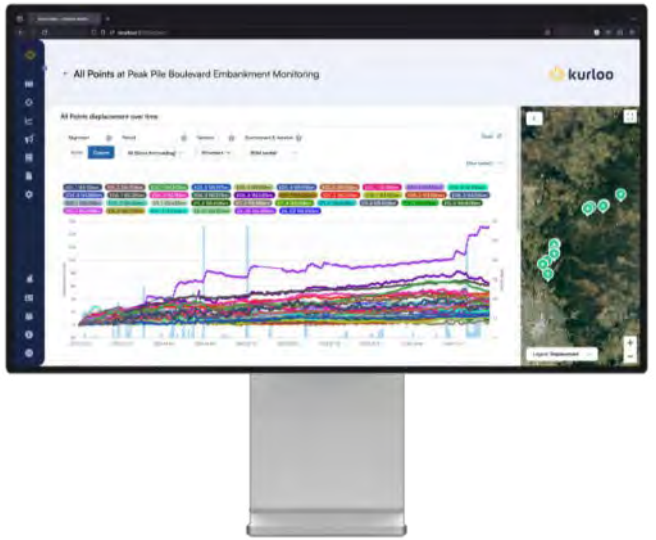
1.

Custom designed Kurloo IoT GNSS Devices



2.

Cloud-based Device management and post-processing solutions



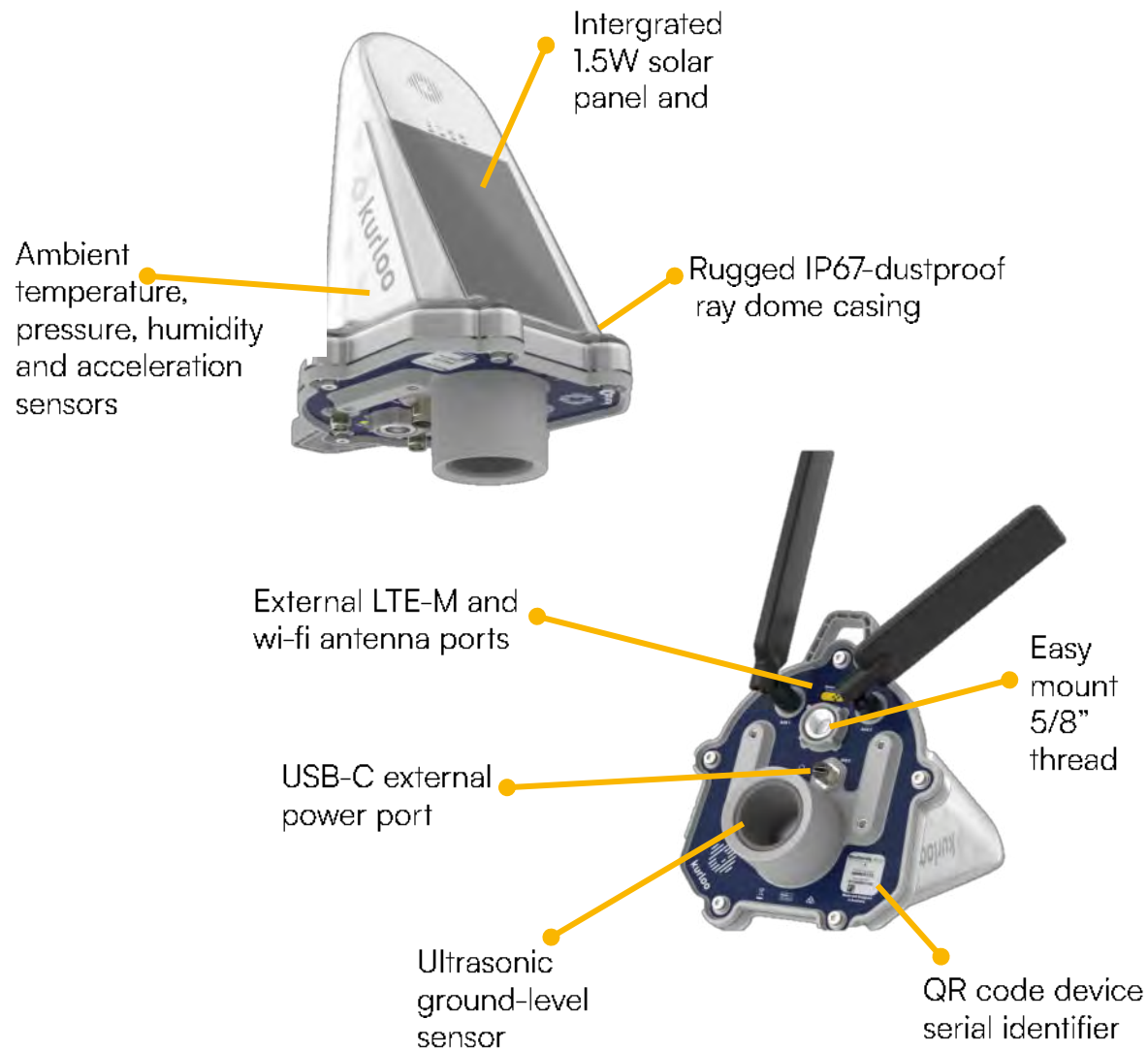
3.

24/7 reporting and Analytics via the ‘Kurloo Nest’ and API

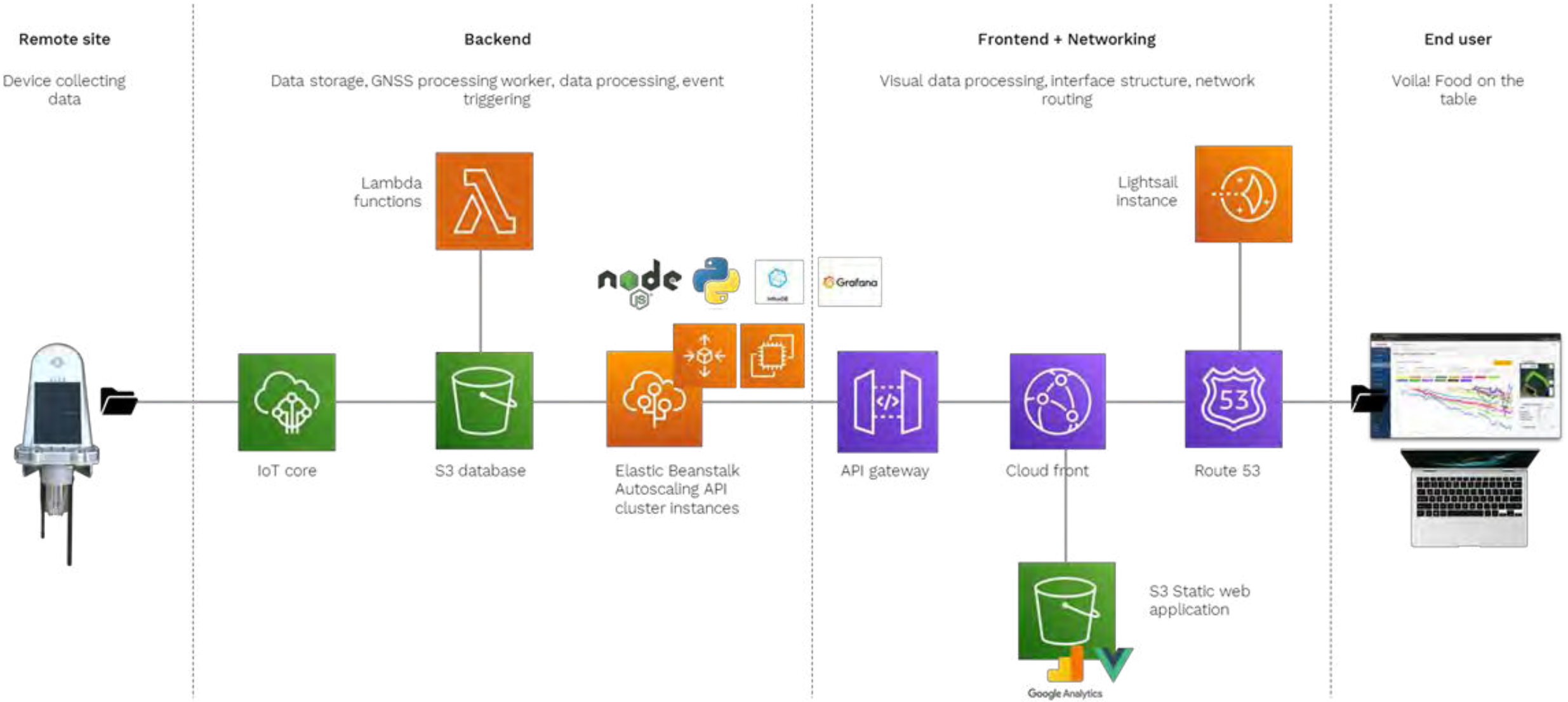
Kurloo Device Overview

Compact and packed with intelligent sensors Kurloo autonomously collects data from the field.

- 169mm x 207mm x 272 mm and weighing just 1.3kg
- Integrated 1.5W solar panel with rechargeable 46Ah LiFePO4 battery (up to 21 days without charge)
- Single-frequency (SF) or multi-frequency (MF) multi constellation GNSS
- LTE-M or Wi-Fi* communications (*additional gateway required for Wi-Fi)
- Multiple integrated sensors that quickly alert to any device or environmental changes



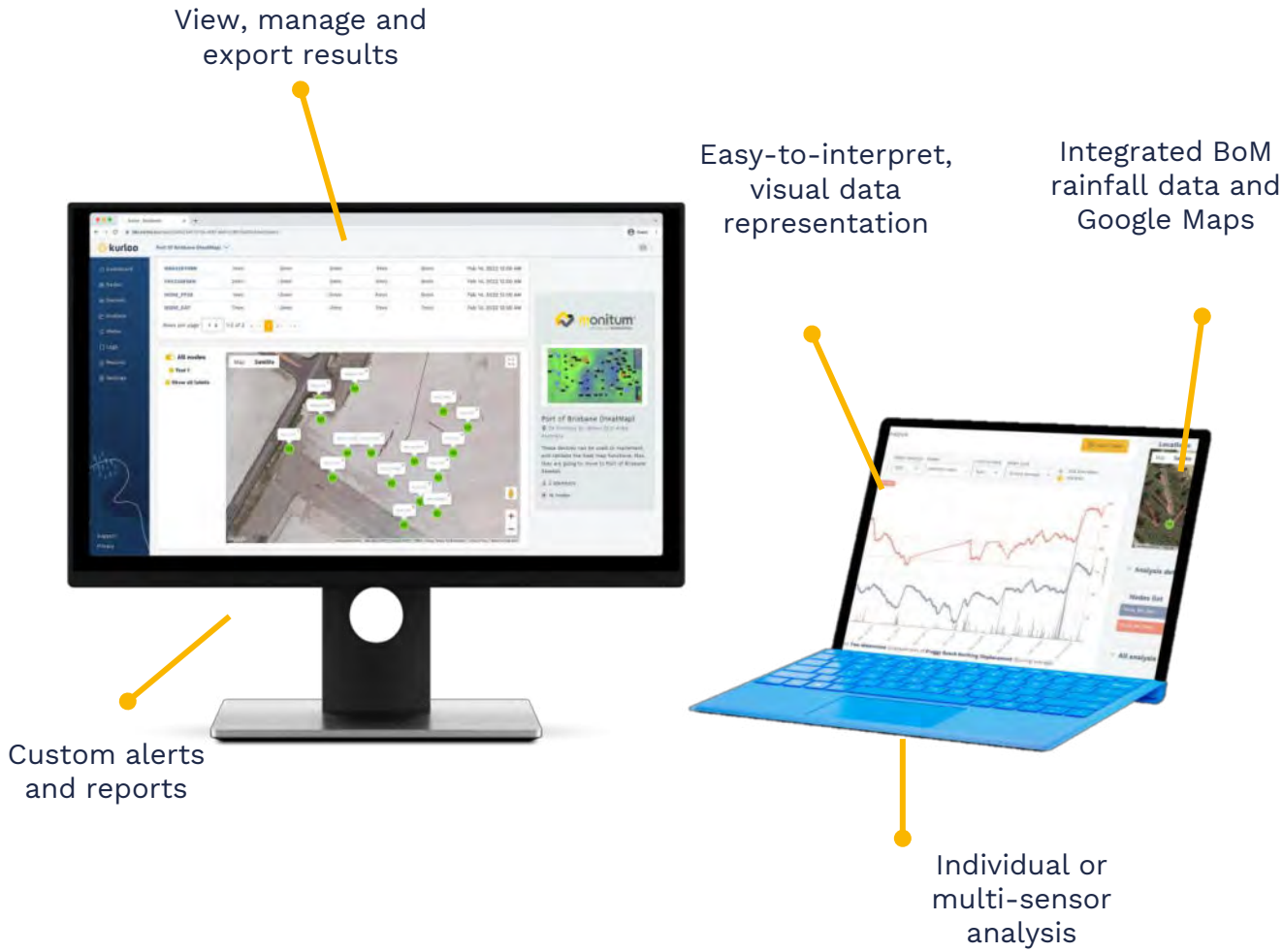
Kurloo Cloud architecture — using AWS



Kurloo nest and API

The Kurloo Nest cloud simply and consistently presents your measurement and analysis; within minutes!

- Dashboard based Live web-based data processing and reporting.
- Accessibility on any device — available 24/7.
- Auto, Alerting and notification when things change.
- Validated insights, correlations and trends over time including rainfall, ground level and accelerometers.
- Secure and reliable cloud based ,2FA and accredited AWS data centres for optimal data security and sovereignty.
- Custom landing pages and company logos available,



Kurloo Installation

Kurloo Applications — Improving Resilience

Kurloo is designed to be used in a variety of industries and has proven success in multiple including Transport & Infrastructure, Railroads, Mining, Tailing Dams and more.

Dams and water

Reclaimed land, ports and airports

Mining stability, waste piles and tailings

Transport corridors, bridges and embankments

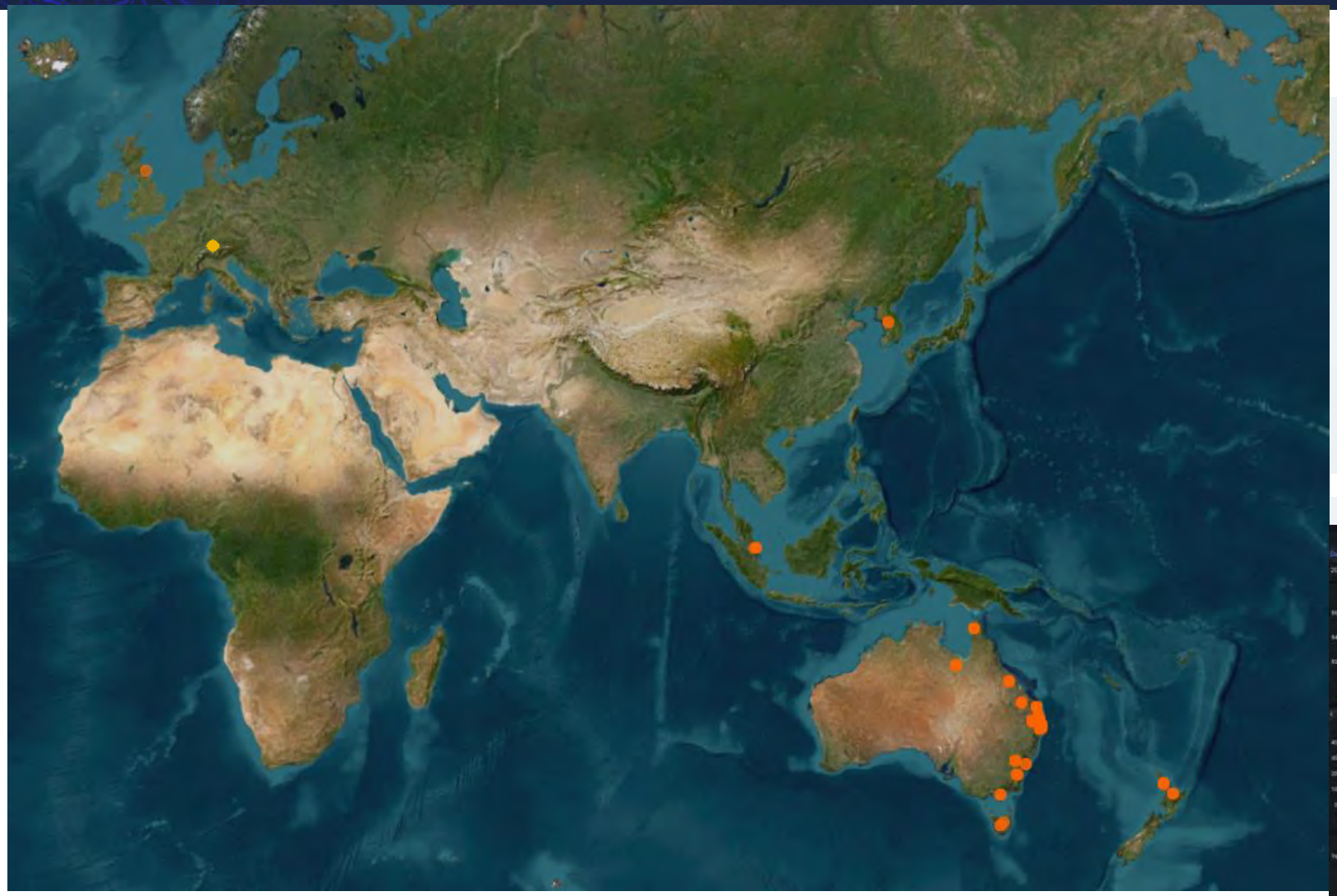
Housing / Local govt., erosion and stability

Heavy industry, storage and pipelines

Coastal erosion

Civil infrastructure and construction

Kurloo Current Projects — November 2024



40+ Projects
300+ devices operating
6 countries

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Use Case
Slope Stability
Froggy Beach
QLD

Use Case — Froggy Beach, QLD | Australia

Site:
Froggy Beach, Gold Coast, Australia
A popular beachside tourist destination.

Problem:
- Significant ductile creep above the beach.
- Cracking and movement in the footpath above slope
- Movement observed in boardwalk down to the beach

Issues:
- Public safety risk
- Negative impact on public space and nearby historic areas

Use Case — Froggy Beach, QLD | Australia

Solution:
Kurloo GNSS devices were installed to monitor the 3D mm relative displacement of the slope on a daily frequency (4D) — (X,Y,Z and Time)

- Corresponding daily Bureau of Meteorology (BoM) rainfall data fed automatically into the Kurloo Nest (online processing platform) to allow simple analysis of the relative displacement to rainfall.

Results:
- With over 2 years of frequent monitoring data, the slope behavior clearly exhibits slips where daily rainfall exceed 50mm.
- Other trends are noticeable where expansion and contraction occurs during lesser rainfall and drier periods. This can be at times up to several cm.

Use Case — Froggy Beach, QLD | Australia

Benefits:

Daily readings from Kurloo highlight the relationship of rainfall and displacement, which would not have been apparent with infrequent manual monitoring surveying.

- ✓ Faster response times
- ✓ Quantifiable results to act upon
- ✓ Improved maintenance planning
- ✓ Justification of remediation expenditure

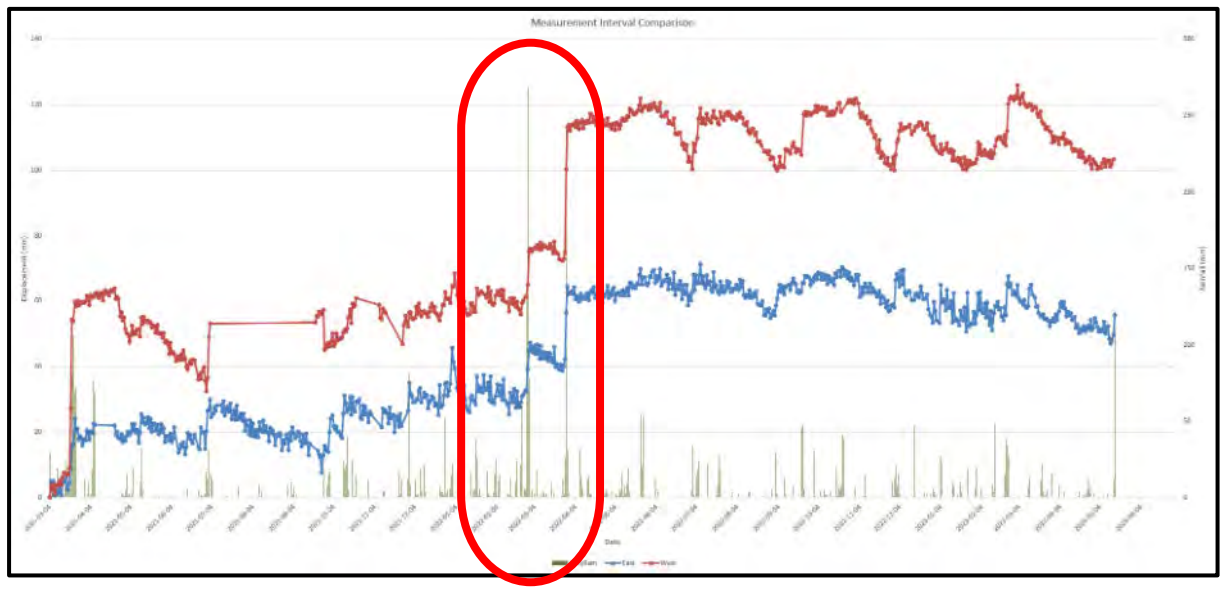


Fig 1: Kurloo **daily** monitoring frequency *(X: monthly; Y: 20mm)*

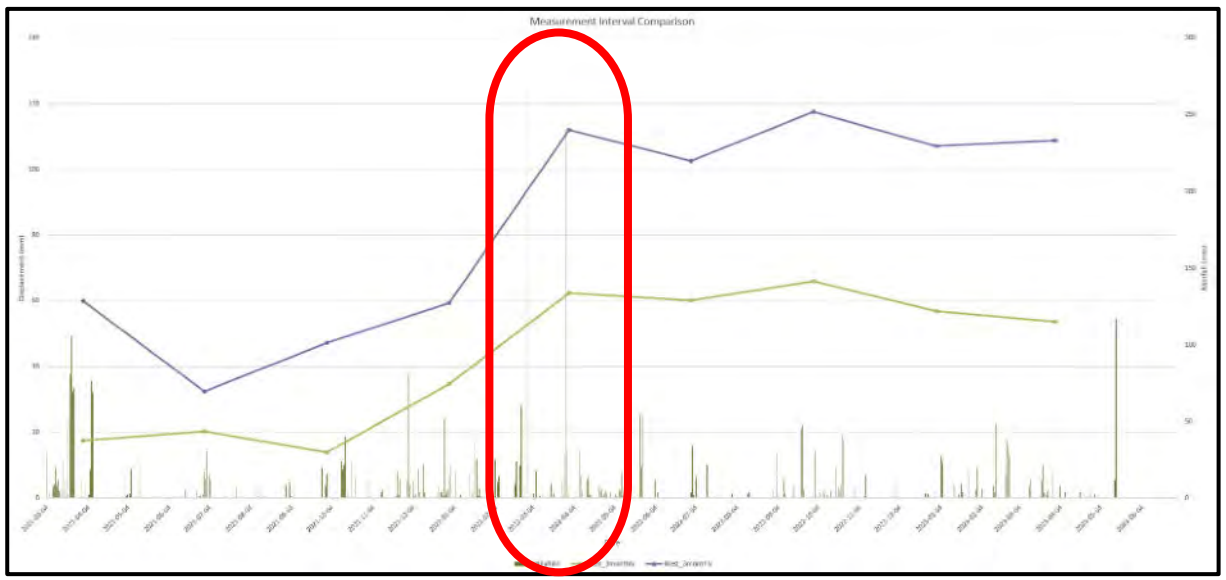
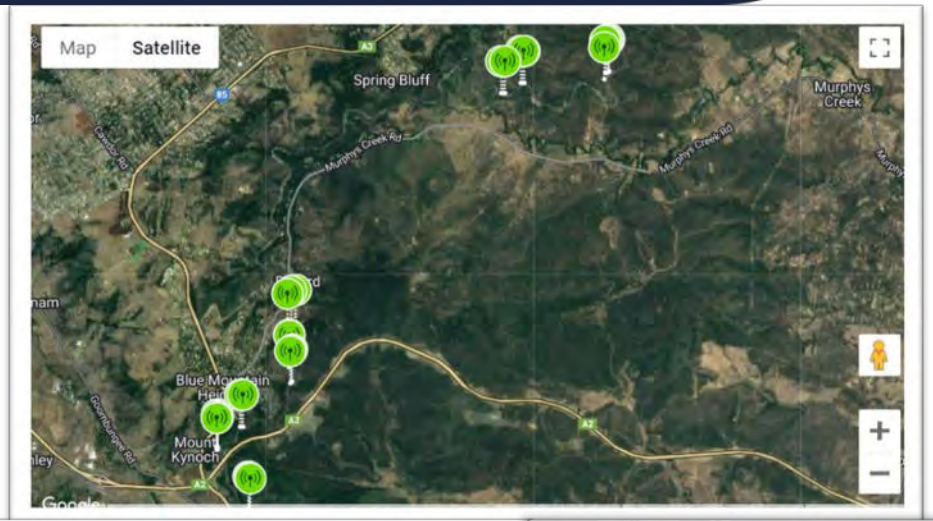


Fig 2: Comparison to routine 3D displacement manual survey measurement **every 3 months**

Transport Use Case — Toowoomba, QLD | Australia

- Legacy critical transport asset
- 35 devices over 10km length
- Live reporting daily of entire site
- Better informed inspections and maintenance

QueenslandRail



Problem:

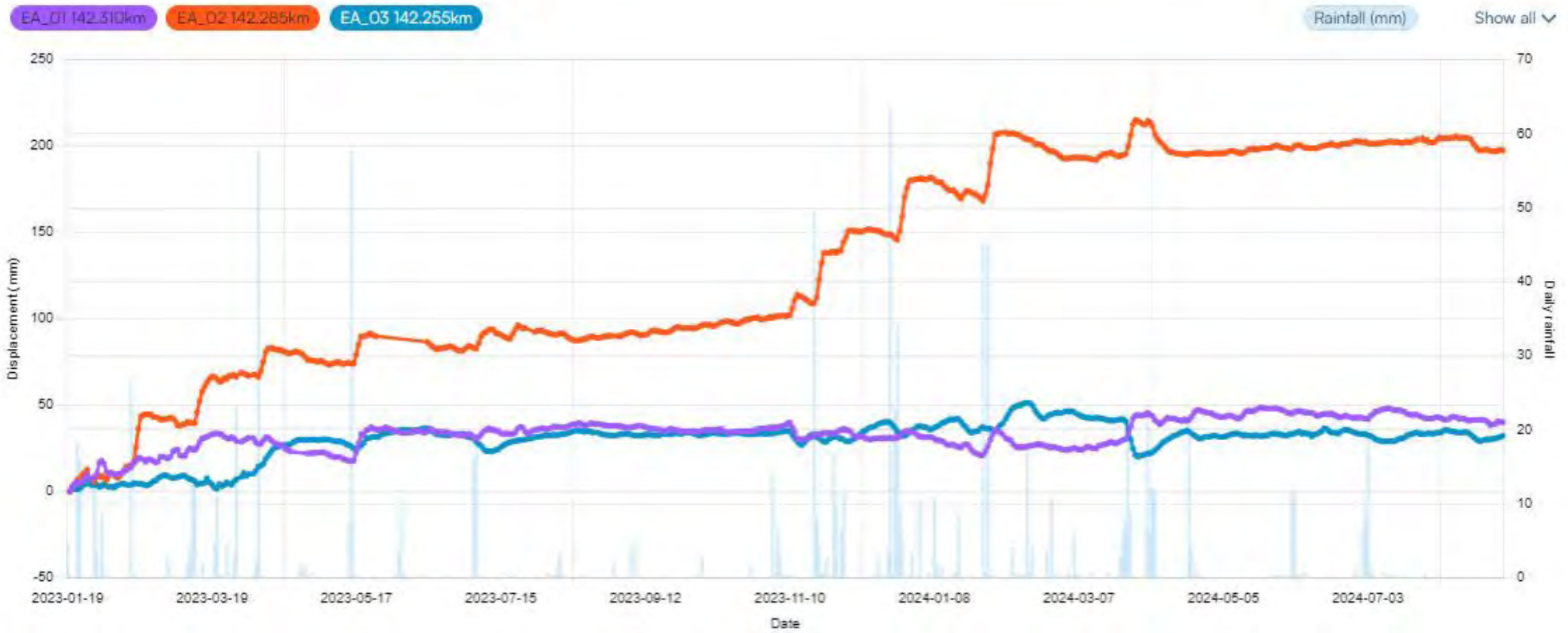
Reliance on frequent visual inspection during and after high rainfall to ensure stability and safety of line operations.

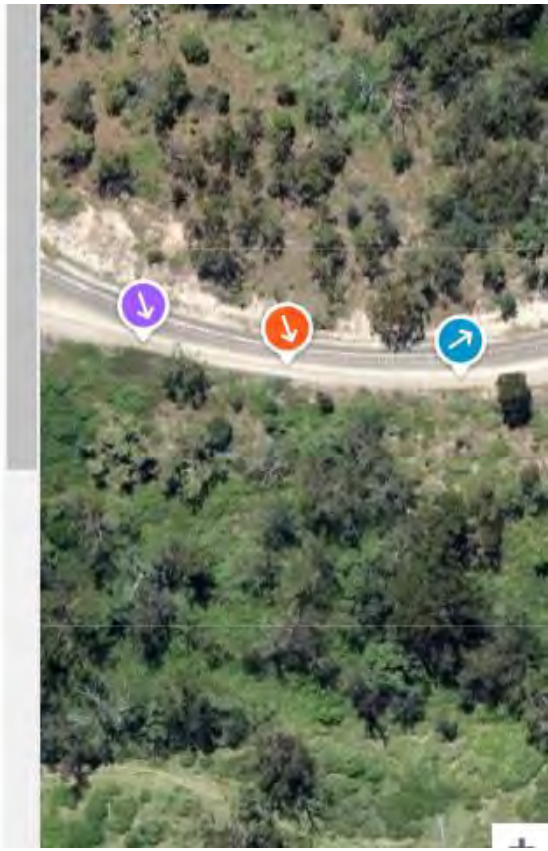
Solution and benefits:

- Installed with Geotech Engineers in 1.5 days in busy rail corridor
- Delivers frequent quantative measurement that support operators and Geotech on priority for inspection and maintenance
- Better informs of impact of rainfall on displacement of embankments

Transport Use Case — Toowoomba, QLD | Australia

Displacement Values & Rainfall over Time

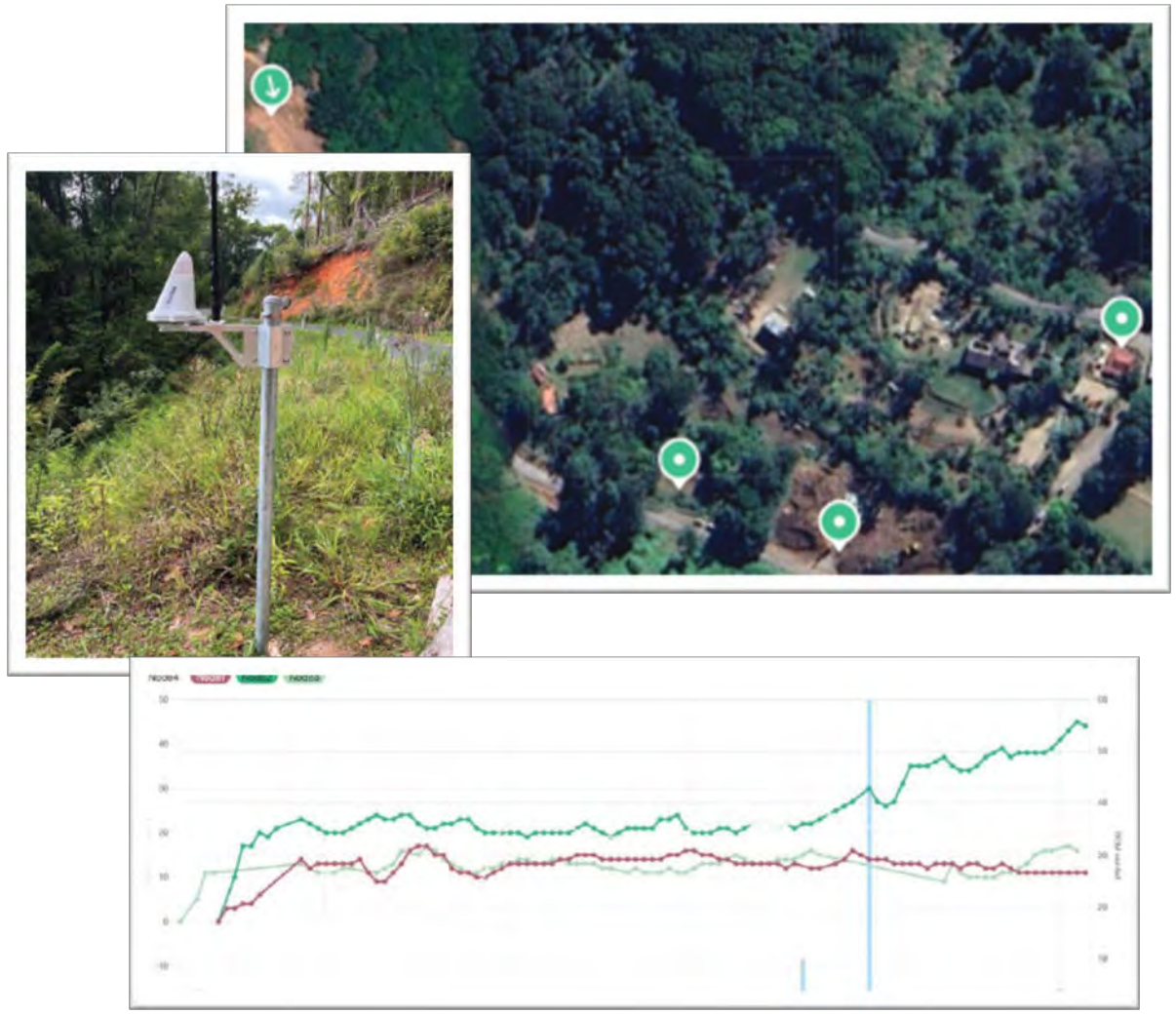




Transport Use Case — Byron Shire, NSW | Australia

NSW, Australia

- Natural disaster slope remediation monitoring
- 4 devices installed. 1km length. 800m slope
- Live daily reporting



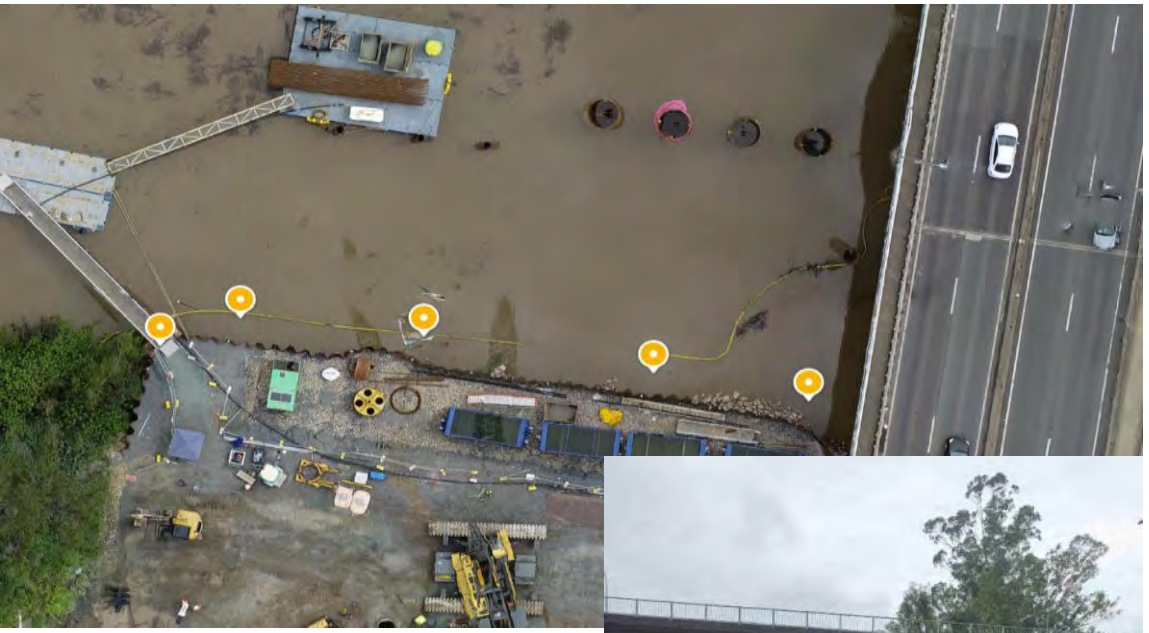
Problem

- Natural disaster led to many significant landslides, as well as many road washouts. Council embarked on an aggressive recovery action plan.
- Extent and frequency of measurement was an issue as well as creep of local benchmarks that adversely contributed to inconsistencies of the data.
- Monitoring had to include to high rainfall in these remote sites with little or no mobile phone reception

Solution and benefits

- Versatility in communications enabled autonomous measurement in remote location eliminating the need to travel to site to collect data.
- **Ability to measure < 1cm precision over 1km or more meant the results aren't impacted by any localised benchmark movement.**
- A cost-effective solution for regional roads that better informs likelihood of slope failure.

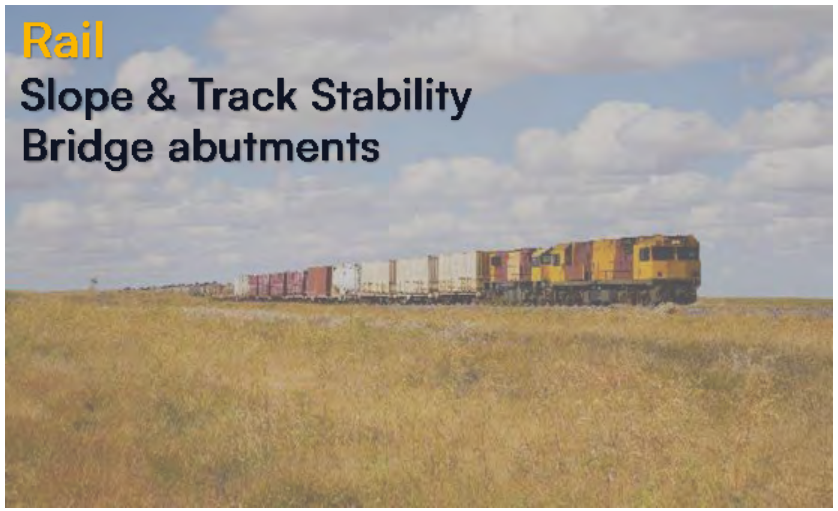
Transport Use Cases — Rivers and Highways in Australia

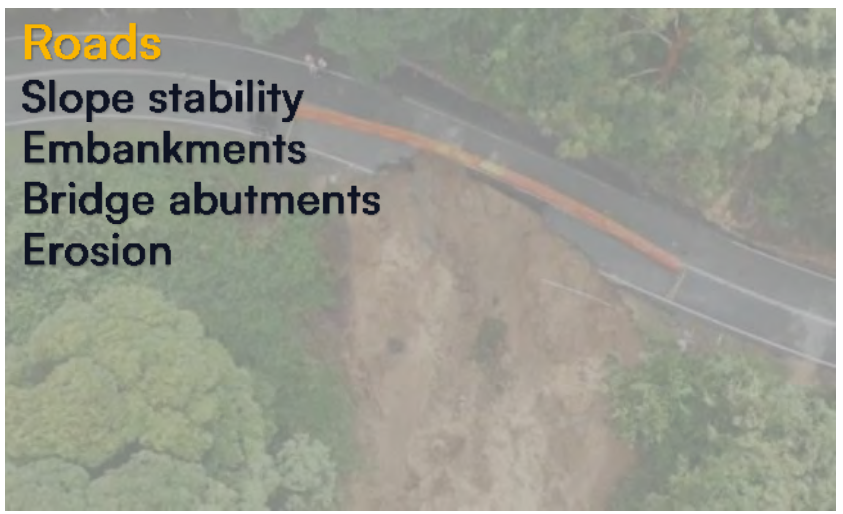


MinStaff Survey

McCONNELL DOWELL

Use Cases — Multiple Sectors Worldwide





Slope Stability monitoring (2024)
Mt. Bogong, VIC, AUSTRALIA

Building Resilience against the reality of Natural Disasters...

.. through Measurement (monitoring)

- ✓ Complementary technologies are making **precise positioning** more **accessible.** Integrated sensors provide indirect data for models
- ✓ **Simple automated systems** can provide **high reliability** with minimal effort in a sustainable way
- ✓ **Continuous reporting and alerting** help improves awareness and can be used for emergency response planning activities
- ✓ Monitoring is a **long-term investment** in the sustainability of transportation protecting the life-blood of many nations' economies and quality of life
- ✓ Provides **insights into geo-behaviours** allowing for **more informed decision making and proactive maintenance schedules**
- ✓ Collaboration will further enhance accessibility to positioning infrastructure in the developing world!

Contact Us

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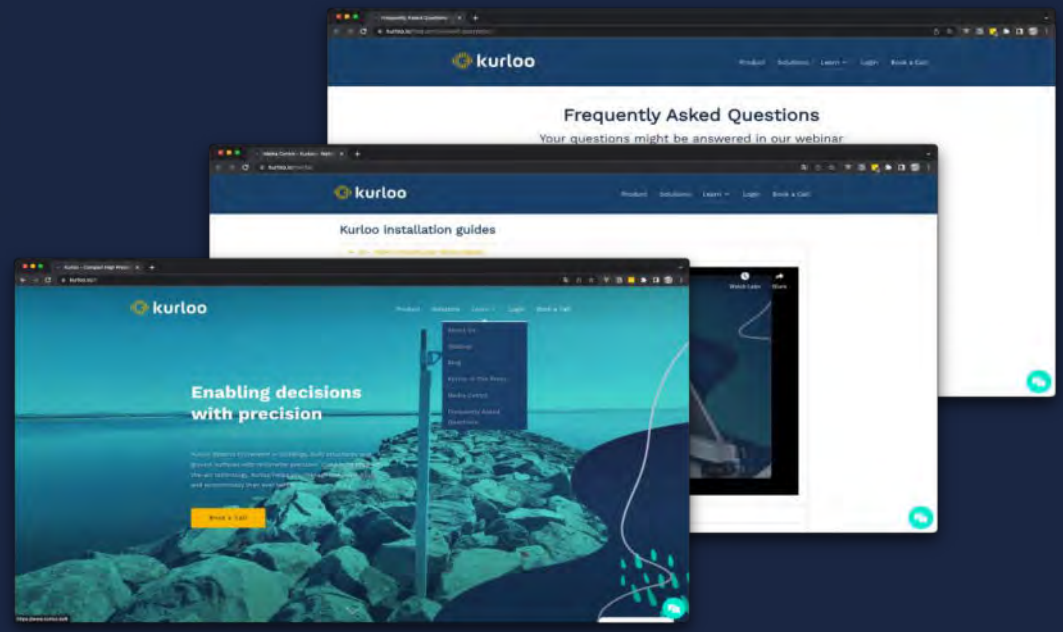

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AUSTRALIAN MADE

GOOD DESIGN AWARD WINNER

Curious about Kurloo?

Book a call

www.kurloo.io

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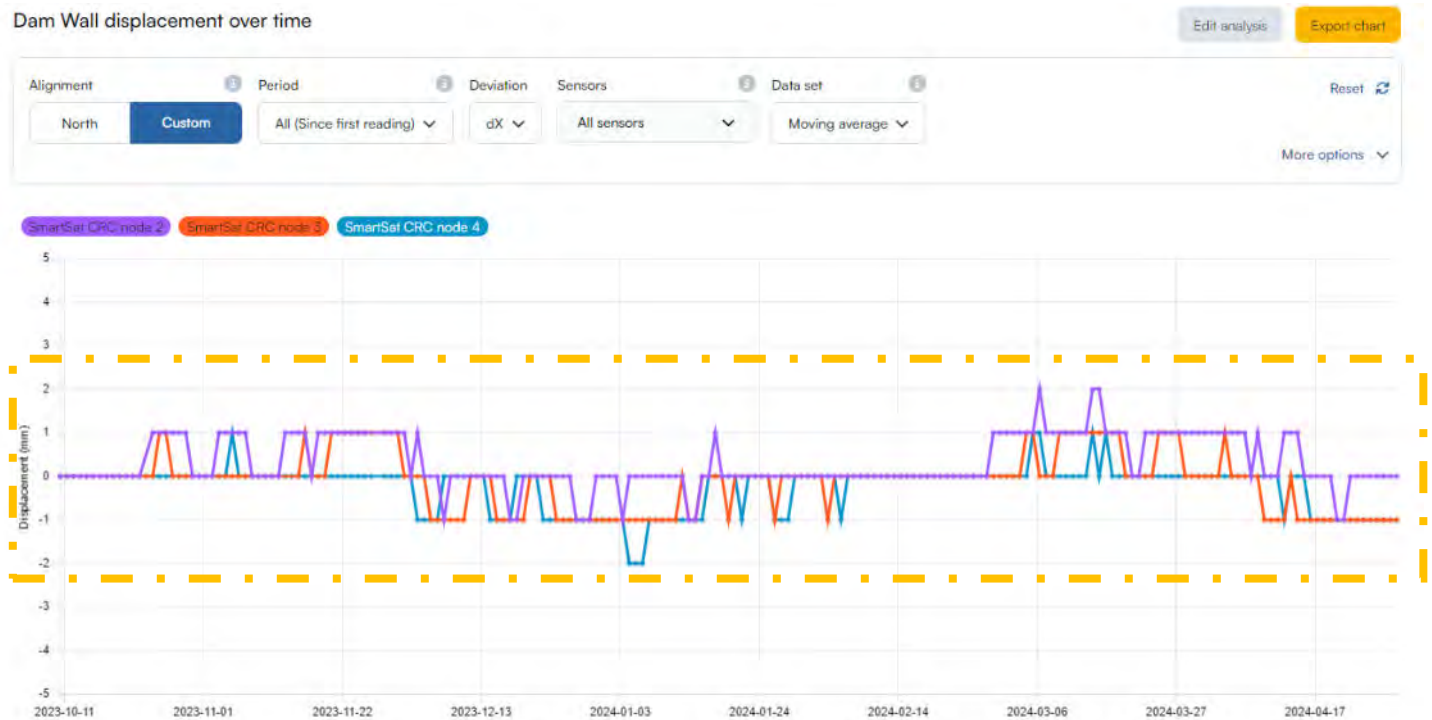
Case 3: Relative Positioning Service (PPK)

8 DECENT WORK AND ECONOMIC GROWTH



Googong Dam wall monitoring

Baseline displacement recording

3 x monitoring devices over 12 months

Benefits for Safety, accuracy and timeliness

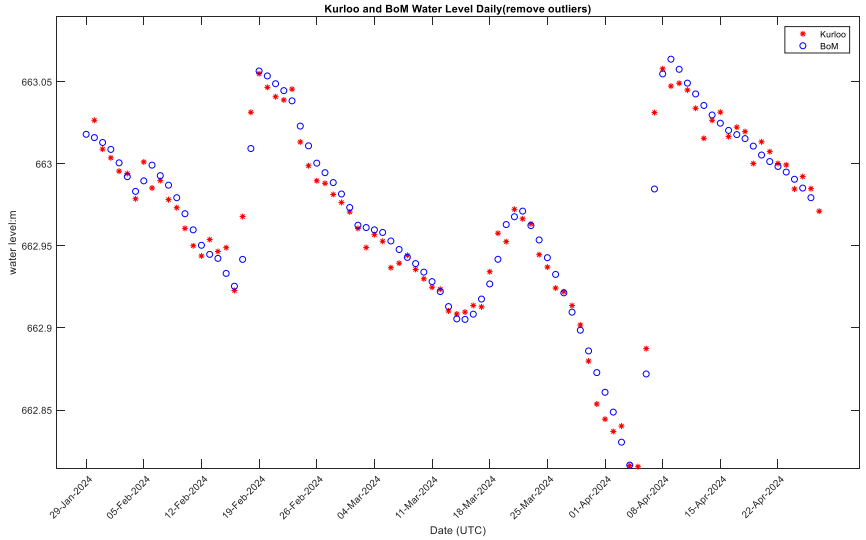
Case 4: Validation and Calibration of Water Level

CSIRO
Australia's National Science Agency

SMARTSAT
Cooperative Research Centre

6 CLEAN WATER AND SANITATION

13 CLIMATE ACTION



Scenario	STD
Compare Kurloo with BoM (Epoch)	0.033 m
Compare Average Daily Solution	0.007m