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Geospatial Artificial Intelligence Analysis for Tailings Storage Facilities (GAIA-TSF)

EUSPA AI week 2026

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EUSPA European Union Agency for the Space Programme

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Source: Reuters, Accident: Jagersfontein, South Africa (2022)

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- Tailings Storage Facilities Monitoring
- Failure Prevention
- Remote Sensing data, In-Situ data
- Artificial Intelligence

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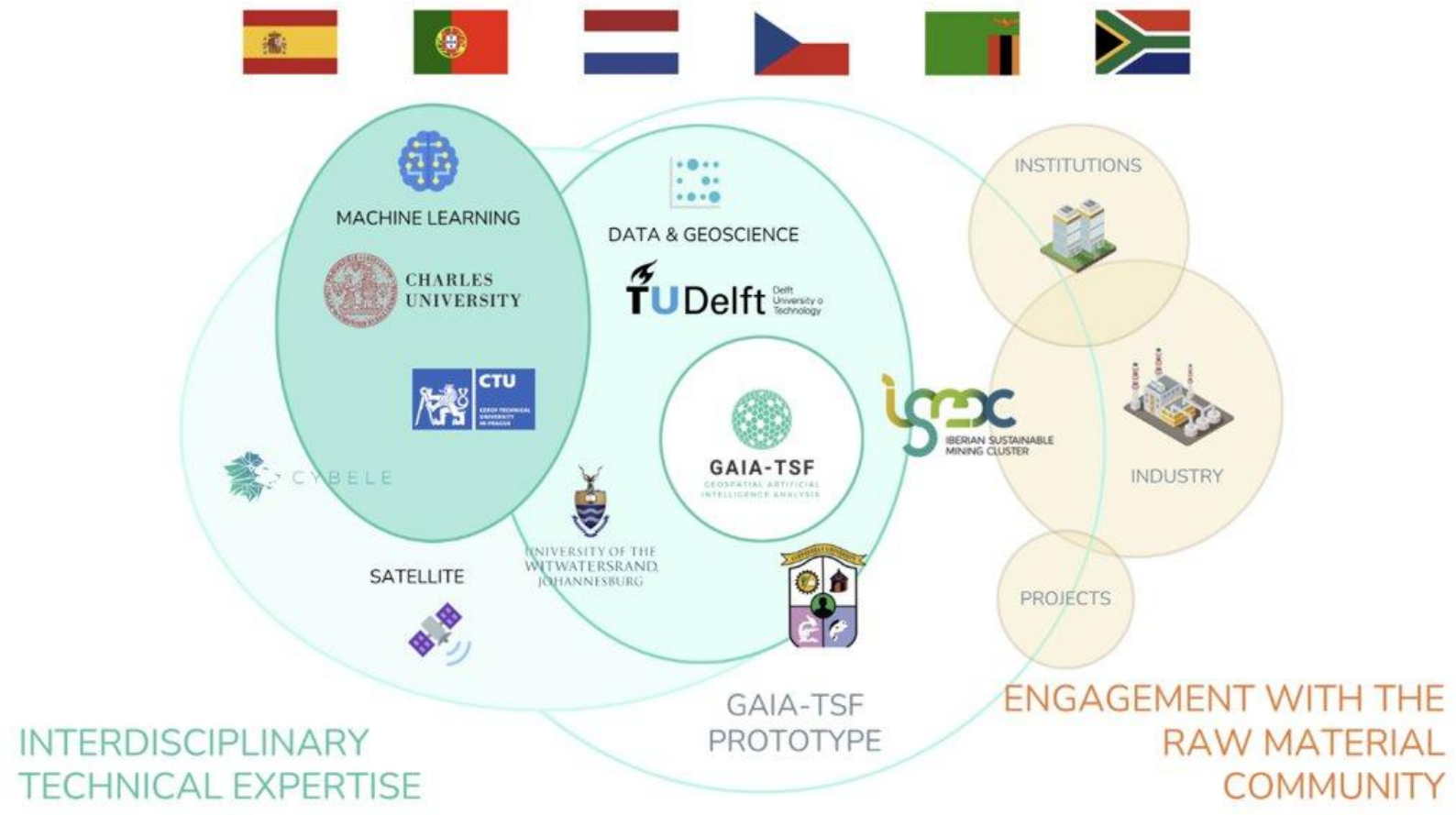
The GAIA Consortium



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The Research Question

How can artificial intelligence and satellite Earth Observation help improve the safety management of tailings storage facilities?

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Tailings Storage Facilities

TSFs are engineered structures designed to store **tailings** — the waste material remaining after valuable minerals are extracted during mining processes.

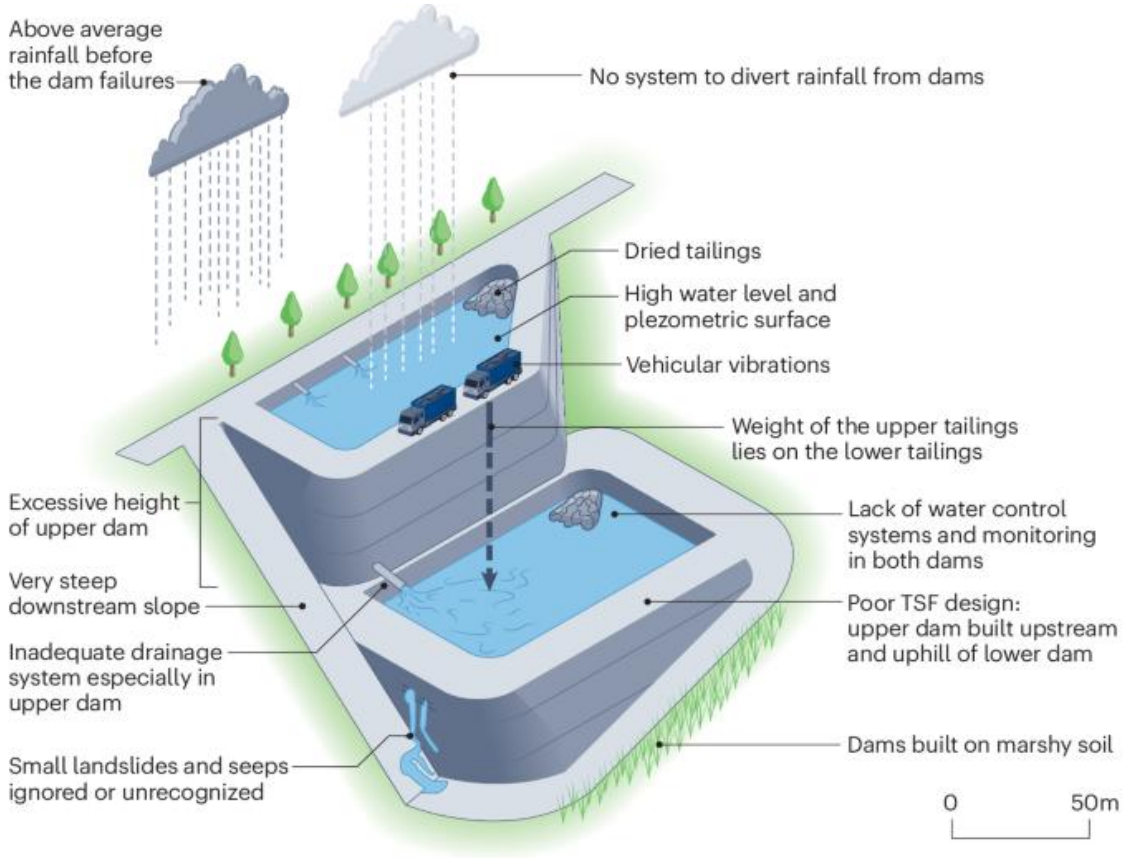

Illustration: Hudson-Edwards et al. 2024

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TSF Failures

Why TSFs matter?

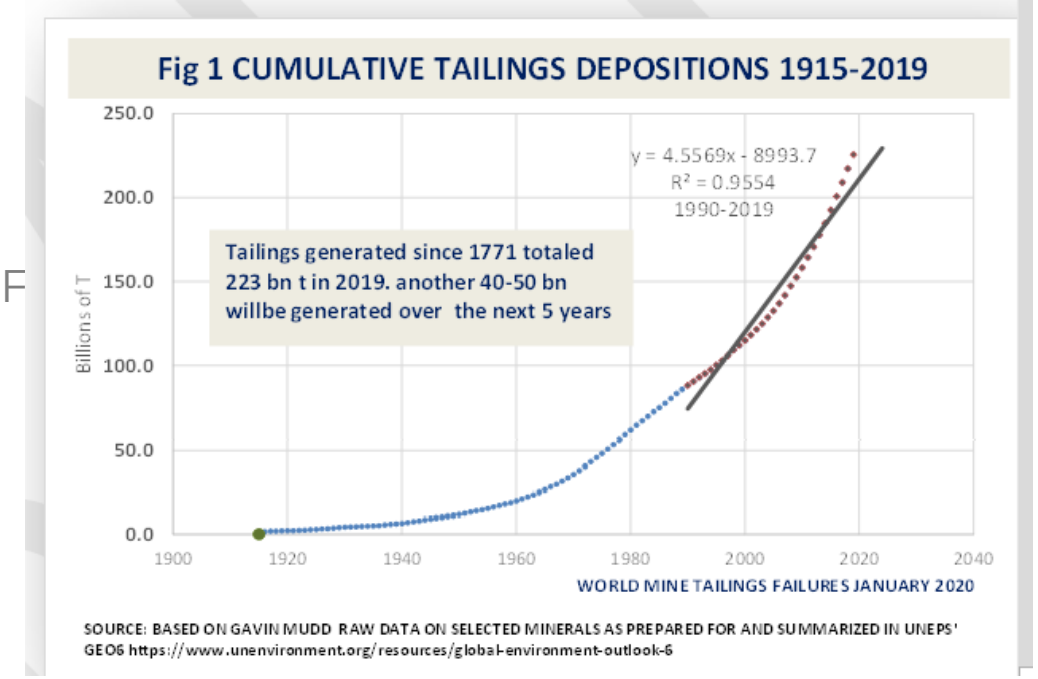
Tailings often contain water, chemicals, and fine solids that pose **environmental and safety risks** if released.

Statistics: roughly 1-2 Tailings Storage Facility (TSF) failures per year globally.

Failure rate: ~1.2%

1-2 failures occur annually

https://worldminetailingsfailures.org



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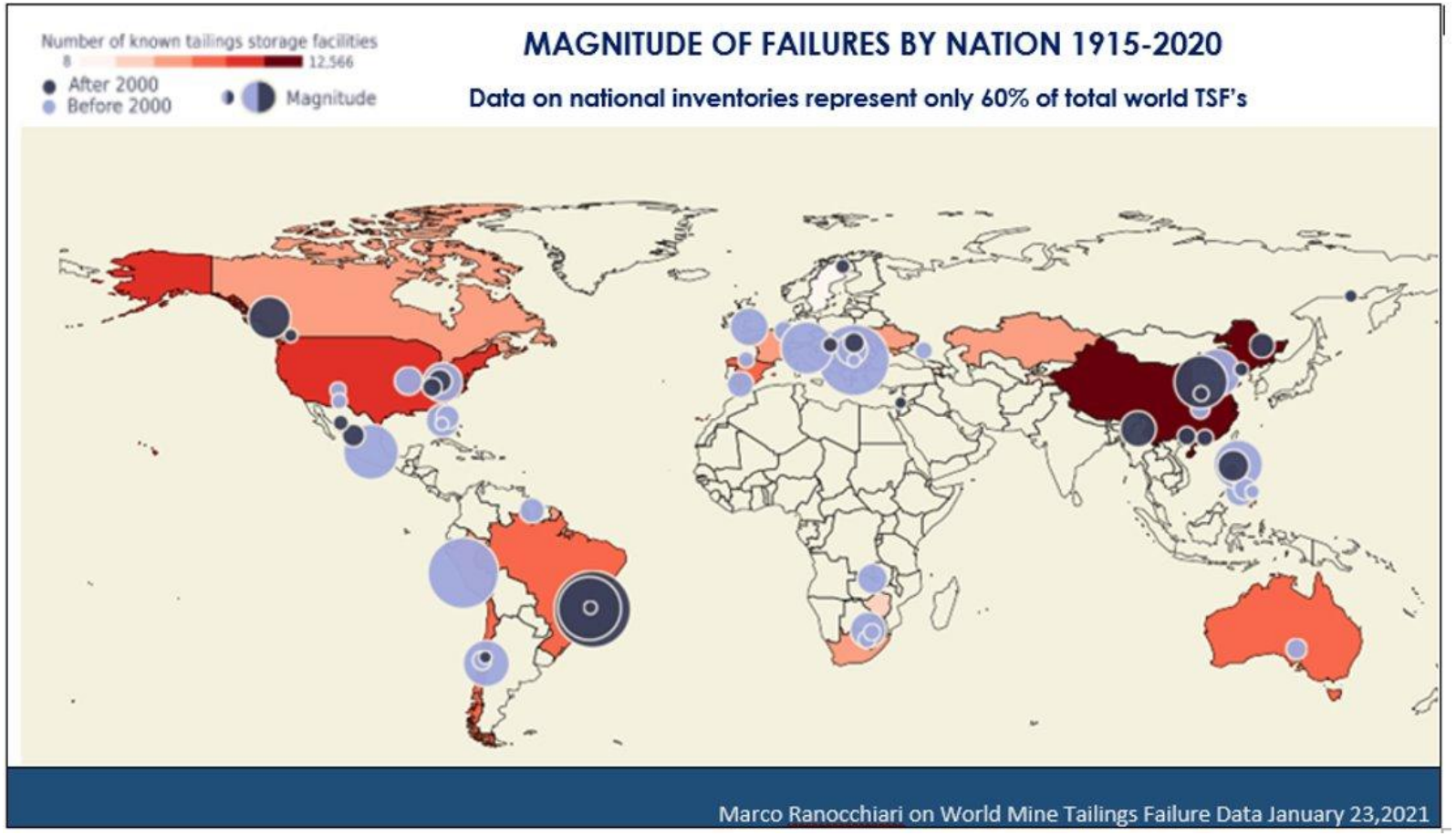
TSF Failures



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TSF Failures

Why Do TSFs Fail?

Heavy Rainfall: A statistically significant cause, increasingly linked to climate change.

Design Methods: The upstream construction method, commonly used in developing countries due to lower costs, carries a high risk of failure.

Age and Abandonment: A significant proportion of TSFs (approximately 20% as of 2020) are abandoned, creating hidden and poorly monitored risks.

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TSF Monitoring Variables

Key Monitoring Needs in the Mining Industry

What Variables can be monitored?

- **Structural stability trends**: Are embankment walls moving, deforming, or bulging?
- **TSF risk contents**: For example, the potential for acid mine drainage.
- **Water level changes**: Excessive ponding increases internal pressure and failure risk.

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GAIA Technologies

How can AI and satellite earth observation help manage the safety of tailings storage facilities (TSFs)?

- **InSAR** (radar): detects **millimetre-scale ground movement** over time — crucial for slope stability.
- **Optical** & multispectral data identifies changes in **surface water quality** (acidification iron oxides).
- **Machine Learning** models trained on deformation time series to flag precursors to failure or exceeding WQ thresholds.

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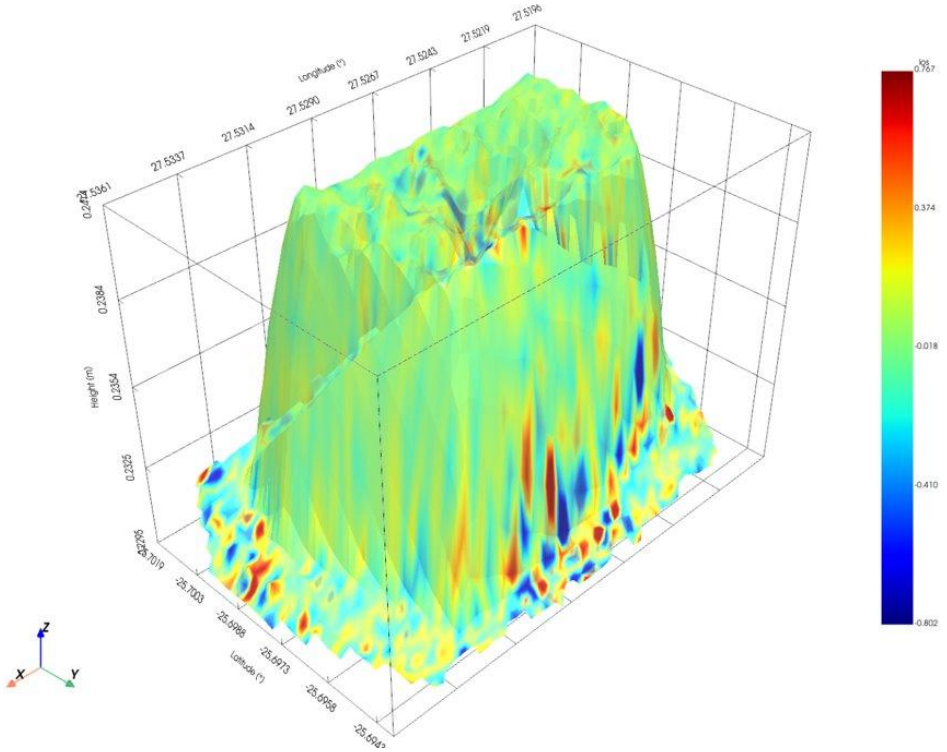
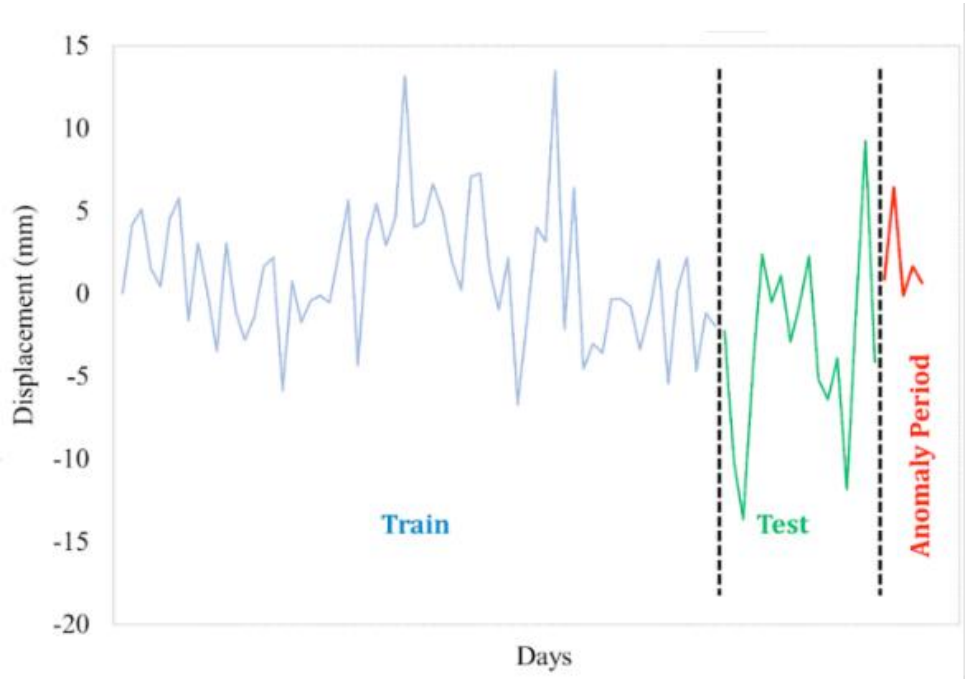
ML-based Ground Movement Analysis





InSAR time series and LSTM model to support early warning detection tools of ground instabilities (Glen Nwaila e tal. 2025, Mirmazloumi et al. 2023)

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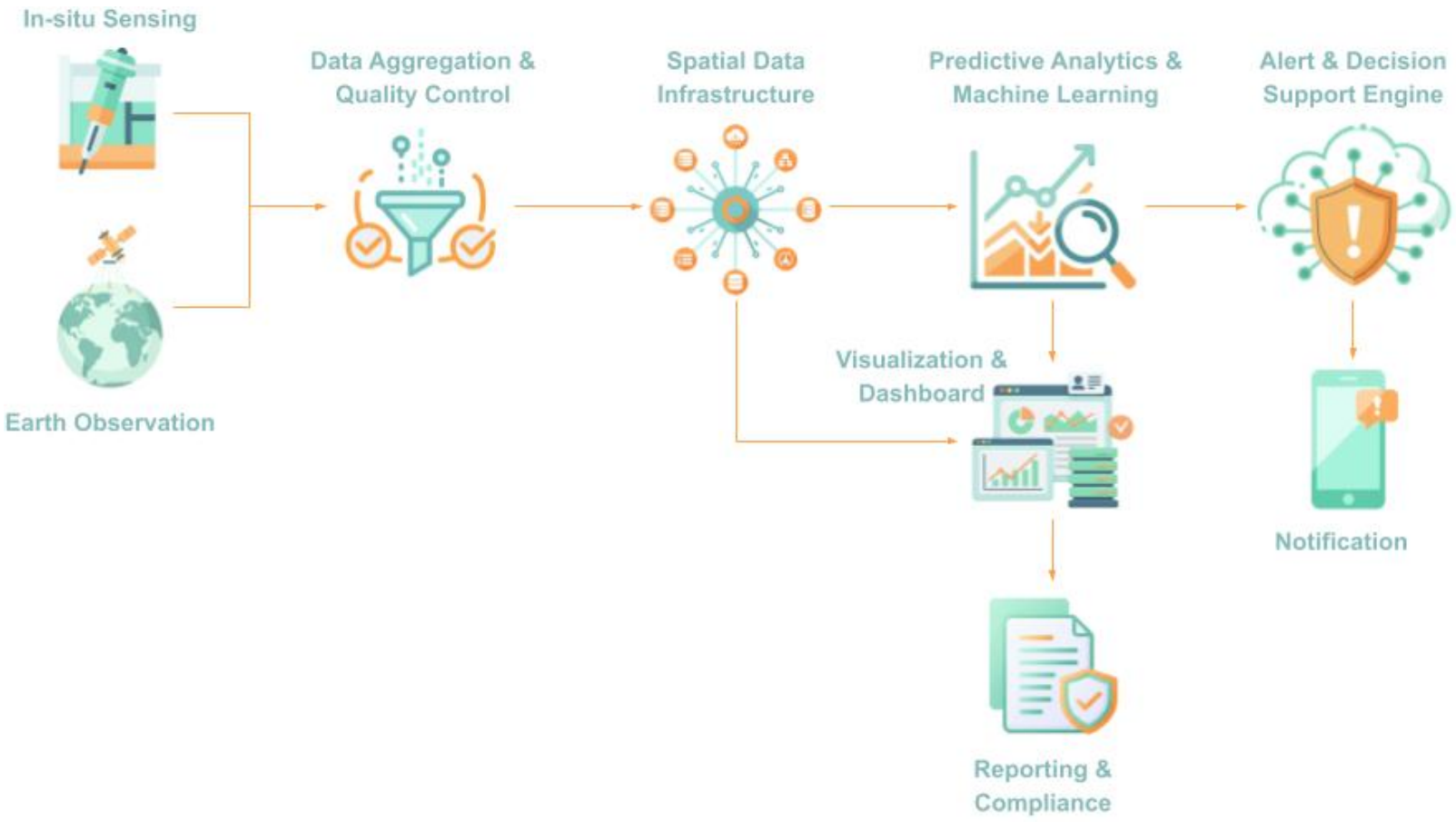
GAIA Prototype



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New solutions to improve TSF monitoring

How can AI and satellite earth observation help manage the safety of tailings storage facilities (TSFs)?

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- **Synergistic**: EO provides data at scale, AI provides intelligence/insight from that data.
- **Predictive early warnings** — AI forecasts where and when risk indicators are trending toward unsafe thresholds.
- Enables continuous spatio-temporal, **proactive risk management** instead of slow, reactive responses.

THANK YOU FOR YOUR ATTENTION

Geospatial Artificial Intelligence Analysis for Tailings Storage Facilities

https://www.gaia-tsf.com/
Linkedin: GAIA- TSF

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