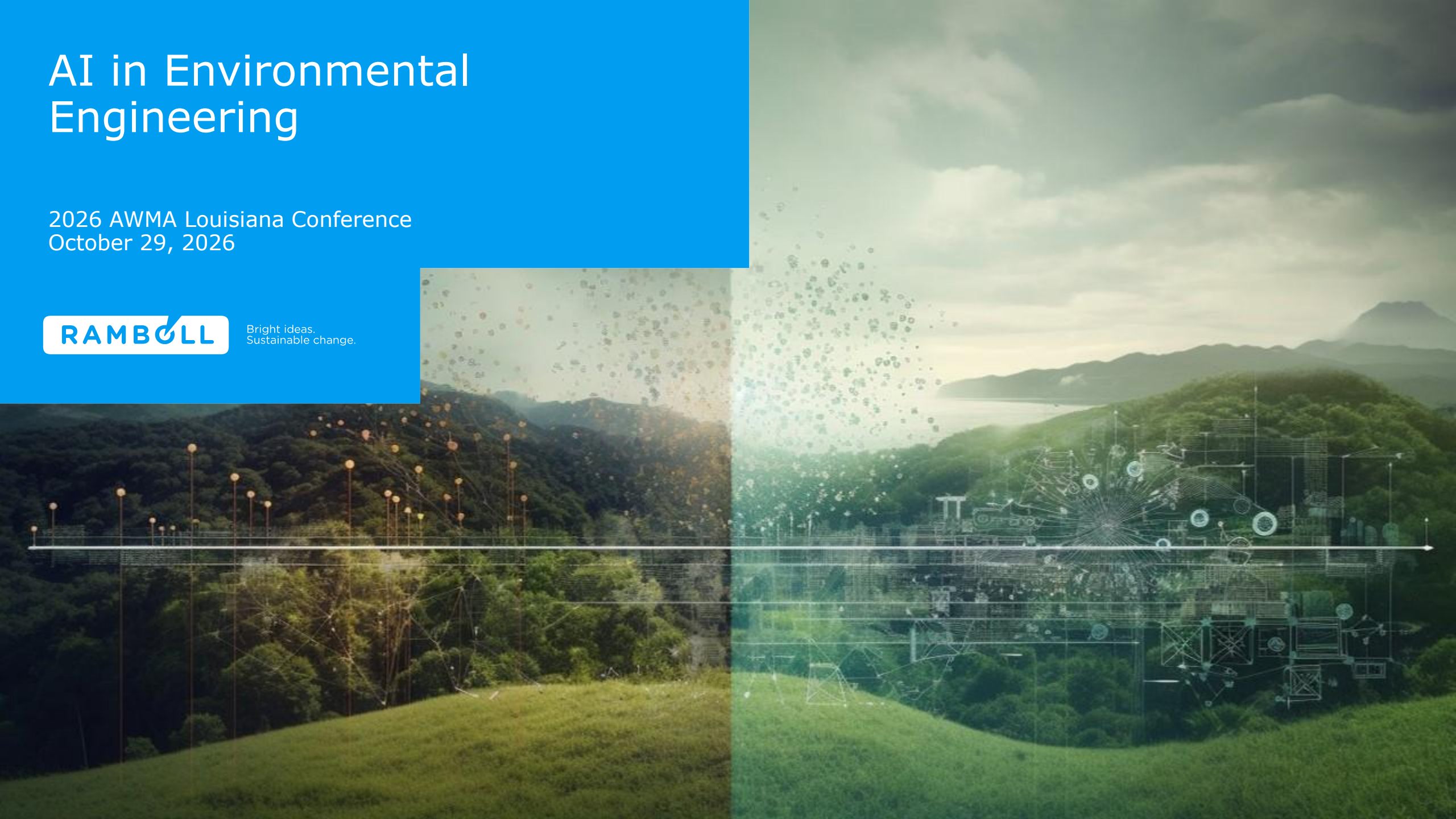
AI in Environmental Engineering

2026 AWMA Louisiana Conference
October 29, 2026

RAMBOLL

Bright ideas.
Sustainable change.



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Agenda

- The Environmental Crisis & AI’s Role- Urgency, Why Now?
- Why Use AI
- Key tools and platforms for Environmental AI
- Application of AI in Environmental Engineering
- How is Ramboll utilizing AI in Environmental Engineering?

The Environmental Crisis & AI’s Role- Urgency, Why Now?

Environnemental challenges demand intelligent solutions



1.5°C

Global warming threshold we're fast approaching

IPCC



7M

Deaths/year from air pollution alone

WHO



40%

Freshwater scarcity affects global population

Wastewater Digest



2B tons

Solid waste generated globally each year

World Bank Group

Why use AI?

Machine Learning

Algorithms that learn from data to detect patterns — e.g., predicting pollutant levels from historical readings.

Deep Learning

Neural networks for image recognition, used in satellite land-cover classification and flood mapping.

Computer Vision

Analyzing aerial/satellite imagery to track deforestation, ice-cap loss, or wildfire spread in real time.

NLP & LLMs

Processing environmental regulations, research literature, and monitoring reports at scale.

Reinforcement Learning

Optimizing complex systems like HVAC, wastewater treatment dosing, or smart grid dispatch.

Digital Twins

Virtual replicas of ecosystems, watersheds, or cities used to simulate and test interventions safely.

Key tools and platforms for Environmental AI?

Geospatial & Remote Sensing

- Google Earth Engine
- ArcGIS + Esri AI
- QGIS + Python
- Sentinel Hub
- Planet API

Machine Learning Frameworks

- TensorFlow / Keras
- PyTorch
- Scikit-learn
- XGBoost / LightGBM
- Hugging Face

Environmental Data Sources

- NOAA Climate Data
- EPA Air Quality API
- OpenAQ Network
- USGS Water Data
- Copernicus CMEMS

Cloud & MLOps

- AWS SageMaker
- Google Vertex AI
- Azure ML
- MLflow / DVC
- Weights & Biases

Application of AI in Environmental Engineering

Climate Modeling

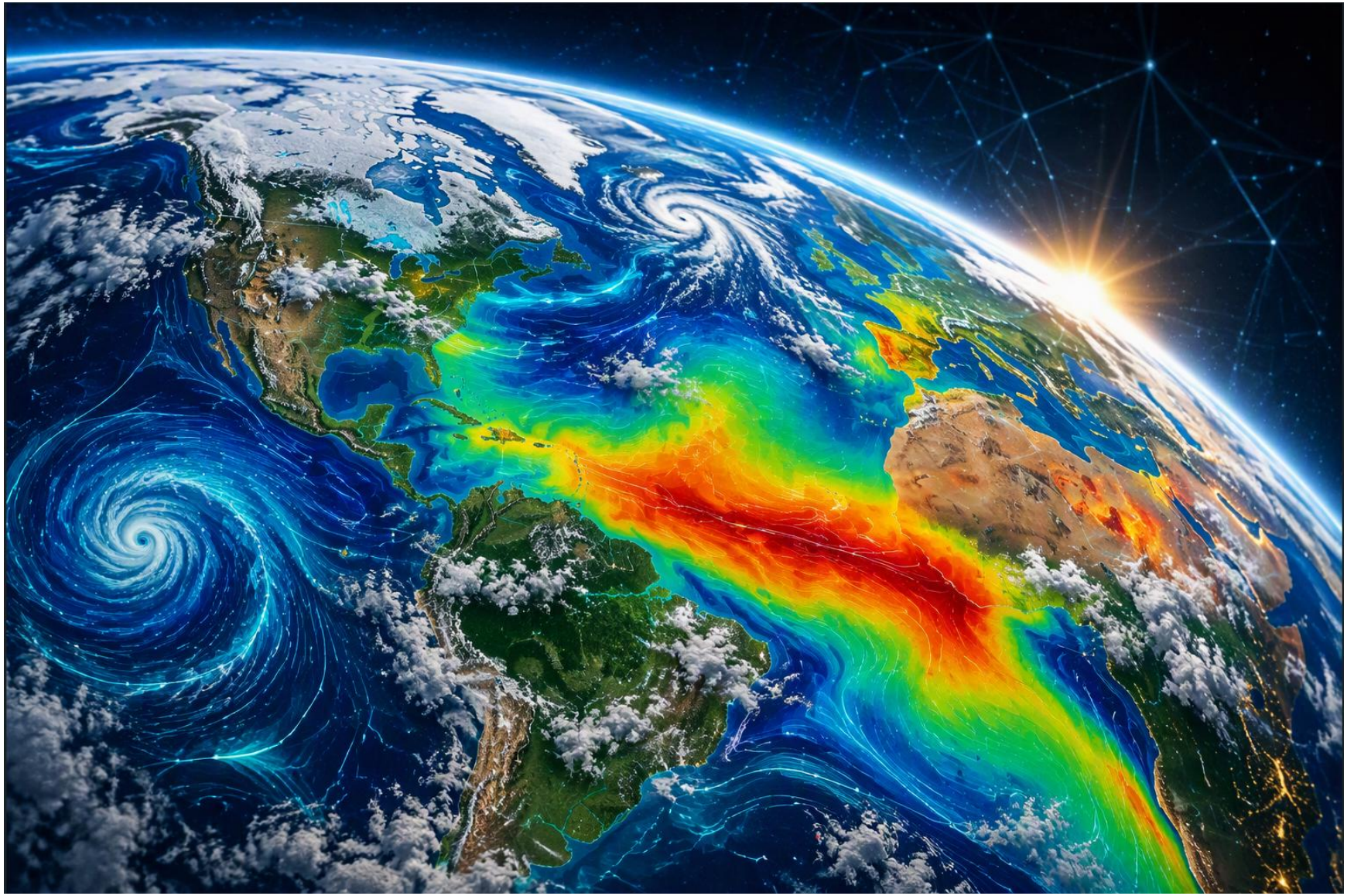


Image generated with AI using Microsoft Copilot

AI enhanced climate modeling

Faster, higher-resolution, more accurate projections

Emulation Speed

AI emulators run 1000x faster than traditional GCMs, enabling rapid scenario testing for policy decisions.
https://allenai.org/blog/ai2-climate-emulator

Extreme Event Prediction

Conventional Neural Networks (CNNs) trained on reanalysis data now detect atmospheric precursors to hurricanes, droughts, and heatwaves 2+ weeks ahead
https://www.climatechange.ai/blog/2024-02-07-forecast-tutorials.

Climate Downscaling

Super-resolution ML translates coarse global models into high-resolution local forecasts for engineering design.
https://dl.acm.org/doi/10.1145/3097983.3098004

Uncertainty Quantification

Bayesian deep learning provides probabilistic outputs, helping engineers make risk-informed infrastructure decisions.
https://journals.ametsoc.org/view/journals/aies/3/4/AIES-D-23-0093.1.xml

Carbon Cycle Modeling

AI learns complex biosphere feedbacks from observational data to reduce uncertainty in carbon budget estimates.
https://esd.copernicus.org/articles/17/651/2026/

Tipping Point Detection

ML identifies early warning signals of irreversible climate tipping points from multivariate sensor streams.
https://esd.copernicus.org/articles/15/1117/2024/

Water resource management



Image generated with AI using Microsoft Copilot

Smart water resource management

AI-driven solutions for Global Water Security

Leak Detection

Acoustic sensors + ML pinpoint leaks in water distribution networks before visible damage occurs.

Water industry Journal

Flood Forecasting

LSTM networks on rainfall-runoff data issue flood warnings in advance with high accuracy.

ScienceDirect

Groundwater Modeling

Physics-informed neural networks predict aquifer recharge rates and contamination plumes.

ResearchGate

Treatment Plant Ops

Reinforcement learning optimizes chemical dosing, energy use, and effluent quality in real time.

ScienceDirect

Remote sensing and land use

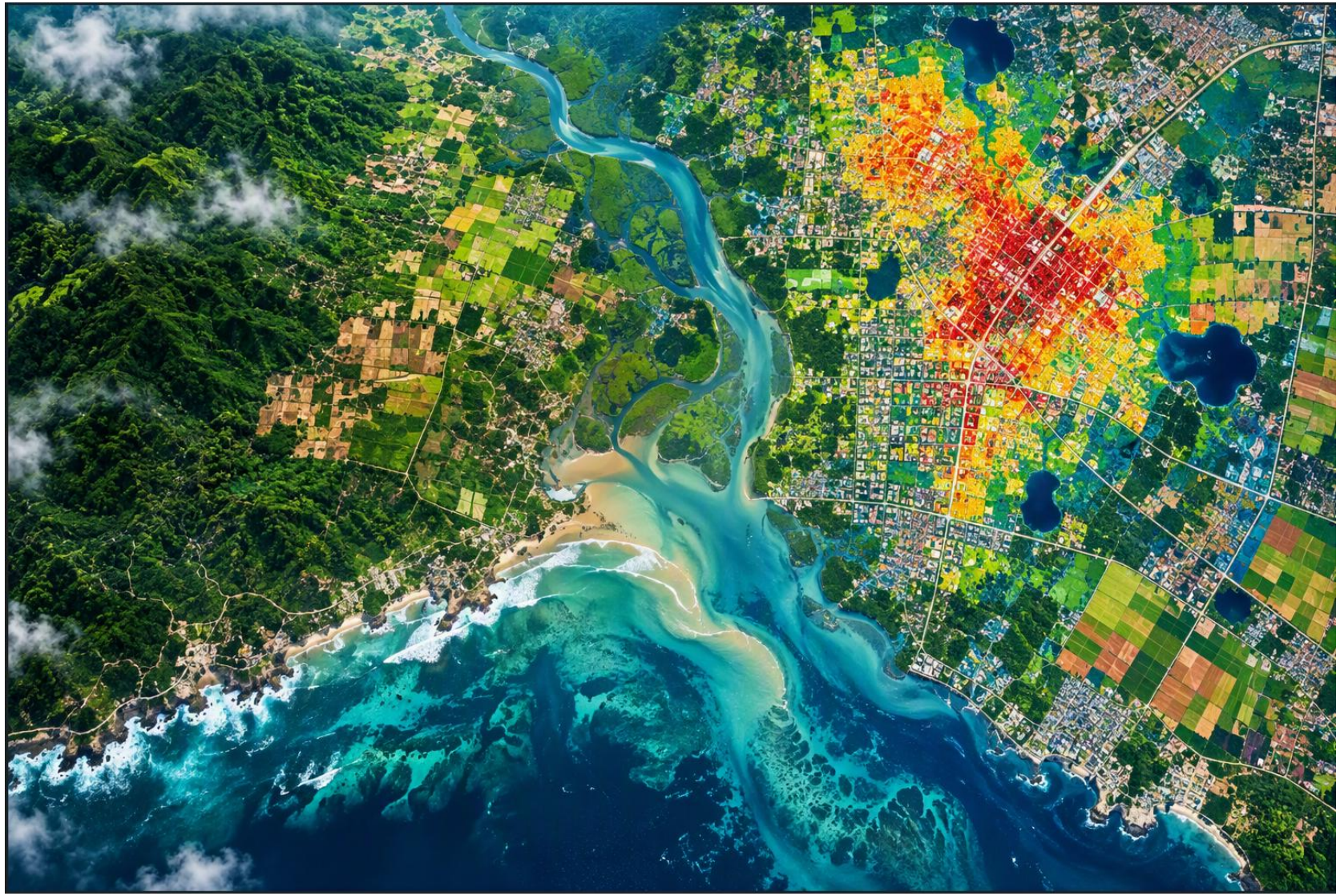


Image generated with AI using Microsoft Copilot

Remote sensing and land use

Eyes in the sky with machine learning

Deforestation Alerts

GLAD alerts detect new forest clearing within days using Landsat + ML, covering the entire tropics.

https://www.globalforestwatch.org/blog/data-and-tools/glad-deforestation-alerts/

Coastal Erosion

Time-series analysis of shoreline position quantifies erosion rates for climate adaptation planning.

https://www.sciencedirect.com/science/article/abs/pii/S0895981125003268

Urban Heat Islands

Thermal IR + deep learning maps surface temperature variation within cities to guide green infrastructure.

https://link.springer.com/article/10.1007/s10668-026-07564-2

Energy systems & emissions optimization



Image generated with AI using Microsoft Copilot

Energy systems & emissions optimization

AI accelerating the clean energy transition

Smart Grid Balancing

DeepMind's AlphaFold-inspired RL cut Google's data center cooling energy by 40% — same approach applied to grid.

Carbon Accounting

NLP + knowledge graphs automate Scope 1, 2, 3 emissions tracking from invoices, utility bills, and ERP data.

Solar Forecasting

Ensemble ML predicts solar irradiance 48h ahead, enabling grid operators to reduce spinning reserves.

Building Optimization

Occupancy sensing + RL dynamically adjusts HVAC and lighting, reducing building energy use 20-30%.

Environmental compliance & regulation

AI as your regulatory intelligence partner

Document Intelligence

- Auto-extract permit conditions from regulatory filings
- NLP flags non-conformances in monitoring reports
- LLMs summarize EIA documents in minutes vs. days
- Automated regulatory change tracking across jurisdictions

Continuous Compliance

- Real-time sensor networks vs. permitted thresholds
- Predictive exceedance alerts before violations occur
- Digital chain-of-custody for environmental samples
- AI-generated compliance reports ready for submission

Risk Assessment

- ML risk scoring for site contamination likelihood
- Bayesian networks quantify environmental liability
- Computer vision detects unauthorized discharges from satellites
- NLP mines enforcement actions to guide audit strategy

Real life success stories

AI environmental applications delivering results

Energy

Google DeepMind · Global

Data Center Cooling

40% reduction in cooling energy via deep reinforcement learning on HVAC systems.

Deepmind

Biodiversity

Global Forest Watch · Tropics

Deforestation Detection

Near real-time alert system detecting forest clearing within 3 days using Landsat + ML.

IOPScience

Challenges and Ethical Considerations

Navigating the complexities of AI in environmental work

Data Quality & Gaps

Environmental sensor networks are sparse and biased toward wealthy regions. Models trained on these data can perpetuate monitoring inequity and underperform where most needed.

Model Interpretability

Regulators and courts require explainable decisions. Black-box models may outperform but fail audits; XAI techniques (SHAP, LIME) are becoming mandatory.

Environmental Cost of AI

Training large models emits significant CO_2. Environmental AI practitioners must ensure net benefits; choose efficient architectures and renewable energy-powered compute.

Community & Environmental Justice

AI systems must not deepen inequities. Indigenous data sovereignty, community consent, and equitable benefit-sharing must be embedded in project design from day one.

Domain Validity

ML models can find spurious correlations. Environmental engineers must apply domain knowledge to validate outputs physically, not just statistically.

Overhyped Expectations

AI is a powerful tool, not a silver bullet. Understanding its limitations prevents misuse and preserves trust with regulators and the public.

Emerging trends to watch

The frontier of environmental AI

Foundation Models for Earth

NASA, ESA, and IBM are developing geospatial foundation models (like climate GPTs) pre-trained on decades of satellite imagery — ready to fine-tune for any env task.

Hyperspectral AI Satellites

Next-gen satellites with 200+ spectral bands + onboard AI will monitor methane leaks, soil health, and water quality at global scale in near real time.

Autonomous Environmental Robots

AI-powered underwater drones, reforestation robots, and atmospheric sampling UAVs are reducing costs of field monitoring by orders of magnitude.

AI for Green Chemistry

ML accelerates discovery of sustainable materials, biodegradable plastics, and novel carbon capture sorbents — shortening R&D cycles from years to months.

Digital Earth Platforms

Open platforms integrating real-time IoT, satellite, and social data into a live global environmental model for policy and emergency response.

Explainable Environmental AI

Regulatory pressure is driving XAI adoption — models must now justify outputs to permitting agencies and environmental courts with interpretable evidence.

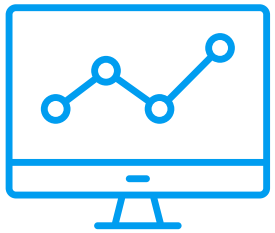
How is Ramboll utilizing AI in Environmental Engineering?

Revolutionizing the Environmental Field: Enhancing Data Analysis, Predictive Modeling, and Decision-Making at Ramboll



Data Analysis and Management

Used to process large sets of environmental data quickly and accurately. This includes monitoring air and water quality, analyzing soil samples, and assessing ecological impacts, which allows consultants to gain deeper insights and identify trends that might not be evident through manual analysis.



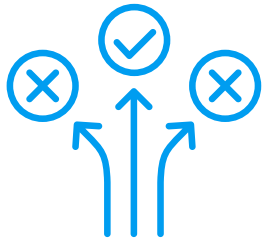
Predictive Modeling

AI algorithms can predict environmental changes and assess the potential impacts of various projects. For example, Ramboll employs AI to forecast pollution levels, climate changes, and biodiversity outcomes, helping clients to plan and mitigate risks more effectively.



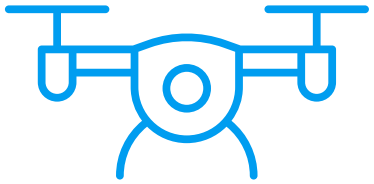
Automation of routine tasks

AI-powered automation reduces the time spent on repetitive tasks like data entry and report generation, allowing consultants to focus on more complex and strategic aspects of their work.



Enhanced Decision-Making

AI systems support environmental consultants in making data-driven decisions by providing actionable insights and recommendations. This includes optimizing resource utilization, improving sustainability practices, and ensuring compliance with environmental regulations.



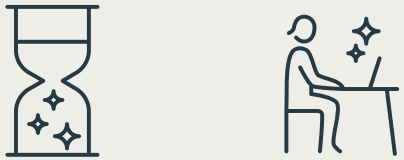
Remote Sensing and Monitoring

AI integrates with remote sensing technologies (e.g., drones, satellite imagery) to monitor environmental changes in real-time. Ramboll uses these technologies for site assessments, habitat mapping, and emergency response, thus improving the accuracy and timeliness of environmental monitoring.

Improving work today and designing systems for the future

NOVA brings cutting edge technology, creating a unique blend of domain expertise and technical excellence.

More Value Today



More value from what we already do

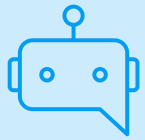
New Ways of Working Tomorrow



New Products



Technical Partnerships



Agentic Workflows



AI Consultancy



Hosted Services

Compliance Intelligence

Delivering Ramboll expertise through AI-enabled systems.

United States

Confidential / Aerospace Manufacturing / EHS & Compliance

The challenge

A joint workshop with a long-standing client raised the question of how AI tools could be brought into an existing EHS and wastewater compliance workflow spanning roughly 50 sites.

The approach

The workshop came first, establishing where value sat and securing buy-in. Build followed, a database, AI agent and dashboard for wastewater compliance, plus an agentic tool prioritizing EHS audit risk.

Why AI?

The objective was a redesigned workflow that keeps generating value over time, deep domain expertise combined with cutting-edge technology and modern thinking, rather than tools alone.

The value generated

A faster, stronger evidence base for compliance decisions and risk-prioritized audits. Beyond the deliverables, the relationship moved from trusted advisor to long-term partner, co-designing how the client works.

How it grew

PHASE 1 — DELIVERED

Wastewater Scoping

Mapped wastewater compliance workflows and built prototypes.

PHASE 2 — VALUE TODAY

Action Plan

Database, AI agent and dashboard for wastewater compliance.

PHASE 2A — NEW WAYS OF WORKING

EHS Audit Prioritisation

Agentic tool prioritising EHS audit risk across ~50 sites.

Each phase proved value — and grew our mandate.

AI Use Cases within the Environment



Land Cover Classifications/ Habitat Classification
AI-Powered environmental monitoring. Geospatial intelligence for sustainable land management and biodiversity restoration.



Development & Optimization of District Heating Networks
- AI optimized heat network design platform to assist in exploring heat network routes by using a spatial machine learning algorithm.

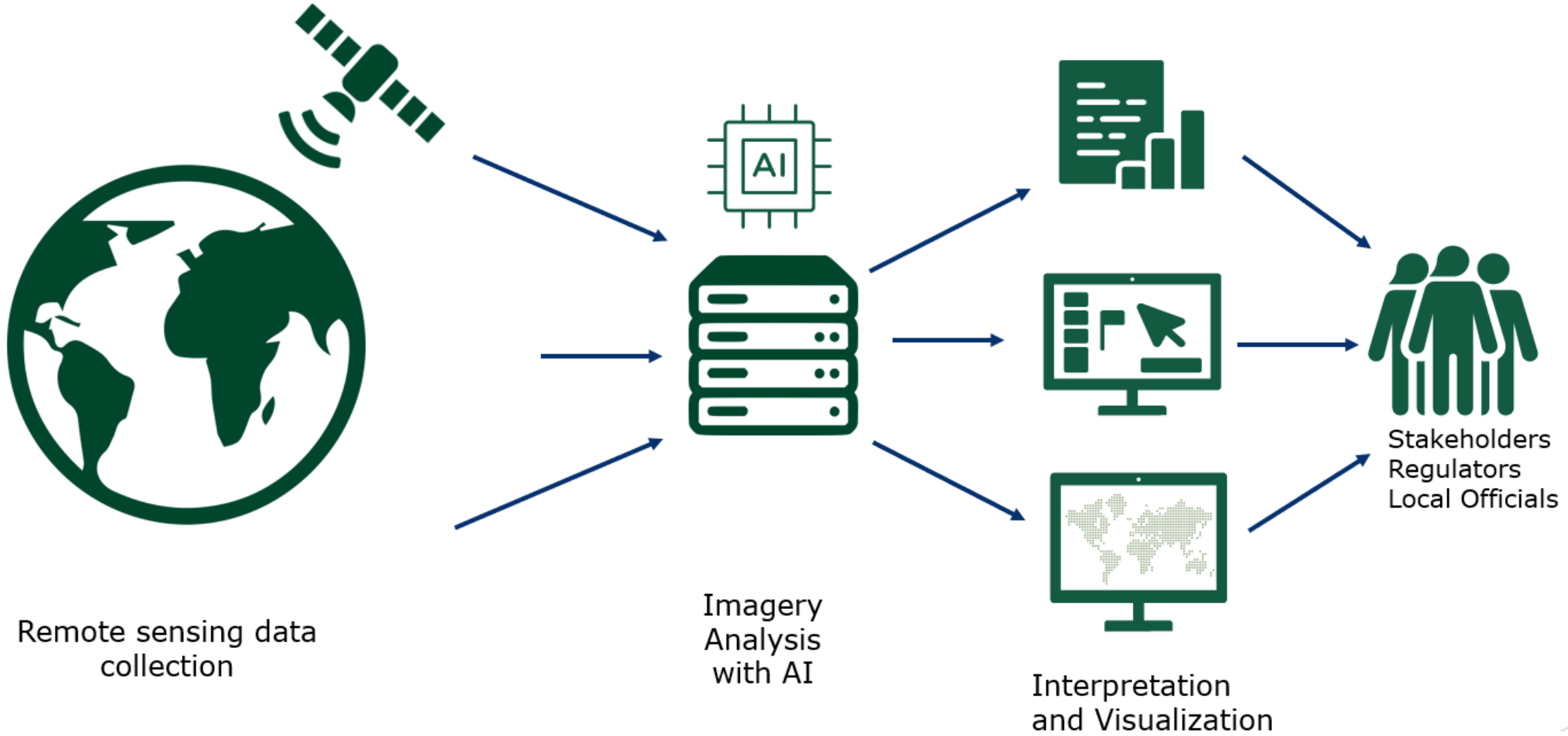


Invasive Species Identification and Vegetation Health Monitoring
AI-Powered environmental monitoring for invasive species and vegetation health monitoring.

Land Cover Classifications/ *Habitat Classification*



Generating environmental insights through remote sensing and AI



Deep Learning Workflow

Training Stage

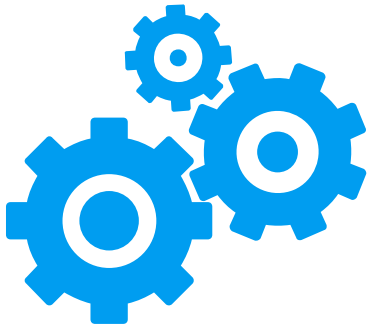
Labeled input data → **Model training** → **Predictive model**

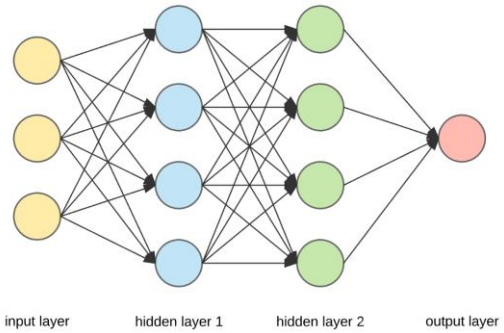
Image chips



Chip labels



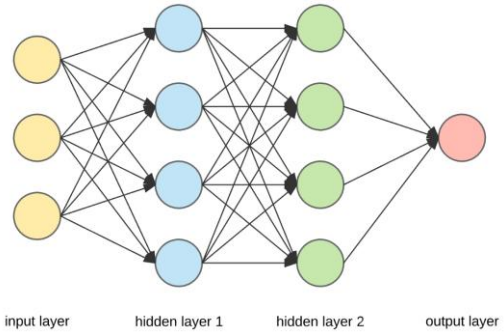




Prediction Stage

Unlabeled input data → **Predictive model** → **Predictions**

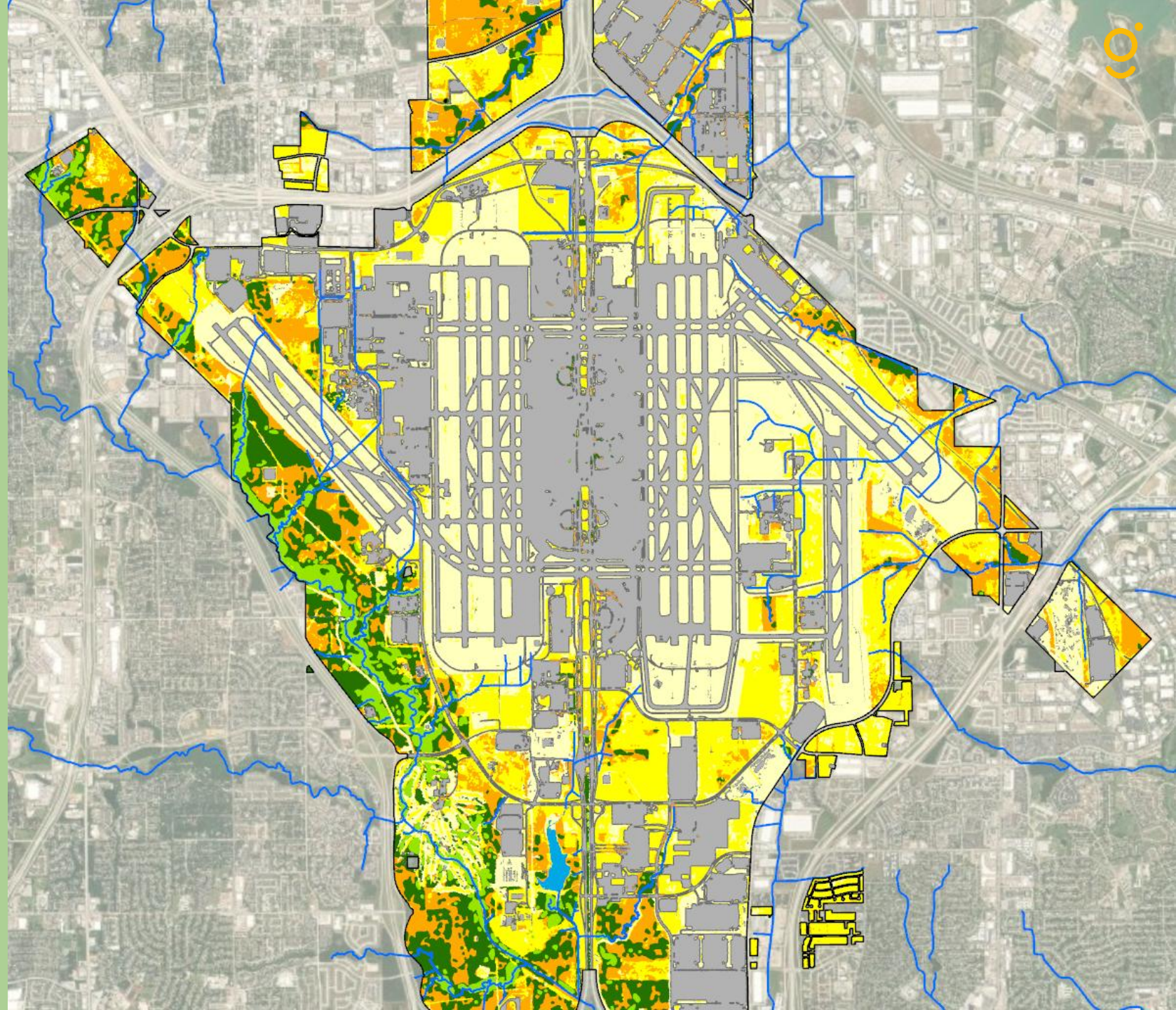






Mapping Results

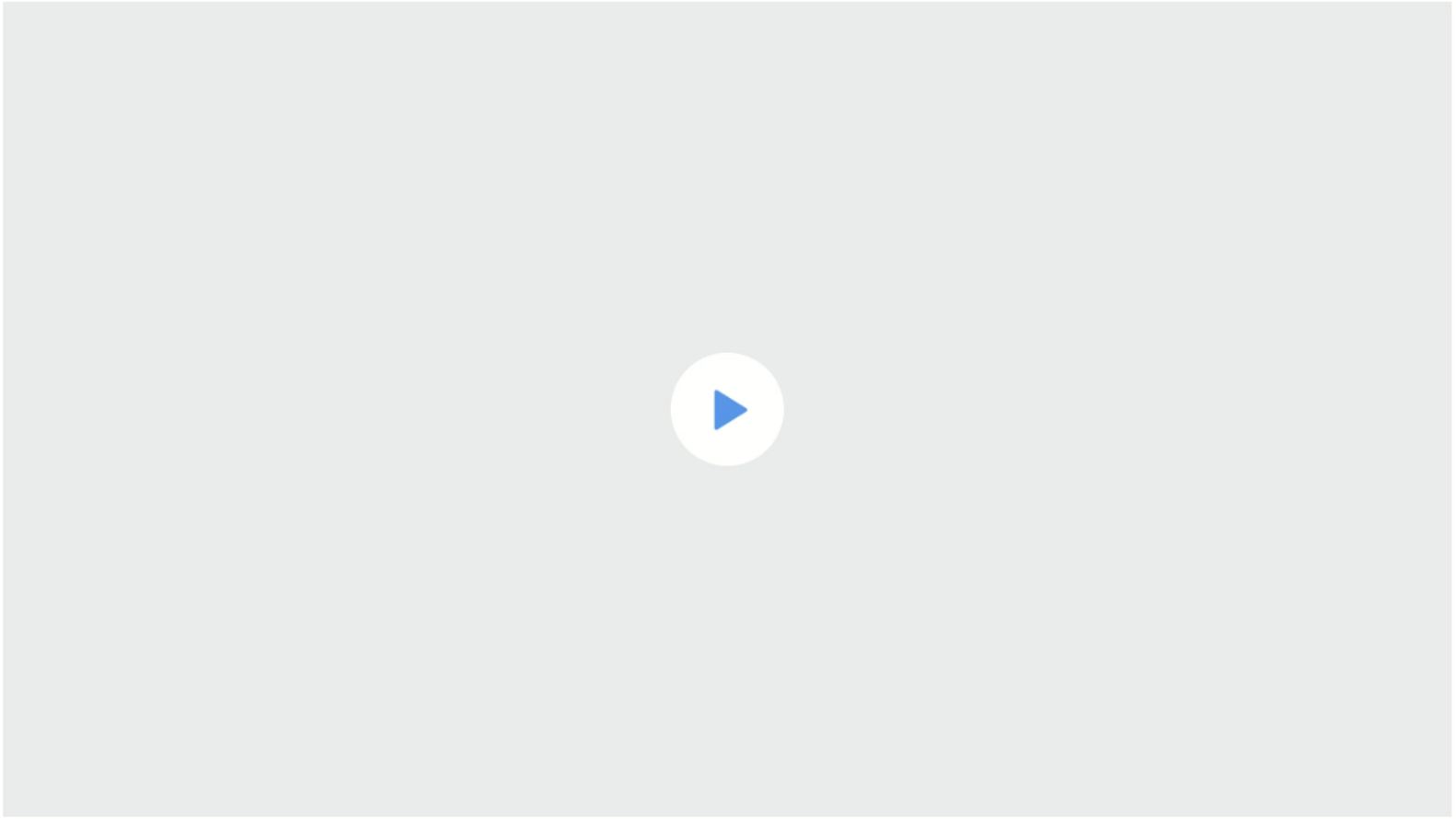
- High Intensity Urban
- Short Grass Prairie/ Managed Grassland
- Blackland Prairie
- Native Invasives
- Medium Priority Woodland
- High Priority Woodland
- Open Water



Development & Optimization of District Heating Networks

Pioneering tools that supercharge heat network delivery

- To effectively deliver on the roll out of district heat networks, Ramboll has invested in an AI optimized heat network design platform, which supports landowners, energy companies, developers, government, and local authorities exploring heat network routes, by using a bespoke spatial machine learning algorithm that generates intelligent designs fast. Based on local data, the platform supercharges citywide heating and cooling network routes and design.



Pioneering tools that supercharge heat network delivery

- **Fast,** our bespoke spatial machine learning algorithm generates and assesses citywide heat networks scenarios in minutes to produce preferred pathways;
- **Iterative and collaborative**, the platform facilitates valuable discussions with partners on preferred pathways, to unlock greater opportunities for the proposed systems;
- **Compatible**, District One data is easily imported from, and exported to all accredited CAD and GIS data standards;
- **Intelligent**, it holistically integrates existing infrastructure data and local knowledge to enable better informed decisions early in the network planning, enhancing feasibility, buildability and sustainability;
- **Engaging,** the online 3D interface enables users and communities to visualise the scheme, supporting stakeholder engagement**.**



District One

Moving Innovation Up the Value Stream

United Kingdom

RAMBOLL

The challenge

Decarbonised heat network decisions are made at the investment stage, yet the engineering evidence supporting them has traditionally arrived far too late, once options have narrowed and risk is already priced in.

The approach

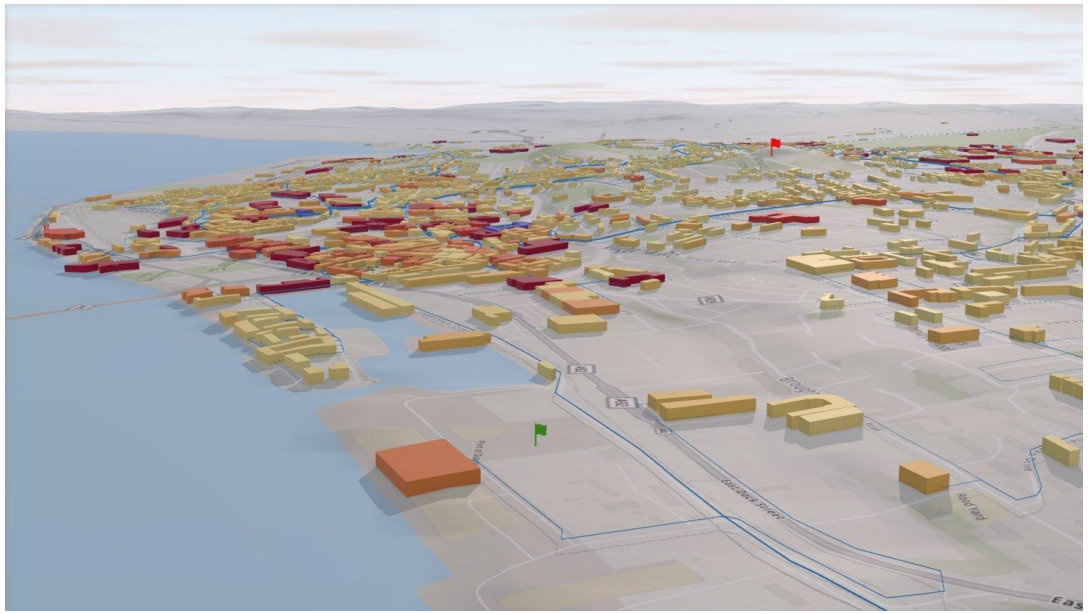
Ramboll's district energy expertise was moved upstream. District One combines spatial machine learning with probabilistic modelling to design and test networks across tens of thousands of scenarios, placing the conversation with investors and clients at the point decisions are made rather than after.

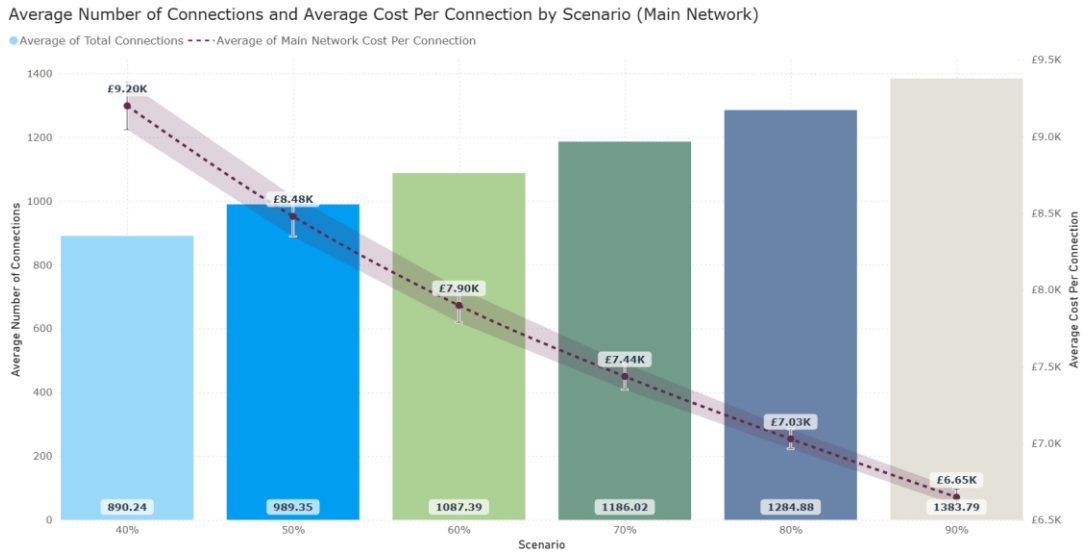
Why AI?

This is not automation of a drawing task. AI is what makes investment-grade, probability-based advice possible this early — surfacing viability, cost and risk across a whole system rather than a single deterministic answer.

The value generated

De-risked, investment-level decision support for the people who fund and build decarbonised energy systems. District One is positioned not as a tool or an efficiency play but as a new kind of advice, co-created with clients, that engineering expertise alone could not have delivered.





Invasive Species Identification and Vegetation Health Monitoring

galago by RAMBOLL



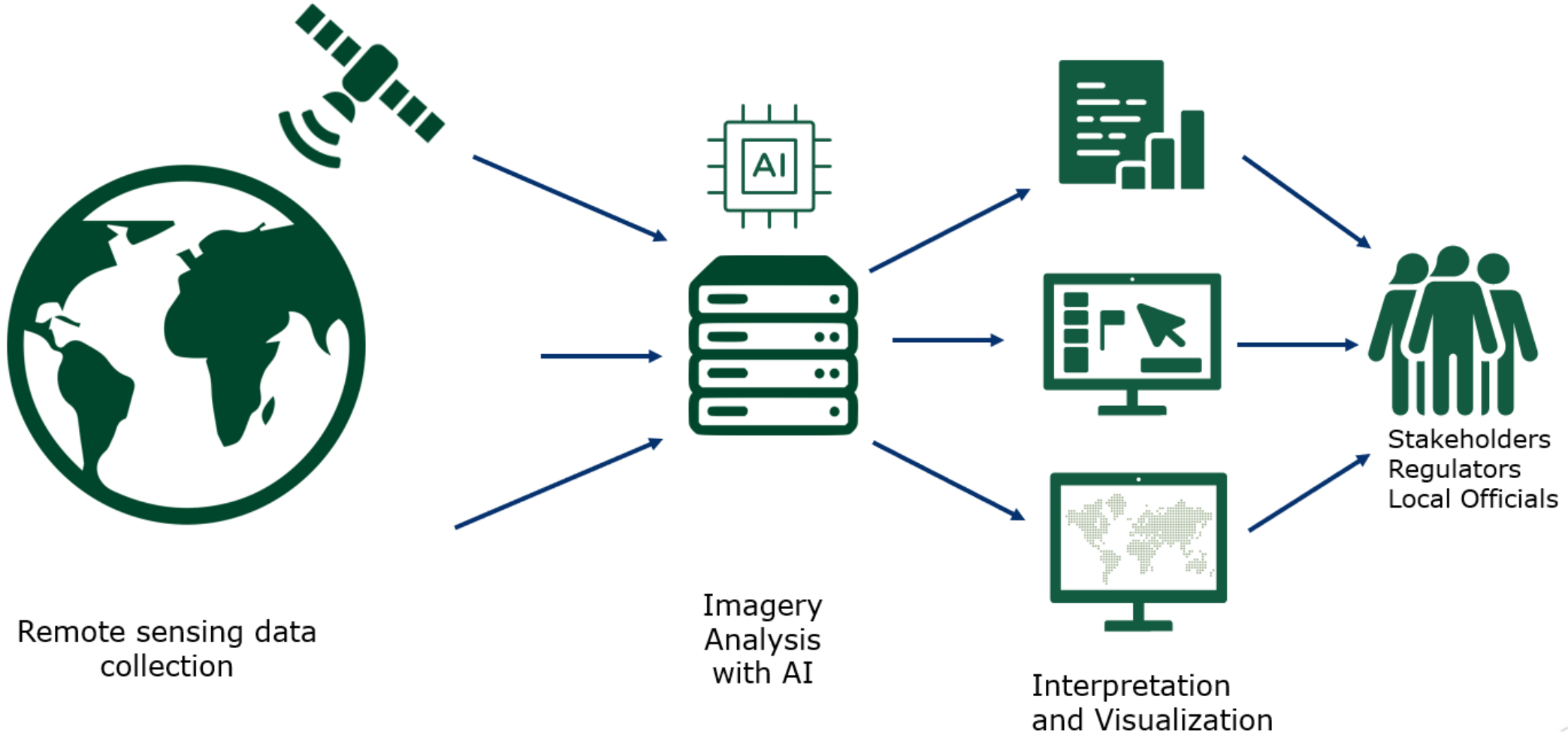
Giant Hogweed Monitoring

In collaboration with a state agency, Ramboll's IDT team developed a pilot-scale methodology for monitoring large tracts of land for giant hogweed, an invasive plant harmful to both human and ecosystem health.

Site Challenges

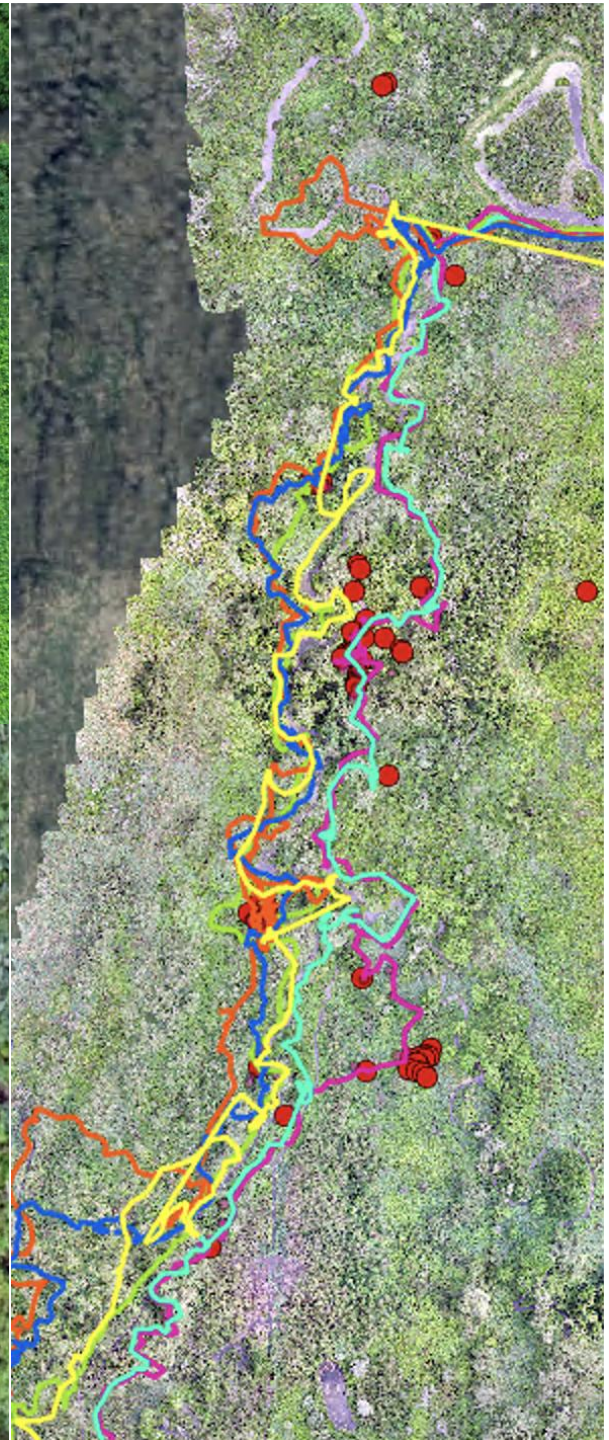
- Identify, locate and manage Giant Hogweed as an invasive species
- Identify spread and aid in eradication field efforts
- Difficult terrain spanning over 1,100 acres

Generating environmental insights through remote sensing and AI







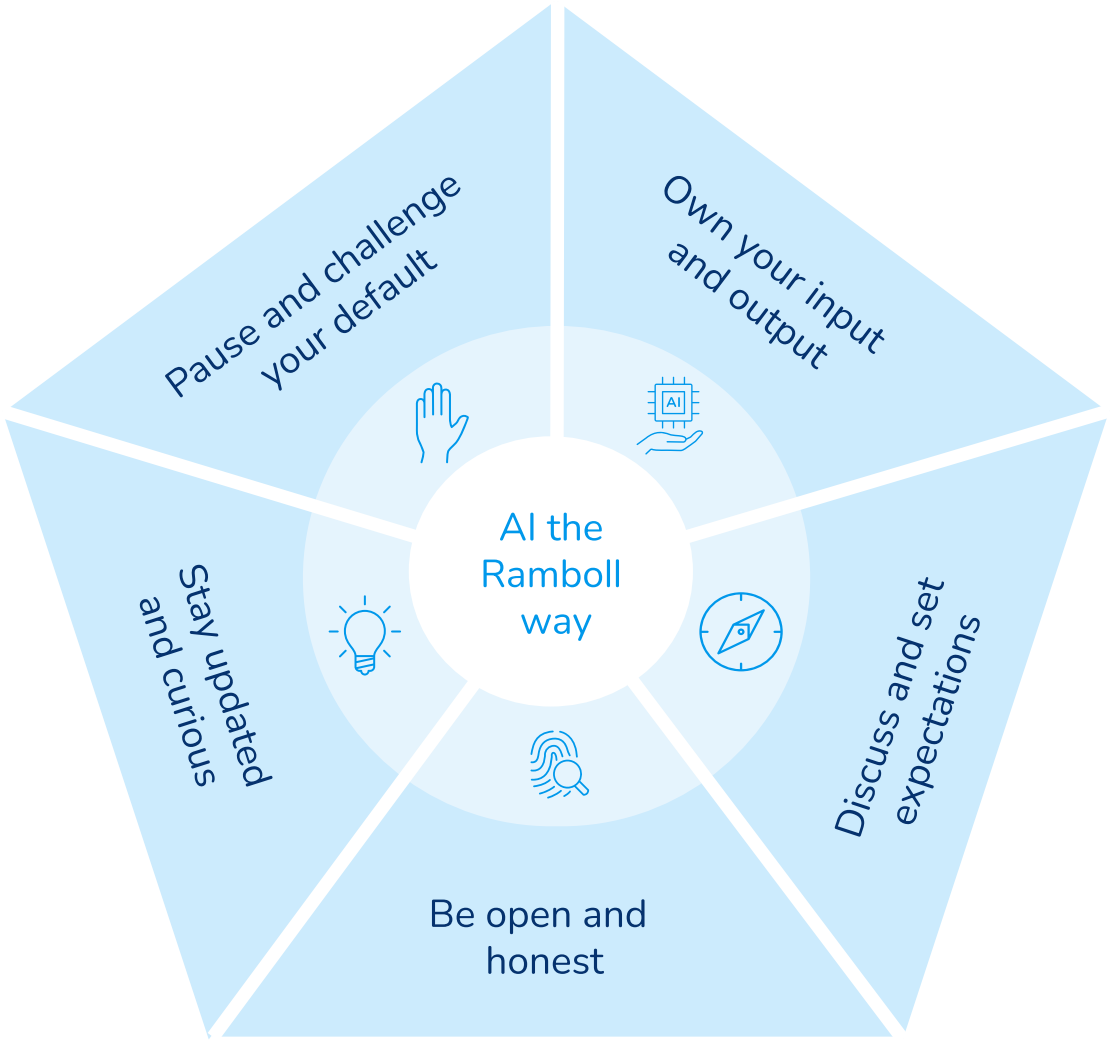


Giant Hogweed Monitoring

Approach/Results

- Collected high resolution imagery using a small, unmanned aircraft system (sUAS/drone)
- Developed an AI/ML model to detect the invasive species in the drone imagery.
- Reserved a portion of training data to evaluate model performance for accuracy, precision, recall, and more.
- The model was deployed across all collected imagery, including imagery not used for training data, to a create site-wide map of invasive species locations.
- Developed a digital site-wide map for field crews.
- With this information in hand, the crew was able to navigate to locations identified in our model, effectively complete management and eradication activities, and ground truth modeling.

Using AI, the Ramboll Way



Using AI, the Ramboll Way

HUMAN FIRST HUMAN LAST

Bright
ideas.
Sustainable
change.

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