Space Observation, Quantitative Risk Assessment Synergy Deliver Value to Mining Operations & Restoration

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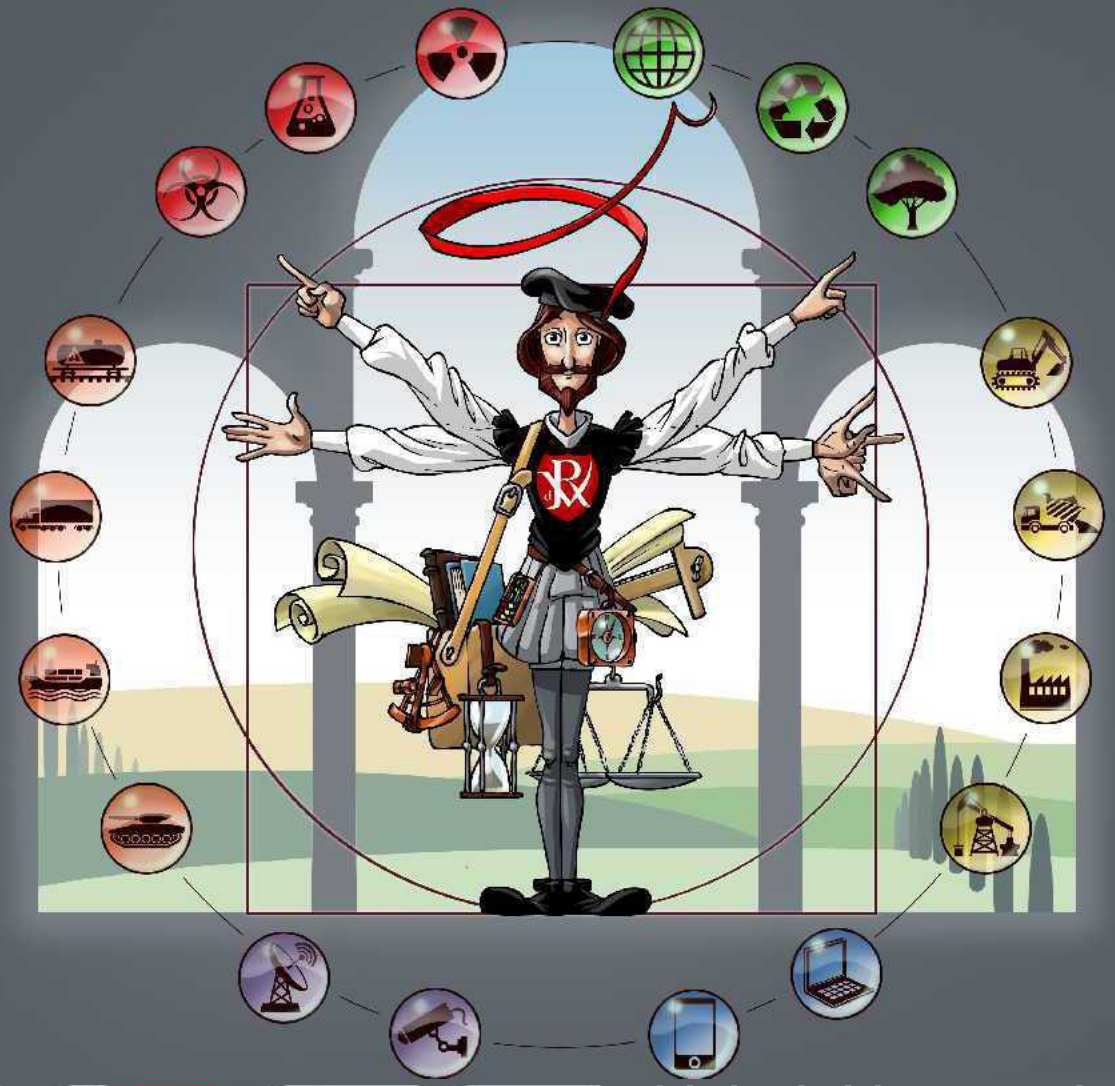

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Definitions

Space Observation refers to a mix of radar and optical satellite image data, as well as specific algorithms.

"Rich data" is the result of the above.

"Rich Data" and classic information flow are the necessary feed for a rational, modern risk assessment.

Quantitative Risk Assessment (QRA) is a risk assessment where probabilities and consequences are quantitative.

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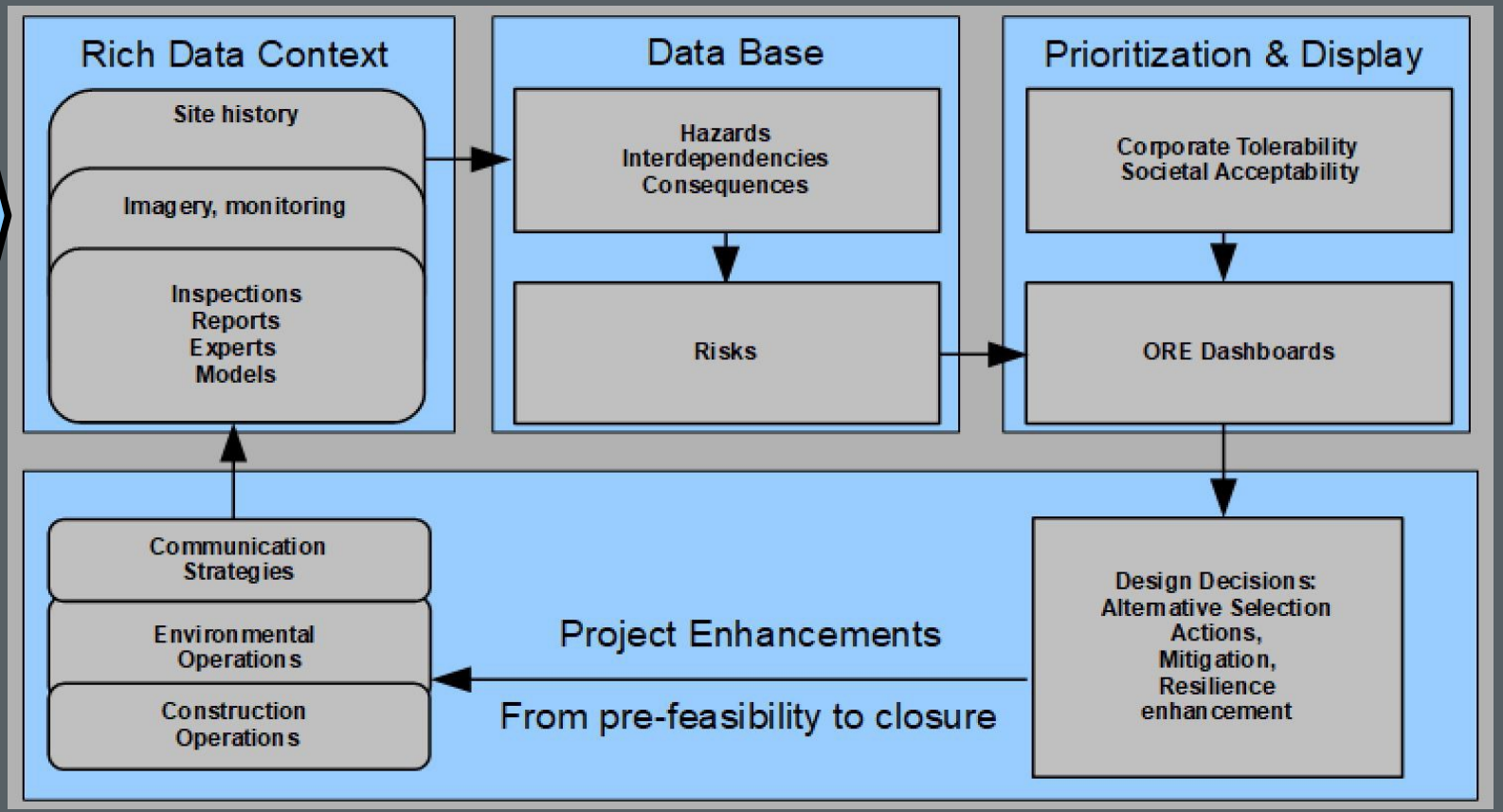
Convergent, scalable, quantitative approaches are necessary to increase reliability while mitigating risks

Space Observation offers endless Possibilities for Seamless Integration.



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ORE & Space Observation deliver value to mining operations and restoration

Supports communication between owners, regulators and the public.

Quickly and at affordable costs.

ORE & Space Observation are beneficial for those who:

Design, permit, construct, operate, insure, close and restore Tailings/ waste storage facilities, Mining Operations in the extraction industry.

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Why ORE & Space Observation?

Numerous voices ask mining companies to make environmental and human safety a priority in management actions and on-the-ground operations.

They require, among other points:

- detailed and ongoing evaluations of potential failure modes,
- residual risks (UNEP uses this term to indicate the risks after known mitigation) assessments and perpetual costs of waste storage facilities (including restoration).

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Value comes from alternative Restoration & Mitigation road maps

In order to perform sensible Risk Informed Decision Making the methodology needs to be:

- Updatable, risks can be updated quickly and affordably.
- Scalable, the same data base and model is progressively scaled-up.
- Drillable, you get exactly the data you are looking for — quantified and prioritized.
- Convergent. No more silo with H&S risks separated from Community risks or Strategic risks, etc.

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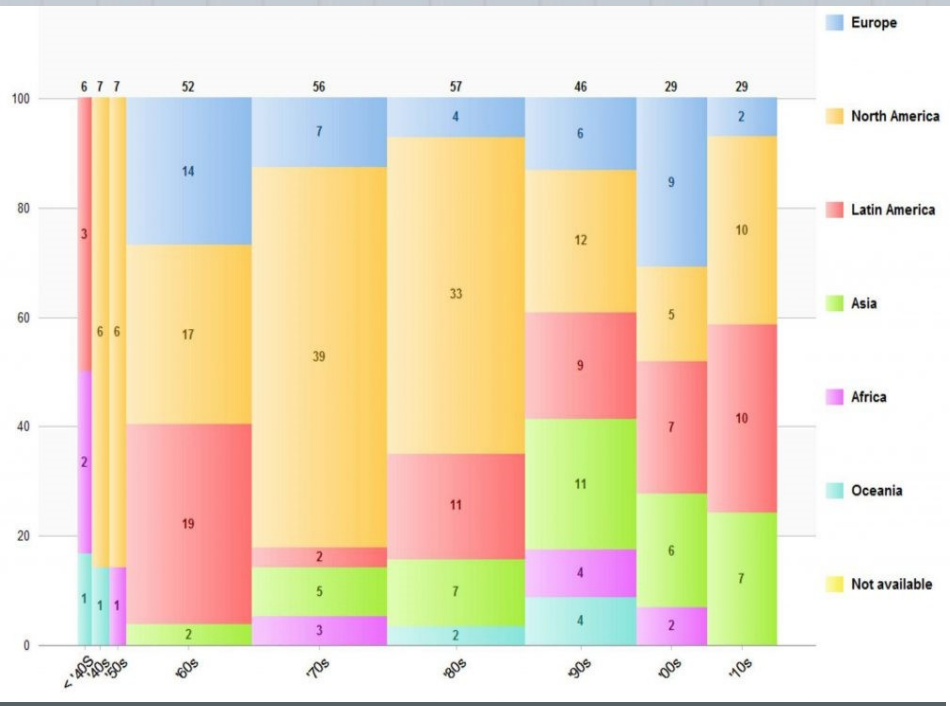
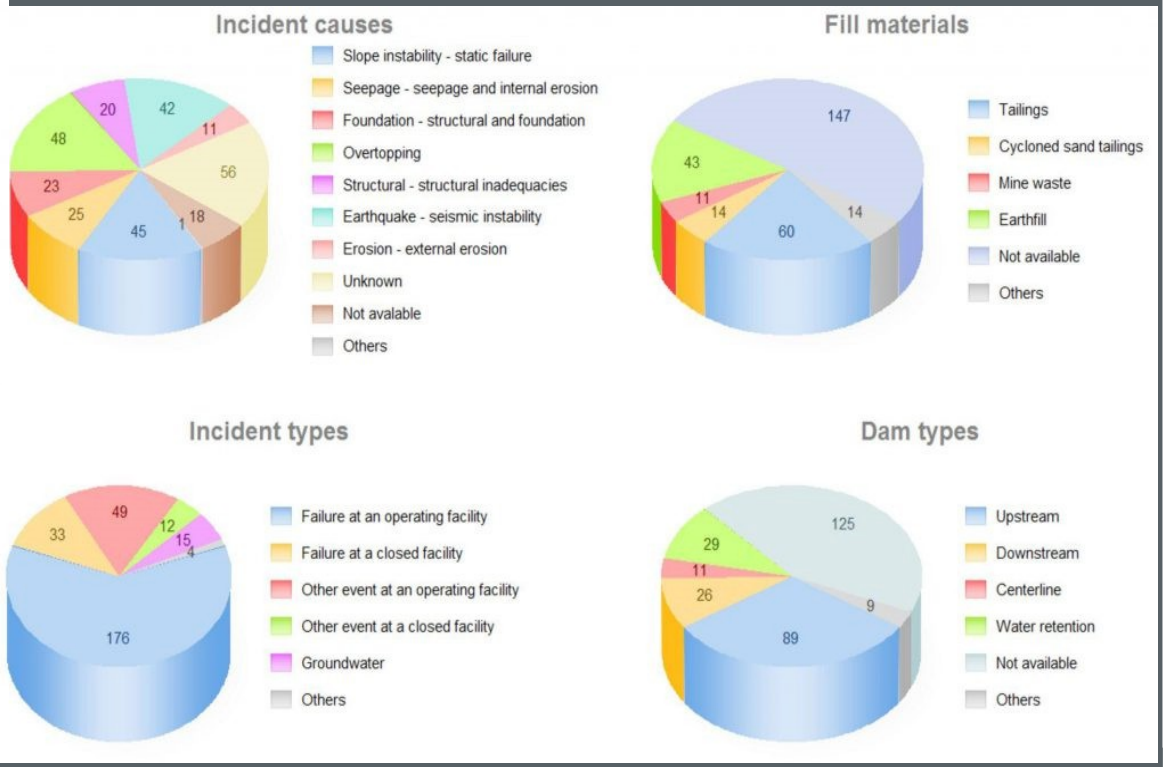
In some cases history allows world-wide benchmarking (tailings)





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Dump adjacent to Tailings

Optical imagery can offer a first glance at the site. Observations can be made without accessing the site.

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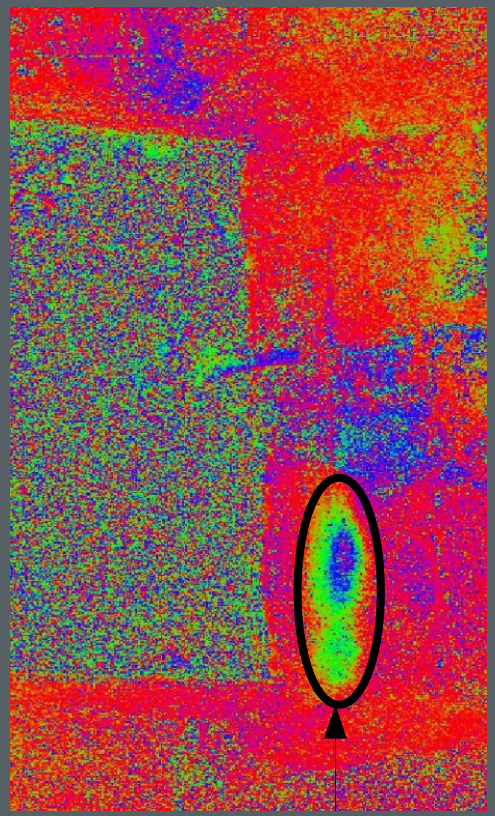
Dump adjacent to Tailings



InSAR monitoring shows deformations of 25 mm developing over two months in one area of the dump.

Deformation of the slope impacts a number of “diagnostic points” of the slope, resulting in an alteration of the probability of failure of the dump.

The restoration project will be modified in this area due to that alteration.

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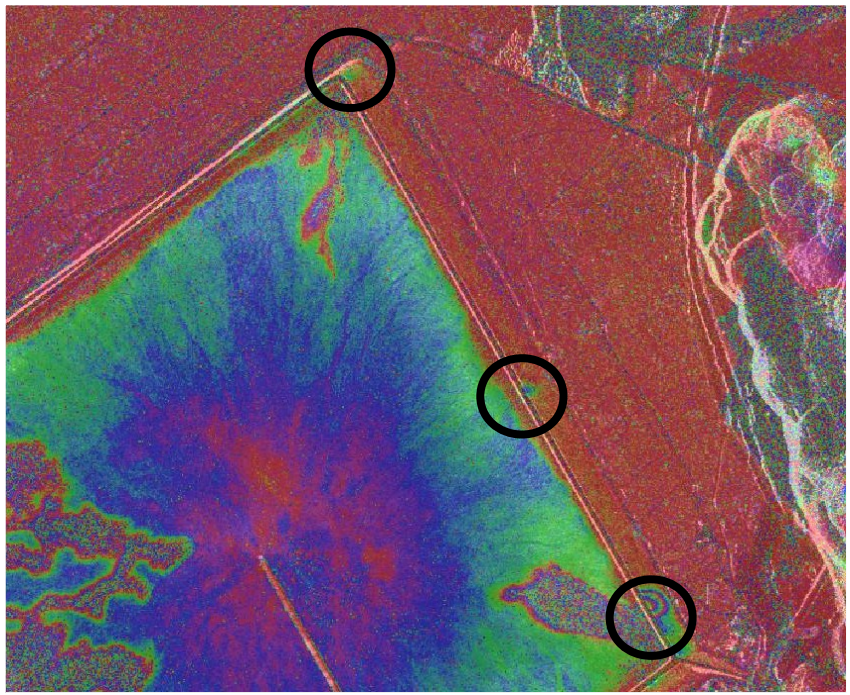
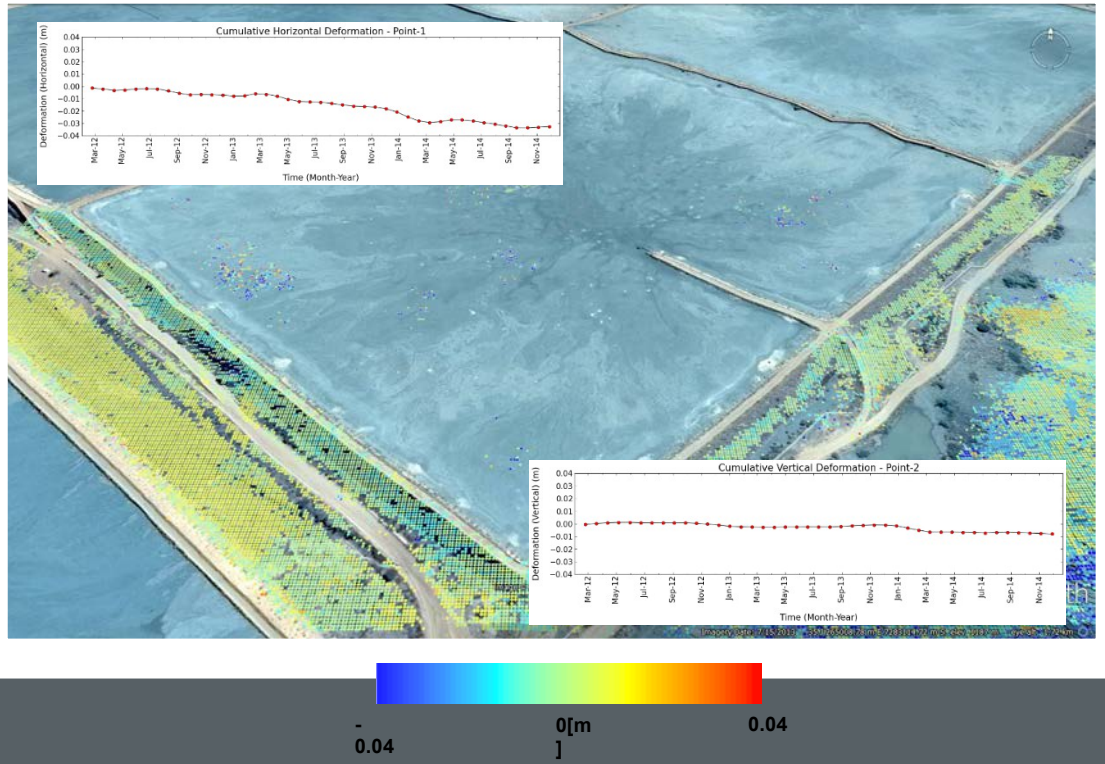
Tailings Dam





1 phase cycle corresponds to approximately 3 cm of subsidence. Deformations, spills, unrepaired damages, etc. enter in the 30 diagnostic points we use to estimate the annual probability of failure.

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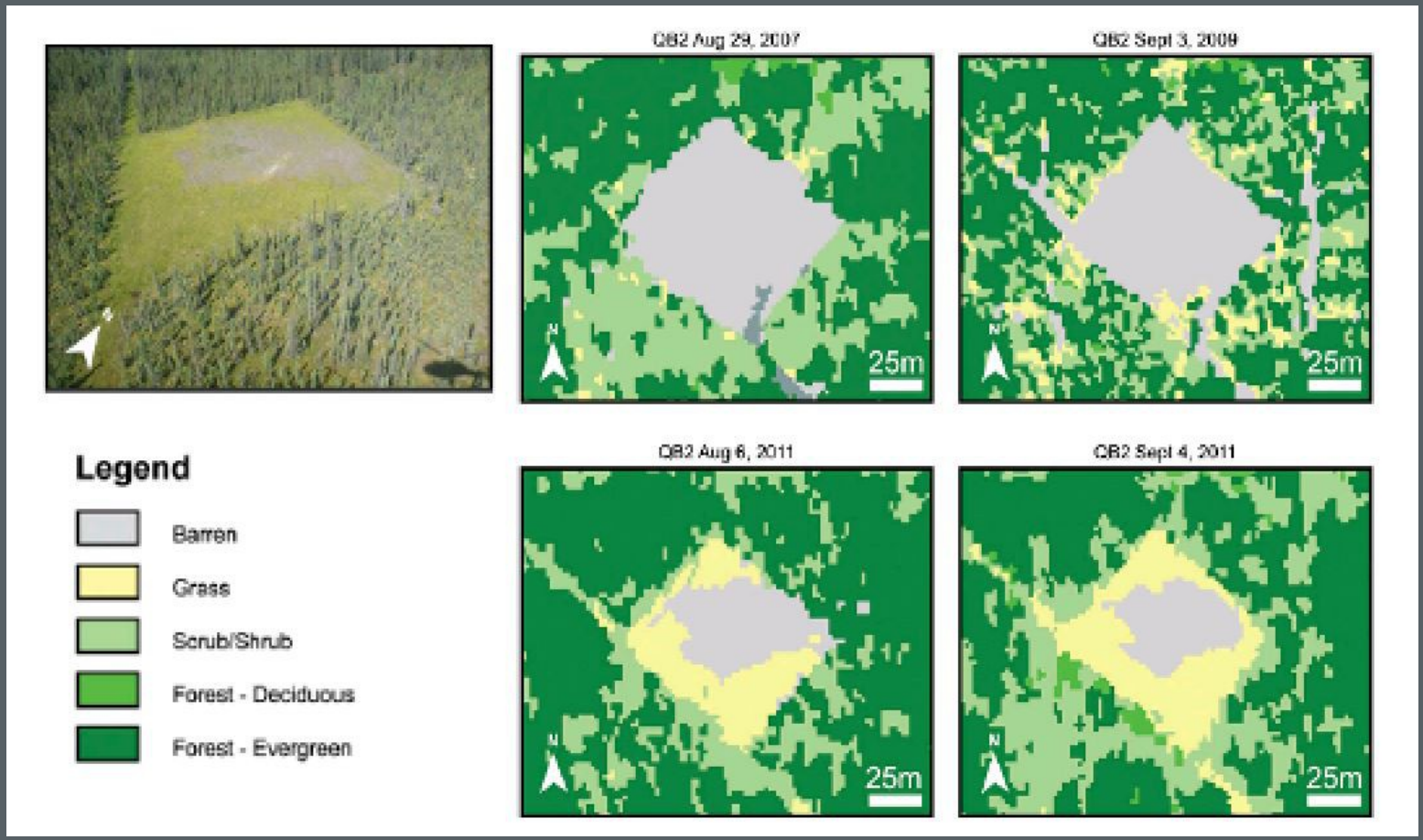
Re-vegetation example



Example from Dacre et al., 2017. High resolution satellite imagery applied to monitoring re-vegetation of oil-sands well pads. Environmental Geosciences v24, n.4.

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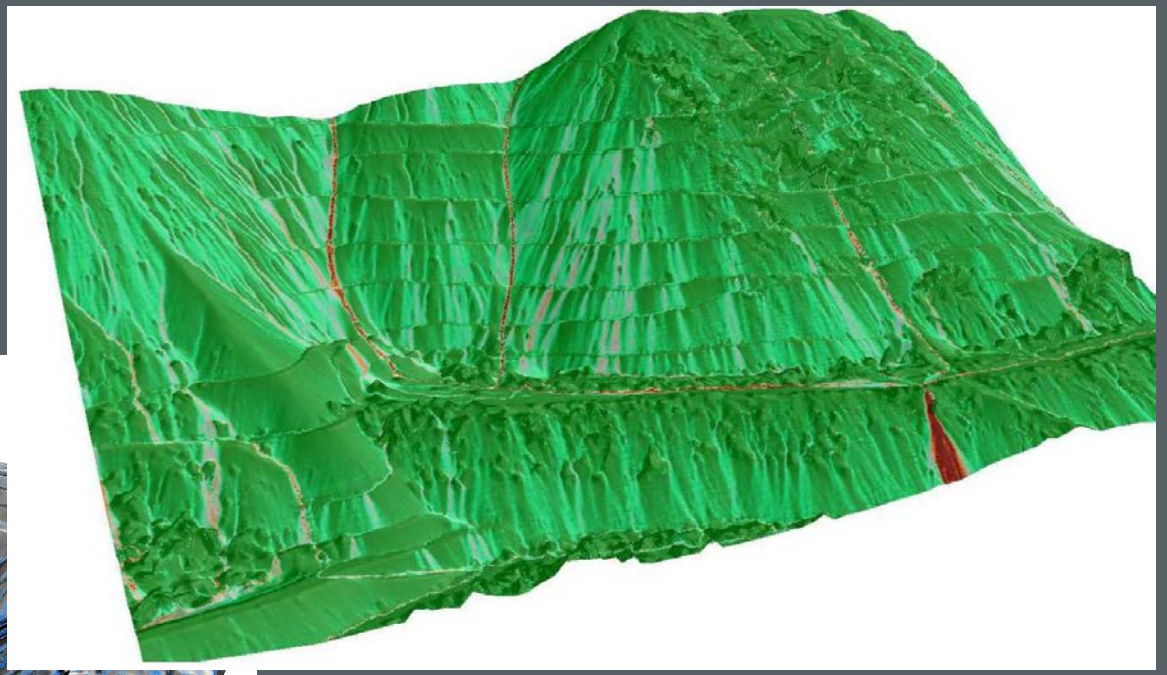
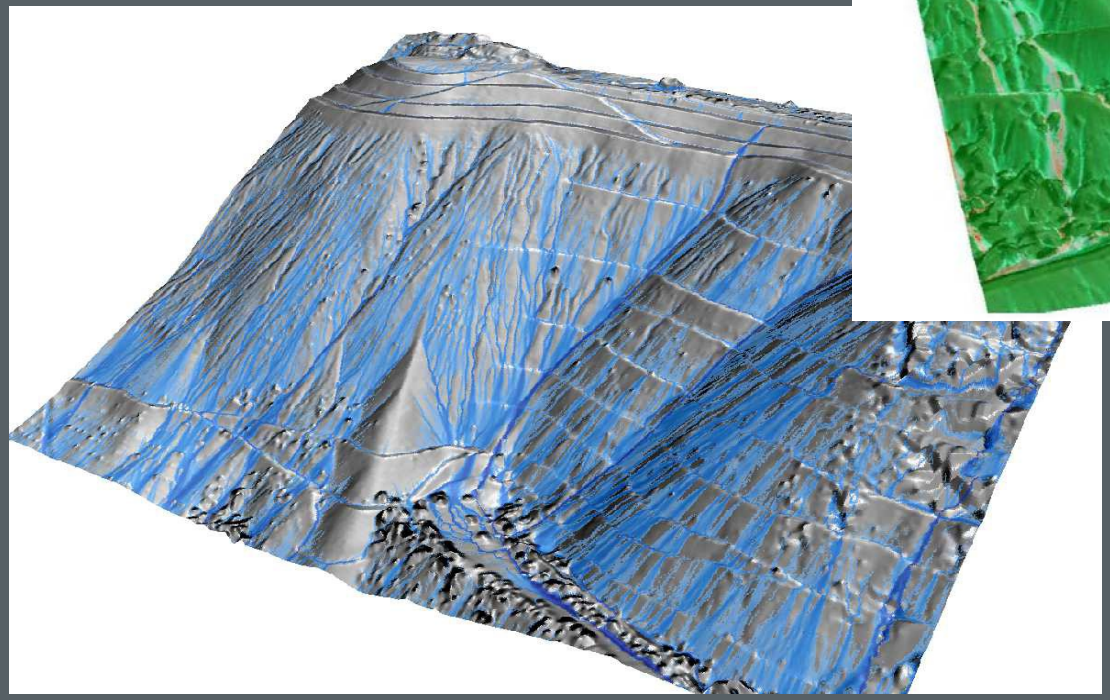
Runoff and erosion evaluations examples

Uncontrolled runoff and erosion alter the annual probability of failure.





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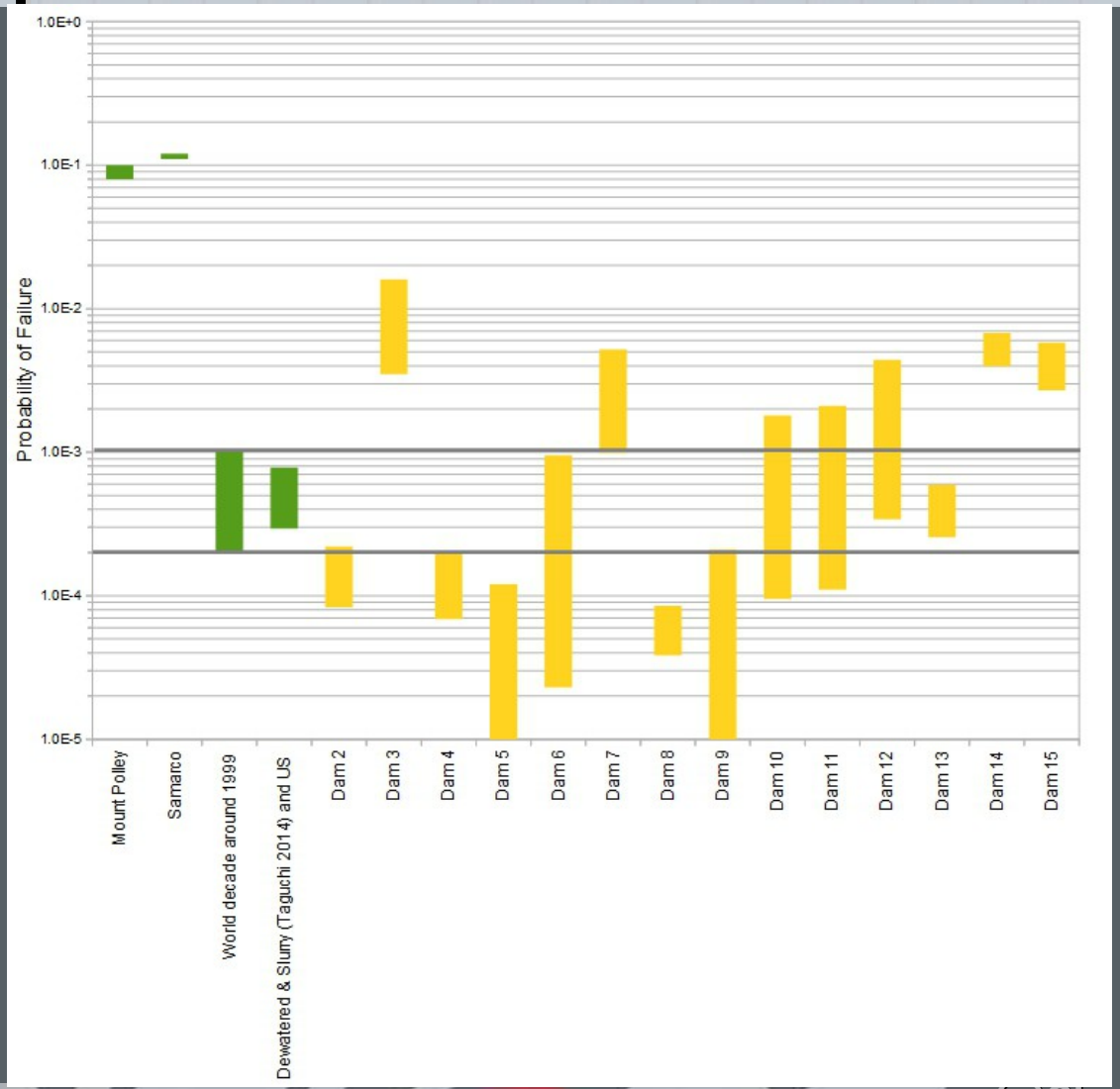
Probabilities of failure, uncertainties and benchmarking can be evaluated for operations and restoration



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Summary of actions for “bad” benchmarking areas, to reduce uncertainties

- Dispatch a ground team of surveyors and geotechnical engineers.
- Compile a photo history (six months) of this area
- Review LiDAR data if available to calibrate
- Re-evaluate, take pertinent decisions
- Major future crisis will be averted!

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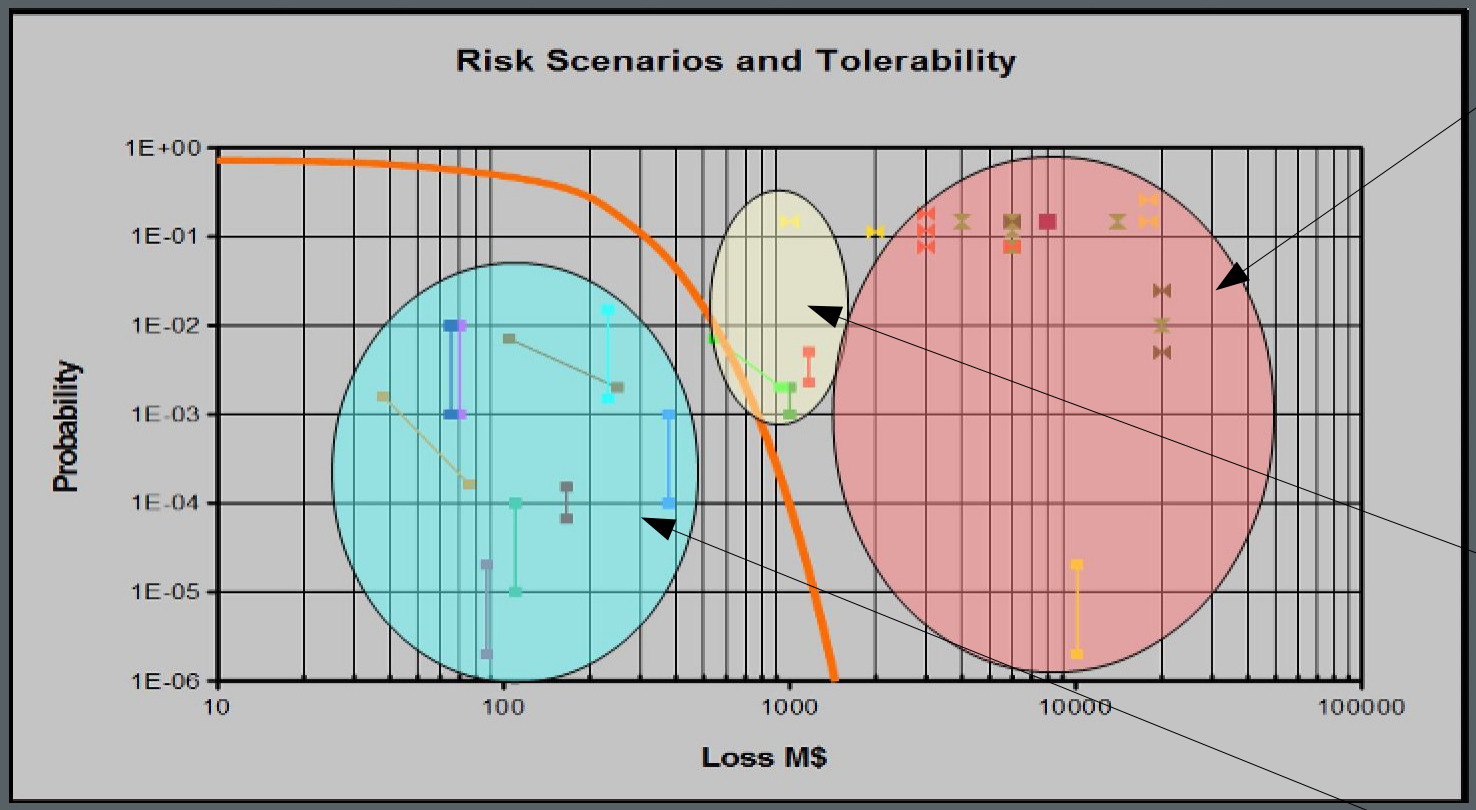
Risk tolerance allows to determine tolerable, tactical &strategic risks for operations & restoration



Strategic: requires system change, restoration alternative

Intolerable, but manageable: requires more investment

Tolerable: good to go!

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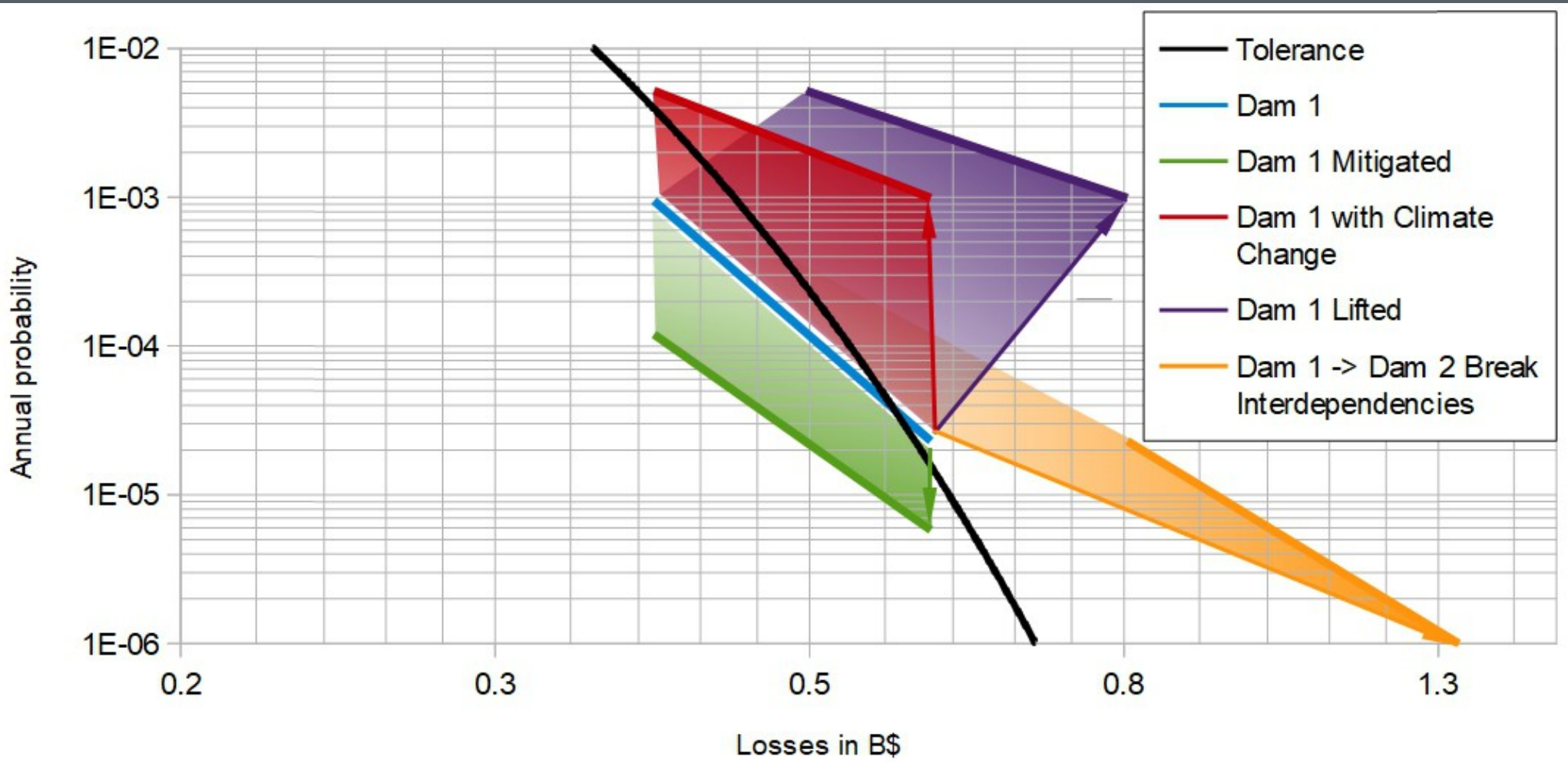
One database, multiple scenarios including possible alterations, climate change effects



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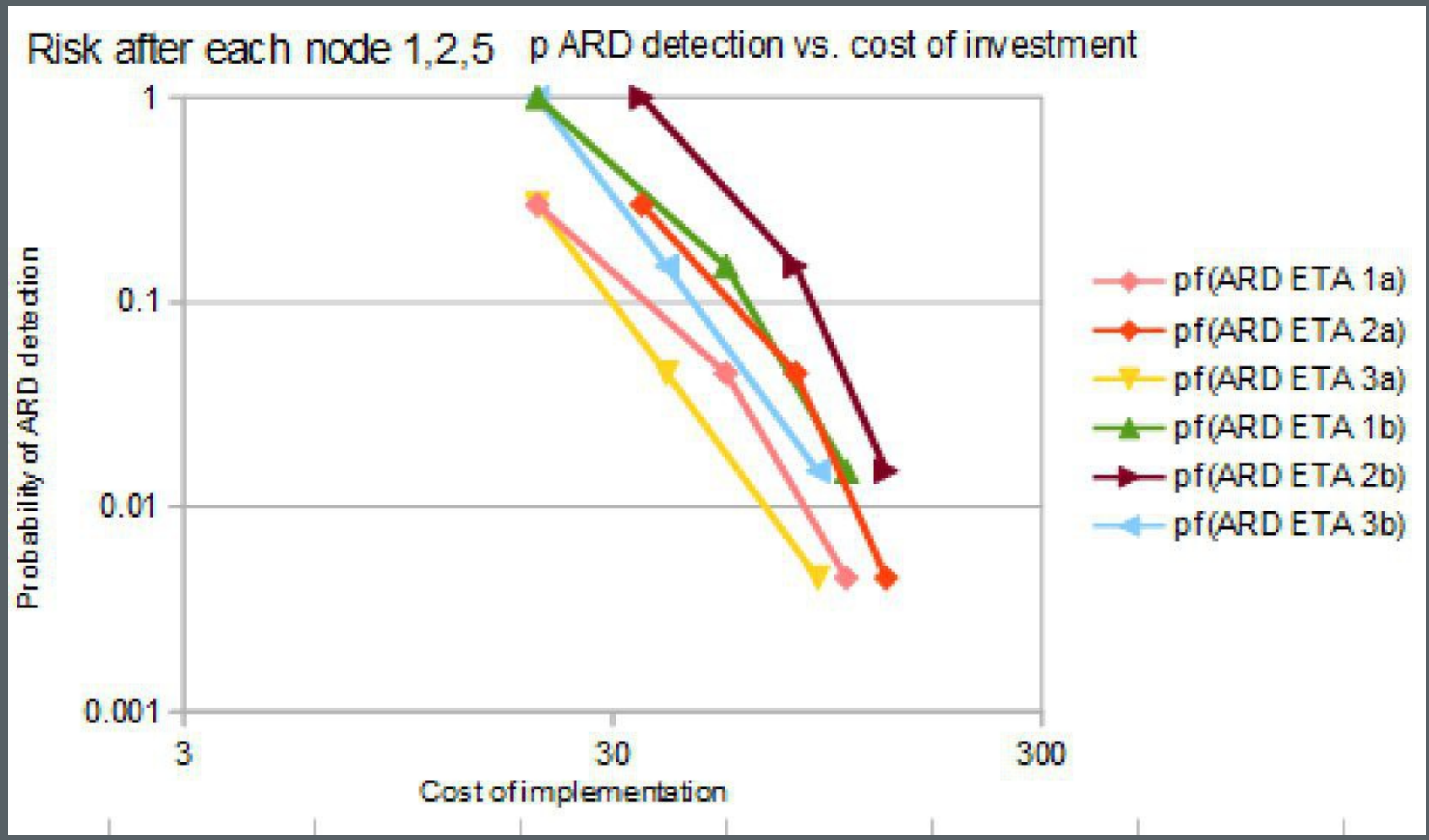
A Restoration example, with 6 ARD mitigation alternatives discussion



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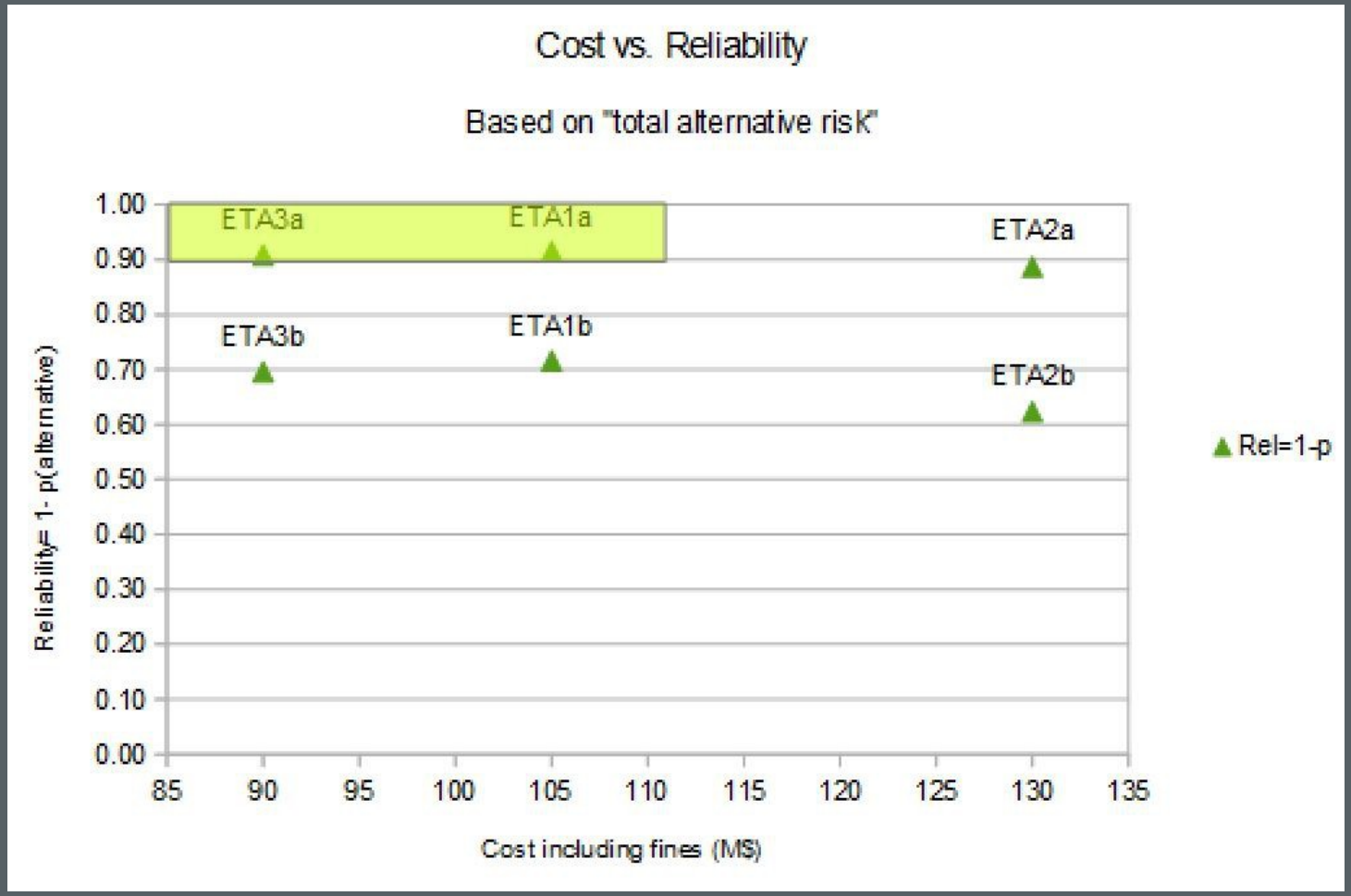

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The wide spectrum of threats and potential consequences on operations and restoration

… shows that siloed approaches do not work.

- Integrative ones are only slightly better.
- Poorly prioritized mitigations are not efficient as they are limited in scope by other operational requirements.
- Investments based on “simplistic” hazard analyses do not help making optimum/ good decisions.

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ORE integration with Space Observation offers an affordable and efficient informed risk support

Tools have to be refined enough to grasp the complex reality, yet operable enough to avoid paralysis by analysis.

Tools have to be efficient, affordable, accommodate extant data and ready to adapt as new data becomes available, especially in long term restoration programs.

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ORE & Space Observation: a powerful mix to compare operations and restorations

Twenty years in the making and testing
Now available for deployments world-wide!

This diverse and adaptable tool is already delivering value to the mining world, and addressing the complex corporate and societal demands of the XXI century.

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