



From Space Data to Flood Resilience

Using Earth observation and the RIIS
PIE model to understand impacts on
People, Infrastructure and the
Environment

UN/IAF Workshop | Antalya, Türkiye | 3 October
2026

Presenter: Nandi Mtethwa (RIIS)

What do we actually need to know?

When a major hazard occurs, decision-makers ultimately need answers to four questions:



WHERE?

Where could the hazard occur, and how far could it extend?



WHAT?

What infrastructure, land and environmental assets are exposed?



WHO?

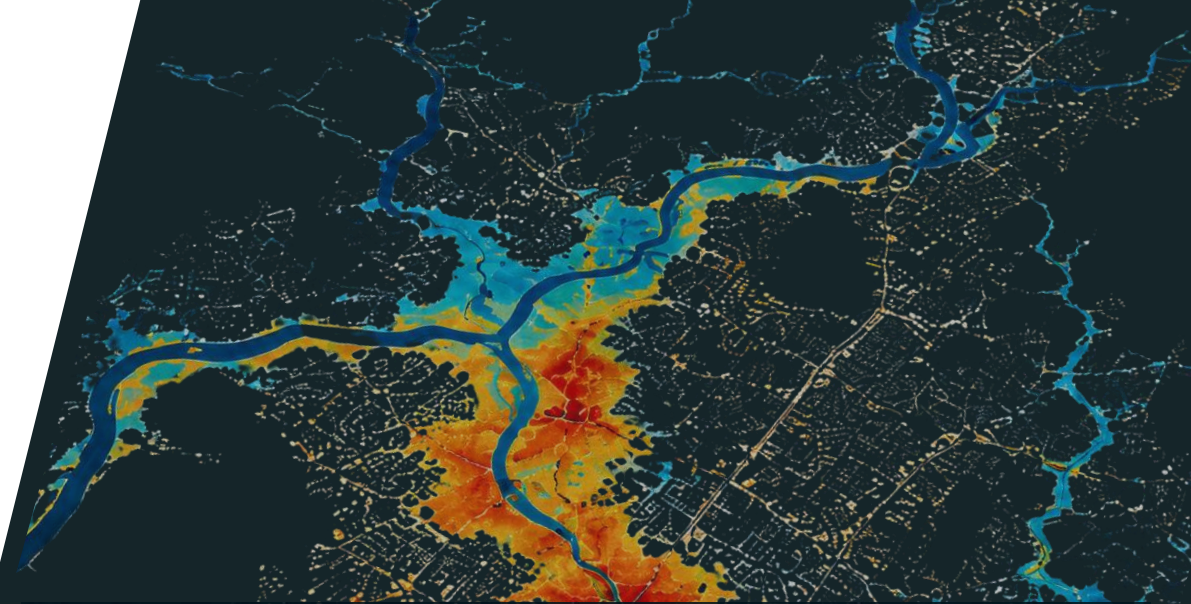
Which communities and how many people could be affected?



WHEN?

How much time is available to respond?

Resilience is not simply knowing that a hazard exists. It is understanding its consequences early enough to act.



POPULATION EXPOSED

128,540

↑ 12%
vs last scenario



BUILDINGS EXPOSED

32,817

↑ 8%
vs last scenario



ROADS AT RISK

164 km

↑ 15%
vs last scenario



CRITICAL FACILITIES AT RISK

47

↑ 5%
vs last scenario

EXPOSURE MAPPING INFRASTRUCTURE & COMMUNITIES

LAYERS

- Population Density
- Buildings
- Critical Facilities
- Road Network
- Power Infrastructure
- Flood Extent (100yr)

EXPOSURE SUMMARY



DECISION SUPPORT

ACTIONABLE INTELLIGENCE BEFORE, DURING & AFTER EVENTS

ALERTS

- HIGH FLOOD RISK**
Zone 7A - Water depth expected to exceed 2.0m within 6 hours. 09:30 AM
- INFRASTRUCTURE AT RISK**
Bridge 012 at risk of inundation within 12 hours. 09:10 AM
- CRITICAL FACILITY IMPACT**
2 hospitals and 3 schools at risk of disruption. 09:05 AM

View all alerts →

LIVE SITUATIONAL MAP



DECISION SUPPORT

ACTIONABLE INTELLIGENCE BEFORE, DURING & AFTER EVENTS



BEFORE

Anticipate impact and prioritise preparedness.



DURING

Monitor in real-time and inform response.



AFTER

Assess damage and support recovery.

Space gives us the scale

Local data gives us the context

Earth observation allows us to repeatedly observe large areas and understand how landscapes are changing. But satellite imagery alone does not provide the decision.



EARTH OBSERVATION

- Satellite imagery
- Land cover
- Settlement growth
- Environmental change
- Infrastructure development

+

LOCAL AND MODELLED DATA

- Population
- Infrastructure
- Hazard models
- Environmental assets
- Operational information

=

RESILIENCE INTELLIGENCE

A satellite can tell us where flooding has occurred. The economic question is: who and what is in its path, what is likely to be affected next, and what decisions can we make before the impact occurs?

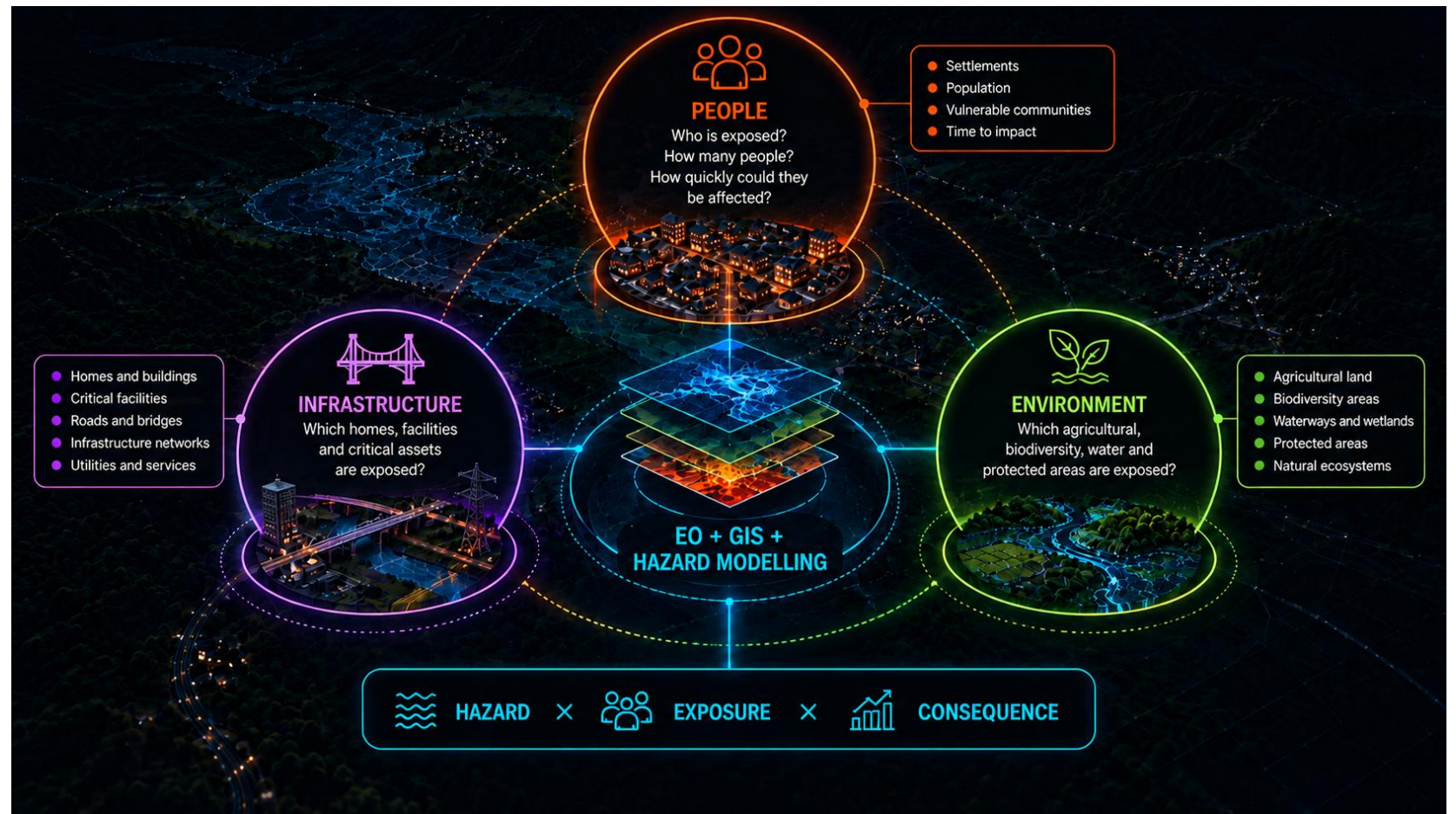
The PIE Framework

Putting consequence at the centre

The RIIS PIE framework moves the analysis beyond mapping the physical hazard to understanding its consequences.

Earth observation (EO), geographic information systems (GIS) and hazard modelling are integrated to determine not only where an event could occur, but who and what lies within its potential impact footprint.

- **People** considers the population exposed
- **Infrastructure** identifies homes, critical facilities and networks
- **Environment** assesses exposure of agricultural land, water resources, biodiversity and protected areas



Together, these layers connect hazard, exposure and consequence, transforming geospatial data into intelligence that can support preparedness, mitigation and emergency response.

From framework to application

What happens if a TSF fails?



At a mine in Limpopo, South Africa, RIIS applied geospatial risk intelligence to assess the potential consequences of a tailings storage facility (TSF) breach. In this case, flooding was not driven solely by extreme rainfall:

The initiating event was the failure of a dam containing a large volume of stored material, releasing it into downstream communities and environments.

While conventional flood-risk applications often focus on rainfall-driven flooding, damaging inundation can have multiple triggers, including dam and infrastructure failure, as well as cascading natural hazards.

Recent disasters globally have reinforced the need to consider the risk posed by large bodies of stored water or material located upstream of communities and critical infrastructure.

The trigger may change, but the impact-analysis framework remains the same: understand the hazard, identify what is exposed, and quantify the consequences for people, infrastructure and the environment.

From modelling the hazard To understanding the consequence

The breach simulations established the potential inundation extent, depth, velocity and arrival time under different scenarios. These outputs were then integrated with Earth observation and geospatial datasets to determine what lay within each potential impact footprint.

01 — MODEL THE HAZARD

Breach scenarios were used to determine the potential inundation footprint, including flood depth, velocity and arrival time.

02 — MAP THE LANDSCAPE

Earth observation and geospatial data provided information on settlements, buildings, land use and environmental features within the surrounding landscape.

03 — ASSESS EXPOSURE

The hazard footprint was intersected with the PIE layers to identify the people, infrastructure and environmental assets potentially exposed.

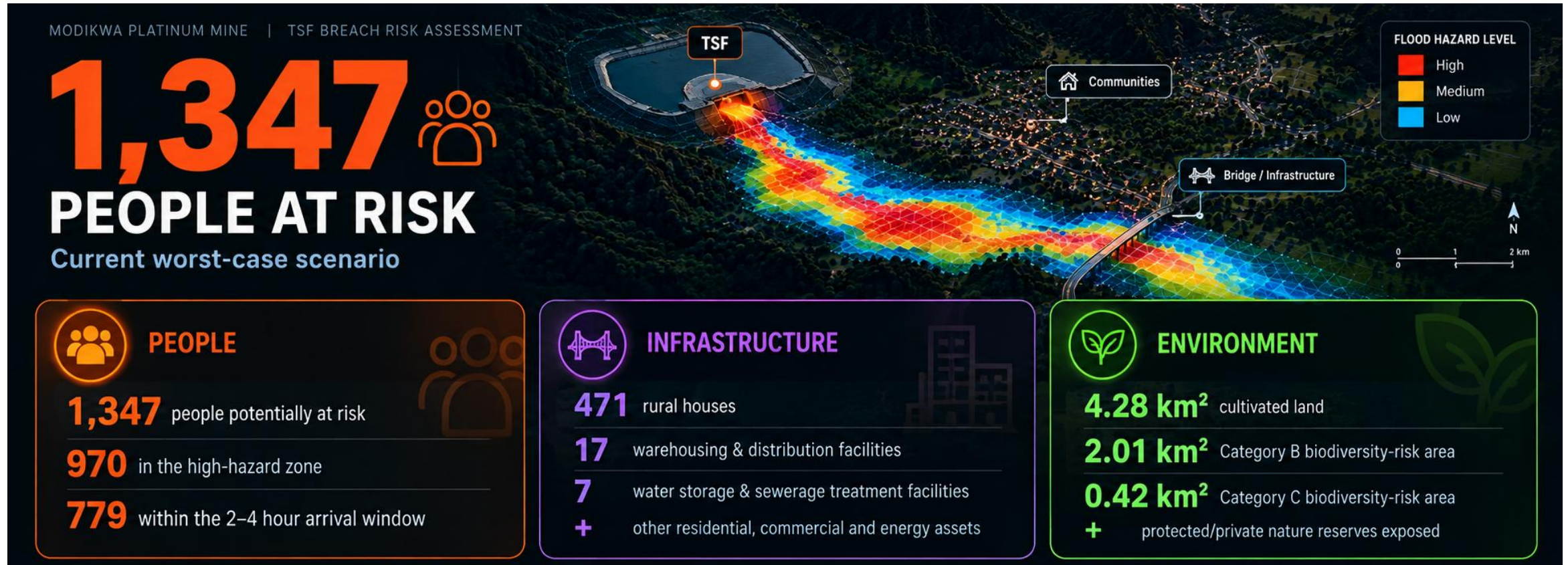
04 — QUANTIFY CONSEQUENCE

The analysis translated the model into decision-relevant measures: how many people, which assets, what environmental areas and how much time may be available to respond.

Integrating EO and geospatial intelligence tells us what that journey could mean on the ground.



From inundation extent To people and assets at risk



A flood footprint becomes decision intelligence when we can quantify who is exposed, what is at risk, and how much time there is to respond.

Risk is dynamic

What happens as the landscape changes?

Archived satellite imagery from 1990–2020 was used to examine how residential development had changed around the mining area and to inform future population-growth scenarios.

The two growth scenarios used in the assessment were **3.5%** and **5.8%**, allowing the analysis to explore how continued development could alter the number of people exposed to a future breach.



Space-based data becomes allows us not only to map today's exposure, but to observe how the landscape has changed and use that evidence to anticipate where tomorrow's risk may emerge.

The value is not the map

It is the decision it enables

Knowing the inundation extent alone was insufficient; decision-makers also needed to understand where people were located, how quickly the hazard could reach them, which assets were exposed, and how the risk could change over time.

01 — PRIORITISE EVACUATION

Use arrival time + population at risk + hazard severity to identify communities requiring the earliest intervention.

02 — PROTECT CRITICAL ASSETS

Identify exposed water, energy, transport, residential and commercial infrastructure and prioritise contingency measures.

03 — MANAGE A CHANGING RISK

Continuously monitor settlement growth, development and land-use change so emergency plans remain aligned with the landscape actually on the ground.

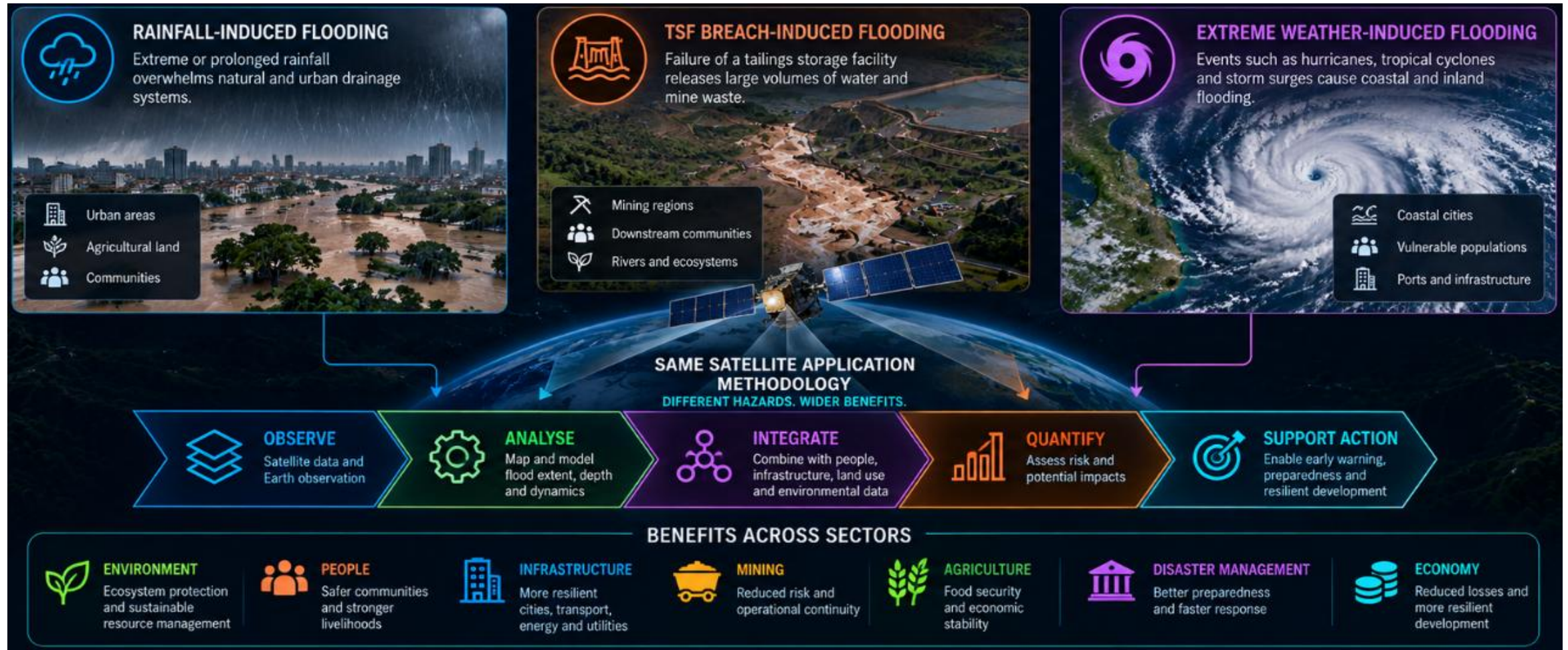
04 — PROTECT ENVIRONMENTAL SYSTEMS

Identify exposed agricultural land, biodiversity areas and protected environments, and strengthen assessment of potential downstream contamination impacts.



Earth observation becomes operationally valuable when it changes what happens before the disaster — where we intervene, who we prioritise, what we protect and how early we act.

THE TRIGGER CHANGES THE FRAMEWORK DOES NOT



Open and accessible EO data can provide the observational layer. The real capability comes from combining that space-derived information with local knowledge, hazard modelling and decision-making systems.

From space capability To economic resilience

The value of Earth observation is not confined to the space sector. The same underlying capability can support decisions across mining, agriculture, infrastructure, disaster management, environmental management, insurance and urban development.

For developing countries, where a single disaster can simultaneously affect communities, productive assets, infrastructure and ecosystems, this creates an important opportunity: one space-enabled capability can support multiple sectors and multiple public-policy priorities.

Space applications



Better risk intelligence



Earlier + better decisions



Reduced disruption & losses



Greater socio-economic resilience

The economic value of a satellite application is realised on the ground — when better information protects lives, livelihoods, productive assets and the systems on which economies depend.

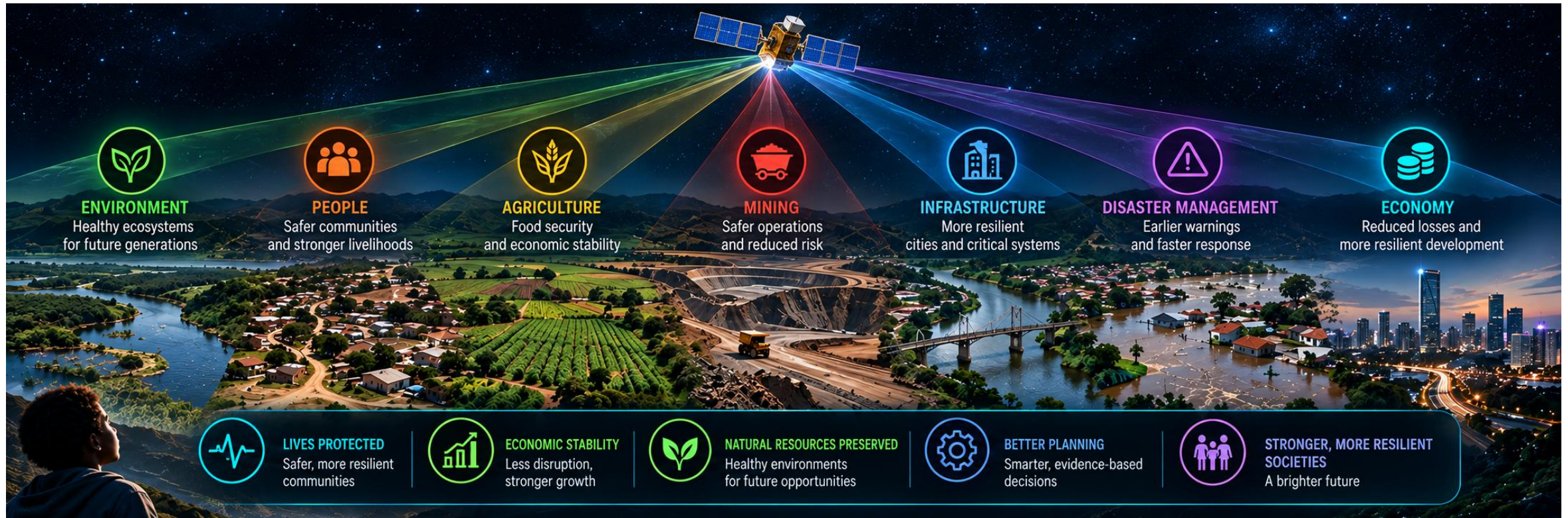
The opportunity for emerging nations

Build around local context

EO becomes significantly more useful when combined with hazard models, local assets, population, infrastructure and environmental information.

Move from projects to capability

The opportunity is not another static risk map. It is a repeatable capability to observe change, reassess exposure and support decisions over time.



Continue the conversation

Nandi Mtethwa

**Data Science CoE Lead
Engagement Manager**

nandi.mtethwa@riis.africa



Works at the intersection of Earth observation, geospatial analytics, innovation and space ecosystem development in Africa.

She leads the RIIS flood risk intelligence work from concept through development, including the application of the RIIS PIE model to assess flood impacts across People, Infrastructure and the Environment.

She also leads the Africa Earth Observation Challenge (AEOC), supporting the development and uptake of EO-enabled innovation across Africa.

