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Beyond Measuring Subsidence: Bridging Observation, Attribution, and Risk for Resilient Infrastructure and Communities

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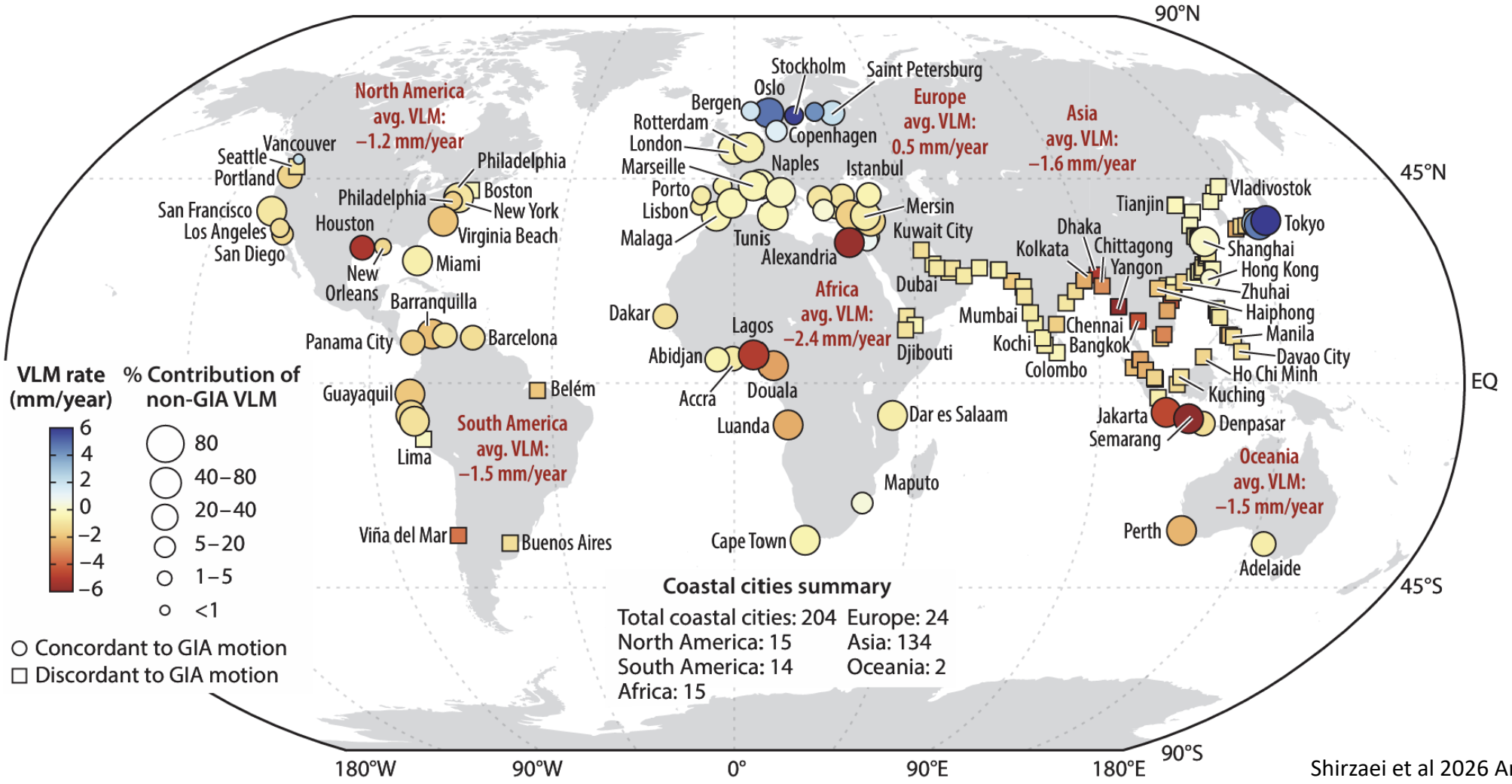
UNITED STATES REPRESENTATIVE TO UNESCO LASII

FEBRUARY 26, 2025

THE SHOCK



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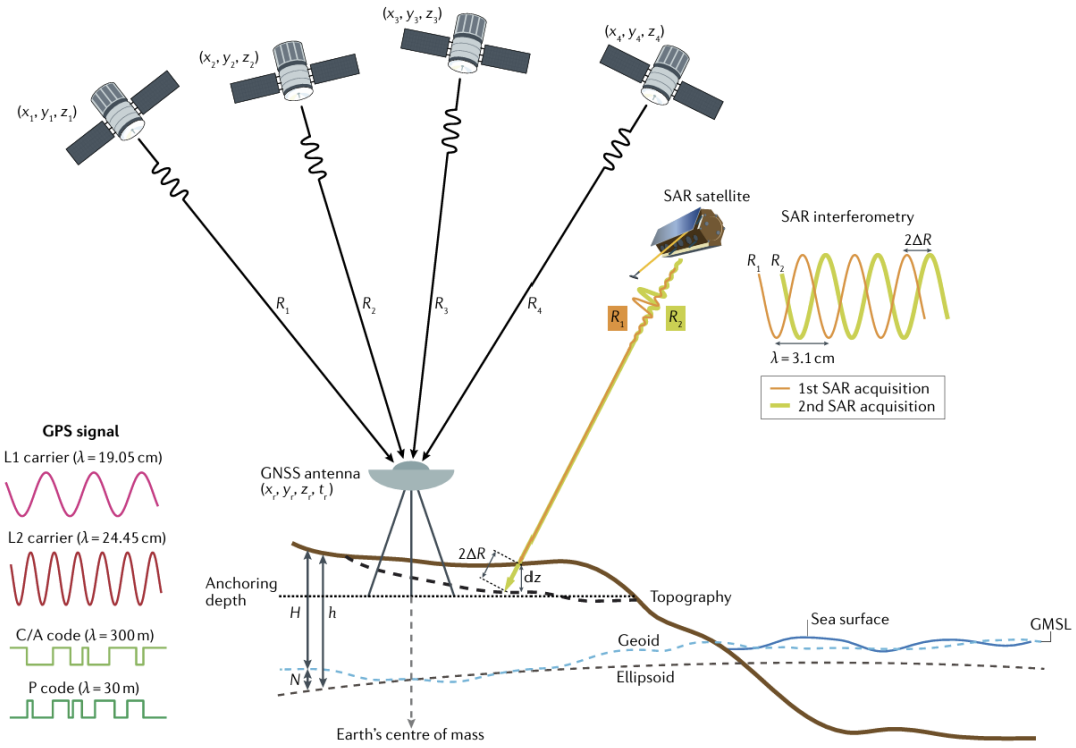
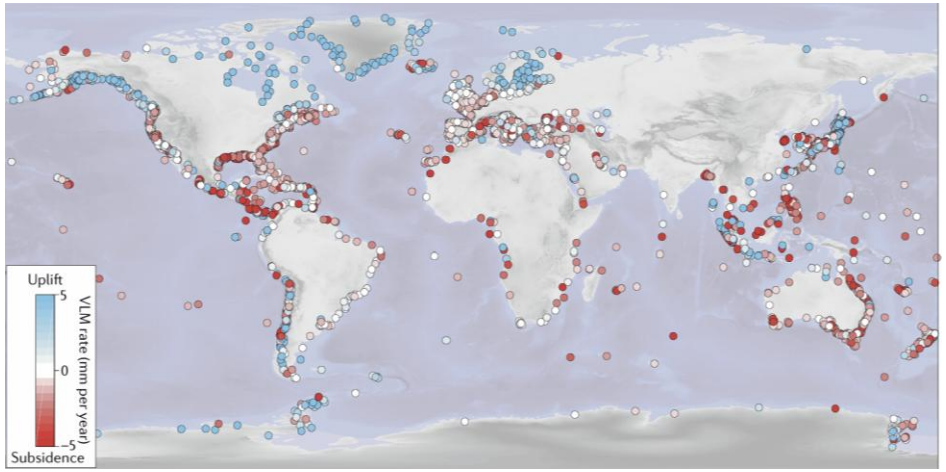
In many coastal cities, land is sinking faster than the ocean is rising.

THE REVOLUTION



GNSS deformation map



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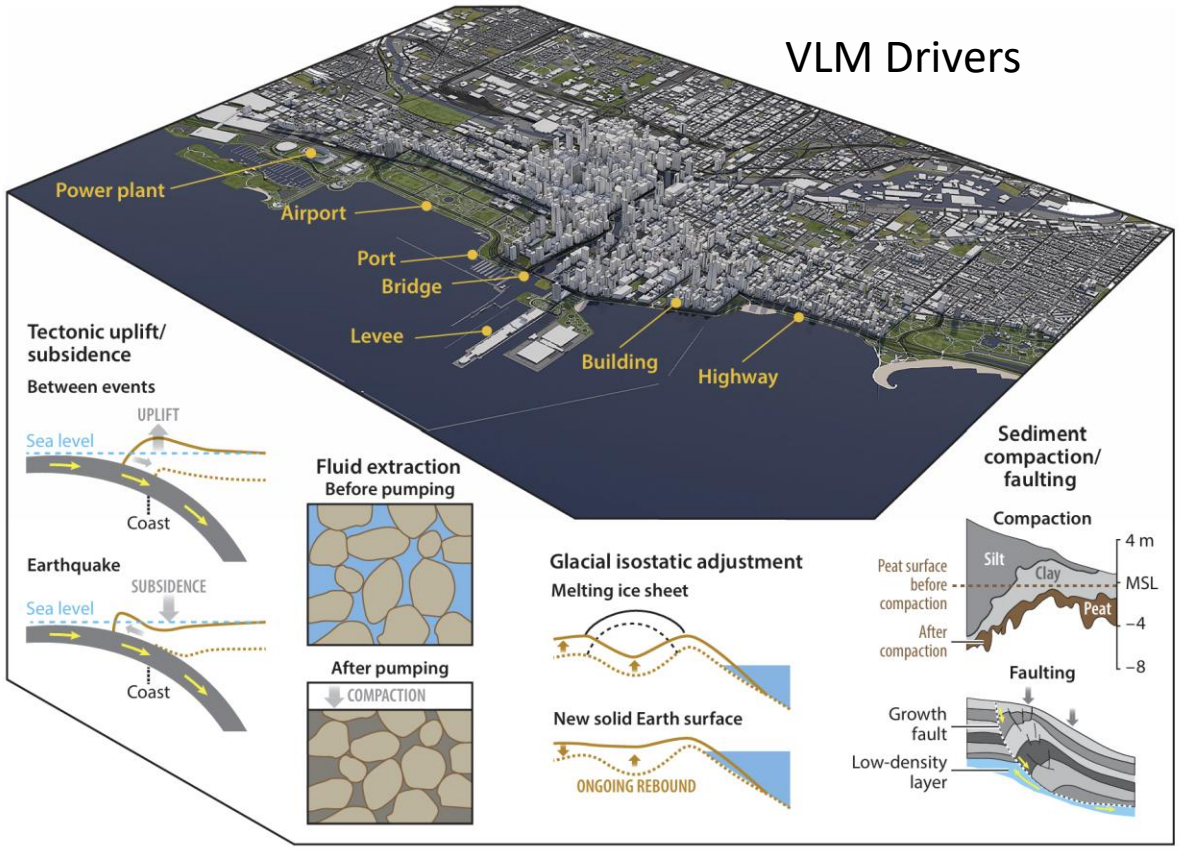
InSAR deformation map

Ohenhen & Shirzaei et al (2024, Nature)

We Can Now Measure Millimeters at City Scale

GAP 1: DETECTION ≠ UNDERSTANDING

VLM Drivers



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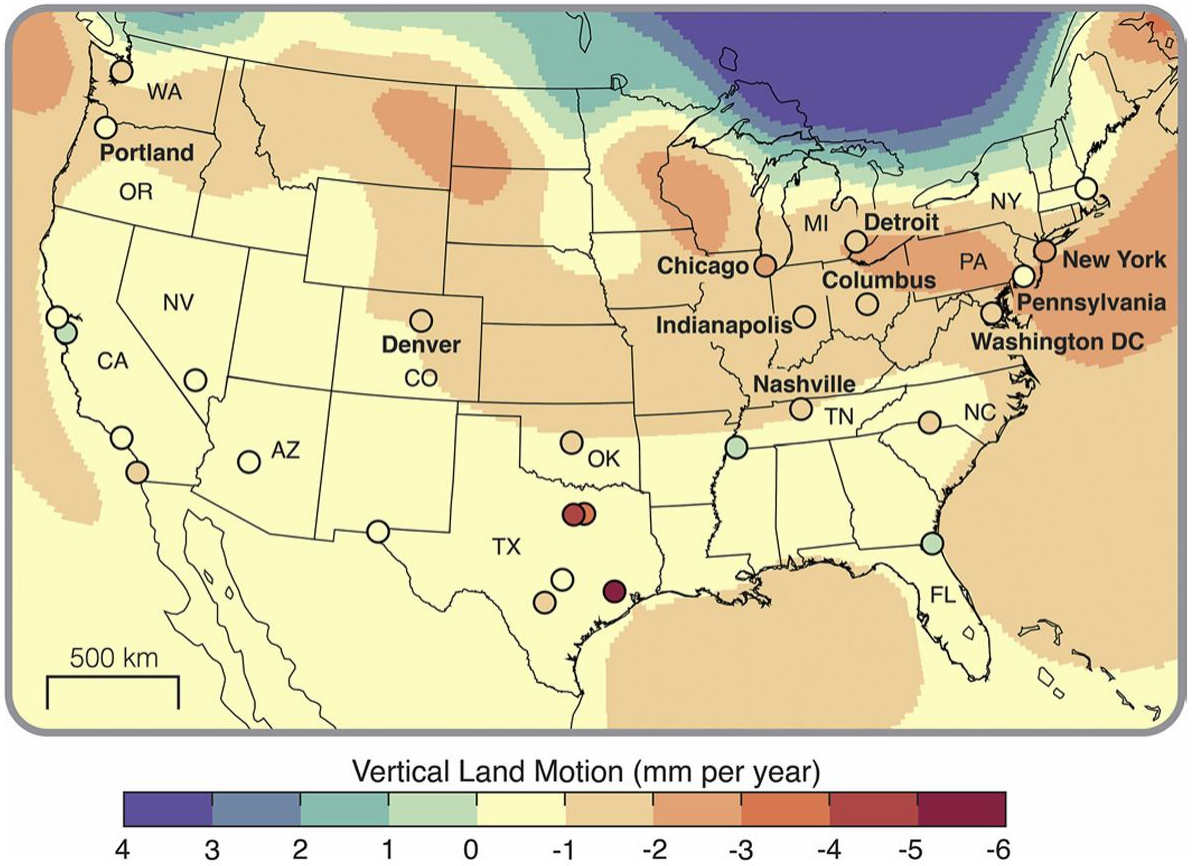
Influence of GIA on Urban Subsidence

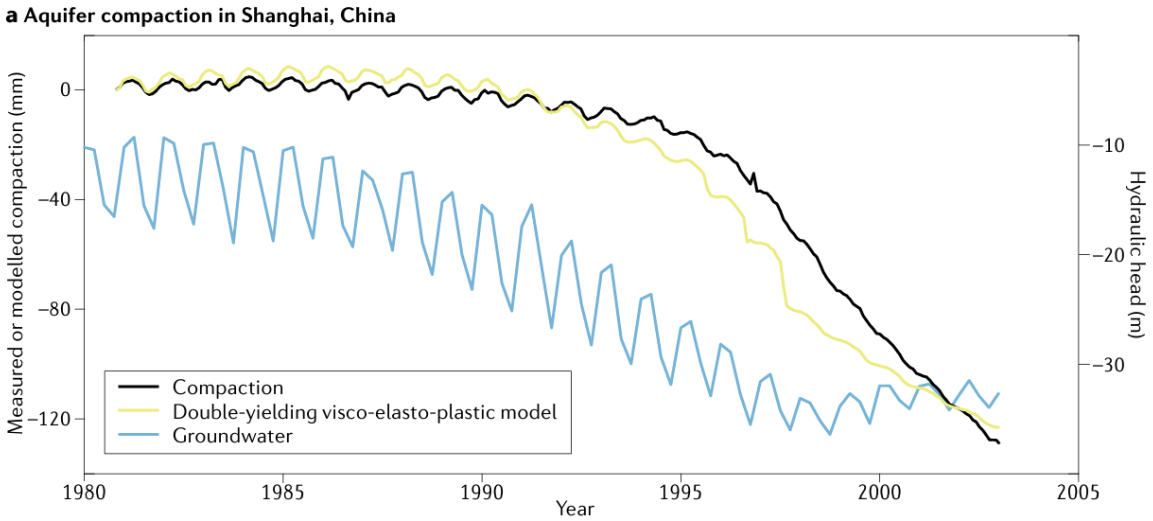


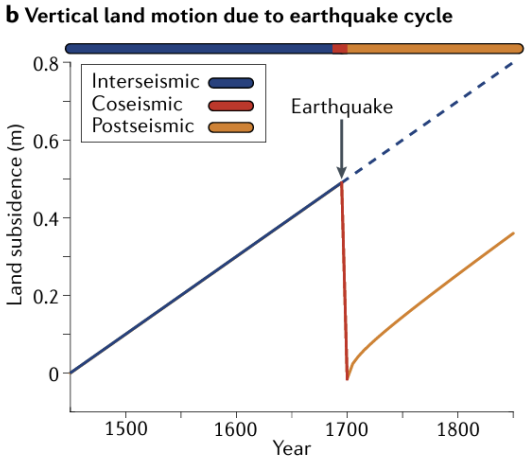
Ohenhen et al (2024, Nature Cities)

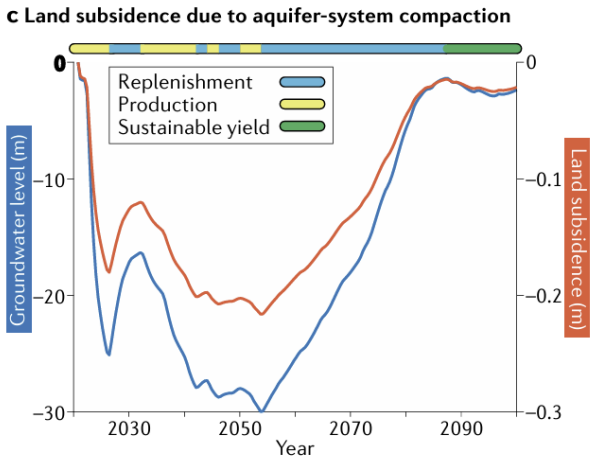
Often, signals from various sources overlap.

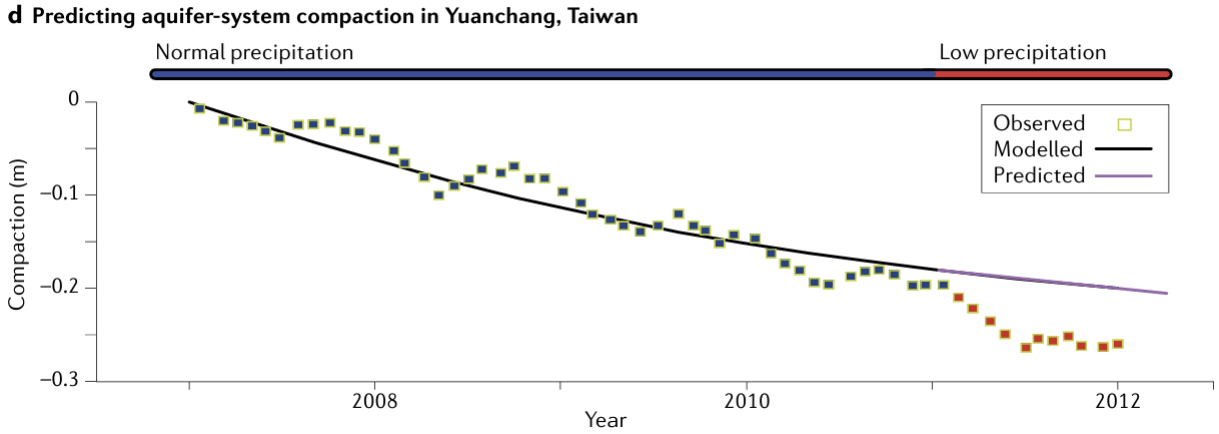
We Detect Motion. We Don't Fully Attribute It.

GAP 2: STATIC PLANNING VS DYNAMIC REALITY









Shirzaei et al 2021 Nature Reviews

Urban Planning Assumes Stationarity. Subsidence Is Not.

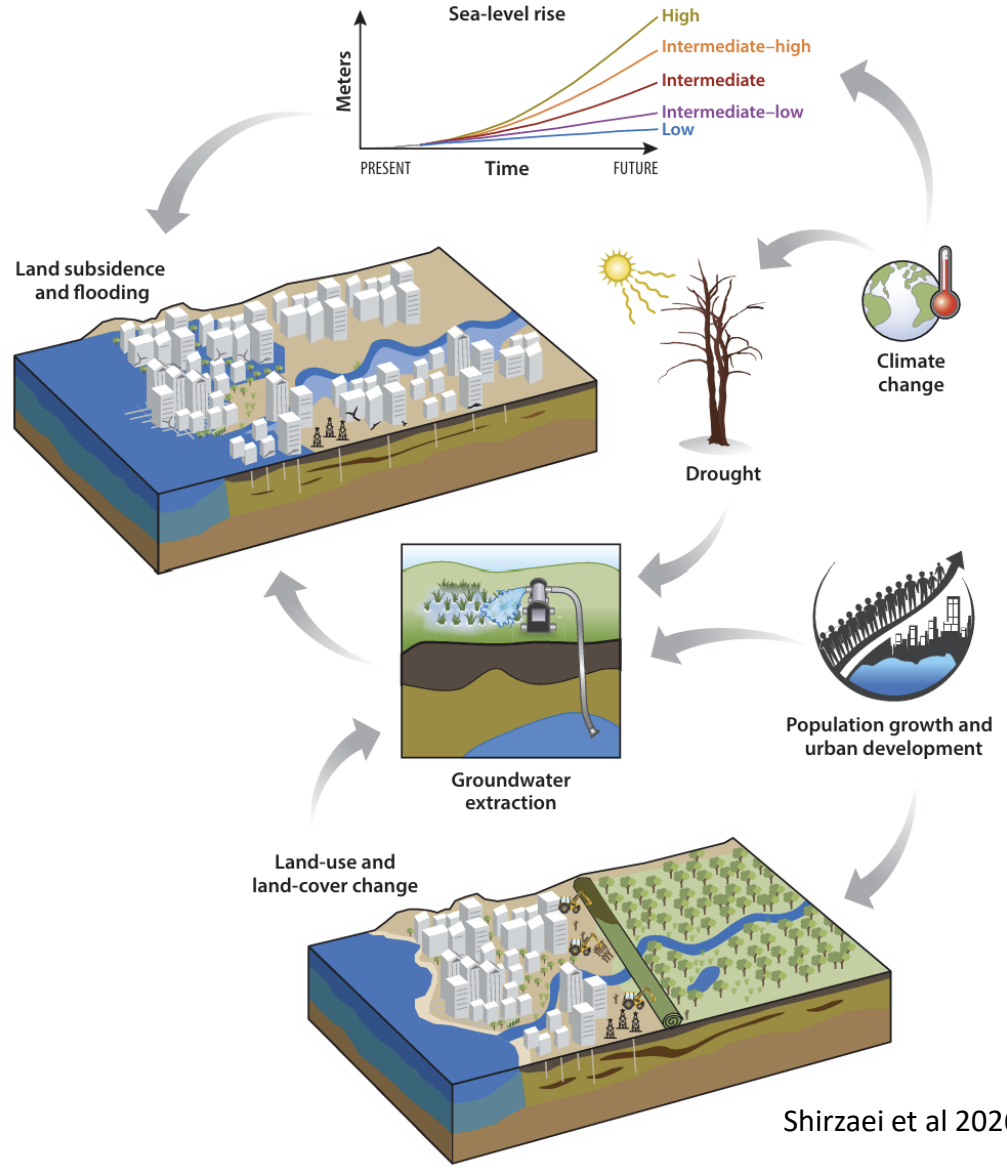
GAP 3: INFRASTRUCTURE BLIND SPOT

Hjort et al. 2022 Nature Reviews

We Lack Deformation-to-Damage Thresholds

GAP 4: COUPLED VS ISOLATED PROCESSES

Interactions between climate change, anthropogenic activities, and coastal hazards in urban coastal environments



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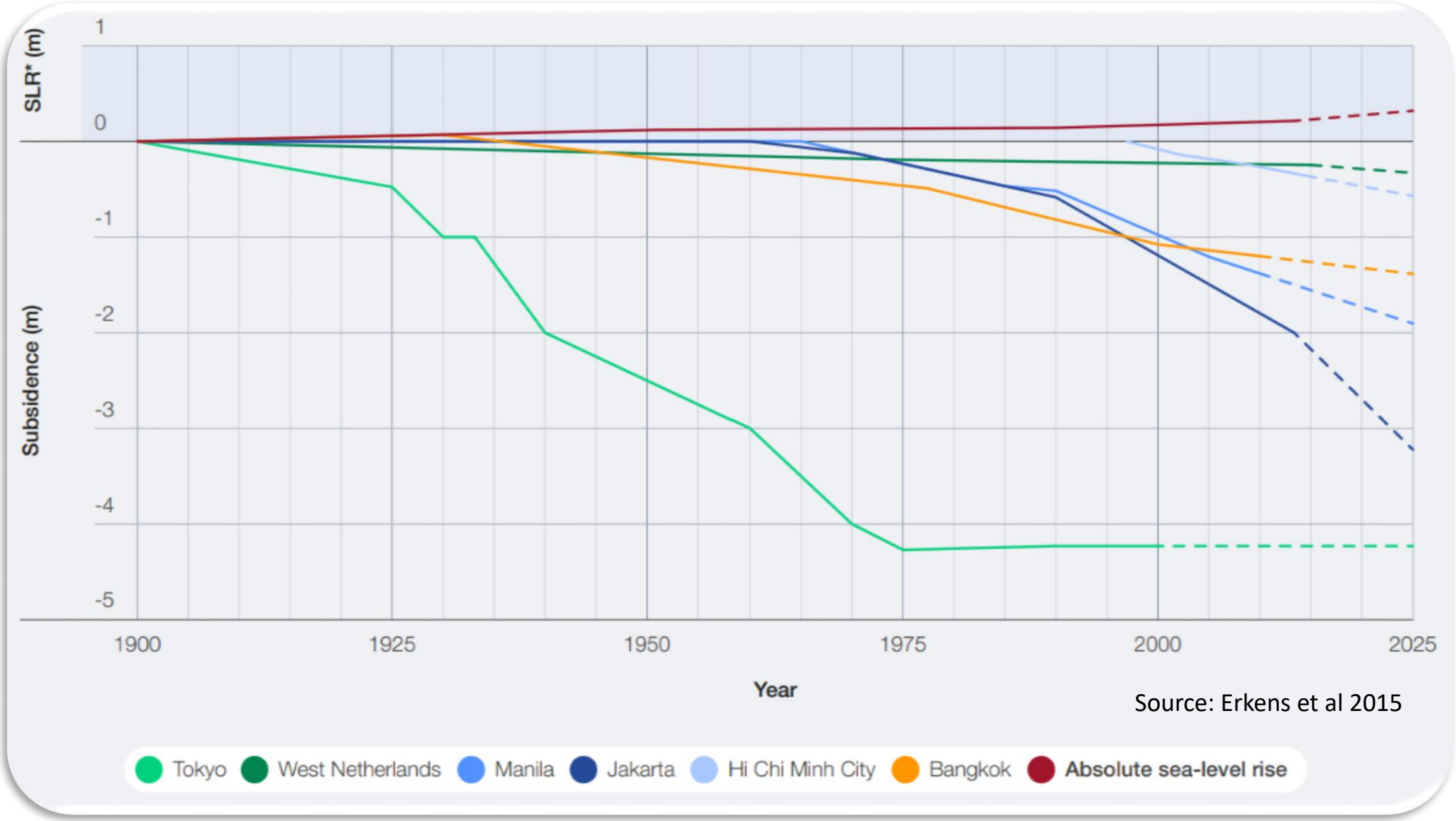
Subsidence Does Not Act Alone.

GAP 5: GOVERNANCE FRAGMENTATION

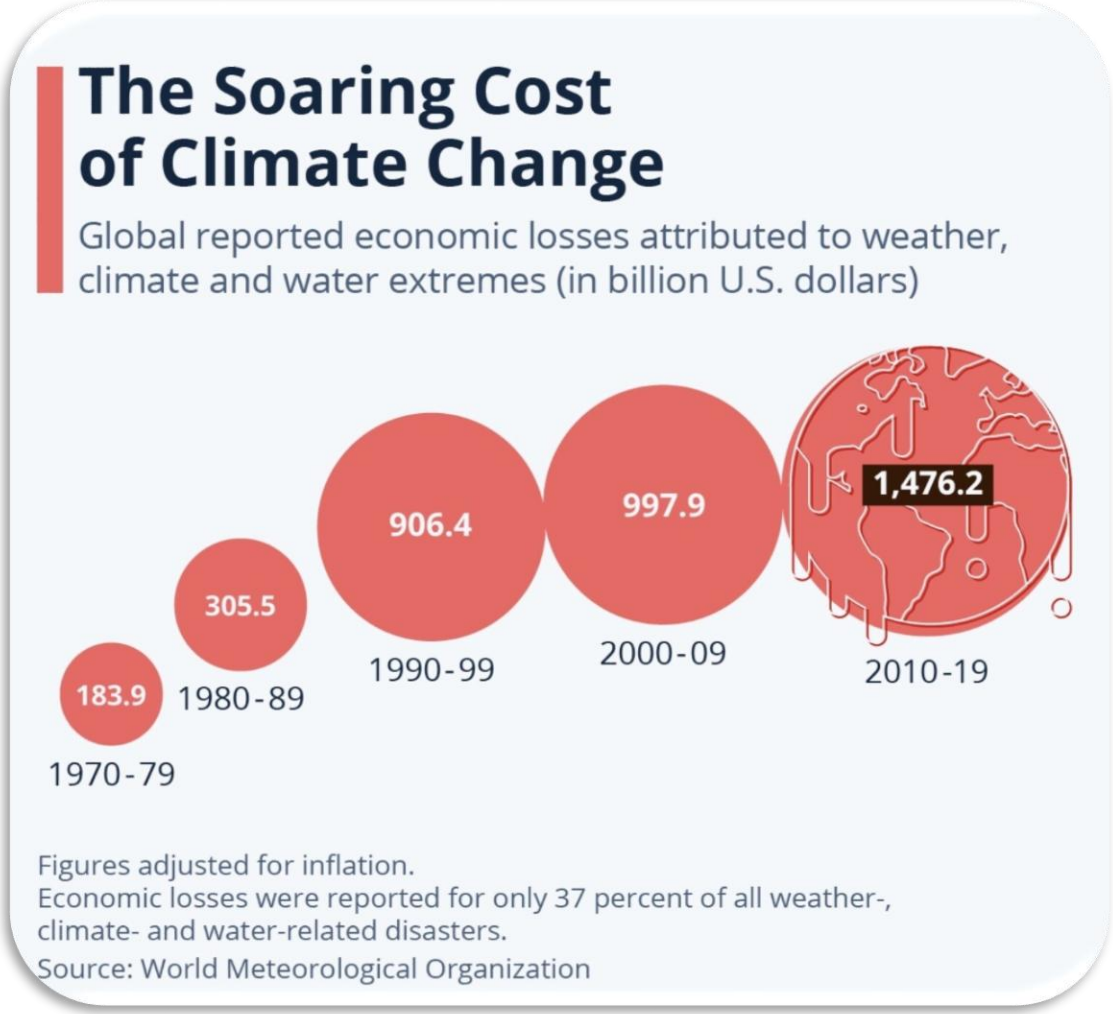


Source: Erkens et al 2015

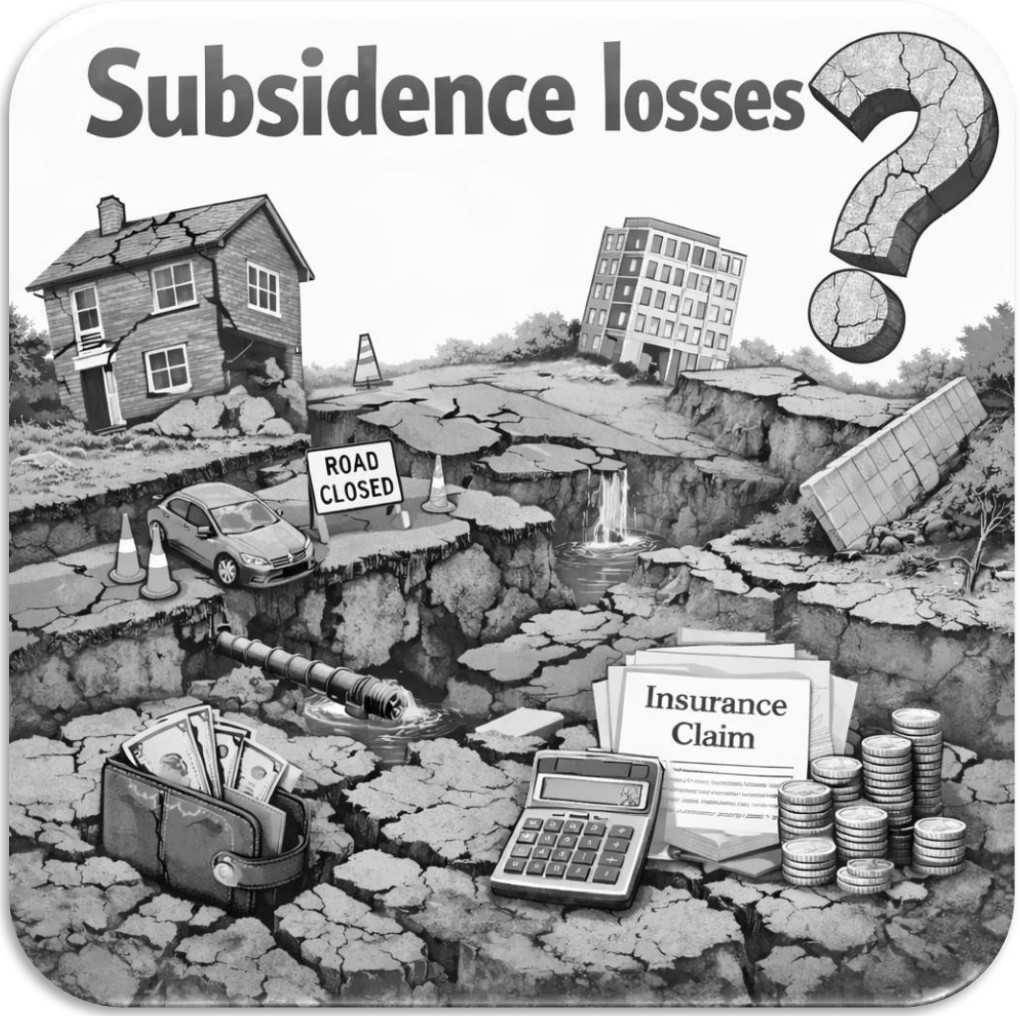
Monitoring Exists. Governance Does Not Scale.

GAP 6: ECONOMIC & LEGAL VACUUM

Climate Losses

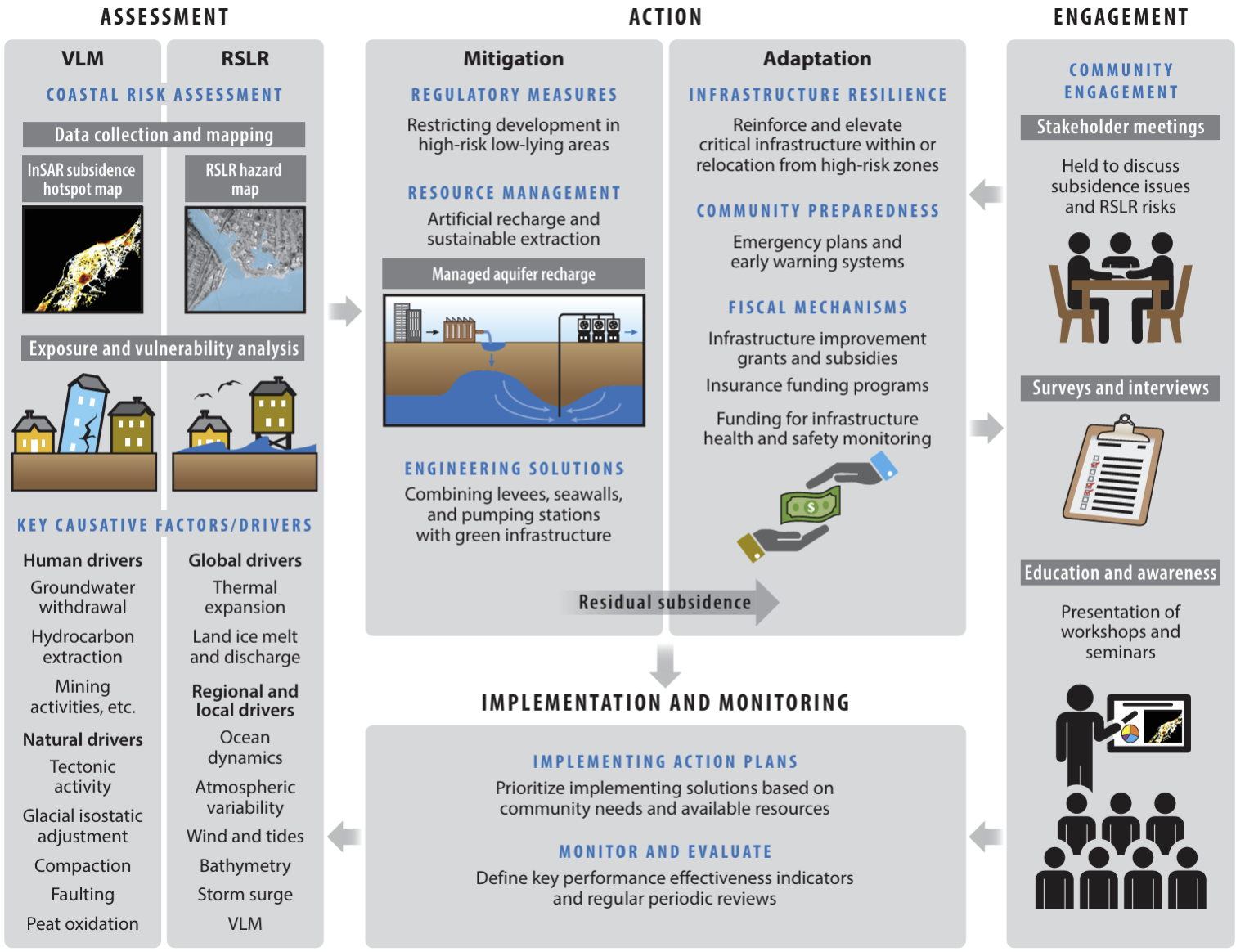


Subsidence Losses



Subsidence Has No Standardized Cost Accounting.

HOW TO DEAL WITH LAND SUBSIDENCE



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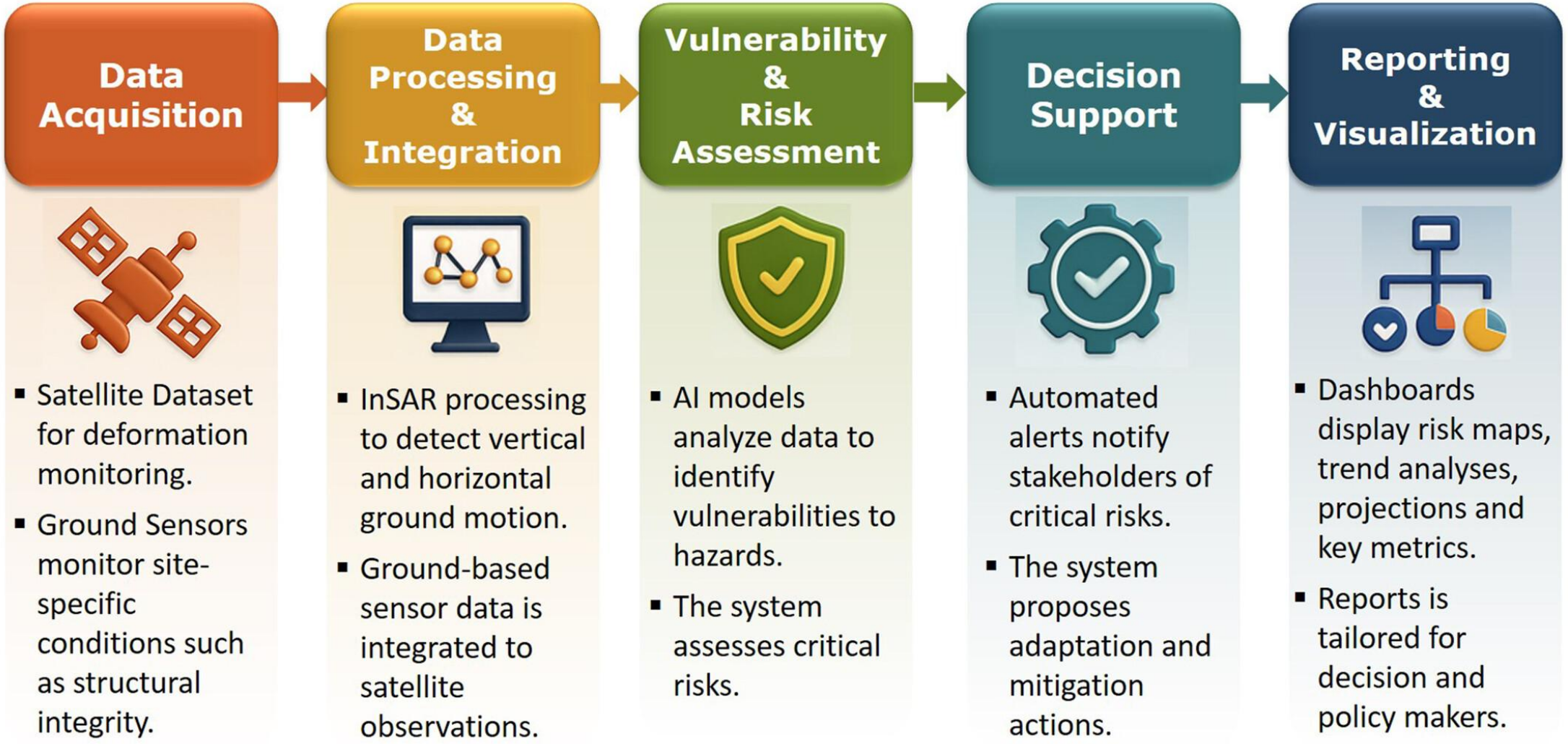
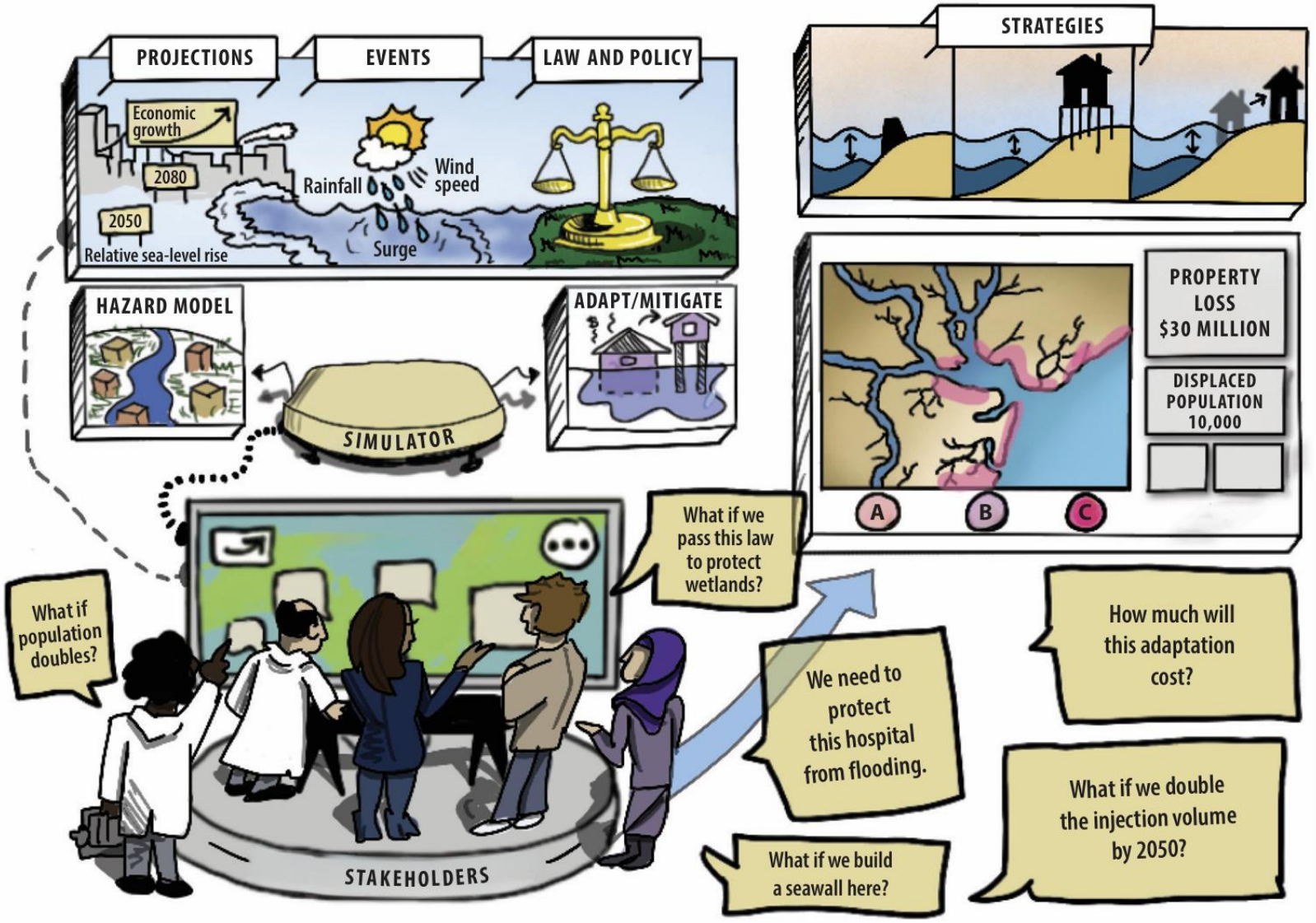
FROM HAZARD TO DECISION MAKING



We Must Move Beyond Mapping.

Dasho and Shirzaei 2025

DIGITAL TWIN FRAMEWORK



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RESEARCH PRIORITIES FOR SUBRISK

Thresholds

Link deformation to functional failure

Coupling

Integrate climate, groundwater, and infrastructure dynamics

Equity

Map who sinks with the ground

Nonlinearity

Capture acceleration and regime shifts

Scenario-based projections

Generate SSP-based projections of subsidence similar to SLR projections

Multi-hazards risk models

Risk models that account for compounding and cascading hazards

Operationalization

Move from maps to decision systems

What the Next Decade Must Deliver

Subsidence is local — and therefore governable.

But only if we integrate it into risk systems.

ANNUAL REVIEW OF EARTH AND PLANETARY SCIENCES

Review Article

Vertical Land Motion and Coastal Cities: Bridging Global Science and Policy for Resilient Communities

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