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RESILIENT CITIES: TECHNOLOGY + FINANCE

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MARINA BAY SANDS, SINGAPORE



Turning Point in China's Urban Development 1980-2025

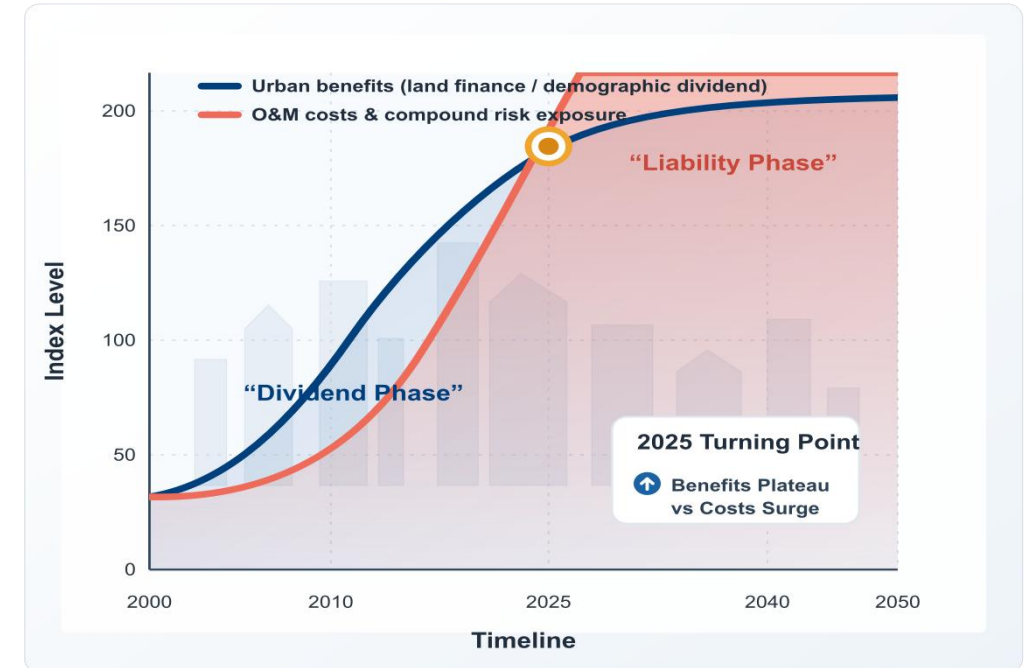
China's urbanization has risen from 19% in 1980 to 67% in 2025.

- Aging infrastructure is entering a period of concentrated risk exposure.
- More frequent extreme climate events are increasing compound risk exposure.

A Shift in the Development Paradigm

- "Phase 1 (1980–2025): Asset accumulation driven by land finance and demographic dividends has peaked.
- Phase 2 (2026+): Asset maintenance, where urban operation costs are rising sharply."

"With aging infrastructure and rising climate risk exposure, Chinese cities face a critical turning point; the future mega cities must develop resilience and climate-adaptation."

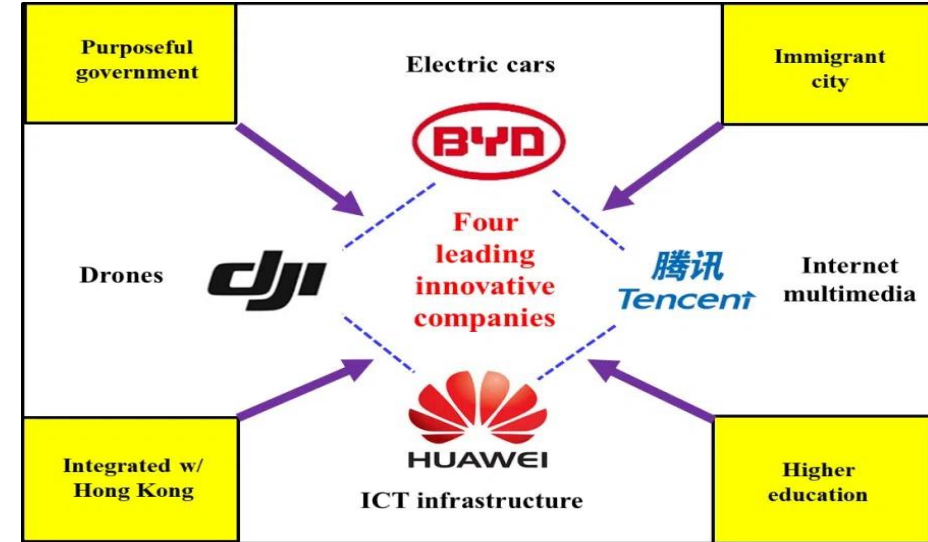


Shenzhen: A Mega City's Story of Developing Resilience



City profile

Established as China's first Special Economic Zone in 1980, Shenzhen grew into a metropolis of more than 17 million people and a global manufacturing and R&D hub.



Why it matters for this topic

- As a mega city, Shenzhen sees climate resilience as essential for “the future city”!
- Shenzhen's leading institutions have sponsored “The 2025 Chinese Resilient Cities Report”

2025 China Resilient Cities Index: What the Report Adds



On May 14, 2026, the 2026 Symposium on Resilient Cities was successfully held in Shenzhen.

Assessment Report of China's Resilient Cities (2025) – Joint work by Shenzhen's leading institutions:

1. Southern University of Science and Technology
2. Ping An **Insurance**,
3. China Resources **Land**
4. Shenzhen **Emergency Management Society**



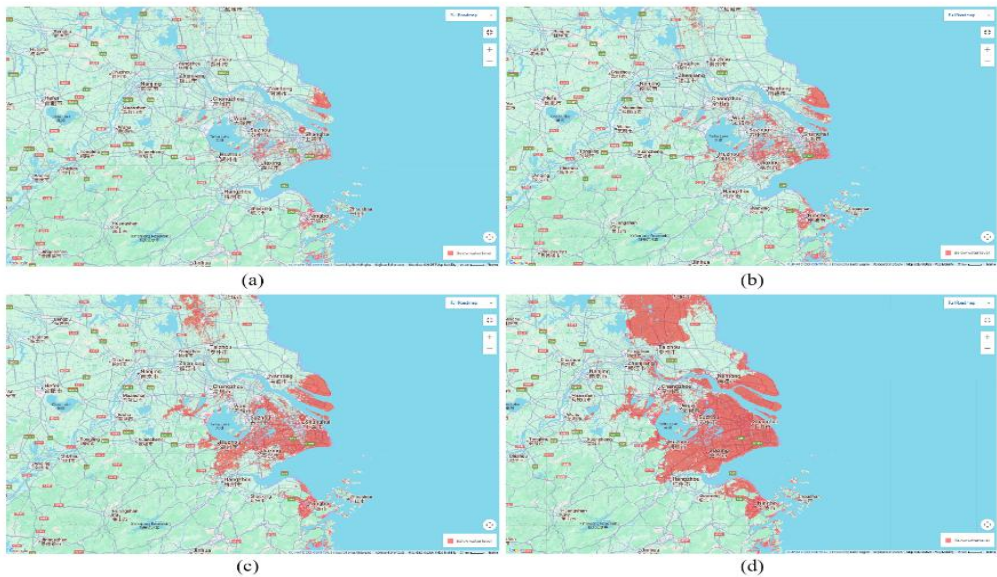
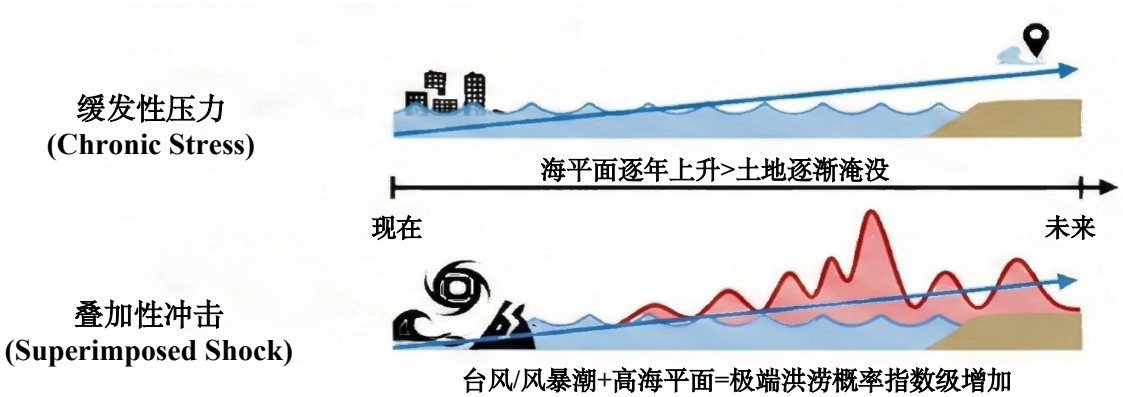


图 9: 长三角地区主要城市在不同海平面上升情景下的风险暴露评估图
注: 本组图详细展示了在不同的海平面上升情景下 (a: 上升 0.2 米, b: 上升 0.5 米, c: 上升 1 米, d: 上升 2 米), 长三角地区主要城市的潜在风险暴露情况。图片来源: <https://coastal.climatecentral.org/map/>



Two types of climate risk

1. Chronic stress: gradual sea-level rise, heat and water scarcity increase baseline vulnerability.
2. Superimposed Shocks: typhoons, storm surges and extreme rainfall push losses upward nonlinearly.

1. Increasing frequency of heavy rainfall events in northern China
2. Urban drainage systems and infrastructure standards require urgent upgrading
3. Cases such as Zhengzhou (7.20 rainstorm)
4. Vulnerabilities of traditional urban planning
5. Weak flood resilience in existing urban infrastructure



Key implication Highlight the urgent need to enhance flood resilience in northern cities

Dr. Wang led the development of resilience rating methodology:

1. Exposure and buffer capacity: climate hazards, environmental stress, water and green space.
2. Social robustness: income, health resources, social security and community capacity.
3. Economic adaptability: industrial structure, innovation and entrepreneurship.
4. Infrastructure reliability: roads, pipelines, utilities, public transit and digital facilities.
5. Governance responsiveness: emergency command and integrated public service capacity.



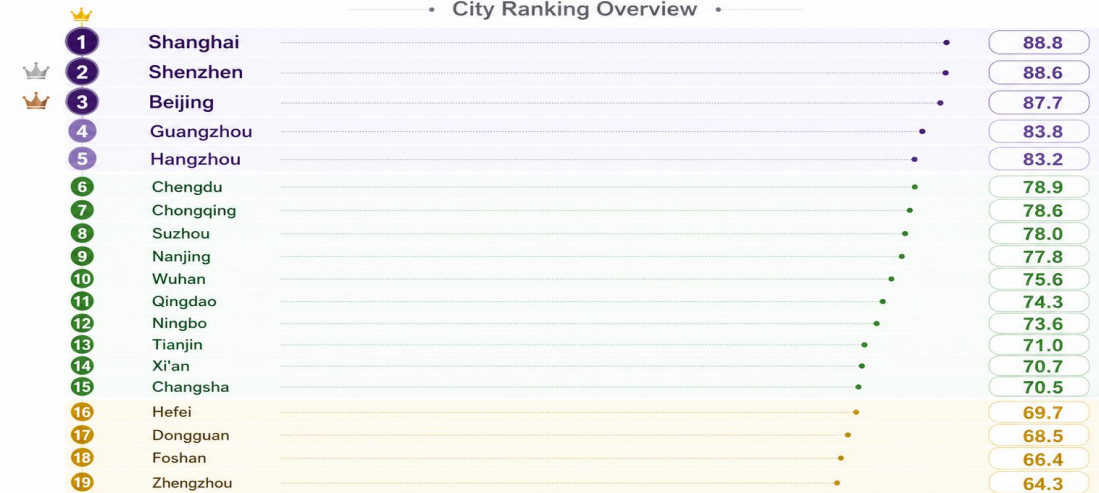
Partial Data for Urban Resilience Rating

Criterion Layer	Capability	Indicator Layer	Unit	Attribute	Criterion Layer	Capability	Indicator Layer	Unit	Attribute	
1. Ecological & Environmental Resilience	Buffering Capacity	Industrial wastewater discharge	10,000 tons	—	3. Economic & Industrial Resilience	Robustness	Per capita GDP	RMB/person	+	
		Industrial SO ₂ emissions	tons	—			Electricity consumption	100 million kWh	+	
		Industrial smoke and dust emissions	tons	—			Total retail sales of consumer goods	RMB 10,000	+	
	Risk Exposure	Direct economic losses from meteorological disasters	RMB 100 million	—		Transformative Capacity	Share of tertiary industry in GDP	%	+	
		Equivalent level of near-source urban earthquakes	—	—			Industrial structure upgrading index	—	+	
		Water resource risk level	—	—			Total exports	USD 10,000	+	
	Buffering Capacity	Per capita park green space area	m ² /person	+	4. Engineering & Infrastructure Resilience	Robustness	Science and education expenditure as a share of GDP	%	+	
		Green coverage rate in built-up areas	%	+			Number of patents granted	items	+	
		Average PM2.5 concentration	µg/m ³	—			Urban entrepreneurial activity	items	+	
	Recovery Capacity	Urban domestic sewage treatment rate	%	+			Per capita urban road area	m ² /person	+	
		Harmless treatment rate of municipal solid waste	%	+			Water supply pipeline density in built-up areas	km/km ²	+	
		Comprehensive utilization rate of general industrial solid waste	%	+			Drainage pipeline density in built-up areas	km/km ²	+	
2. Social & Community Resilience	Robustness	Per capita disposable income of urban residents	RMB	+		5. Smart & Governance Resilience	Recovery Capacity	Gas penetration rate	%	+
		Population density	persons/km ²	—				Public buses per 10,000 people	standard buses	+
		Engel coefficient of urban households	%	—				Number of road lighting lamps	lamps	+
	Buffering Capacity	Per capita savings balance	RMB	+	Transformative Capacity		Length of roads with street lighting installed	km	+	
		Hospital beds per 1,000 people	beds	+			Length of sewage pipelines	km	+	
		Physicians per 1,000 people	persons	+			Length of stormwater pipelines	km	+	
		Social insurance coverage rate	%	+			Mobile phone users at year-end	10,000 users	+	
		Per capita grain output	%	+			4G base stations per 10,000 people	units/10,000 people	+	
	Recovery Capacity	Per capita general public budget revenue	%	+	Transformative Capacity		Fixed-asset investment completed in urban municipal public facilities construction	RMB 10,000	+	
		Healthcare expenditure as a share of fiscal expenditure	%	+		Integrated online government service capability	yes or no	+		
		Social security expenditure as a share of fiscal expenditure	%	+		Full-time staffing of subdistrict/township integrated information command centers	persons	+		
	Transformative Capacity	Employees in public administration and social organizations	persons	+		Whether “one-click” emergency command linkage has been achieved	yes or no	+		
		Urbanization rate	%	+		Resilient city research institutions	units	+		
		College students per 10,000 people	persons	+						
	Public library collections per 100 people	volumes/items	+							

Five cities with leading resilience index



2025 China Resilient Cities Index



How to read the ranking

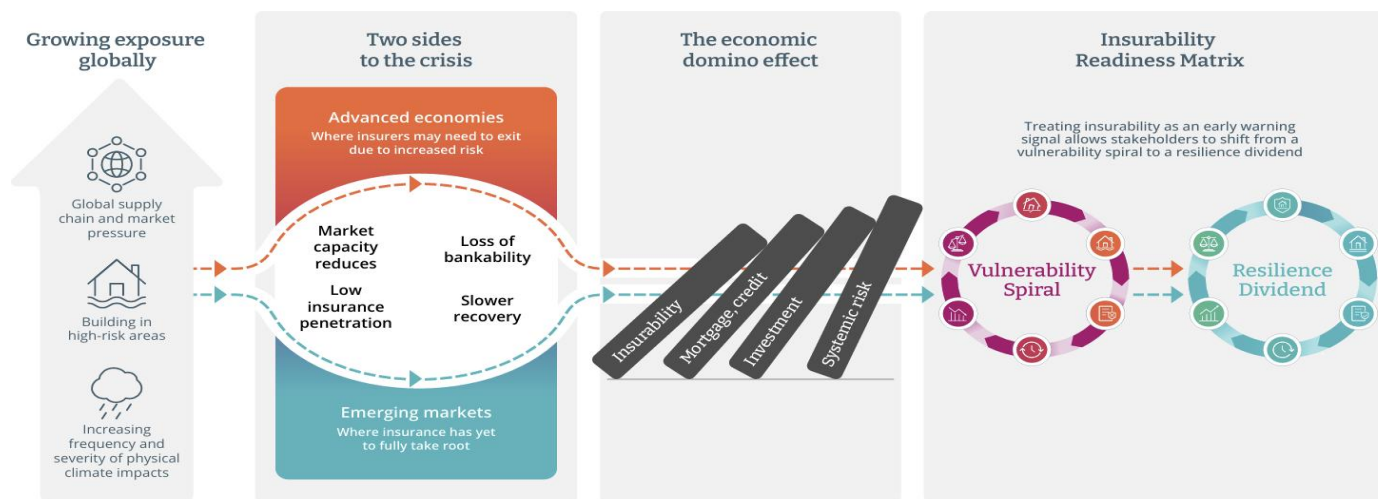
- The 2025 index ranks Chinese cities across 5 core dimensions.
- This ranking is not a "winner list" —it identifies gaps for targeted investment and governance integration.



March 2026

The canary in the coalmine: Insurability as a resilience signal

Figure 1: Insurability as a resilience signal: from systemic risk to action

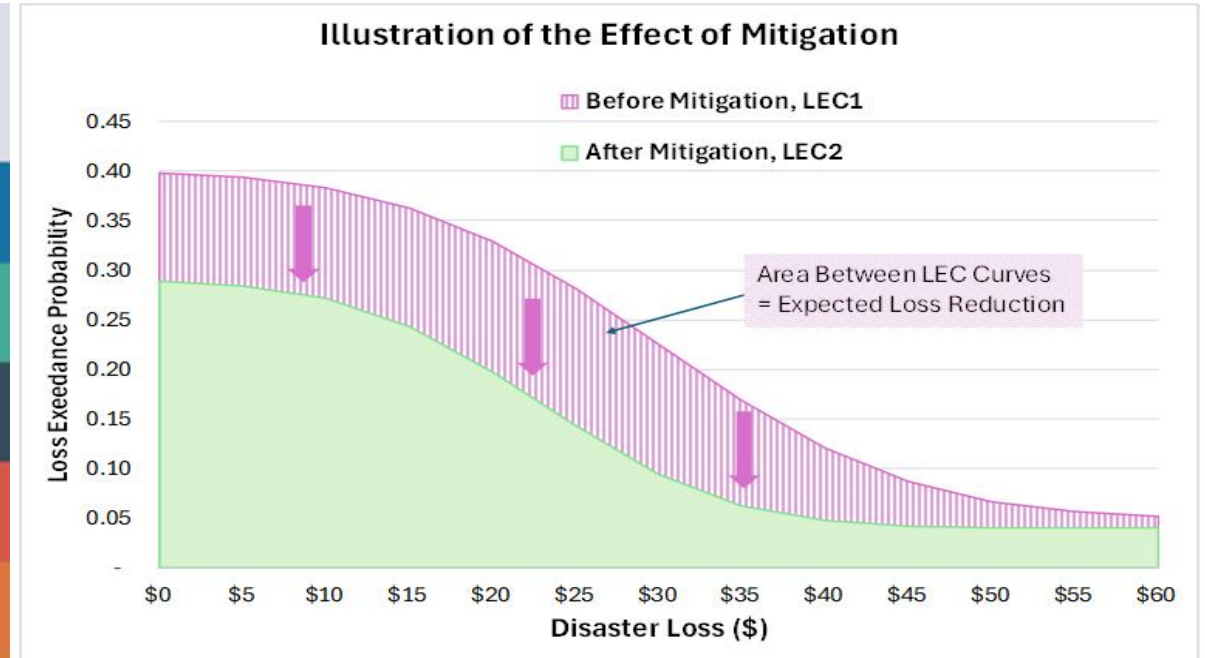


Emerging markets in Asia

- Markets where insurance never fully took root.
- Cities are not familiar with insurance instruments

Why Insurers Must Leverage on Mitigation?

National Benefit-Cost Ratio (BCR) Per Peril *BCR numbers in this study have been rounded		
Overall Hazard Benefit-Cost Ratio		
	Beyond Code Requirements	Federally Funded
 Riverine Flood	\$5:1	\$7:1
 Hurricane Surge	\$7:1	Too few grants
 Wind	\$5:1	\$5:1
 Earthquake	\$4:1	\$3:1
 Wildland-Urban Interface Fire	\$4:1	\$3:1



Source: *Natural Hazard Mitigation Saves*, National Institute Building Sciences, 2019



AI Predictive Maintenance

Tech: IoT sensors + ML algorithms

Use: Real-time health monitoring for industrial & power assets.

- Downtime ↓ **50%**
- Maintenance cost ↓ **40%**
- Asset lifespan ↑ **20%**



Drone Inspection

Tech: Aerial drones + thermal imaging

Use: Audits for bridges, pipelines & solar farms.

- Cost ↓ **50%**
- Safety risks ↓ **90%**
- Accuracy ↑ **30%**



IoT Env Monitoring

Tech: Wireless sensor networks

Use: Early warnings for floods, wildfires & quakes.

- 1-3h advance warnings
- Evacuation cost ↓ **25%**
- Damage ↓ **60%**



Big Data Analytics

Tech: Cloud + AI models

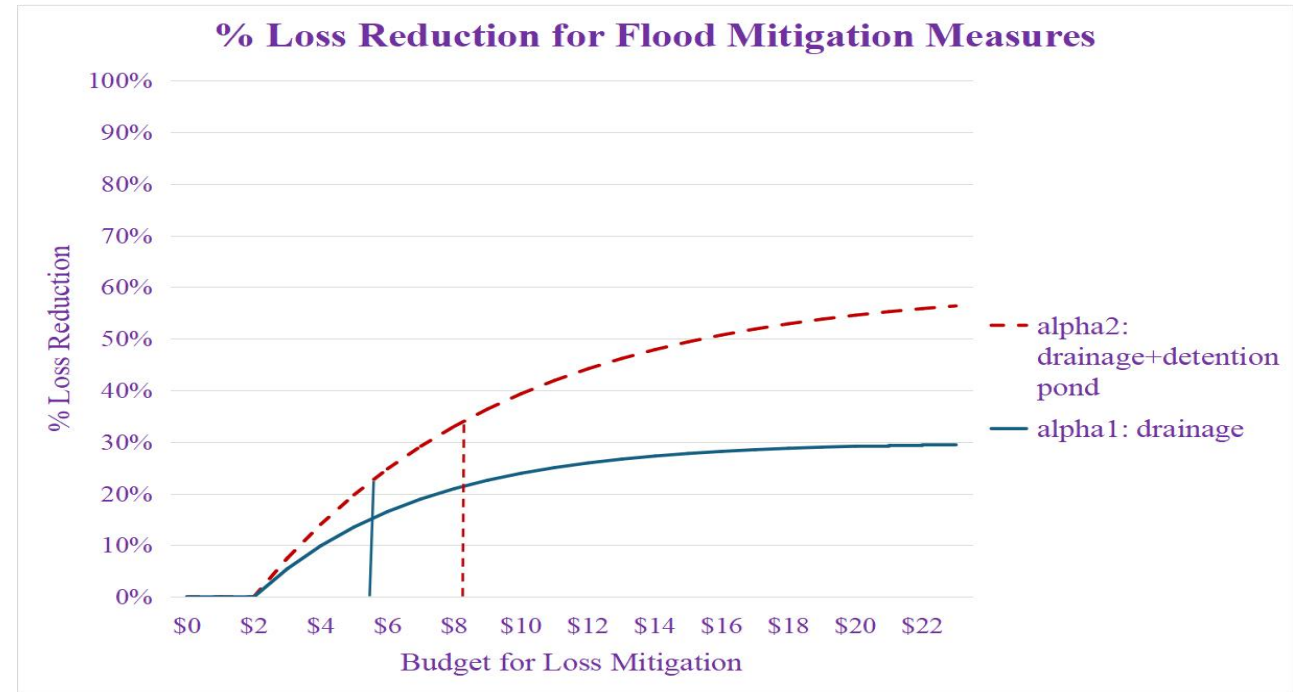
Use: Disaster modeling & resource allocation.

- Response efficiency ↑ **35%**
- Ops cost ↓ **20%**

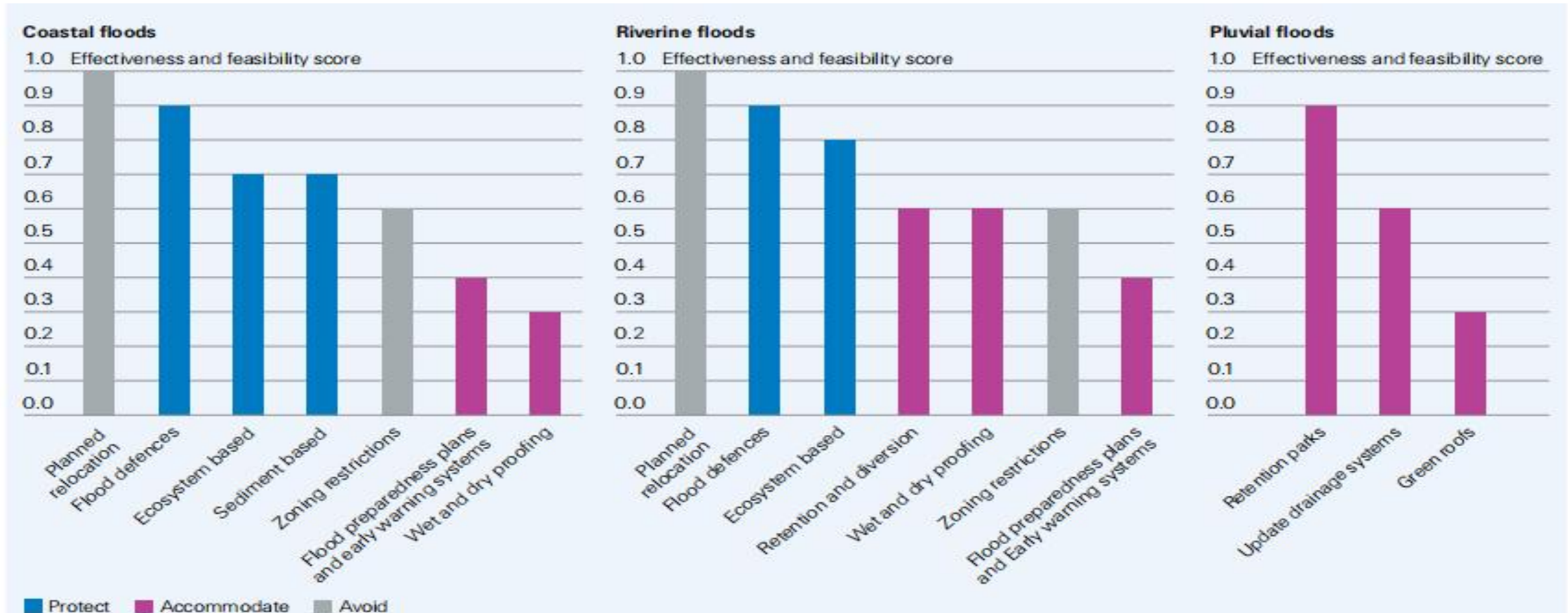
Smart technology investment delivers high ROI by minimizing losses, cutting operational costs!

$$\text{LRF Formula: } \alpha(z) = \alpha^{up} \left(1 - e^{-\rho \frac{z}{z_0}} \right)$$

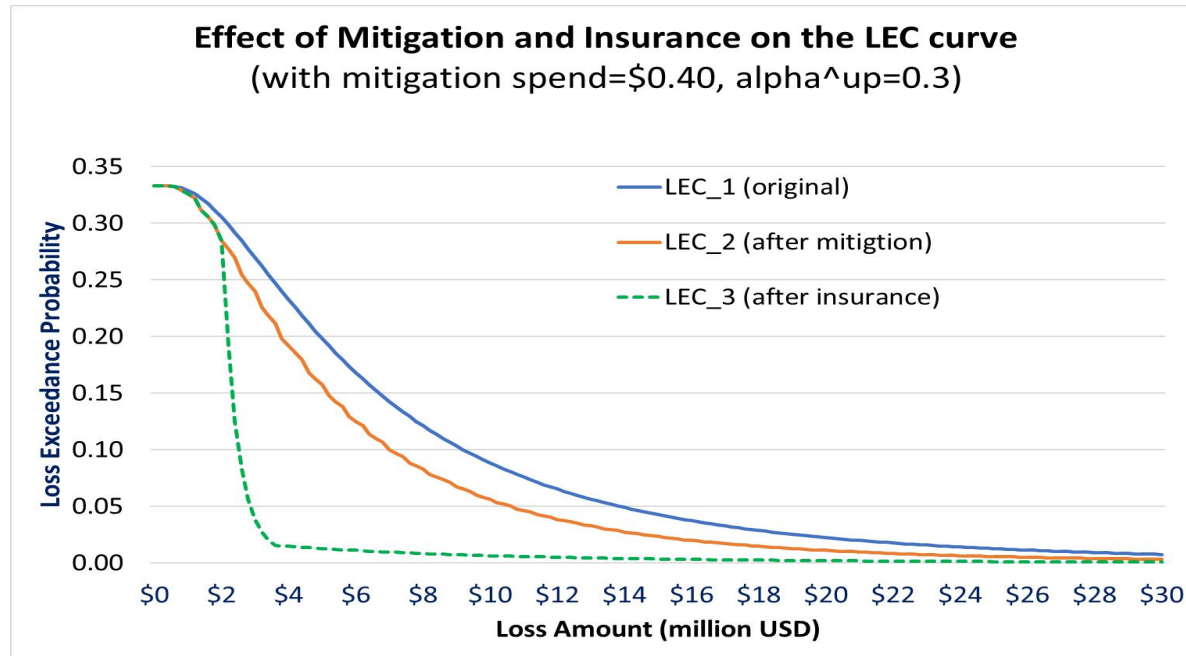
- $\alpha(z)$: the loss reduction percentage
- z : the amount of mitigation spending
- z_0 : the anchor spending
- α^{upper} : the maximal loss reduction
- $0 \leq \rho \leq 1$: the effectiveness coefficient



Empirical Studies of Loss Reduction Function



Source: Swiss Re Institute



Three curves, one decision problem

- LEC₁: the original loss exceedance curve under natural disaster risk.
- LEC₂: the curve after mitigation investment reduces hazard impact and vulnerability.
- LEC₃: the retained-loss curve after insurance transfers part of the remaining risk.

Question: how to allocate budget between mitigation spending and risk transfer?

1. Insurance Risk Innovation

Climate De-Risk Insurance (CDRI)

Redirects premium funds to pre-disaster prevention, aligning financial mechanisms with proactive risk reduction rather than just post-event payouts.

Parametric Insurance Models

Triggers automatic, transparent payouts based on objective weather or seismic metrics, eliminating delays in traditional claims processing.

2. Incentive-Driven PPPs

Conditional Subsidies

Government insurance subsidies are tied to verified resilience upgrades—such as flood-proof infrastructure or early warning systems—ensuring public funds drive measurable risk reduction.

Risk-Differentiated Pricing

Insurance premiums reflect actual risk exposure, rewarding cities with low-risk zoning and green infrastructure. This creates a financial incentive for proactive urban planning.

3. Digital Infrastructure

Blockchain Smart Contracts

Enables fraud-proof, real-time disbursement of emergency funds and insurance payouts. Immutable ledgers ensure transparency and accountability in financial transactions.

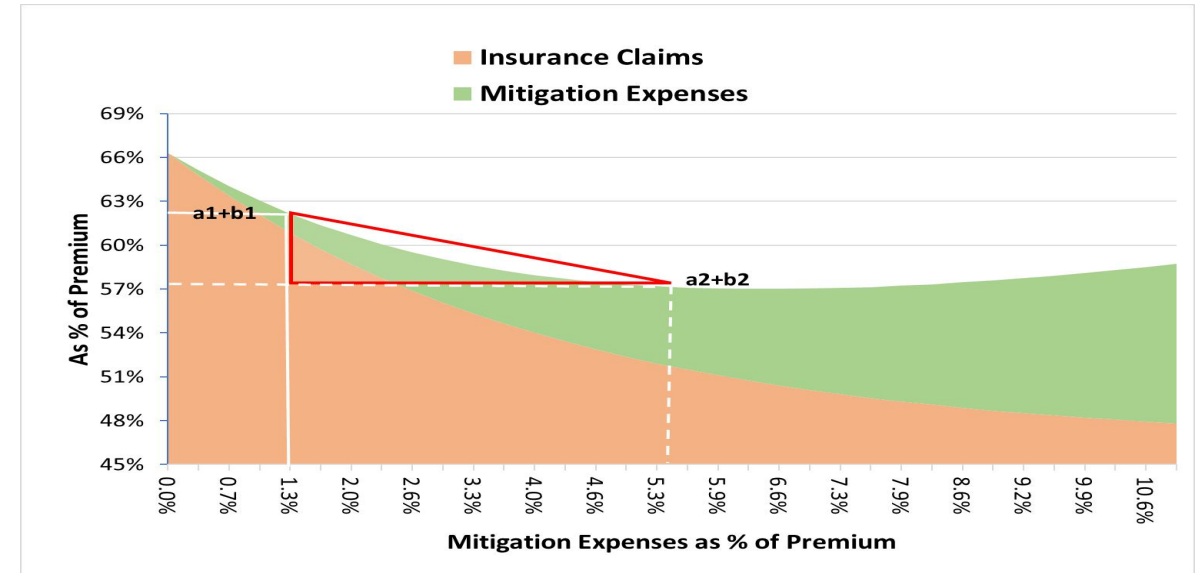
Tokenized Resilience Assets

Transforms resilience projects into tradable digital assets, unlocking liquidity from institutional investors and democratizing access to green infrastructure financing.

Core Mindset Shift: Resilience is an Investment, Not an Expenditure.
Proactive investment in urban resilience yields a **4:1 to 7:1** return on investment.

An Example of Climate De-Risk Insurance in Action

- In 2022, total agricultural insurance premiums in Guangdong Province were **8.11 billion yuan**, the insurance loss ratio was **60.8%**.
- Risk mitigation expenditure of **108 million yuan** (1.33% of premium) resulted in loss reduction of **448 million yuan**.



	a. Mitigation Spending	b. Insurance Loss Ratio	Total Cost: a+b
Case (1)	1.33%	60.80%	62.13%
Case (2)	5.50%	51.63%	57.13%
Difference: (2) - (1)	+4.33%	-9.17%	-5.00%



- ① Ping An targets high-risk road sections in county-level rural areas, implemented road-traffic safety + hazard mitigation
- ② Leveraging claims data to pinpoint hazardous road segments, the project cooperates with traffic authorities.
- ③ Customised improvement plans are formulated for each site, with safety hardware and traffic lights



Those traffic lights light up safe roadways across 270 counties

31
Covered Provinces

1404
Road Segments
Improved

8044
Installed
Safety-Facility

90%
Accident-Rate Reduction

Transforming from a Developer to a City Resilience Operator

From "Construction" to "Resilience Operator"

Working closely with urban planning to play a key role in building urban resilience.

District Master Planning Model

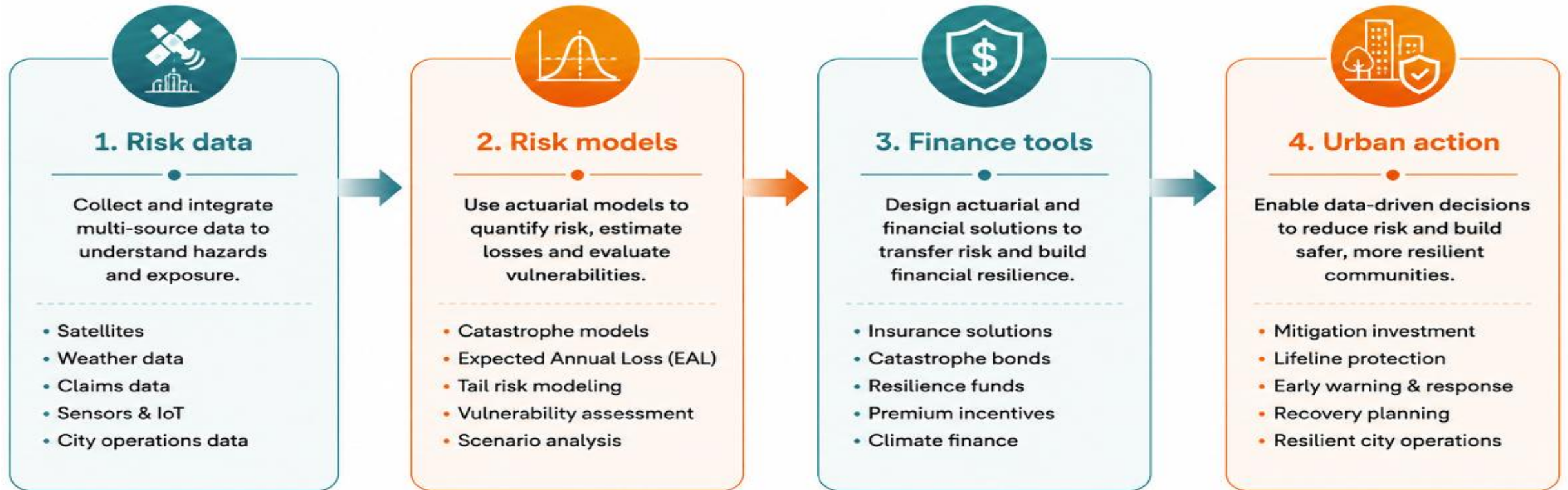
Integrating the concept of urban resilience into the entire project lifecycle, from planning and design to post-construction operations.

Nanshan Houhai Central Area

A success story of how China Resources Land contributes to City Development



From the old Dachong Village to today's China Resources City



The complete cycle: from data, to models, to finance, to city action.

The Resilience Actuary: Integrate Cross-Disciplinary Expertise to Build Resilient Urban Financial Solutions

Hazard-Exposure Data

1. **Hazard data:** Use rainfall, typhoon, flood, and heat scenarios for frequency-severity loss estimates
2. **Exposure data:** public assets, key infrastructure

Vulnerability & Loss Reduction

1. Urban Planning Experts
2. Construction Experts (drainage system, NBS)
3. Nature-based solutions and GEP quantification

Design financial solutions

1. Parametric index-based insurance
2. Mitigation, Retention vs transfer
3. Economic Value Added for actions

New Actuarial Skills Required:

- (1) Collect and integrate professional insights from cross-sector specialists
- (2) Master technical approaches toward risk loss mitigation and climate adaptation
- (3) Build creative financial solutions that create value for all involved stakeholders

Growing Demand of Talents in Asia

1. Asia faces intensifying climate change, rapid urbanization and expanding new and emerging risks.
2. The bottleneck is talent who can translate early-warning technology into quantifiable, pricable and implementable solutions.
3. These skills extend actuarial strengths into urban resilience, infrastructure risk and sustainability finance.

Climate & urban risk

Typhoons, floods, lifeline systems, low-altitude economy and energy storage.

Risk reduction practice

Monitoring, mitigation, cost-benefit analysis and premium-discount design.

AI & digital systems

Digital twins, early warning and rapid loss assessment.

**January 25–30, 2026 · jointly offered
with CAS China**



- **Curriculum:** urban planning, loss mitigation practices, AI-enabled early warning systems, emergency management, index-based insurance.

- **Field visits:**

- Shenzhen Weather Station;
- China Resources Land;
- Industrial & Commercial Bank of China
- Ping An Insurance

The camp trains the next generation of professionals to bridge actuarial science, engineering, and AI for scalable urban resilience solutions

Closing Remarks

- 1. Unaddressed climate and infrastructure risks create rising, non-linear costs—proactive resilience investment is the only way to avoid this fiscal trap.**
- 2. New technologies cut losses and operational costs, delivering high ROI that makes resilience investments accessible for cities.**
- 3. Actuaries can advance urban resilience through cross-disciplinary collaboration, innovative finance, and data-driven risk management.**



Thank you!

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