

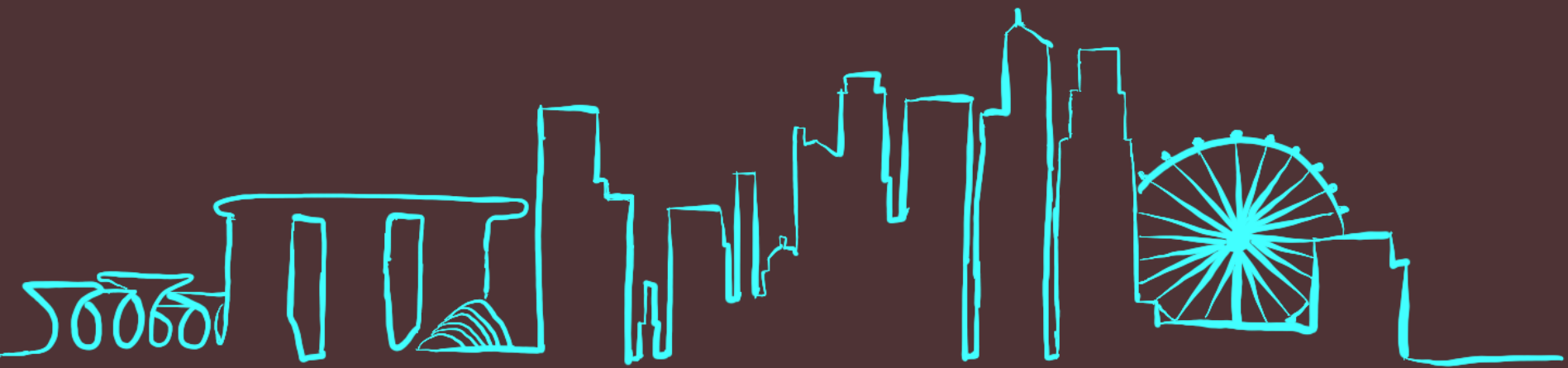
DISRUPTING DISASTER CHOOSING THE RISK TRAJECTORY OF OUR CITIES

**David Lallemant | david-lallemant.com | [@davidlallemant](https://twitter.com/davidlallemant)
Asian School of the Environment, NTU | Stanford Urban Resilience Initiative**

Urban Risk and Resilience



Urban Risk and Resilience



Chiang Mai, Thailand



Source: R Maps Package

Chiang Mai, Thailand, 2005 floods



Source: David Lallemant

Chiang Mai, Thailand – Wat Chedi Luang damaged in the 1545 earthquake



Source: David Lallemant

Banda Aceh following the 2004 Indian Ocean Tsunami



Source: AP Photo/Eugene Hoshiko

Downtown Port-au-Prince, Haiti, 2010



Source: David Lallemant

Christchurch, New Zealand, 2011

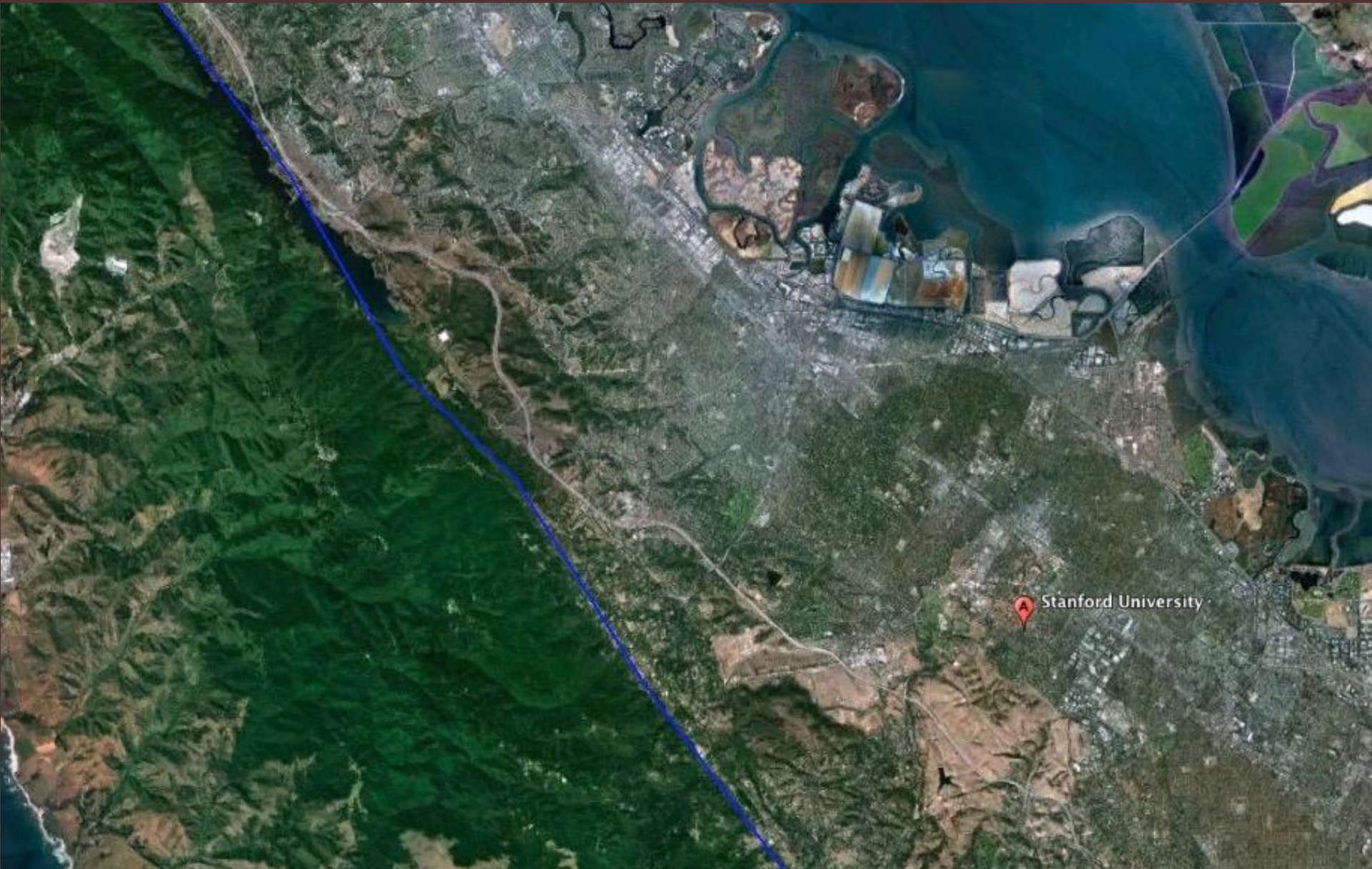


Kathmandu, Nepal, 2015



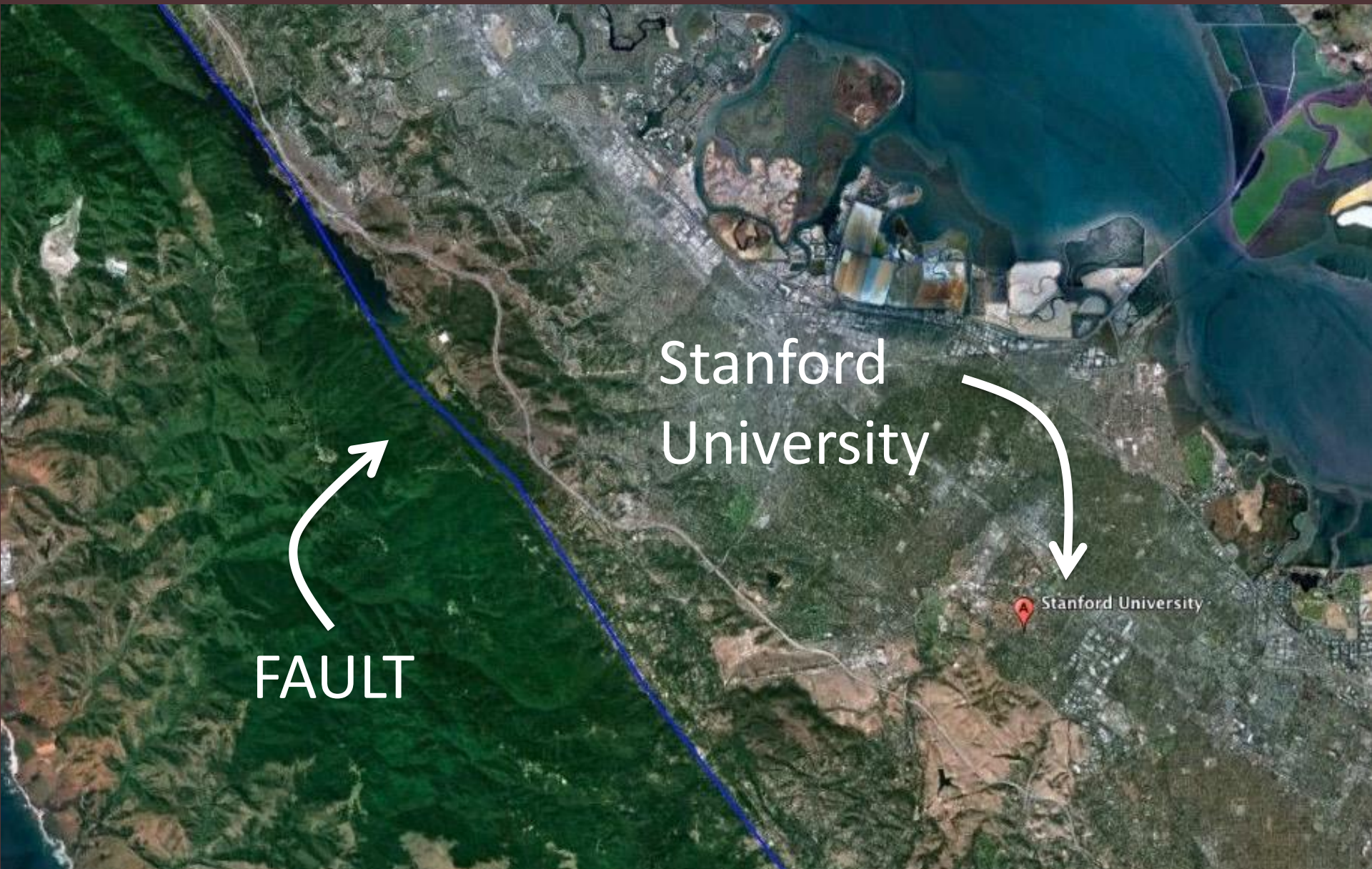
Source: Niranjana Shrestha, AP Photo

Stanford Campus and the San Andreas Fault



Source: Google Earth Image

Stanford Campus and the San Andreas Fault



Source: Google Earth Image

Shakespeare on “Un-Natural” Disasters

Shakespeare on “Un-Natural” Disasters

King Lear, Act1, Scene 2.

The Earl of Gloucester says:

"These late eclipses of the sun and moon portend no good to us. Though the wisdom of nature can reason it thus, and thus, yet nature finds itself scourged by the sequent effects. Love cools, friendship falls off, brothers divide. In cities, mutinies; in countries, discord; in palaces, treason; and the bond cracked 'twixt father."



Shakespeare on “Un-Natural” Disasters

Then the earl leaves, and his son Edmund responds:

"This is the excellent foppery of the world, that when we are sick in fortune, often the surfeit of our own behaviour, we make guilty of our disasters the sun, the moon and the stars, as if we were villains on necessity, fools by heavenly compulsion, knaves, thieves and treachers by spherical predominance; drunkards, liars and adulterers by an enforced obedience of planetary influence; and all that we are evil in by a divine thrusting on. An admirable evasion of whoremaster man, to lay his goatish disposition on the charge of a star."

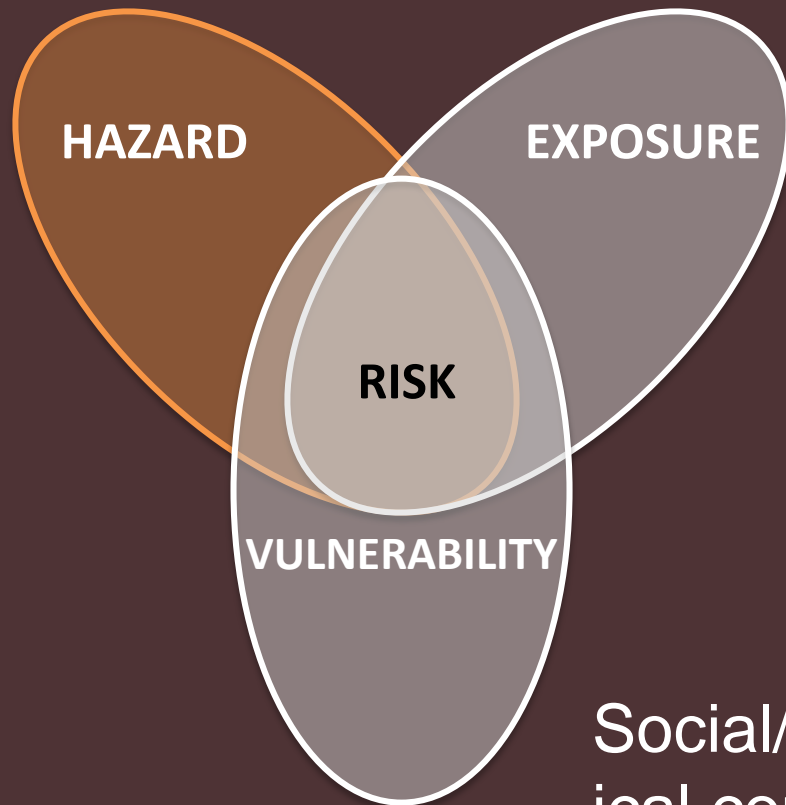
Definitions: Risk, Hazard, Vulnerability, Exposure

Definitions: Risk, Hazard, Vulnerability, Exposure



Definitions: Risk, Hazard, Vulnerability, Exposure

Geophysical
drivers



People,
Assets

Social/economic/physical
conditions

Definitions: Risk, Hazard, Vulnerability, Exposure

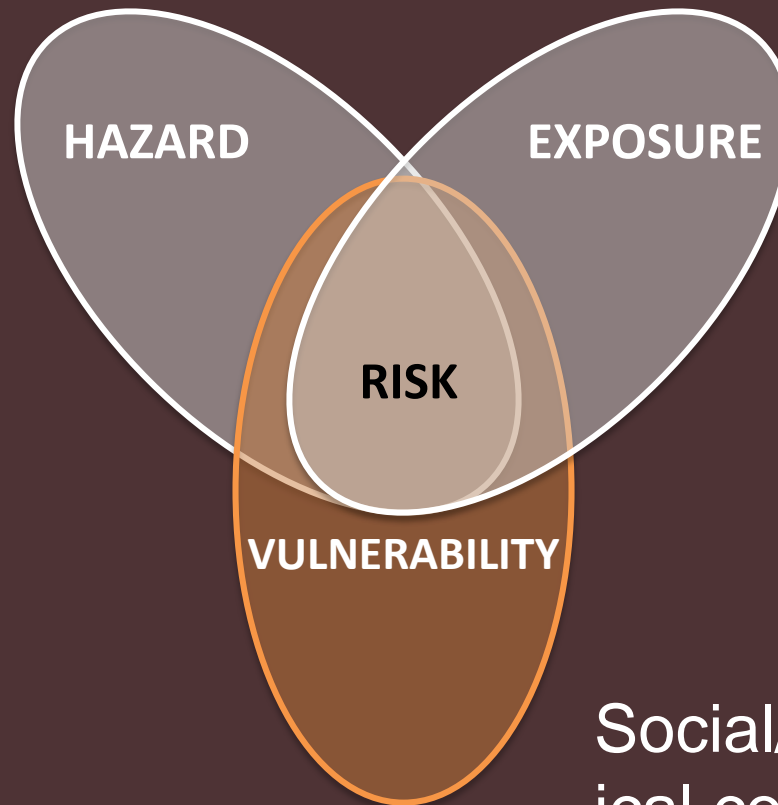
Geophysical
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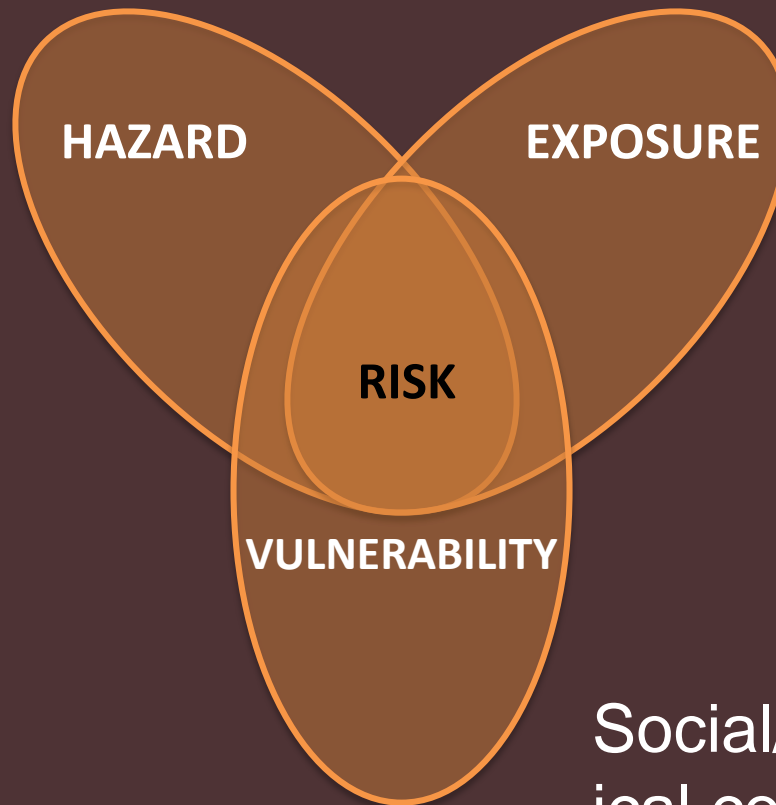


People,
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Definitions: Risk, Hazard, Vulnerability, Exposure

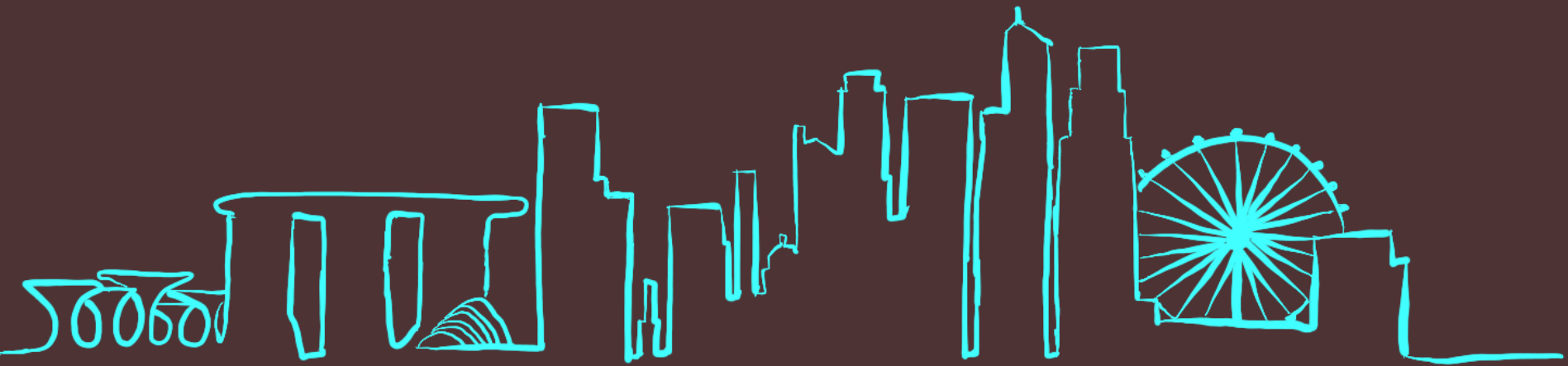
Geophysical
drivers

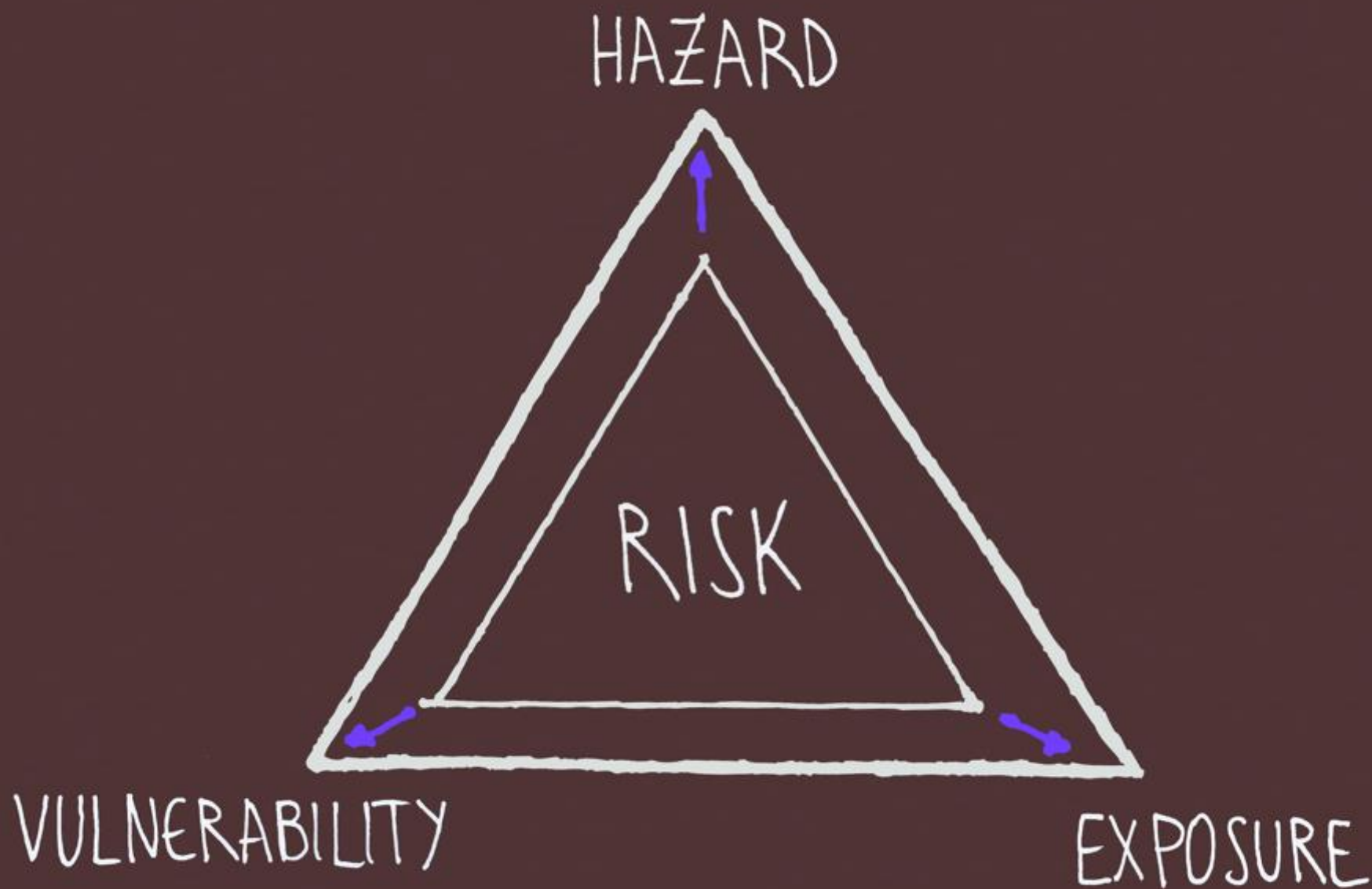


People,
Assets

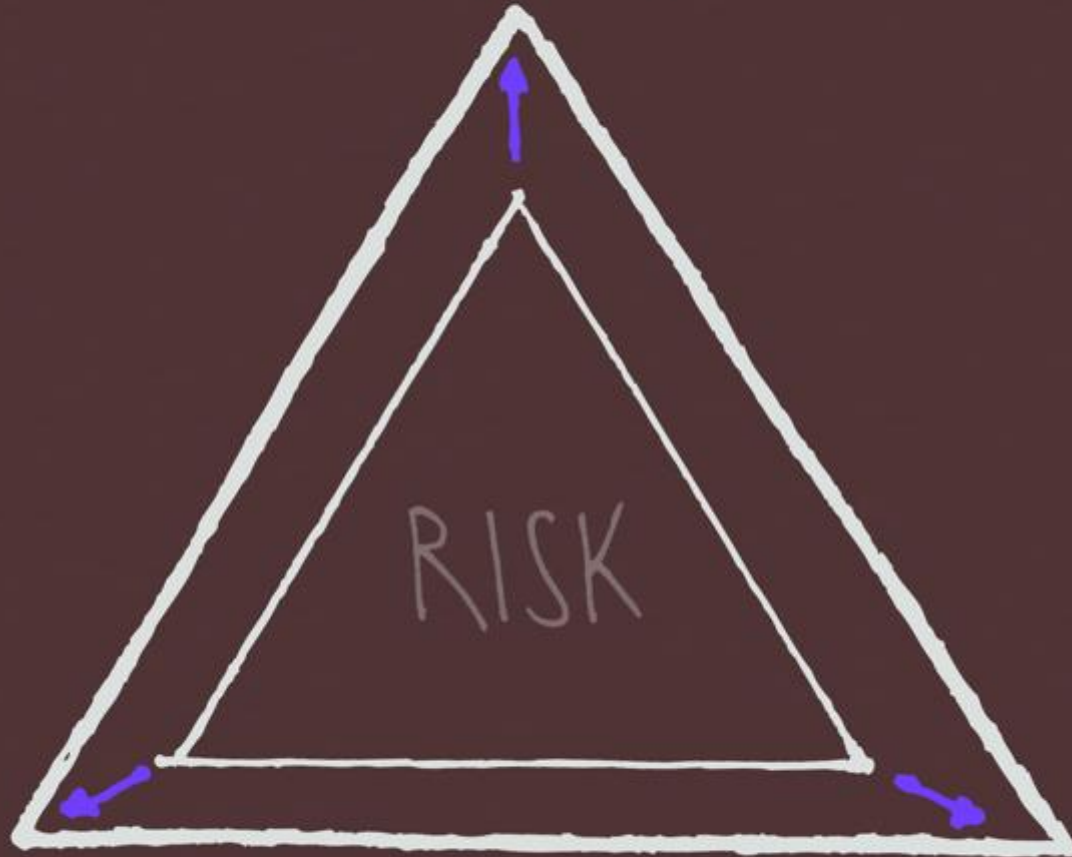
Social/economic/physical
conditions

Urban Risk and Resilience



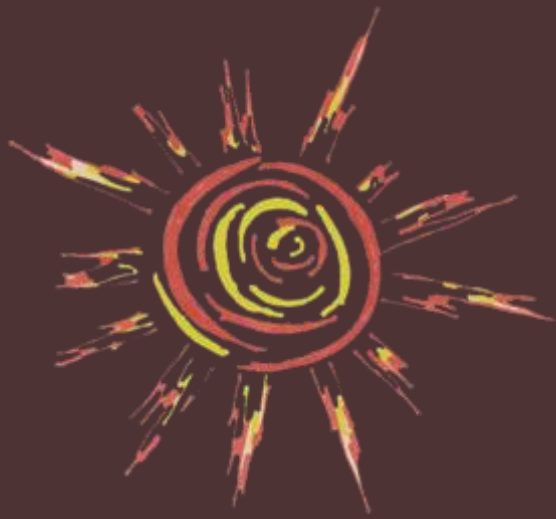


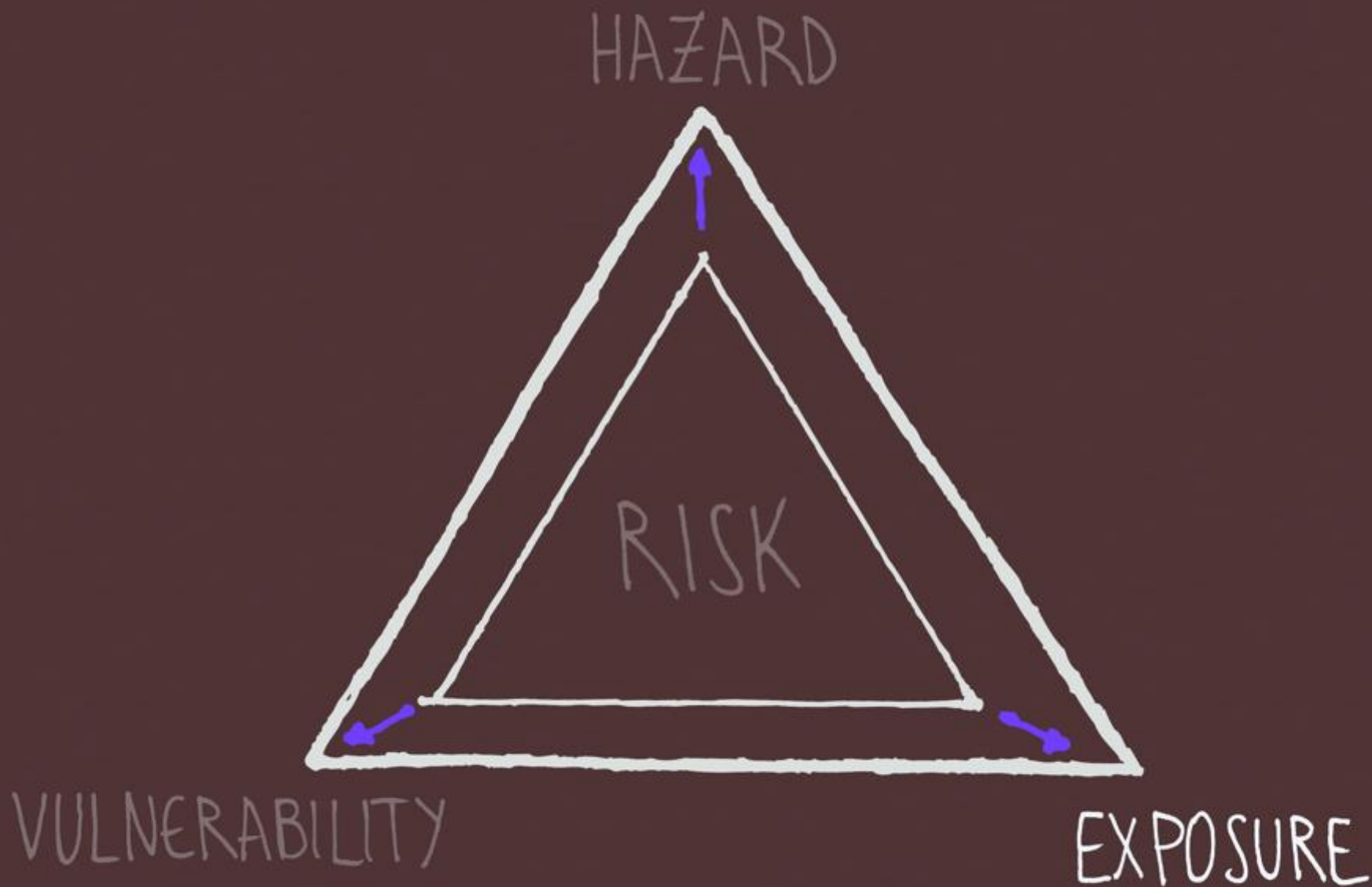
HAZARD



VULNERABILITY

EXPOSURE





60 YEARS OF GLOBAL URBANIZATION



RURAL POPULATION



URBAN POPULATION



1970

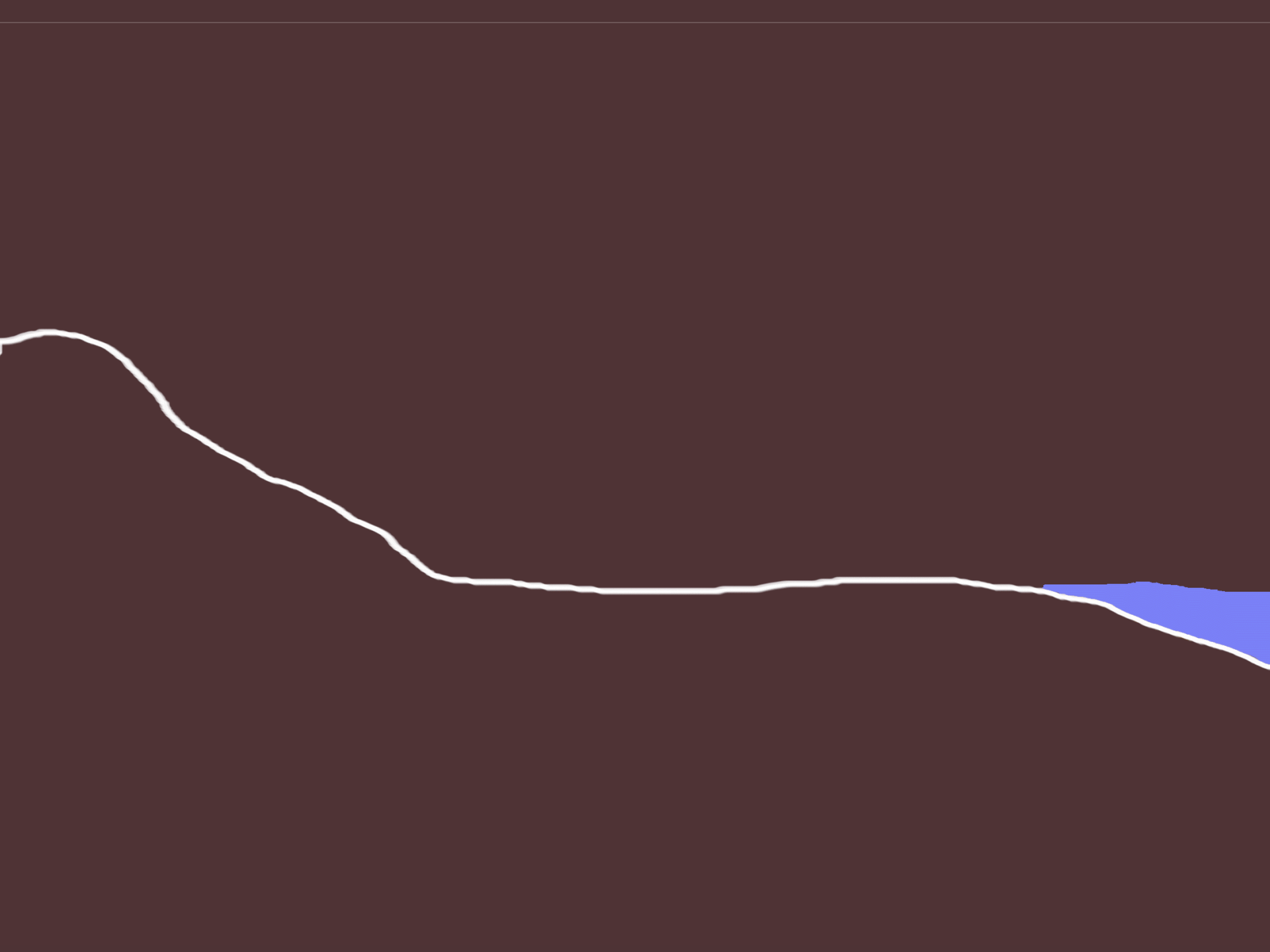


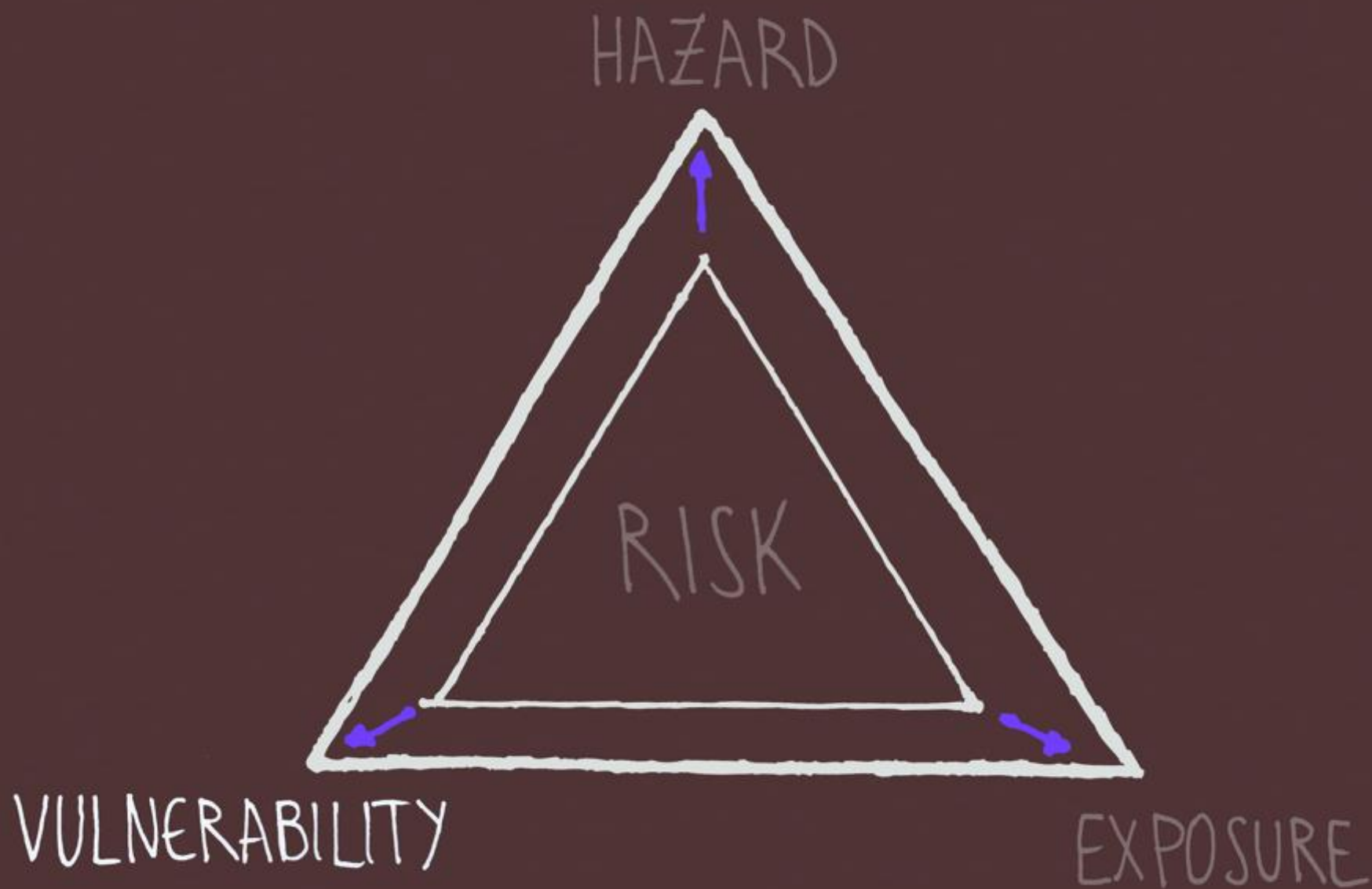
2015

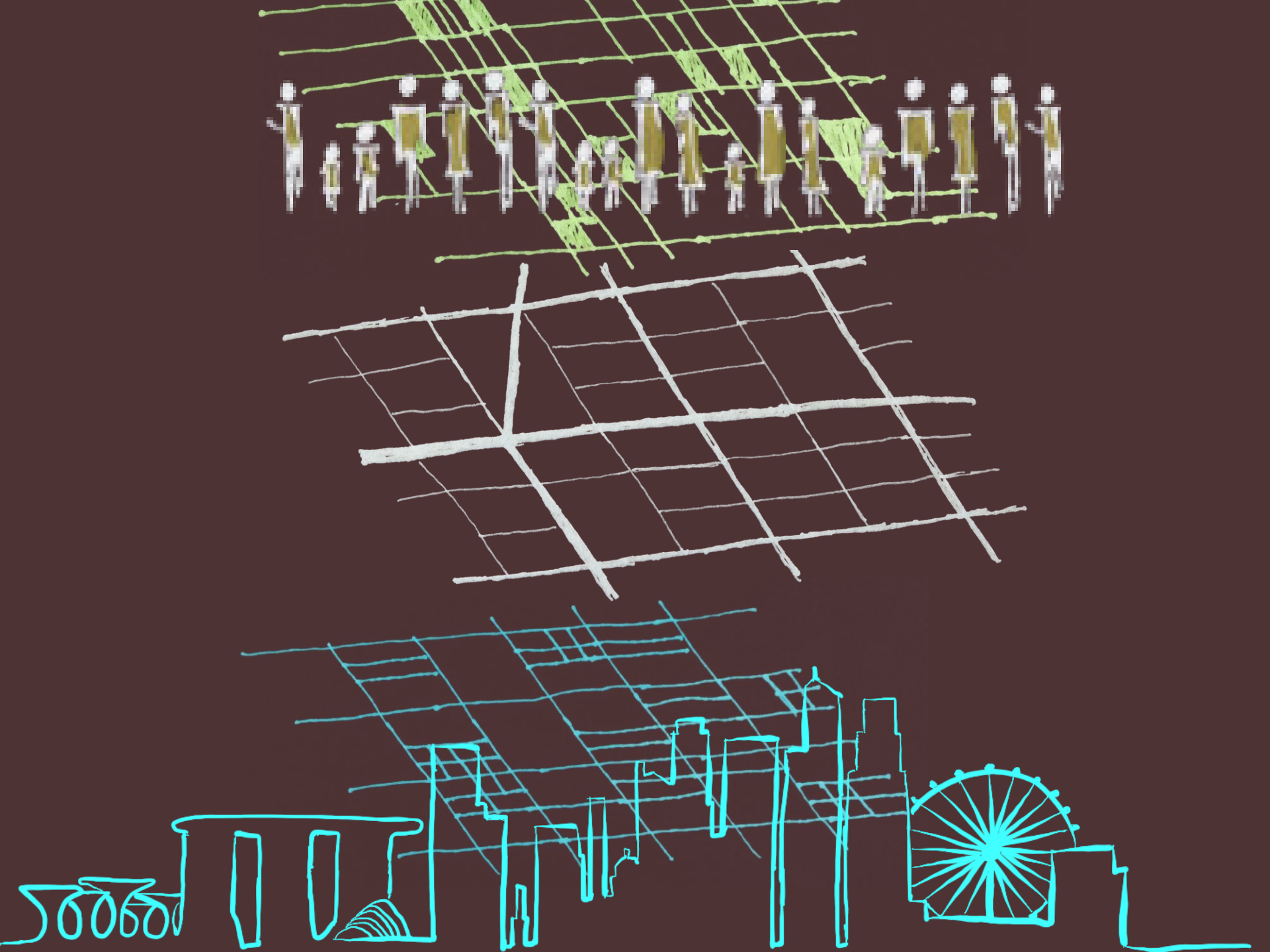


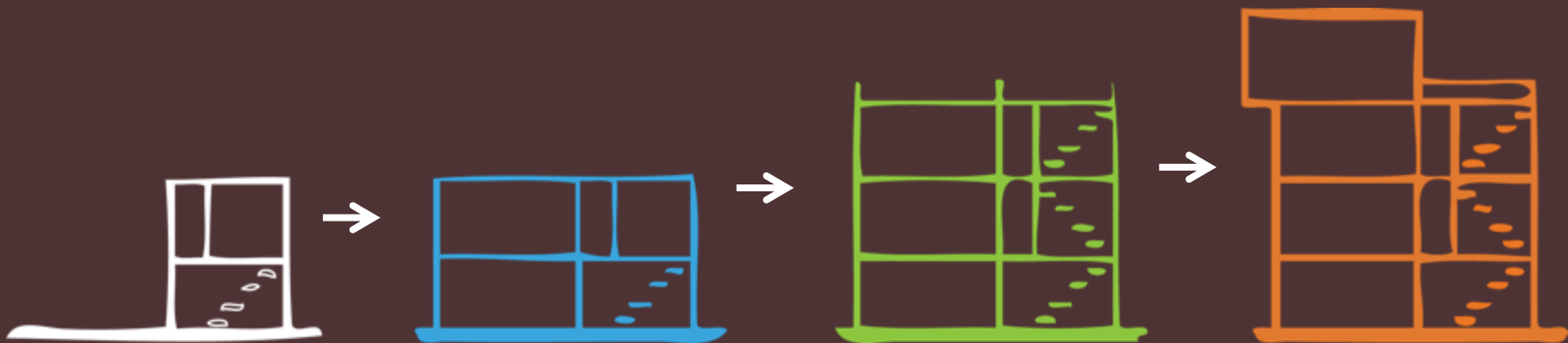
2030

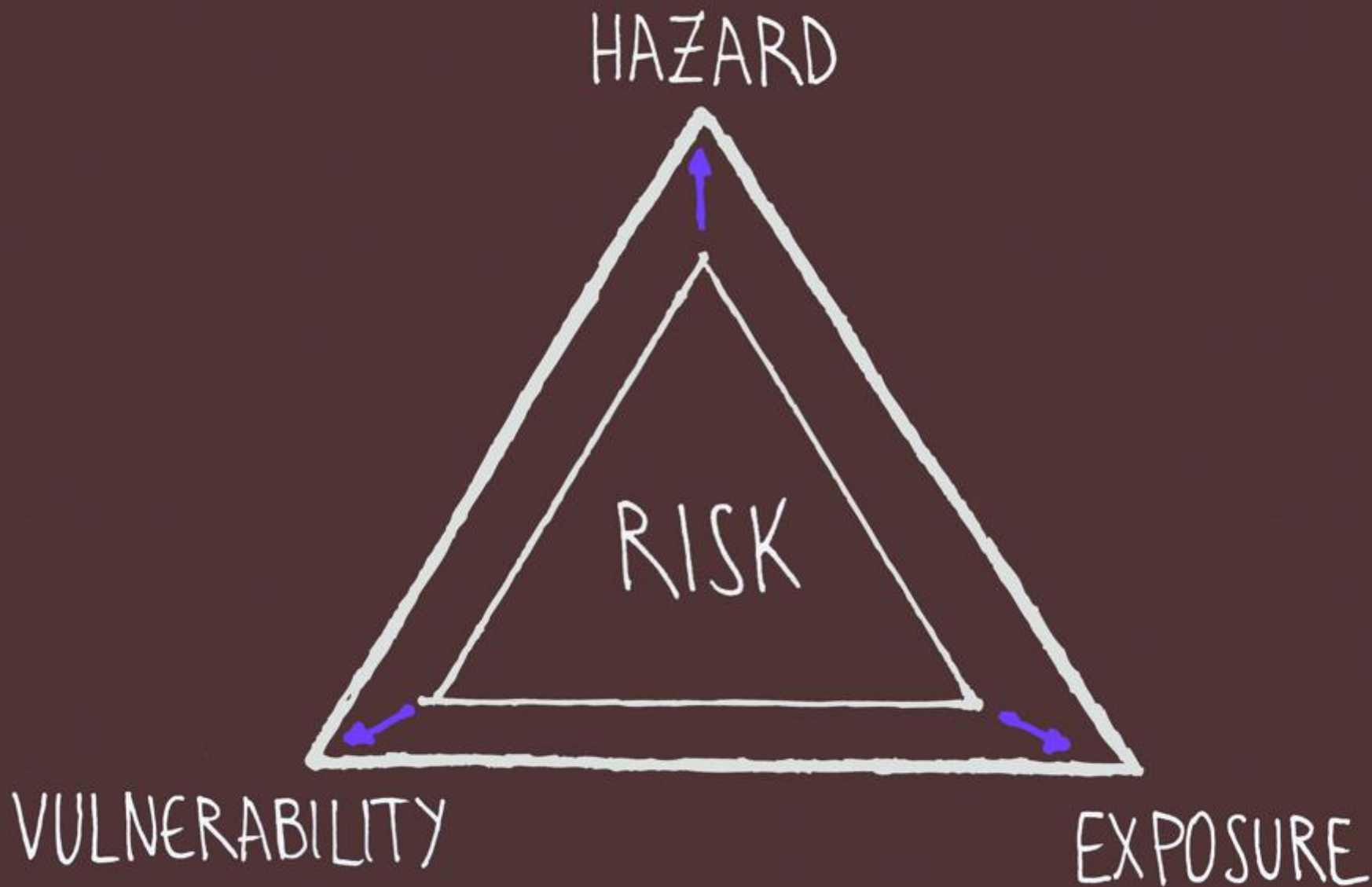




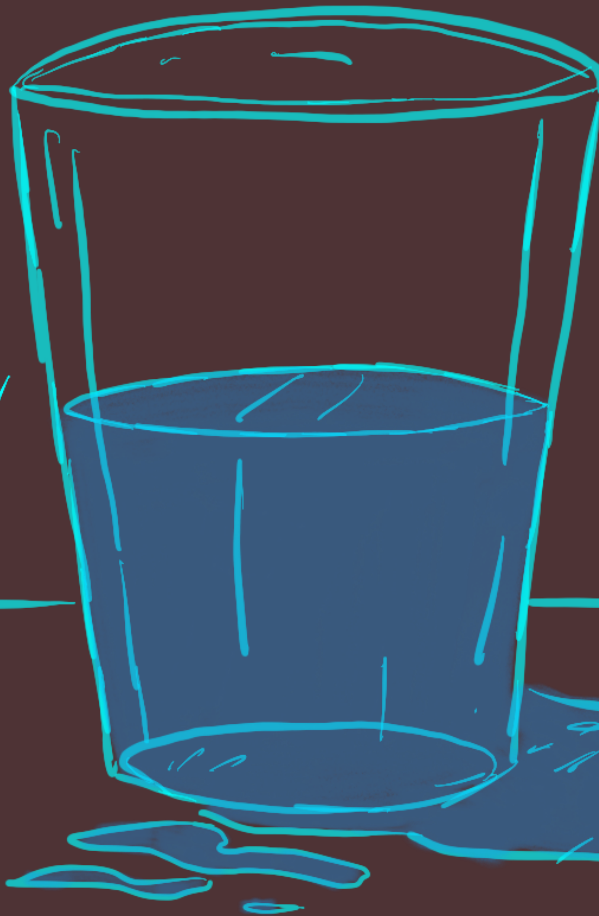








HALF
EMPTY



↑
HALF
FULL

60 YEARS OF GLOBAL URBANIZATION



RURAL POPULATION



URBAN POPULATION



1970



2015



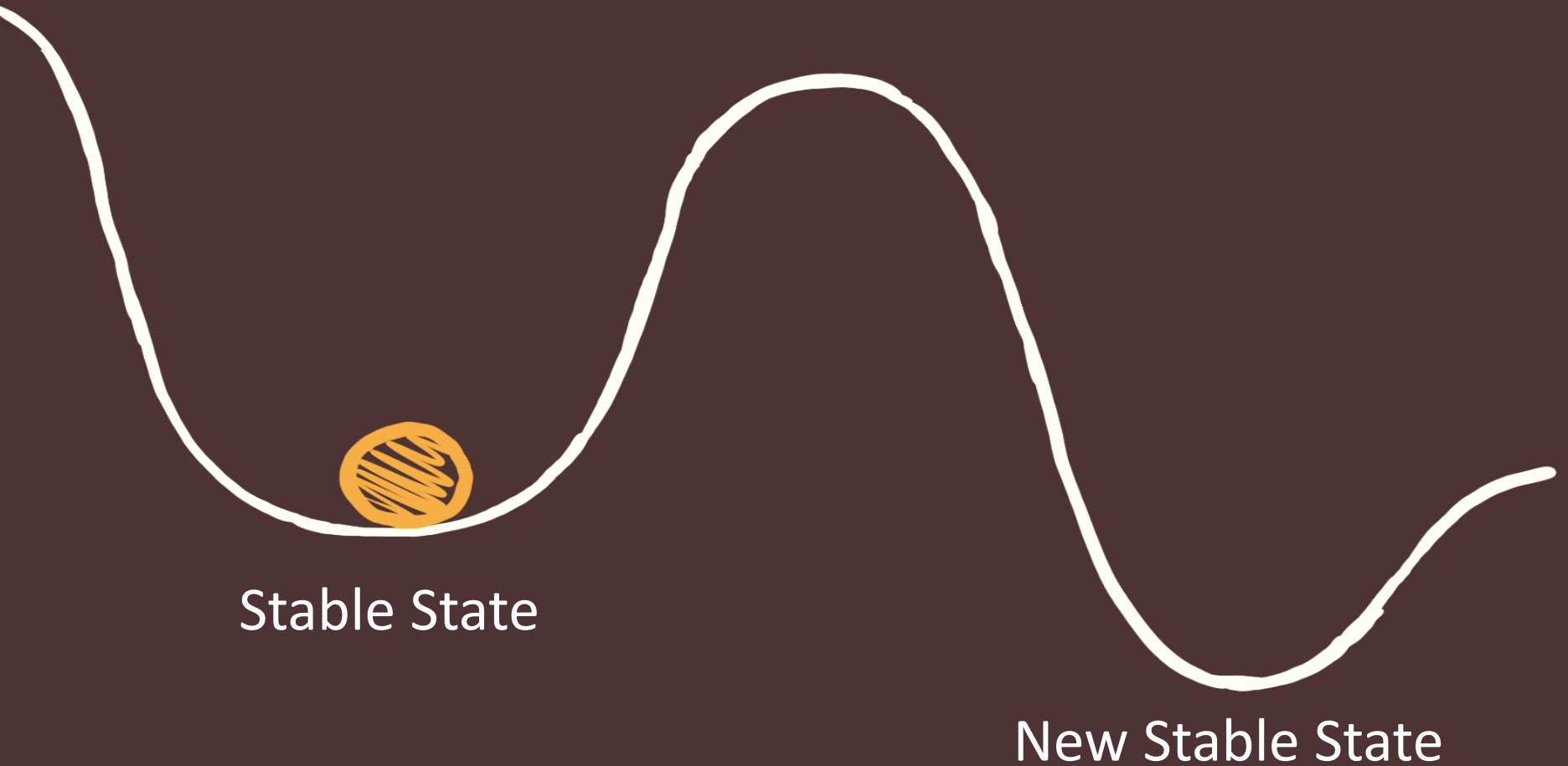
2030



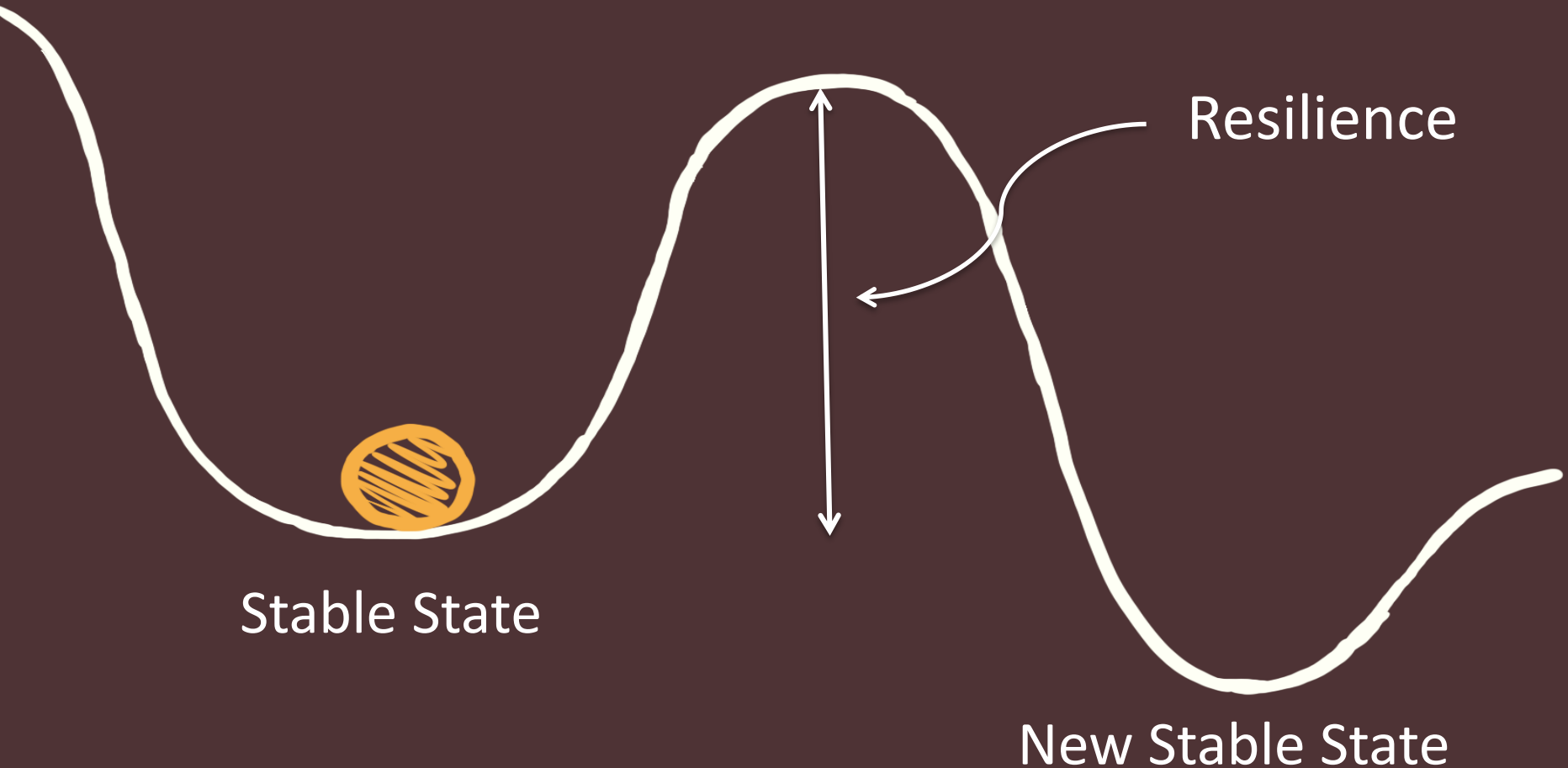
Disrupted Balance
Society at (increasing) Risk

So what do we do?

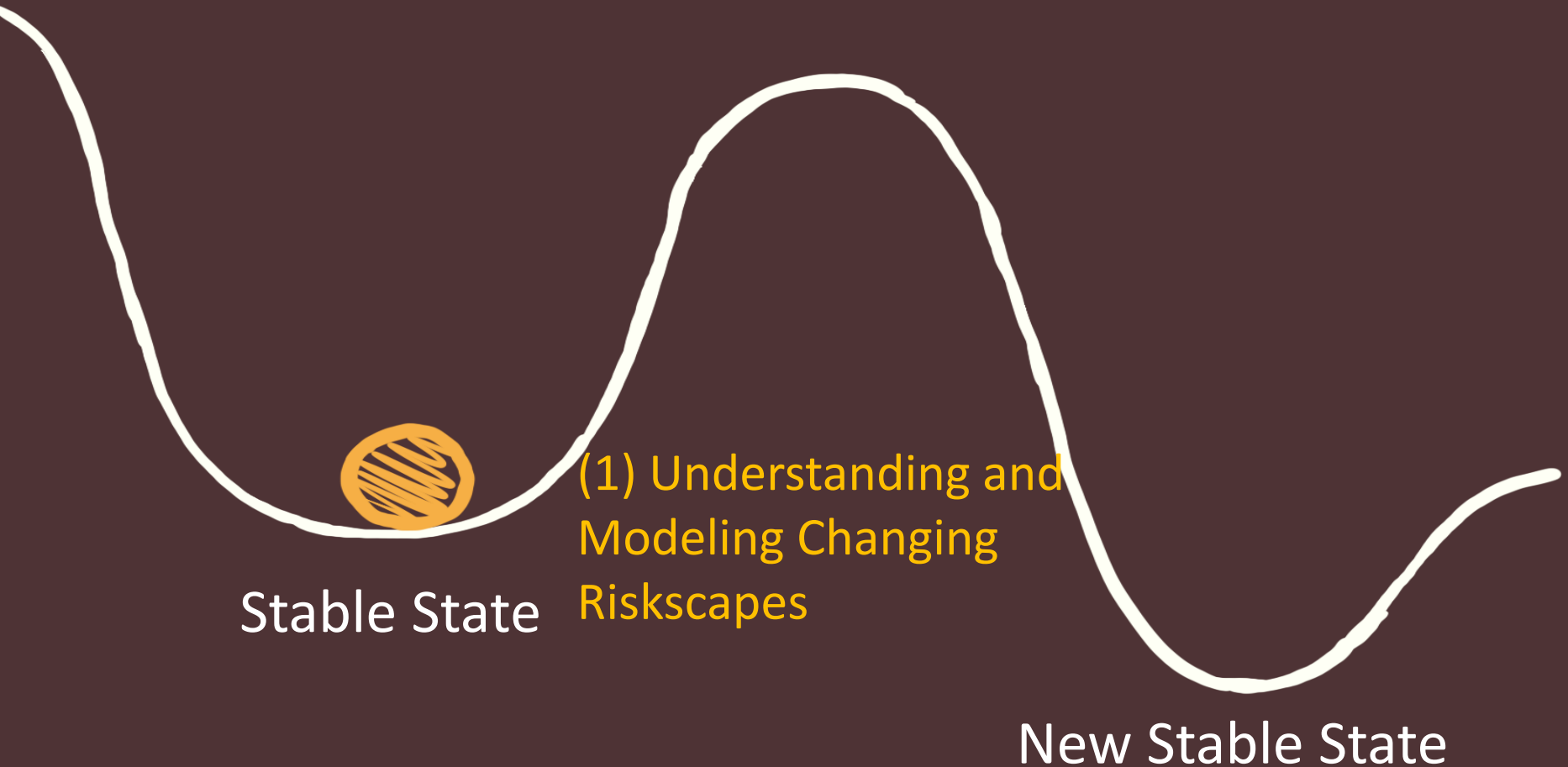
Ecological Concept of Resilience



Ecological Concept of Resilience



Ecological Concept of Resilience



HAZARD MODELING

NOVEL SPATIAL ANALYSIS TECHNOLOGIES
FOR MODELING SPATIALLY DISTRIBUTED
HAZARDS [COLLABORATION W/ GOOGLE
AND USGS]

EXPOSURE MODELING

NOVEL TECHNOLOGIES FOR CAPTURING
EXPOSURE AND ITS CHANGES OVER
TIME [GOOGLE, WORLD BANK, GFDRR]

DAVID'S RESEARCH

STORYBOARD

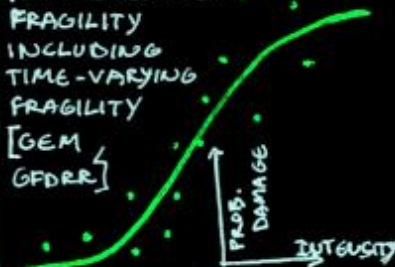
RESILIENCE POLICY AND PLANNING



PRODUCING EVIDENCE
AND DEVELOPING TOOLS
TO PROMOTE SUSTAINABLE
AND RESILIENT CITIES

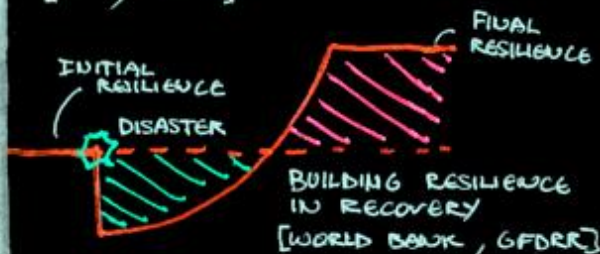
VULNERABILITY MODELING

STATISTICAL PROCEDURES
FOR MODELING
FRAGILITY
INCLUDING
TIME-VARYING
FRAGILITY
[GEM
GFDRR]



DISASTER RECOVERY

MODELING RECOVERY OVER TIME
[GEM, UCLA]



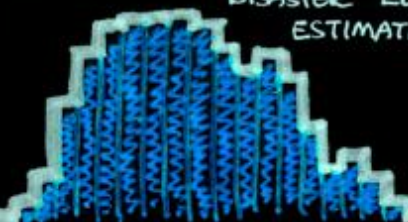
POST-DISASTER DAMAGE ASSESSMENT



REMOTE SENSING
AND GEOSTATISTICAL
ANALYSIS FOR
RAPID POST-DISASTER
LOSS ESTIMATION.

LOSS PREDICTION

PROPAGATING UNCERTAINTY
IN URBAN OR REGIONAL SCALE
DISASTER LOSS
ESTIMATION



HAZARD MODELING

NOVEL SPATIAL ANALYSIS TECHNOLOGIES
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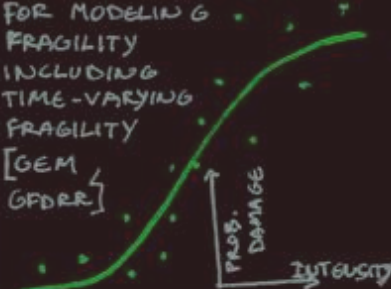
RESILIENCE POLICY AND PLANNING



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GFDRR]



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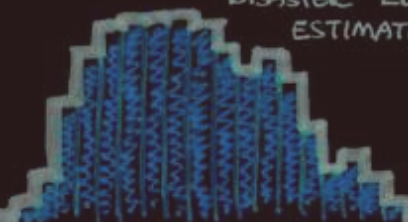
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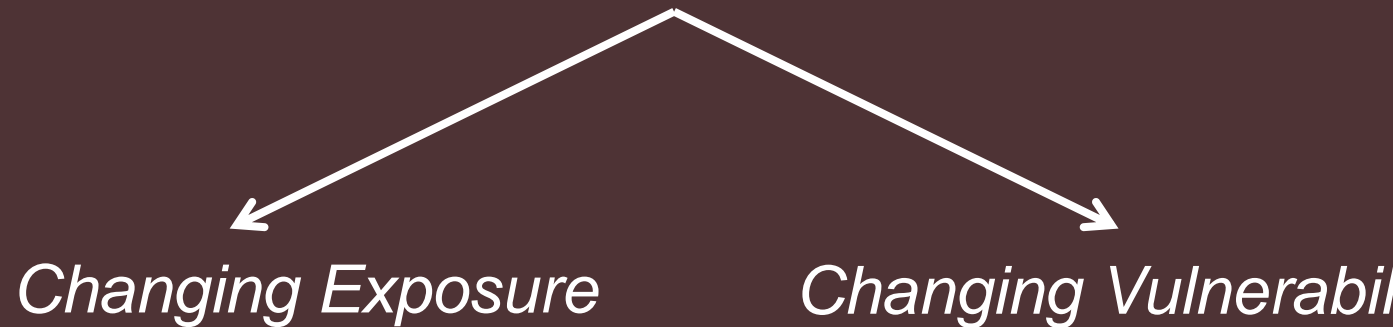
PROPAGATING UNCERTAINTY
IN URBAN OR REGIONAL SCALE
DISASTER LOSS
ESTIMATION



Understanding Changing Risksapes

Guiding questions:

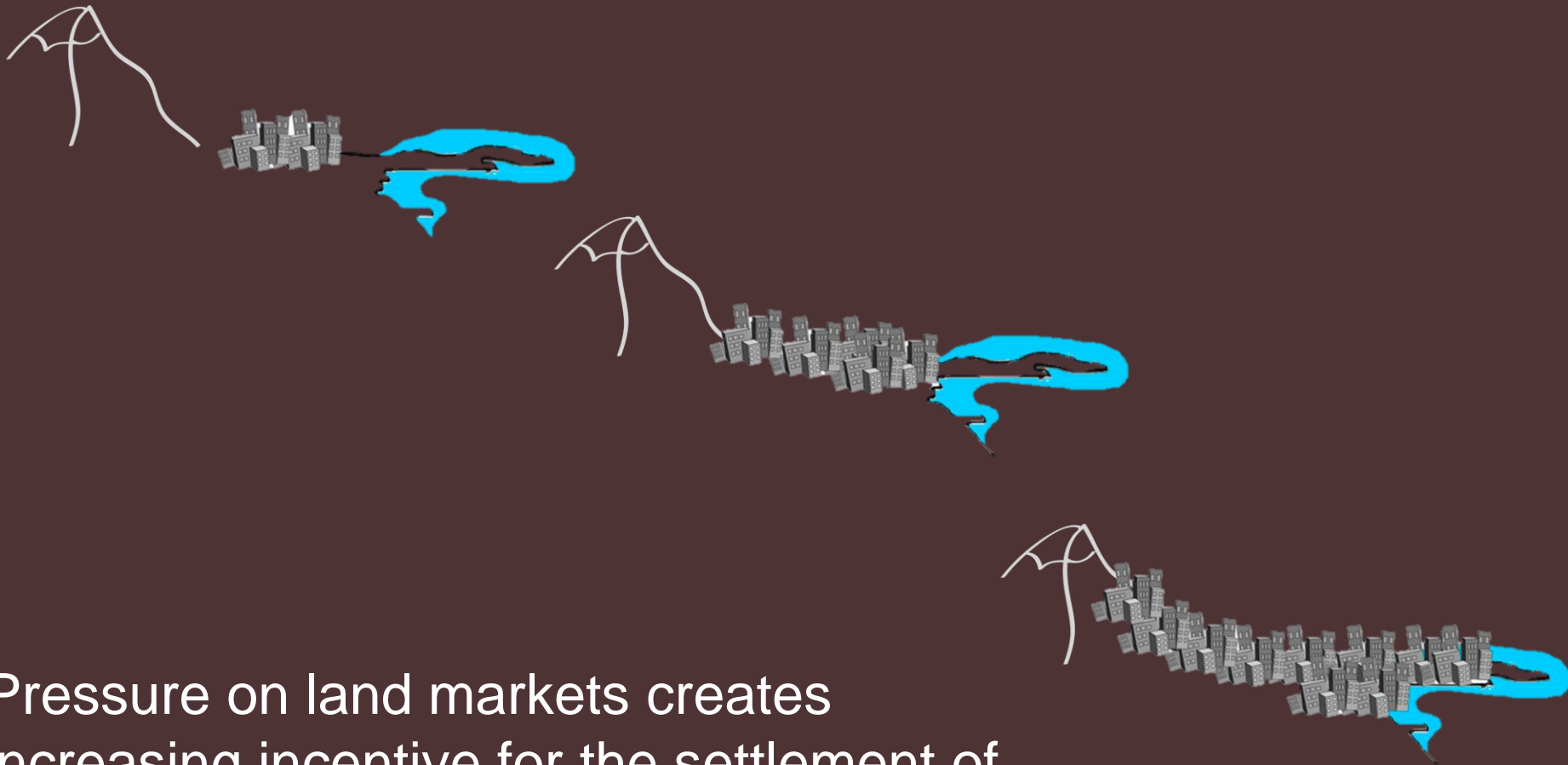
How are dynamic processes of urbanization changing the risk profile of cities? Focusing on two *dynamic process*:



Earthquake risk as case study (changing risksapes not driven by changing hazard)

What tools can be developed to support resilient and sustainable cities?

Understanding Changing Exposure

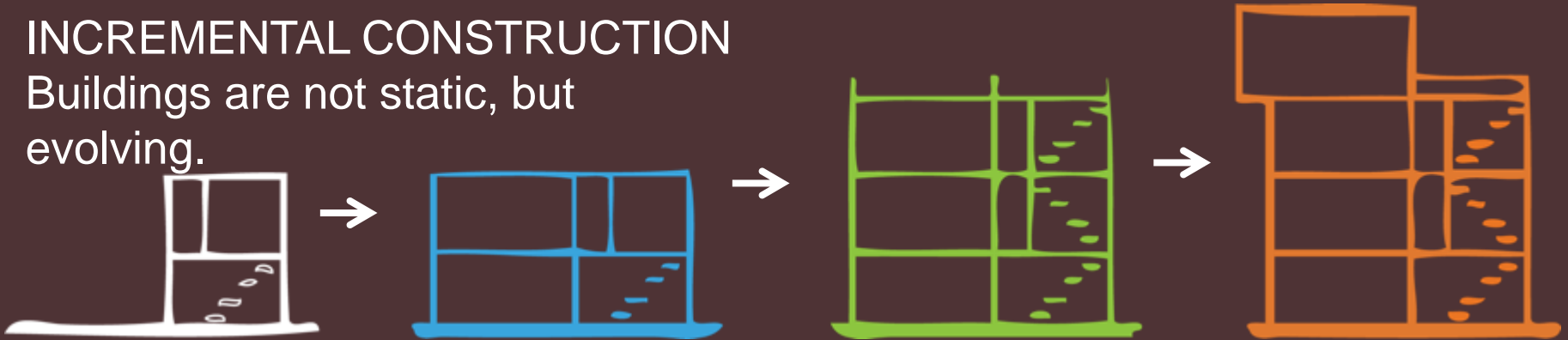


Pressure on land markets creates increasing incentive for the settlement of increasingly hazardous sites, including steep slopes, liquefiable land (reclaimed) flood zones etc.

Understanding Changing Vulnerability

INCREMENTAL CONSTRUCTION

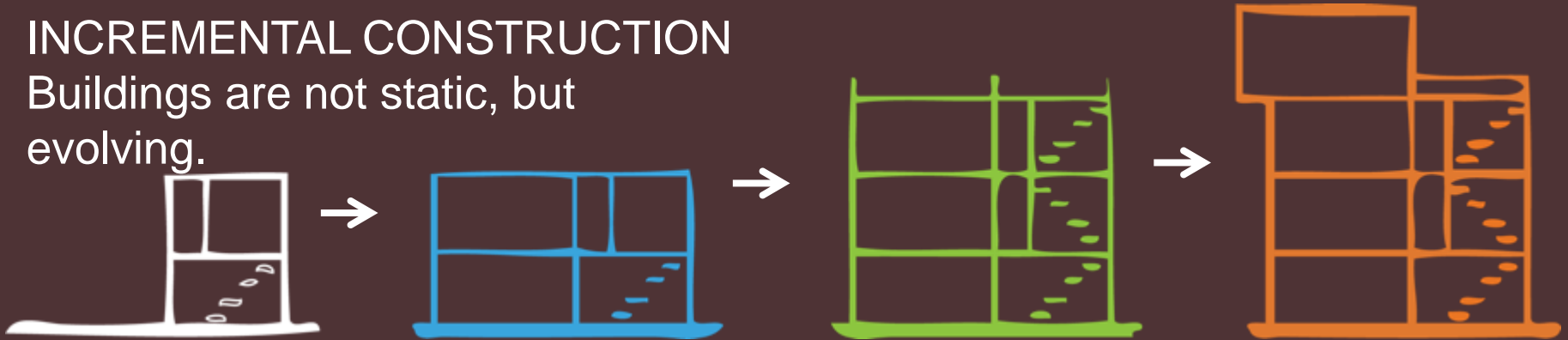
Buildings are not static, but evolving.



Understanding Changing Vulnerability

INCREMENTAL CONSTRUCTION

Buildings are not static, but evolving.



The add-hoc process of incremental construction is the default and most prevalent form of urban construction.



Julia King, "Incremental Cities"



April 24th, 2013

Source: Munir Uz Zaman Agence France-Presse



April 24th, 2013

Source: Munir Uz Zaman Agence France-Presse



April 24th, 2013

Source: Munir Uz Zaman Agence France-Presse



April 24th, 2013

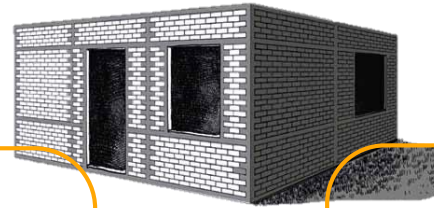
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Modeling Changing Risksapes

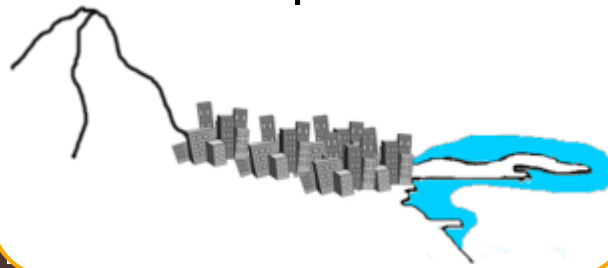
HAZARD



VULNERABILITY



EXPOSURE



LOS

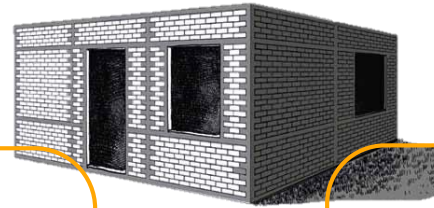


Modeling Changing Risksapes

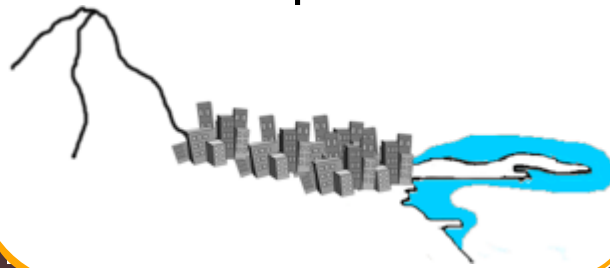
HAZARD



VULNERABILITY



EXPOSURE



LOS



(dynamic)

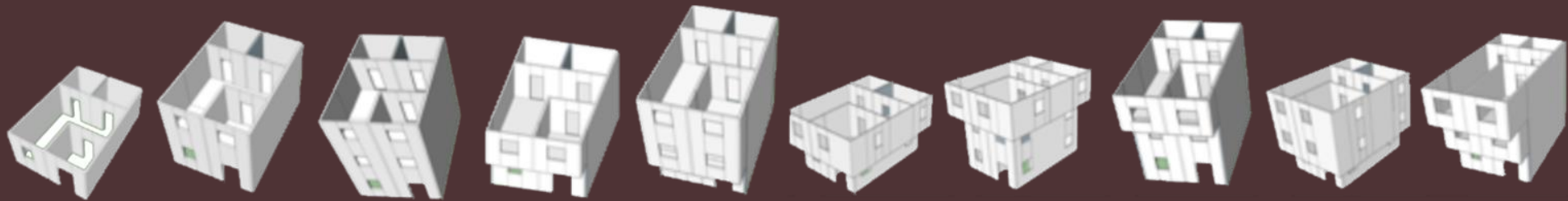
Modeling Changing Riskscape of Kathmandu Valley



Photo by Anne Sanquini

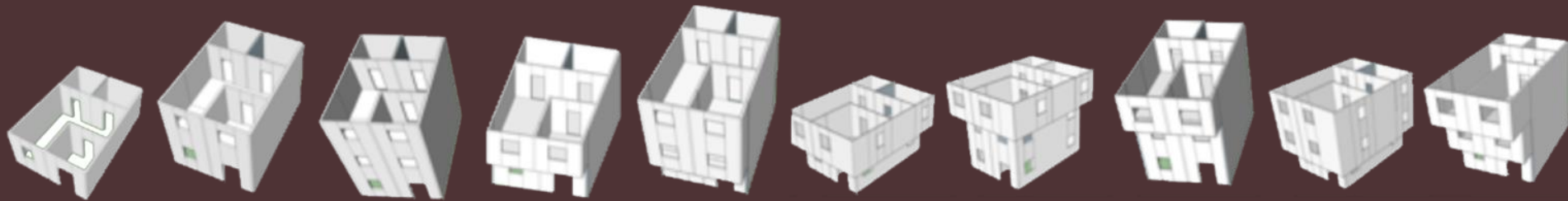
Modeling Dynamic Vulnerability

Catalog common building expansion states:

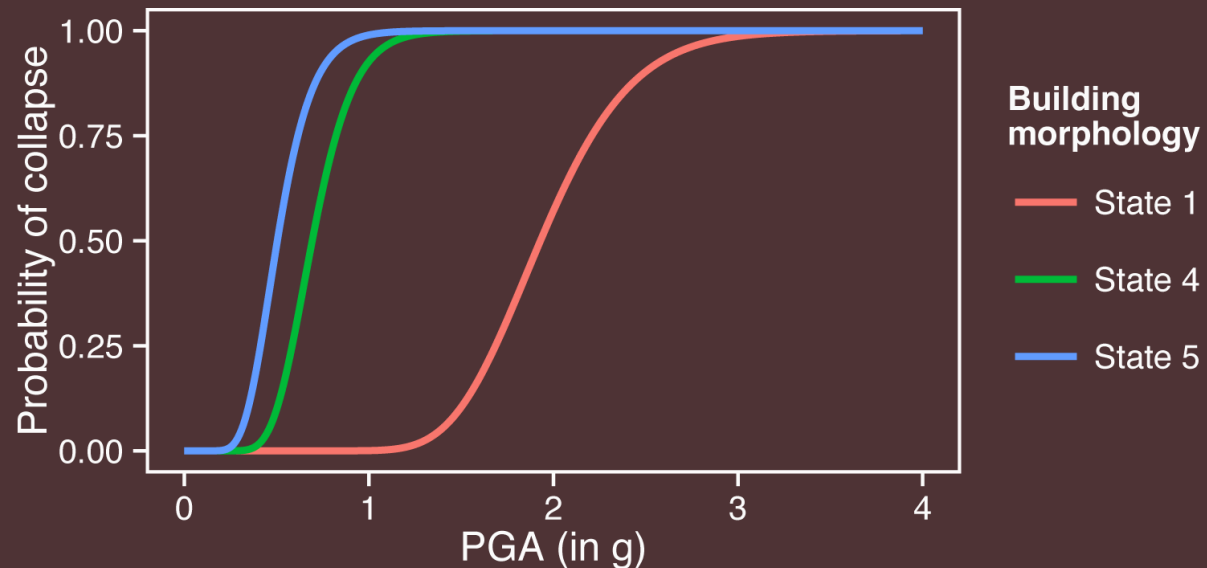


Modeling Dynamic Vulnerability

Catalog common building expansion states:



Fragility model
associated with
every building
state.



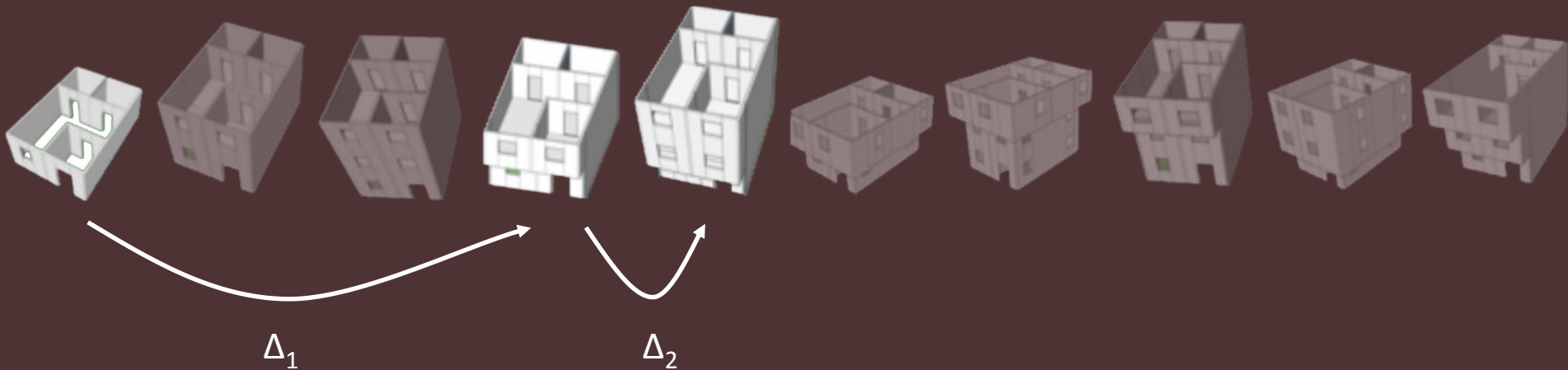
Incrementally
increasing
vulnerability?



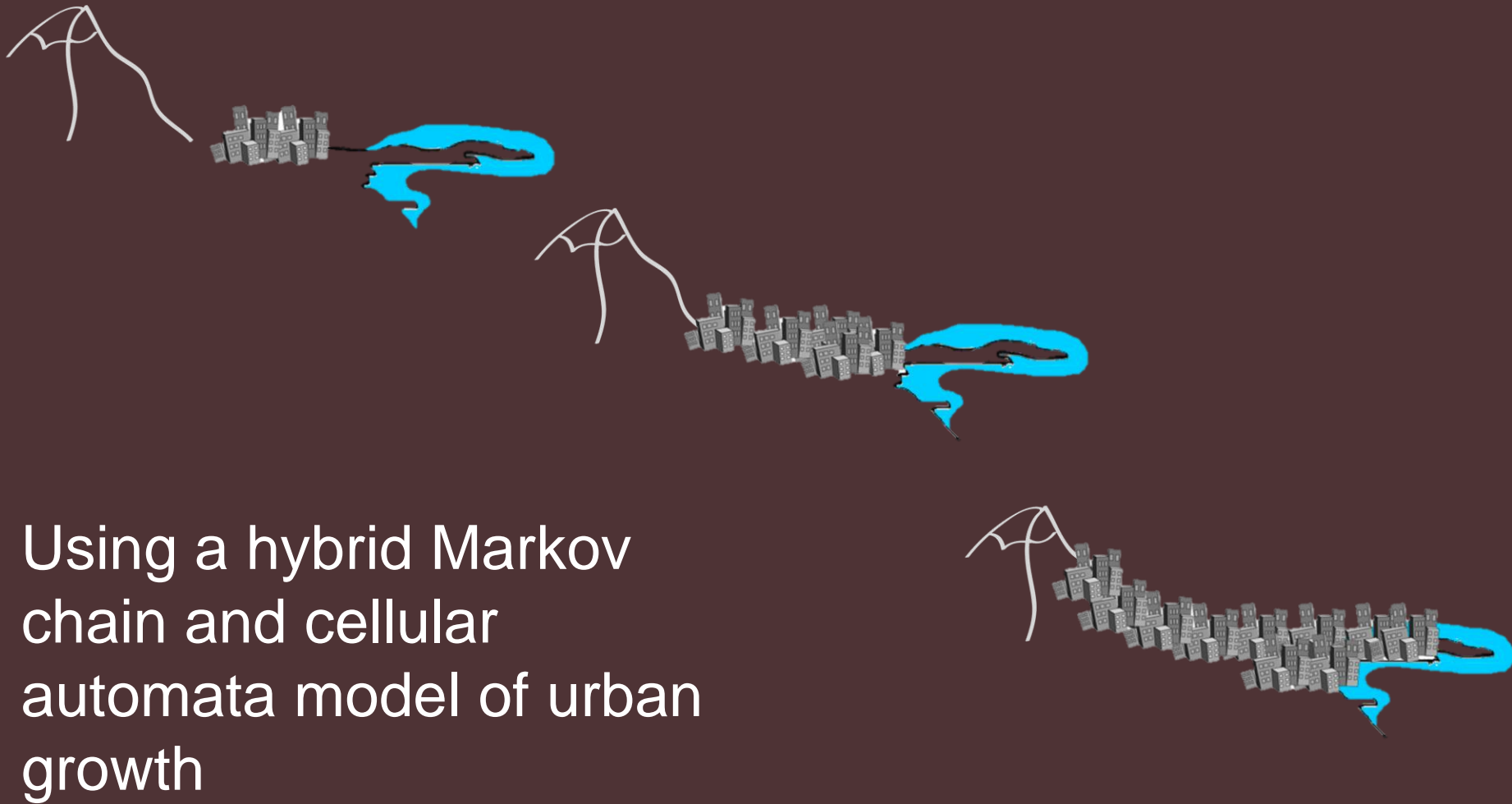
Photo by Anne Sanquini

Modeling Dynamic Vulnerability

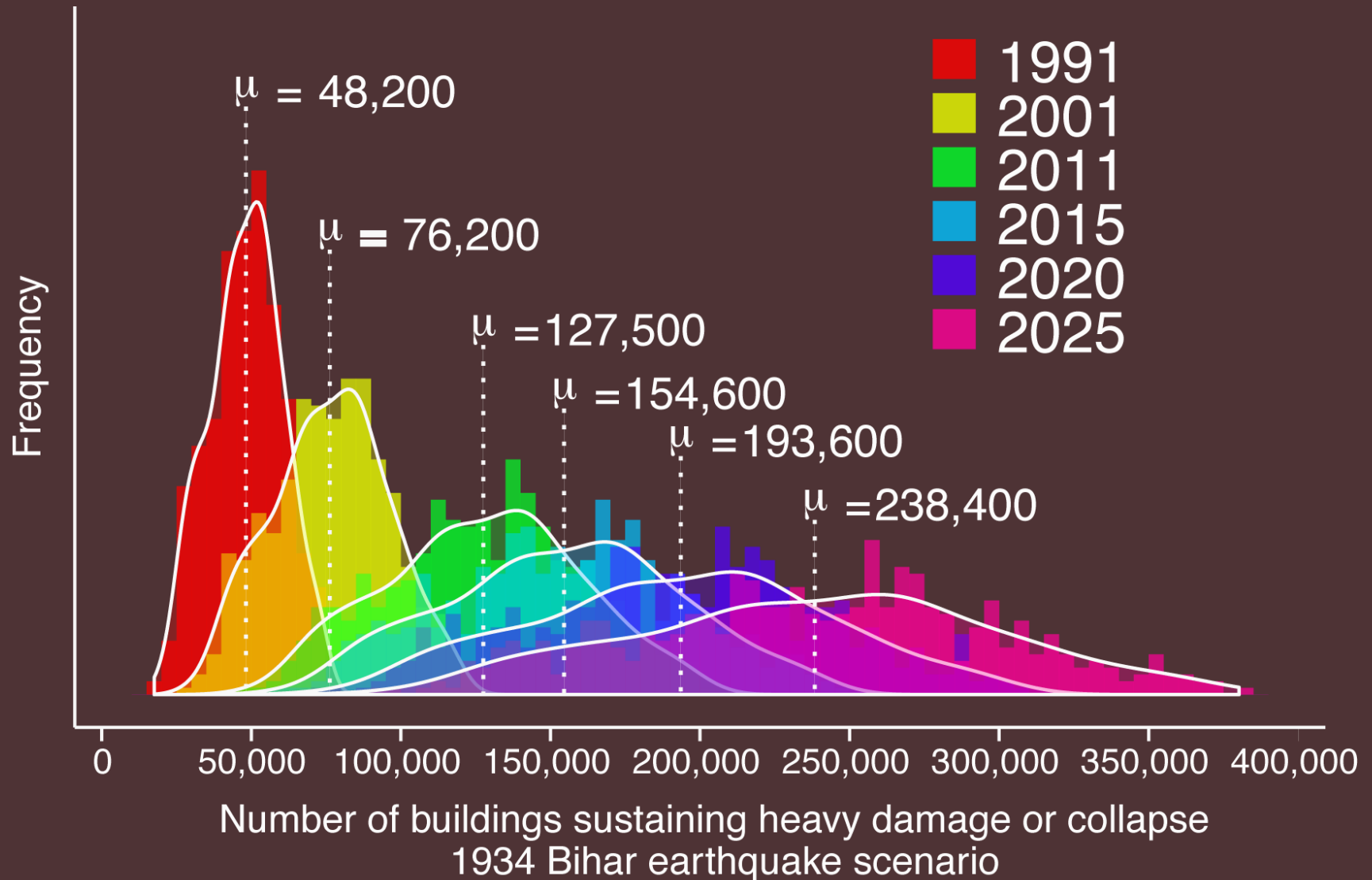
Stochastic model of incremental building expansion:



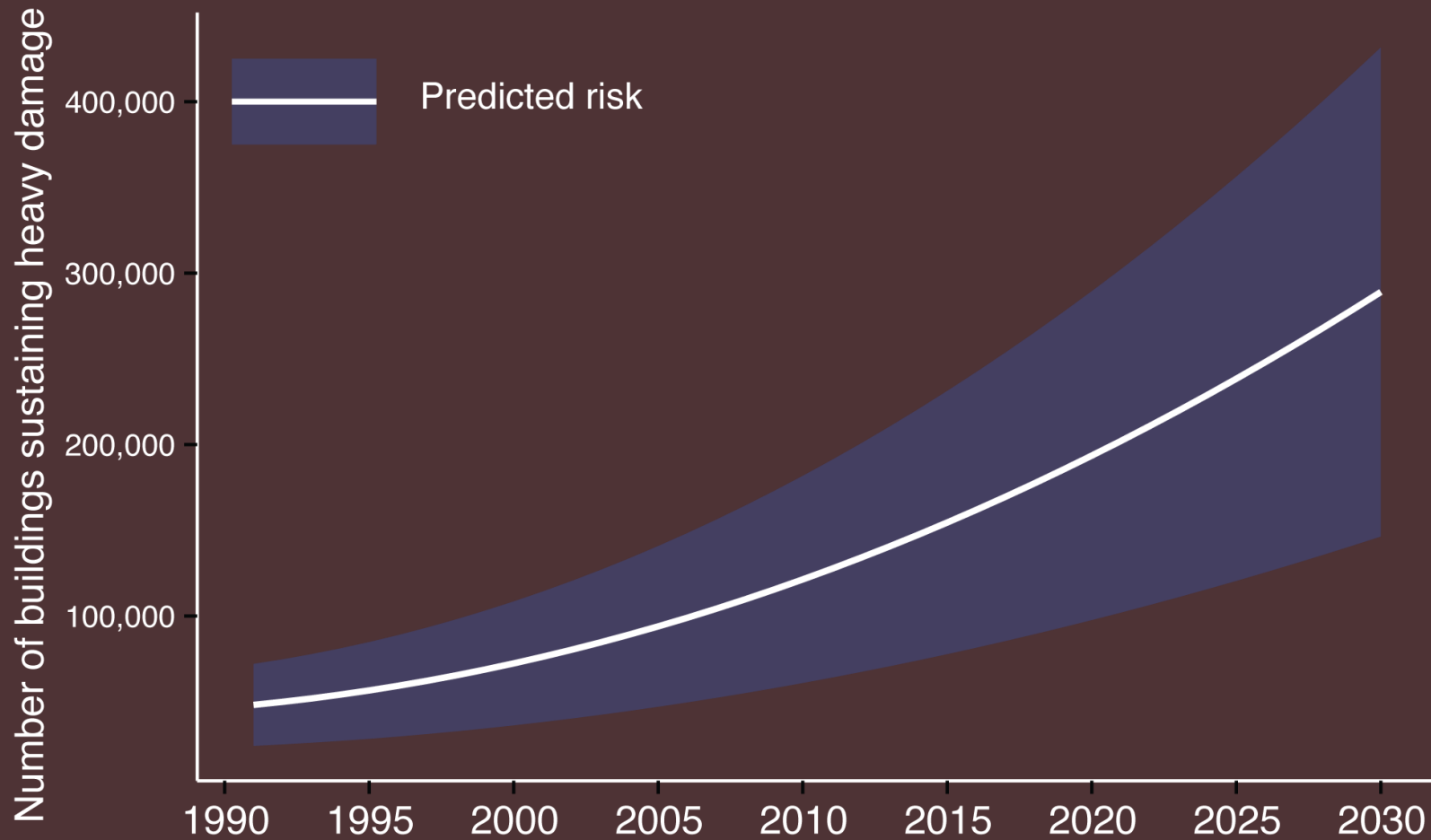
Modeling Dynamic Exposure



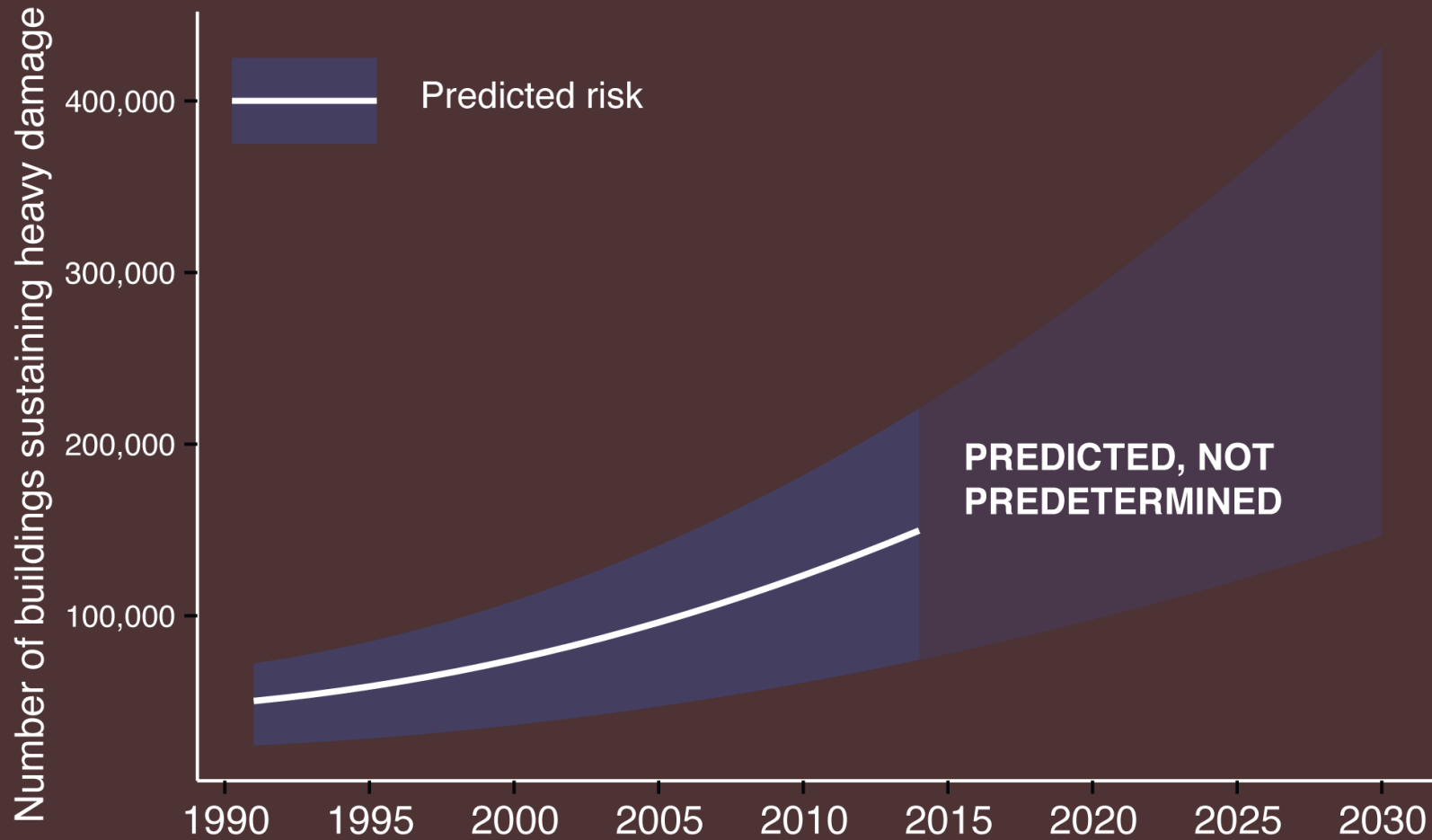
Modeling Changing Riskscape of Kathmandu Valley



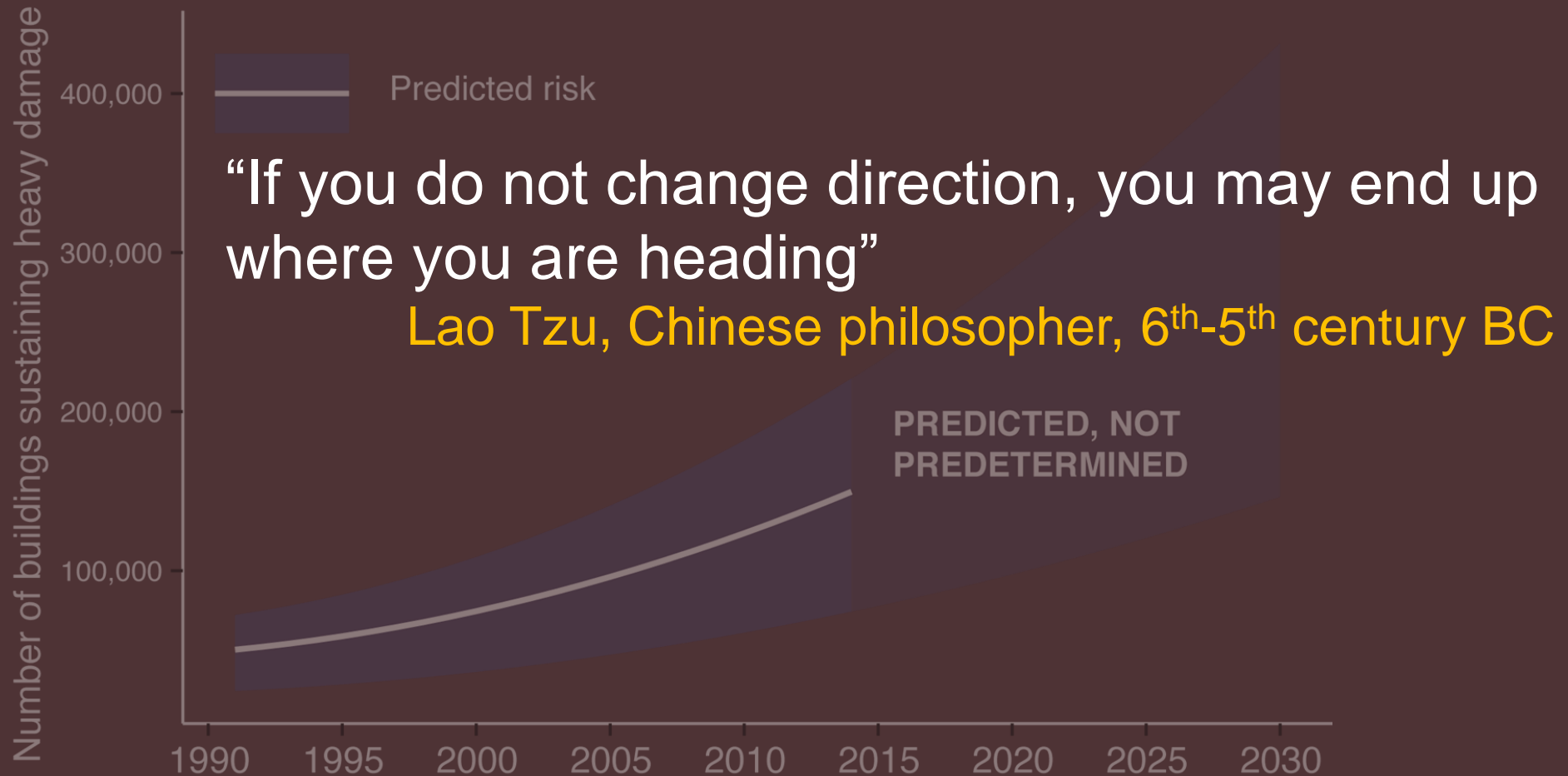
Modeling Changing Riskscapes



Controlling Changing Riskscapes

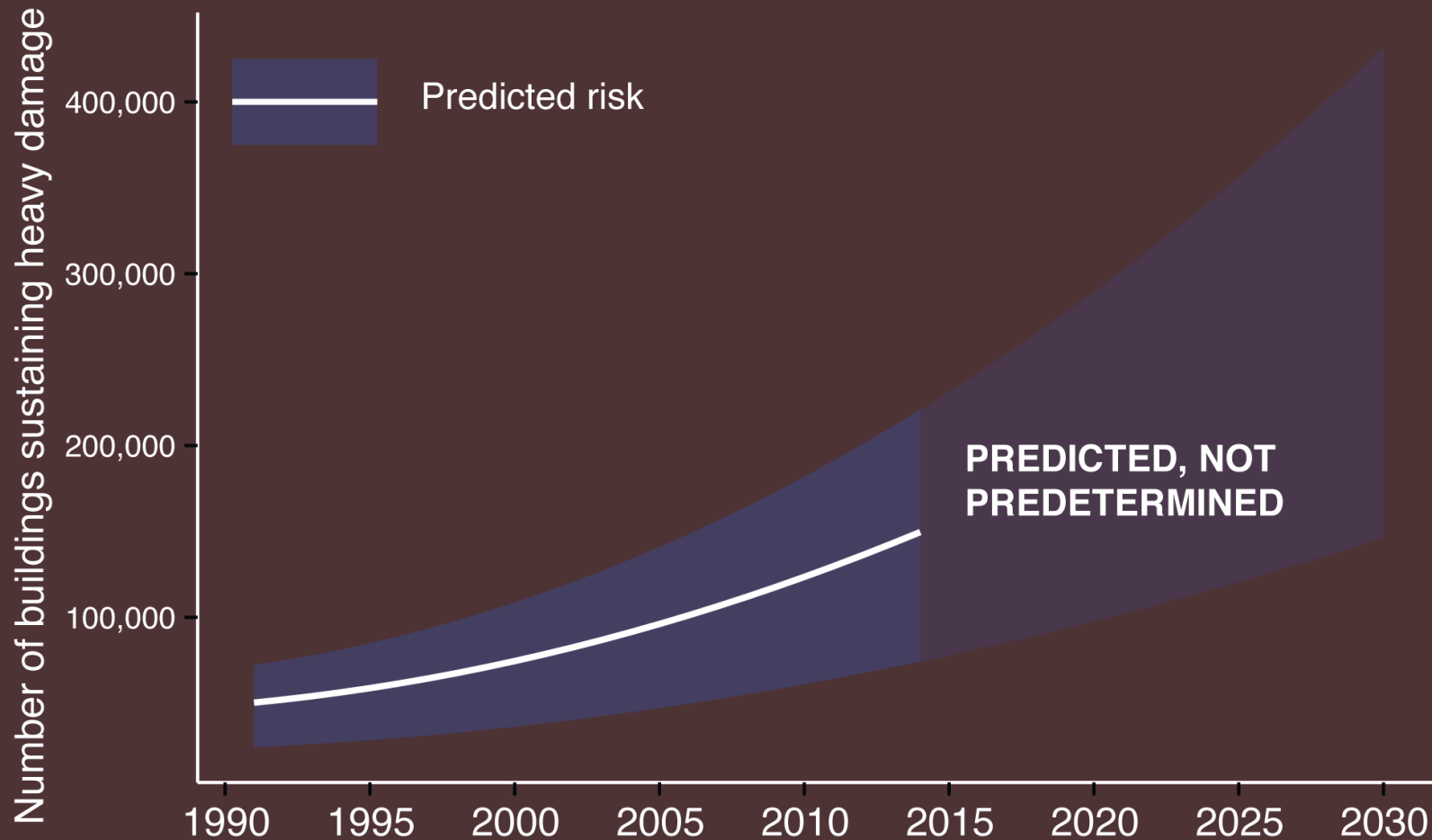


Controlling Changing Risksapes



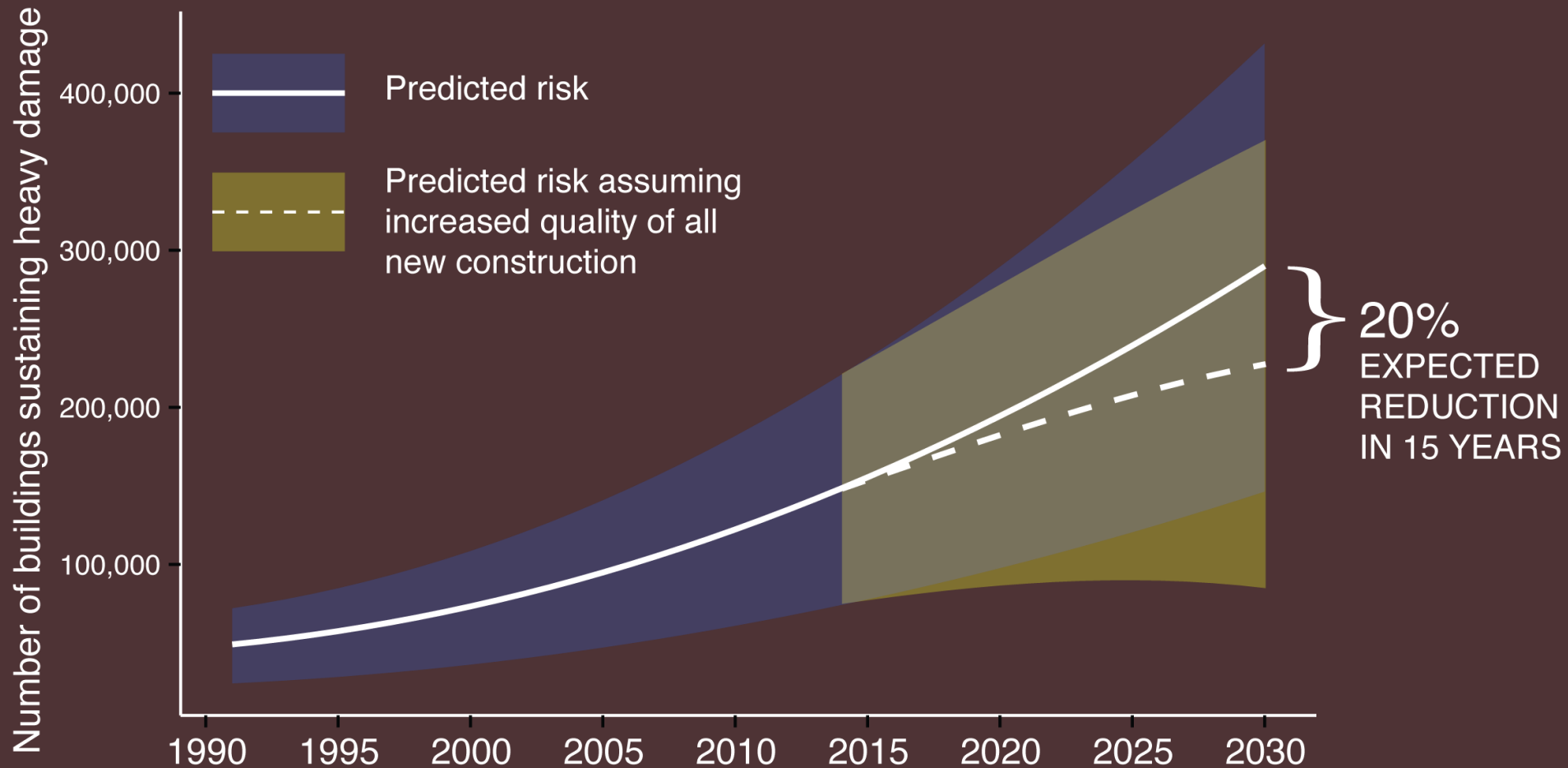
Controlling Changing Risksapes

What if all new construction is better designed for earthquakes?



Controlling Changing Risksapes

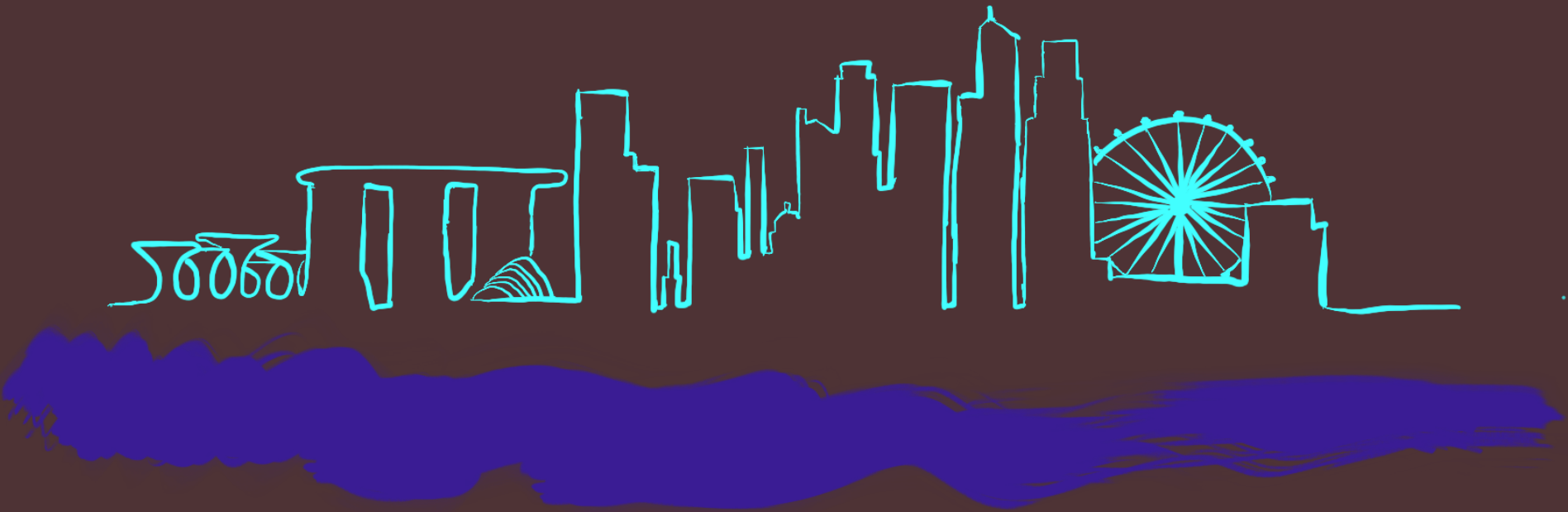
What if all new construction is better designed for earthquakes?



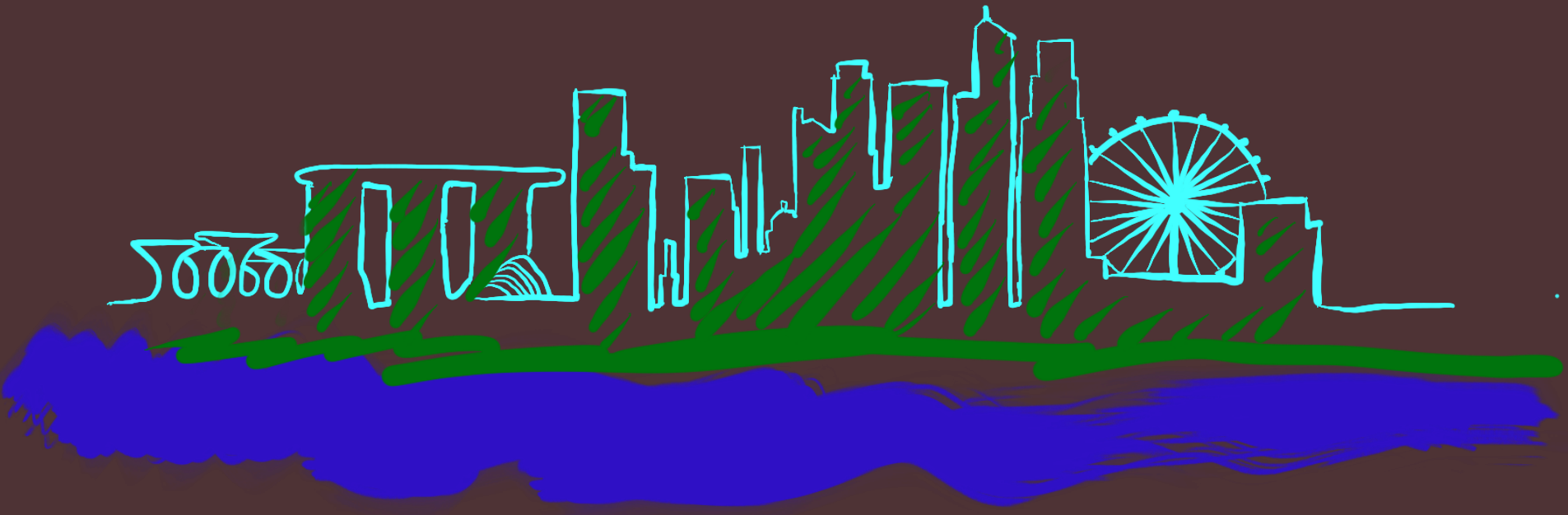
Ecological Concept of Resilience



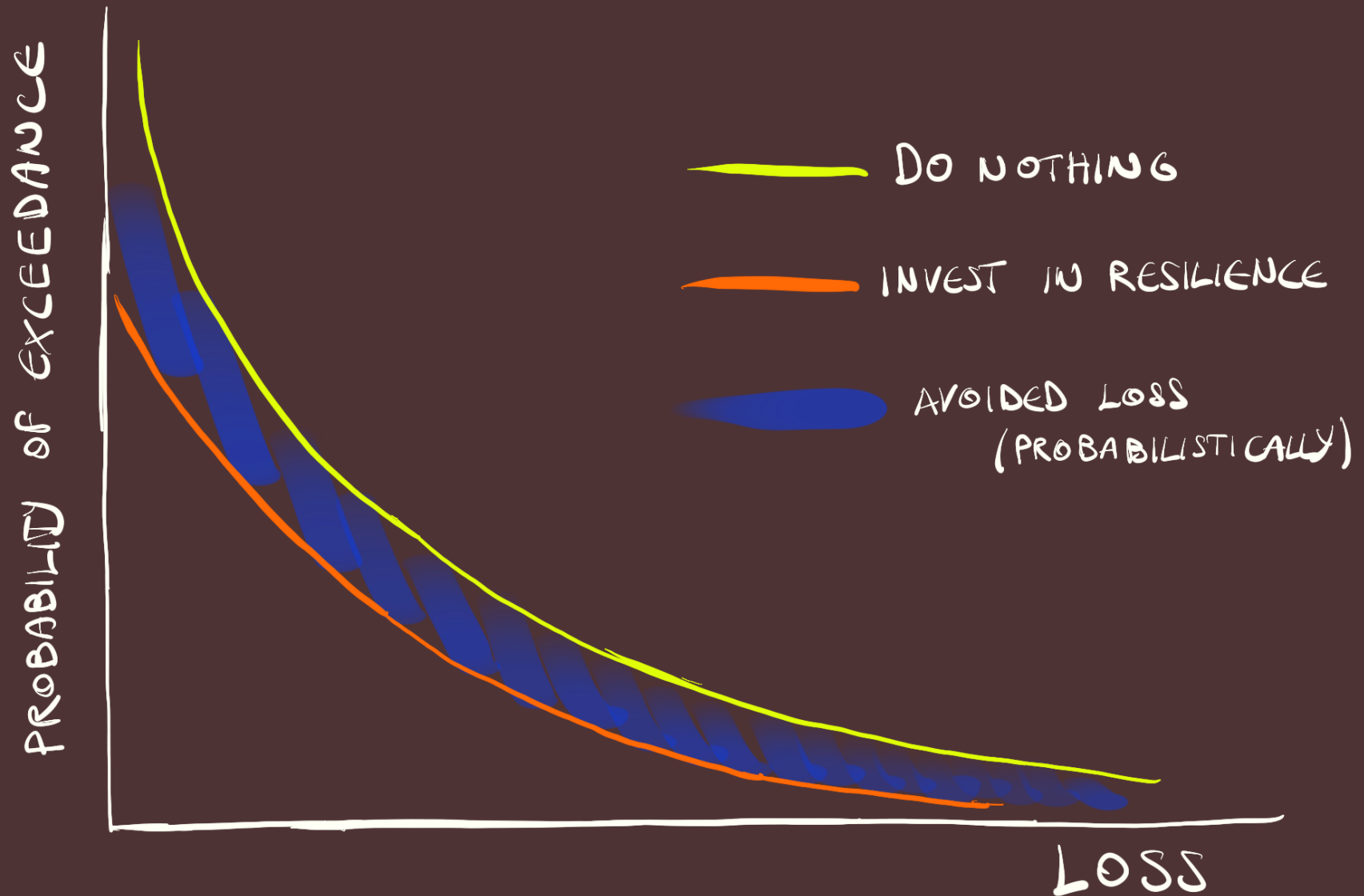
Investing in Resilience



Investing in Resilience



Investing in Resilience



Building Our Resilience

1st DIVIDEND: AVOIDED LOSSES

Building Our Resilience

1st DIVIDEND: AVOIDED LOSSES

2nd DIVIDEND: DEVELOPMENT

Building Our Resilience

1st DIVIDEND: AVOIDED LOSSES

2nd DIVIDEND: DEVELOPMENT

3rd DIVIDEND: CO-BENEFITS

Building Our Resilience

1st DIVIDEND: AVOIDED LOSSES

BENEFIT
WHEN
DISASTER
OCCURES

2nd DIVIDEND: DEVELOPMENT

BENEFIT
REGARDLESS
OF DISASTER

3rd DIVIDEND: CO-BENEFITS

Building Our Resilience



THE TRIPLE DIVIDEND OF RESILIENCE

Realising development goals through the multiple
benefits of disaster risk management

THOMAS TANNER, SWENJA SURMINSKI, EMILY WILKINSON, ROBERT REID,
JUN RENTSCHLER, SUMATI RAJPUT



The Triple Dividends of
Resilience

ODI, GFDRR, World Bank,

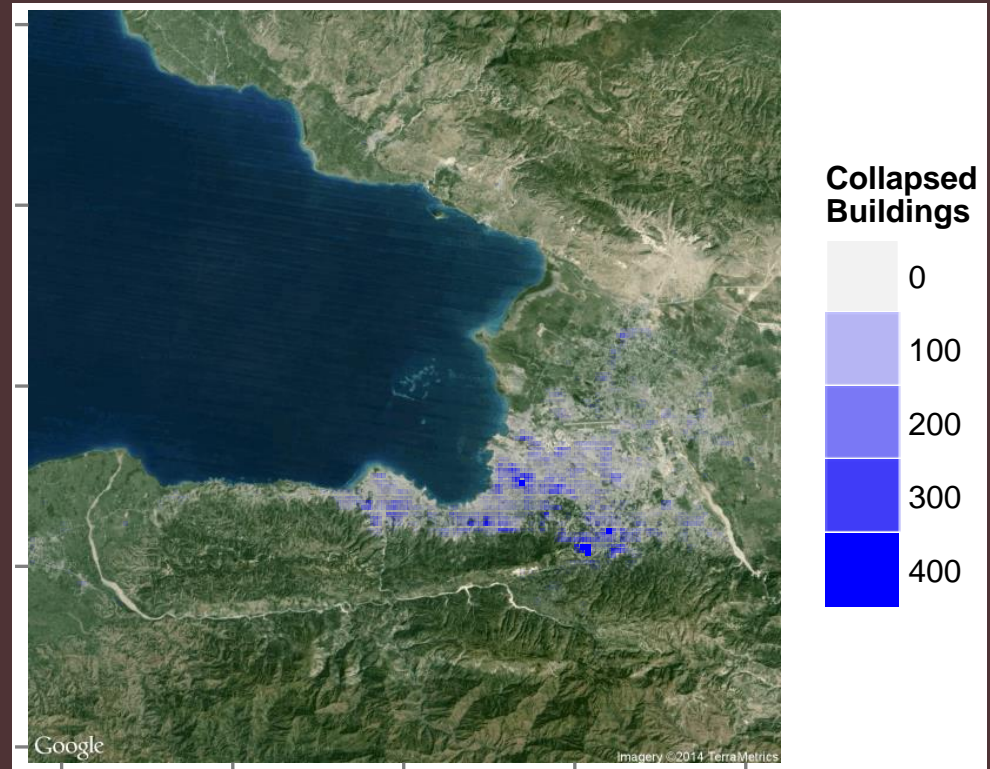
Ecological Concept of Resilience



Remaining Earthquake Risk of Port-au-Prince, Haiti

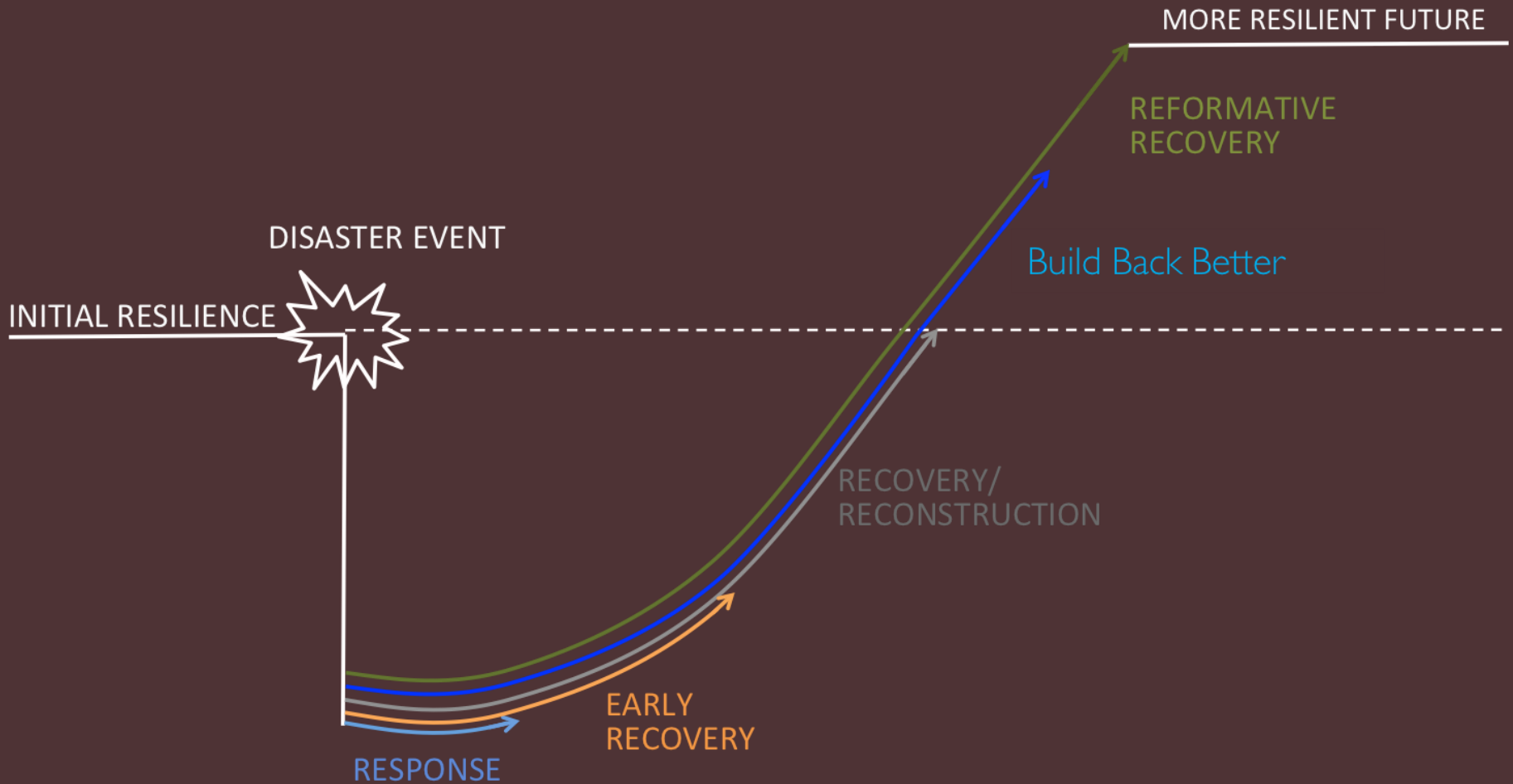


Actual 2010 event
31,000 buildings collapsed



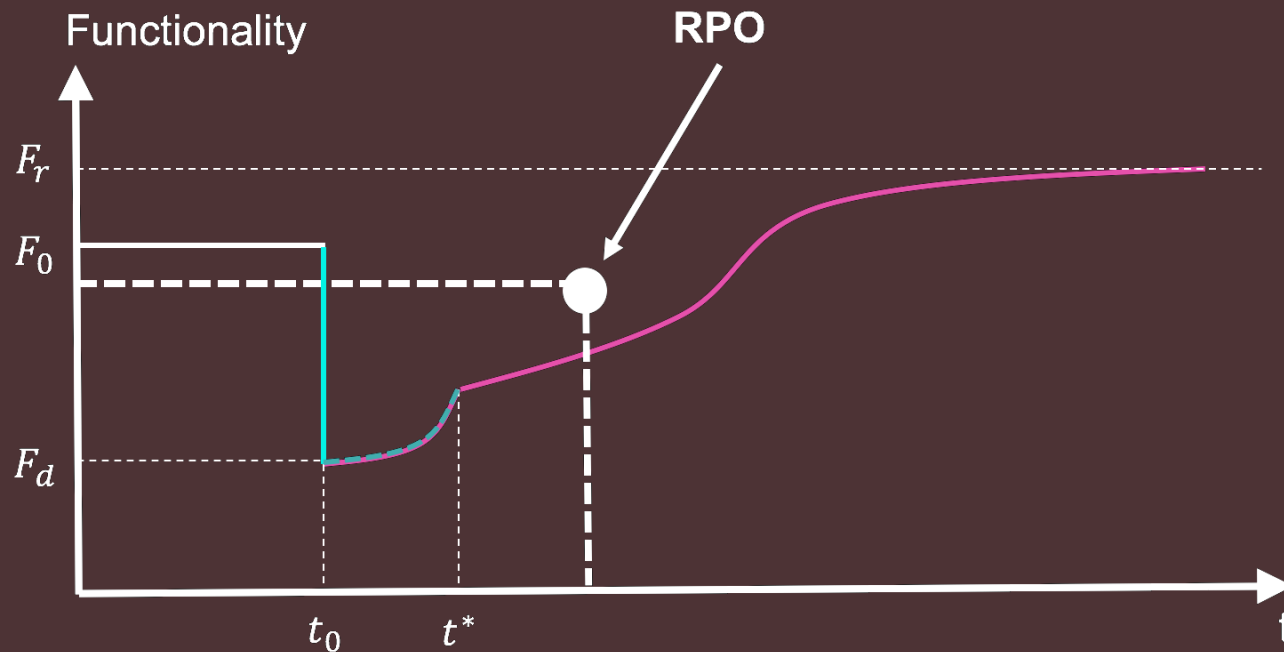
Expected Plausible Event
63,000 buildings collapsed

Promoting Reformative Recovery



Reformative recovery: The concept of “reformative recovery” is set in contrast to the traditional “restorative recovery.”

Promoting Effective Recovery

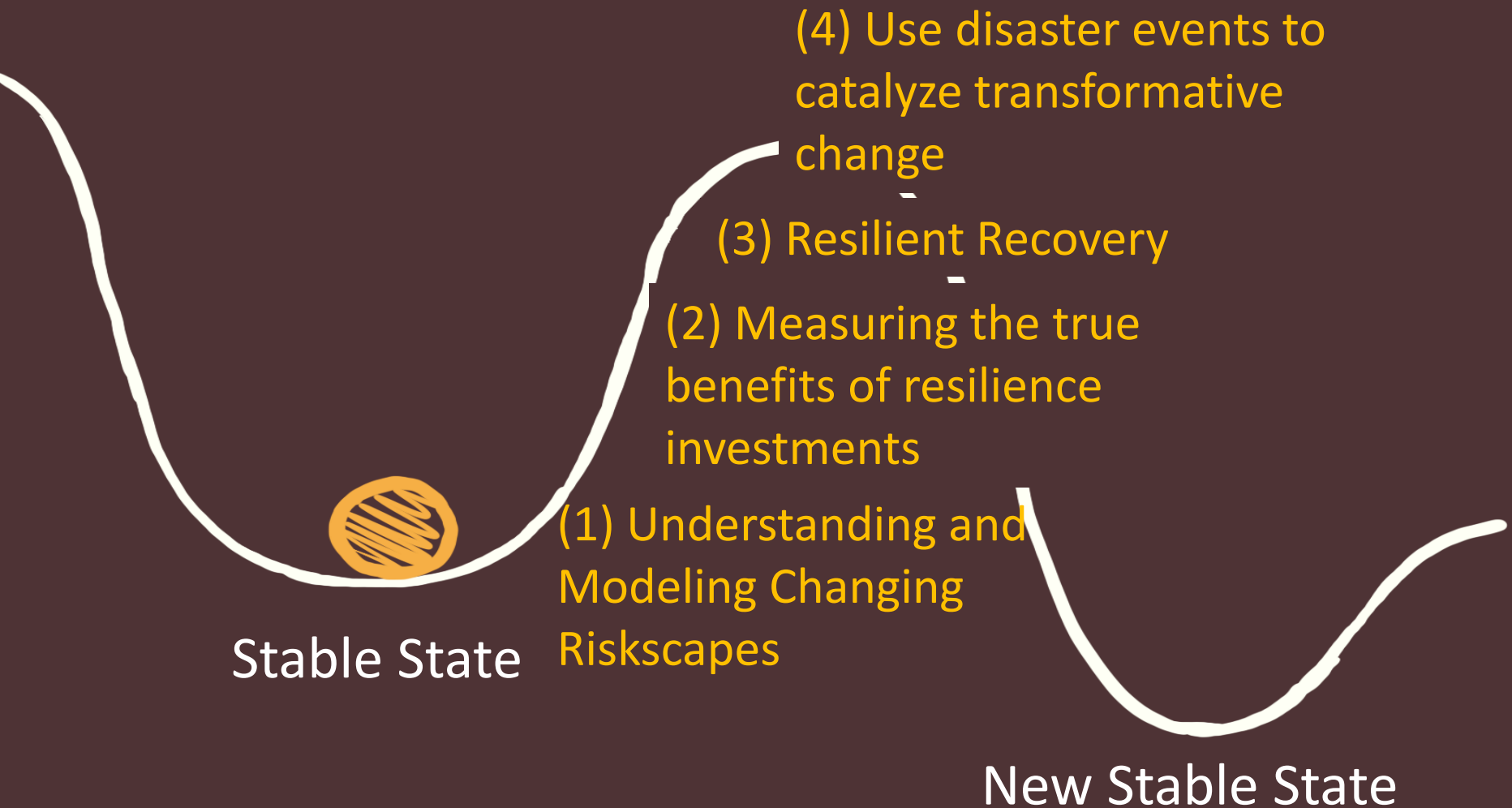


Absorptive:
Capacity to withstand immediate impact

Adaptive:
Capacity to recover partial functionality through temporary modification of behavior

Restorative:
Capacity to reach a NEW permanent stable state of functionality

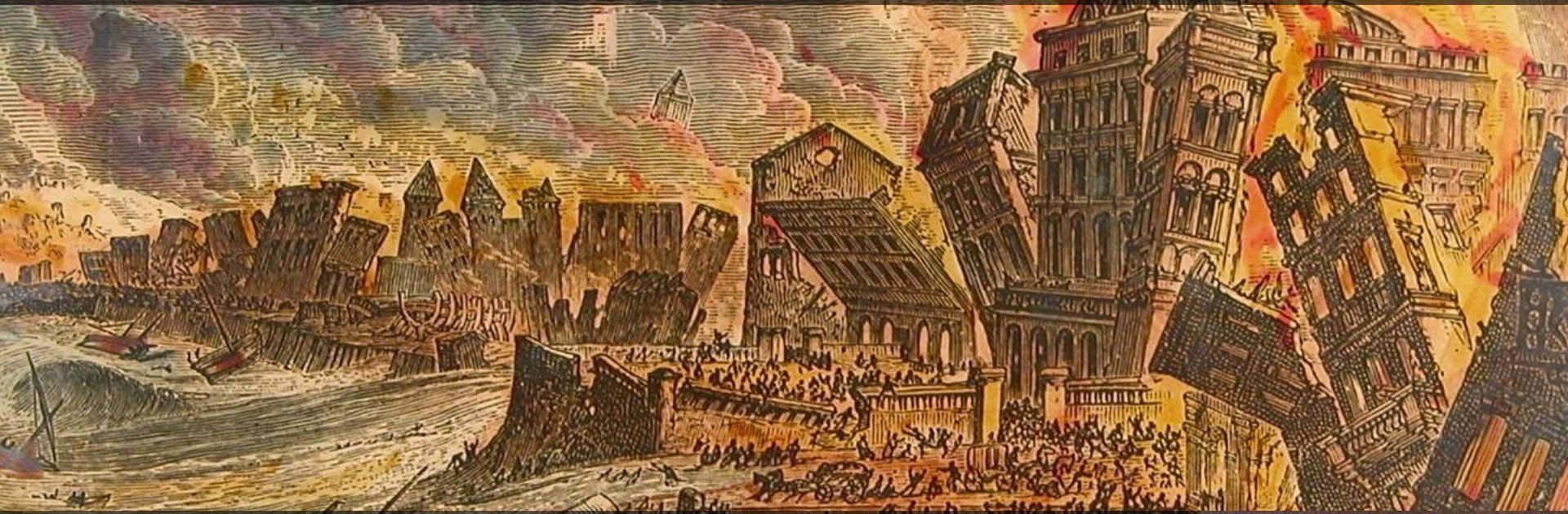
Ecological Concept of Resilience



1755 Lisbon Earthquake



1755 Lisbon Earthquake

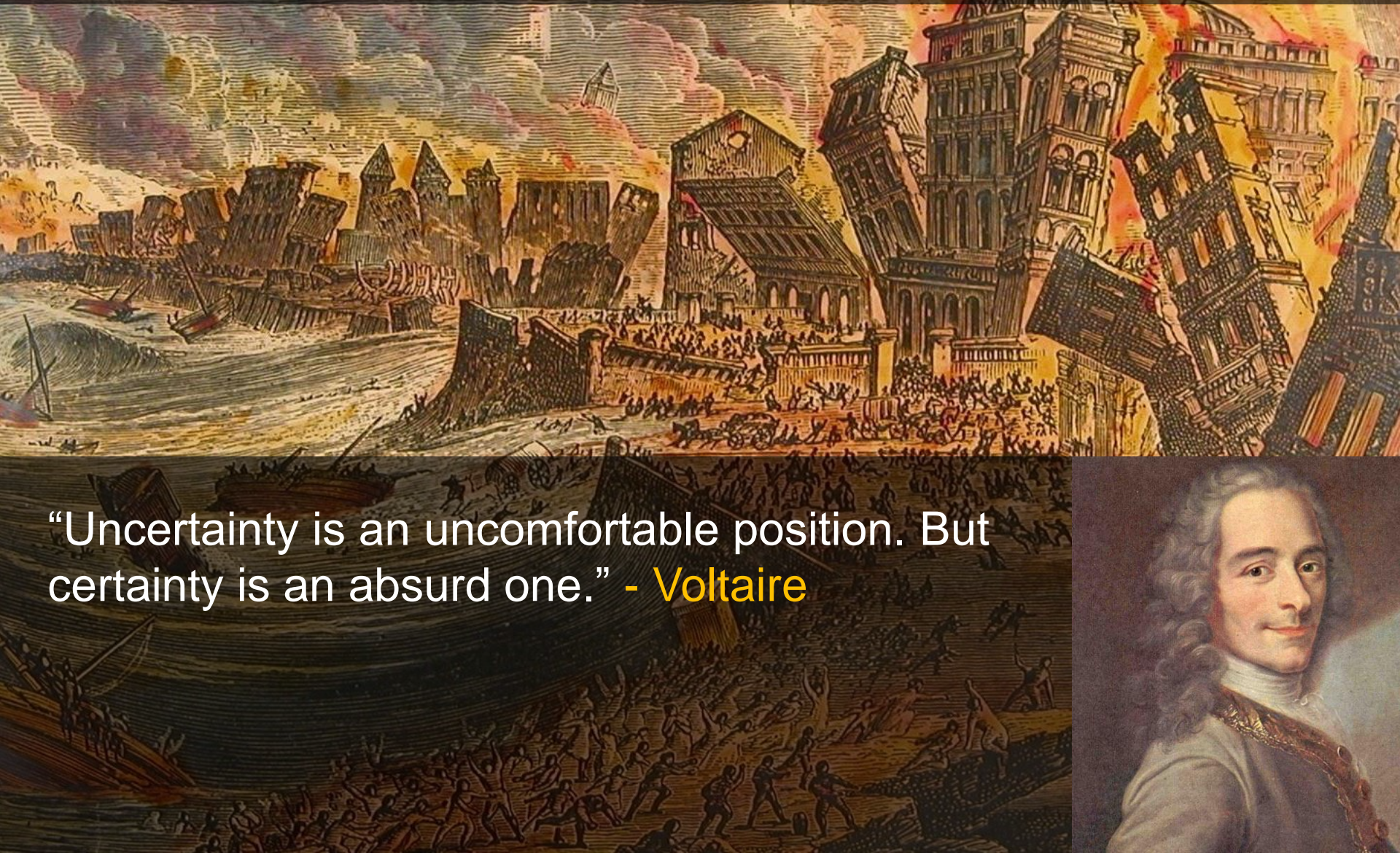


"What crime, what sin, had those young hearts
conceived
That lie, bleeding and torn, on mother's breast?
Did fallen Lisbon deeper drink of vice
Than London, Paris, or sunlit Madrid?
In these men dance; at Lisbon yawns the abyss."

Passage from Voltaire's Poem on the Lisbon



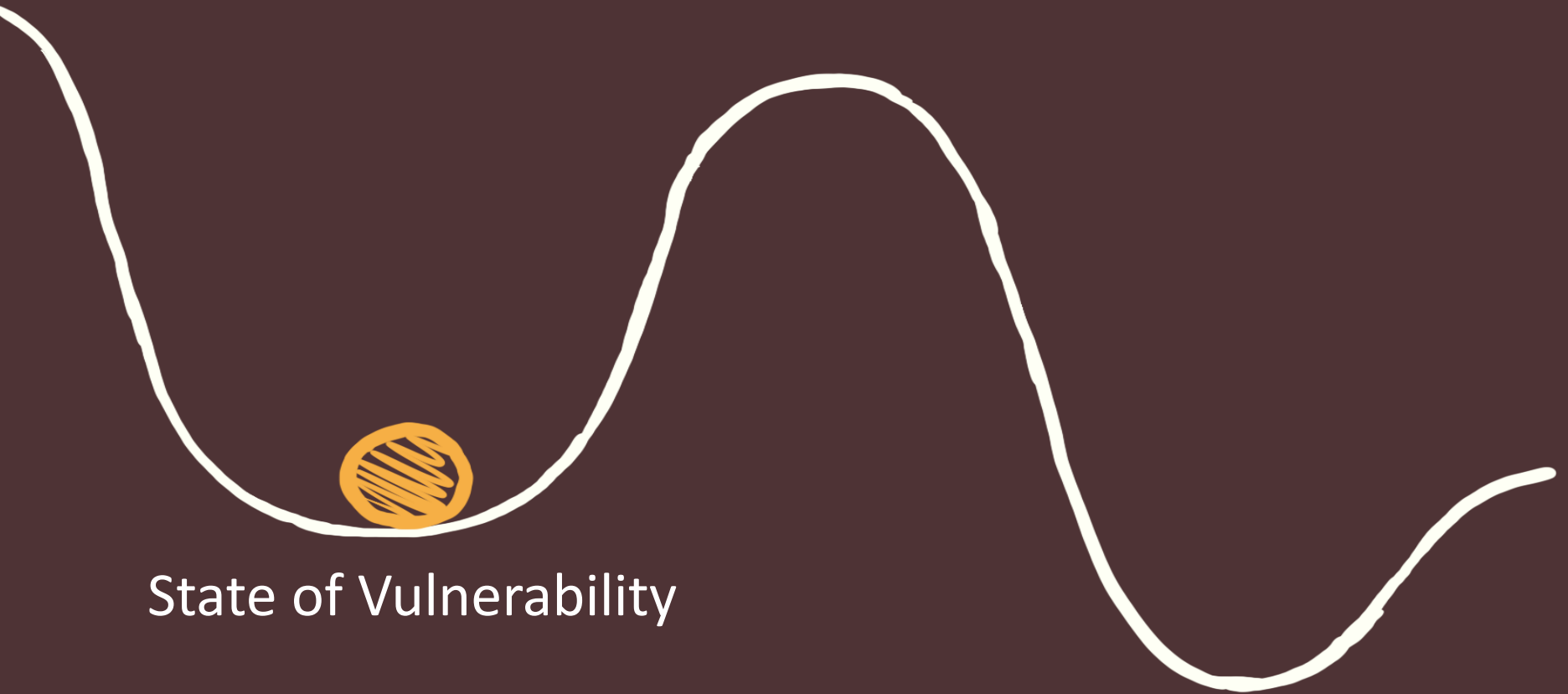
1755 Lisbon Earthquake



“Uncertainty is an uncomfortable position. But certainty is an absurd one.” - **Voltaire**

Resilience

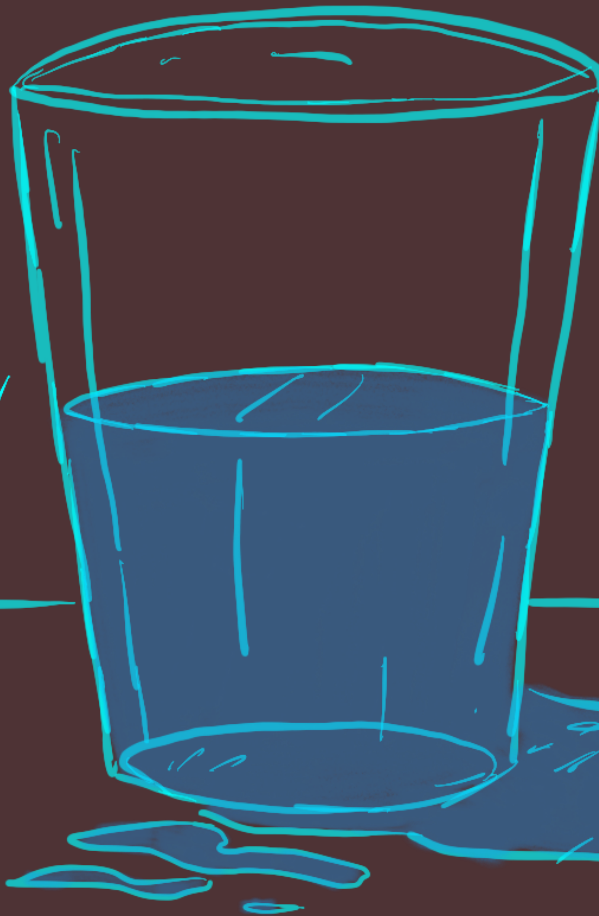
Resilience



State of Vulnerability

Lower State of
Vulnerability

HALF
EMPTY



↑
HALF
FULL

Thank you!

Thanks as well to:

- U.S. National Science Foundation
- The World Bank
- Global Facility for Disaster Reduction and Recovery (GFDRR)
- United States Geological Survey
- Google
- Red Cross
- Shah Family Fellowship
- John Blume Fellowship



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