MANAGING GROWING RISK AND RECOVERING STRONGER FROM DISASTER

Swiss Re Institute & Asia Society Switzerland, Oct 4th 2022

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Principle Investigator @ Earth Observatory of Singapore
National Research Foundation Fellow

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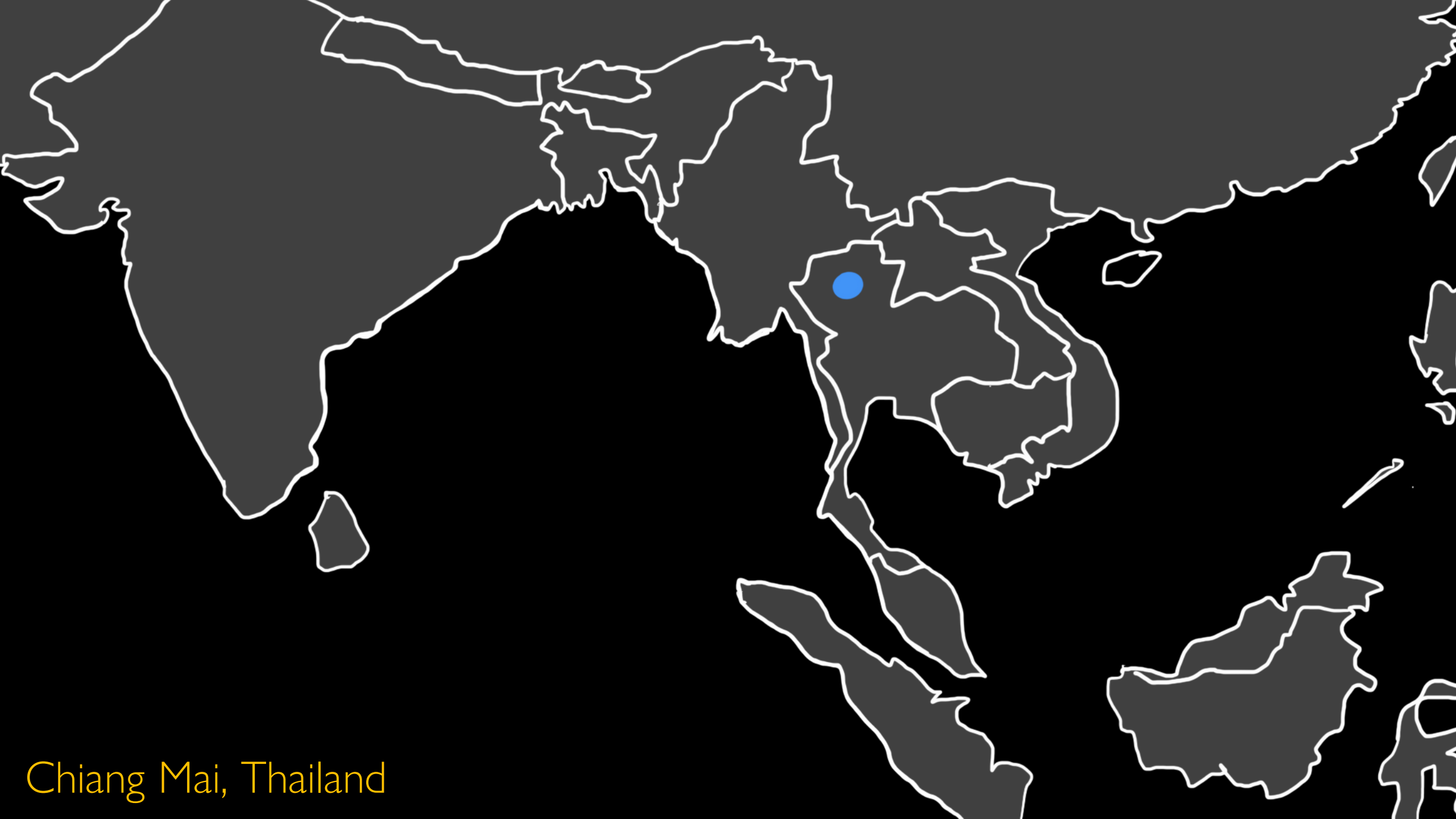
EARTH OBSERVATORY OF SINGAPORE

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

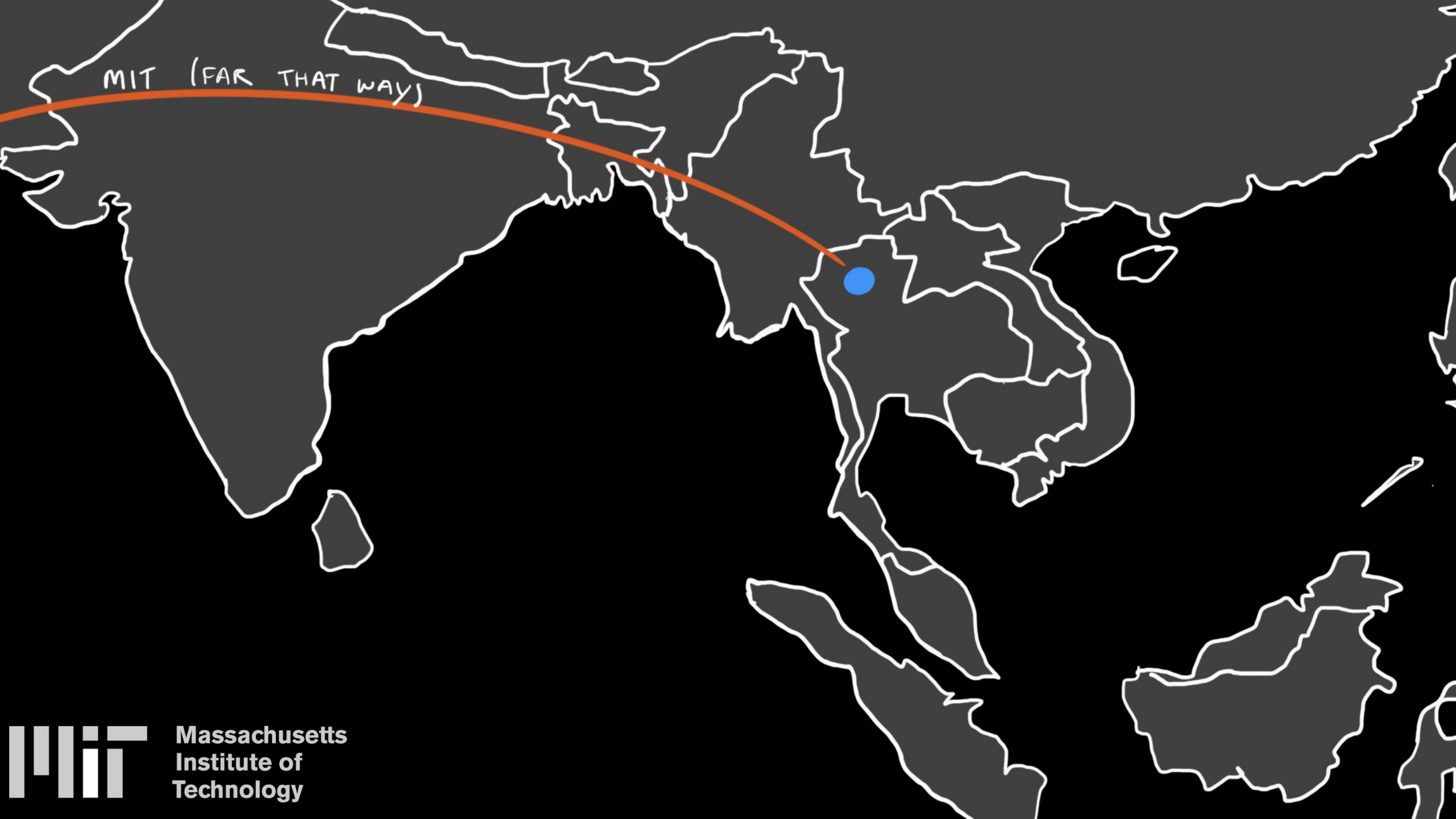

Chiang Mai, Thailand

Chiang Mai, Thailand

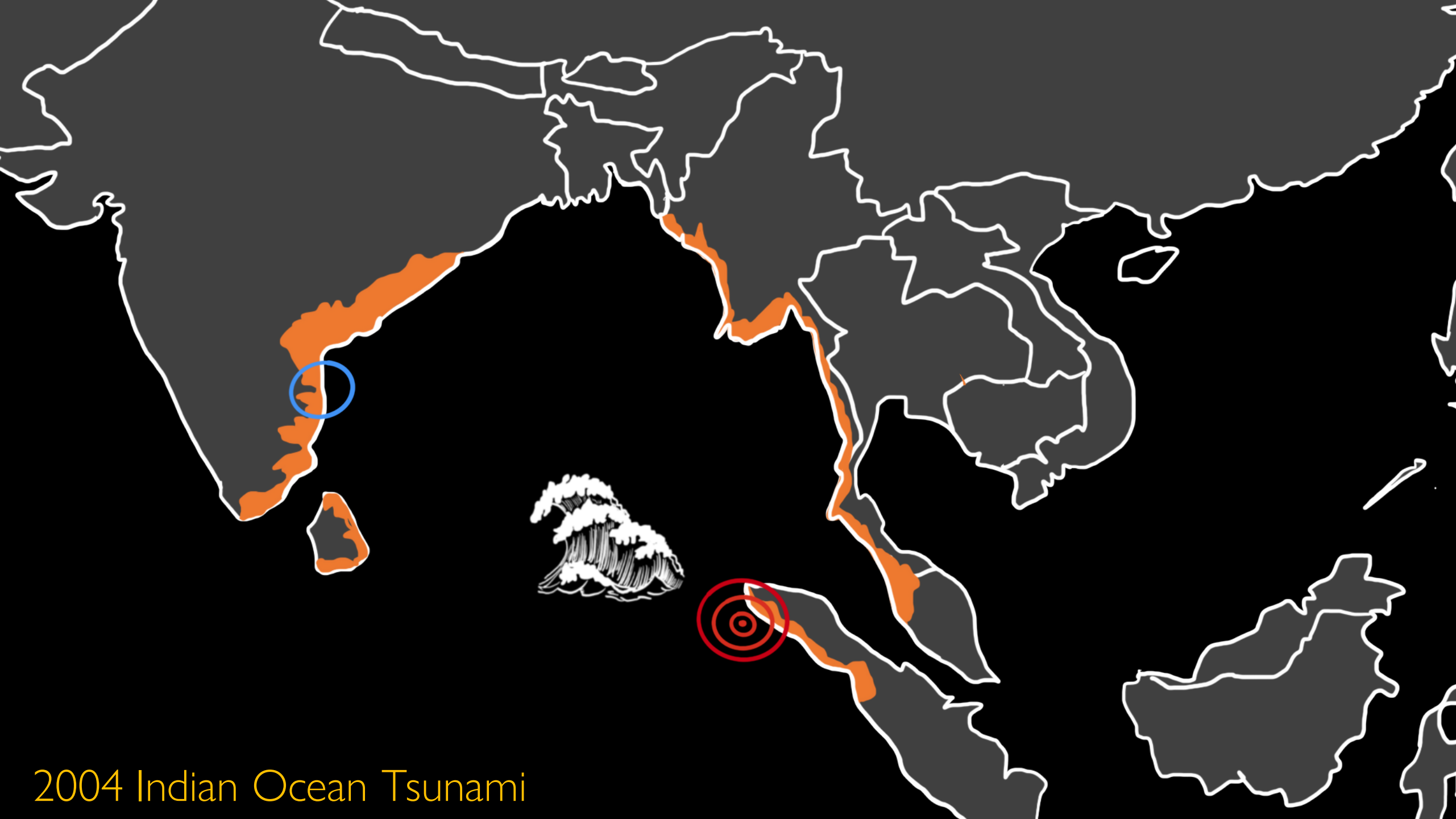
Image credit: David Lallemant

Chiang Mai, Thailand

Image credit: Panumet Tanraksa, Bangkok Post, Oct 3rd, 2022

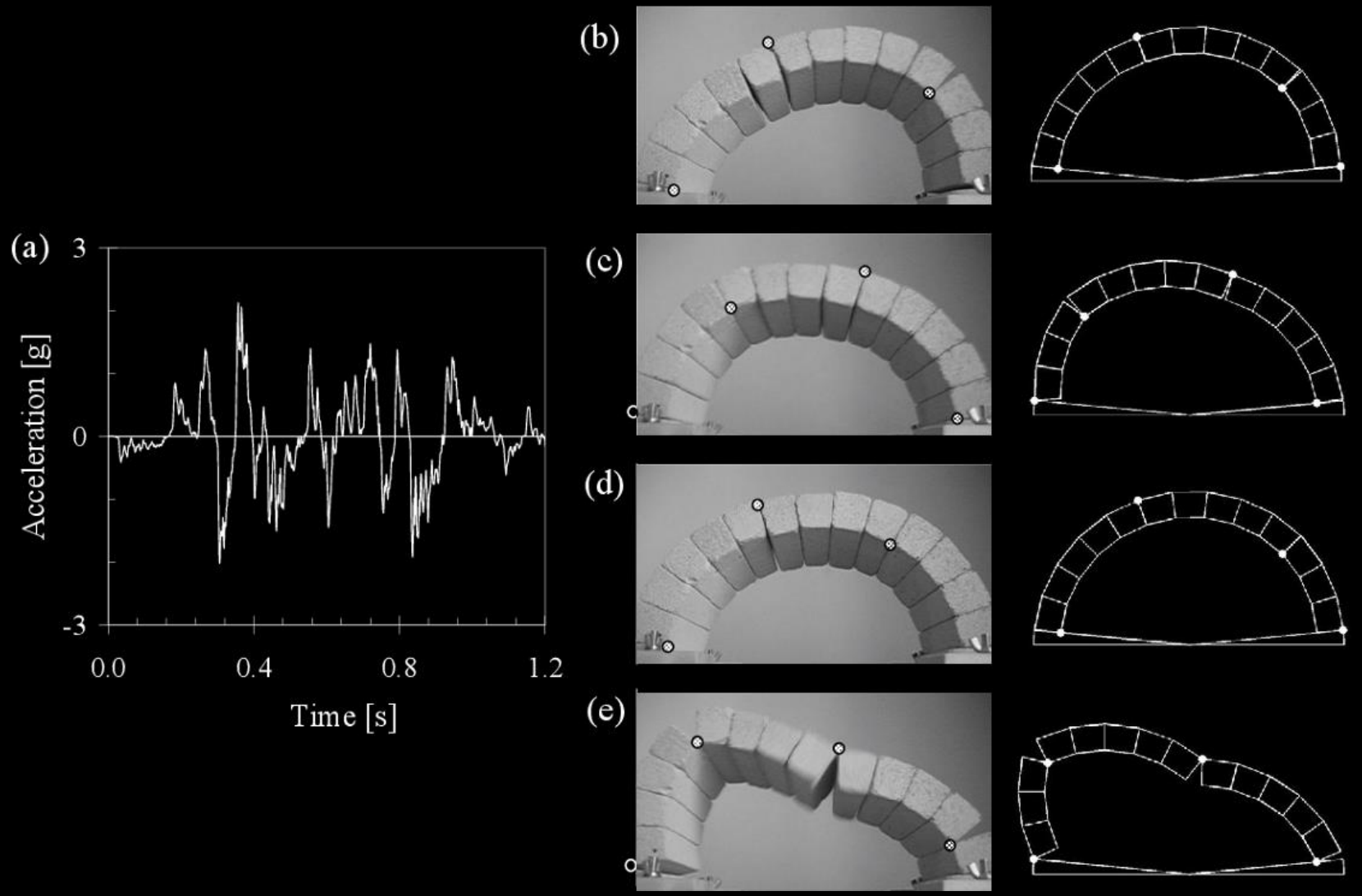


Massachusetts
Institute of
Technology


2004 Indian Ocean Tsunami

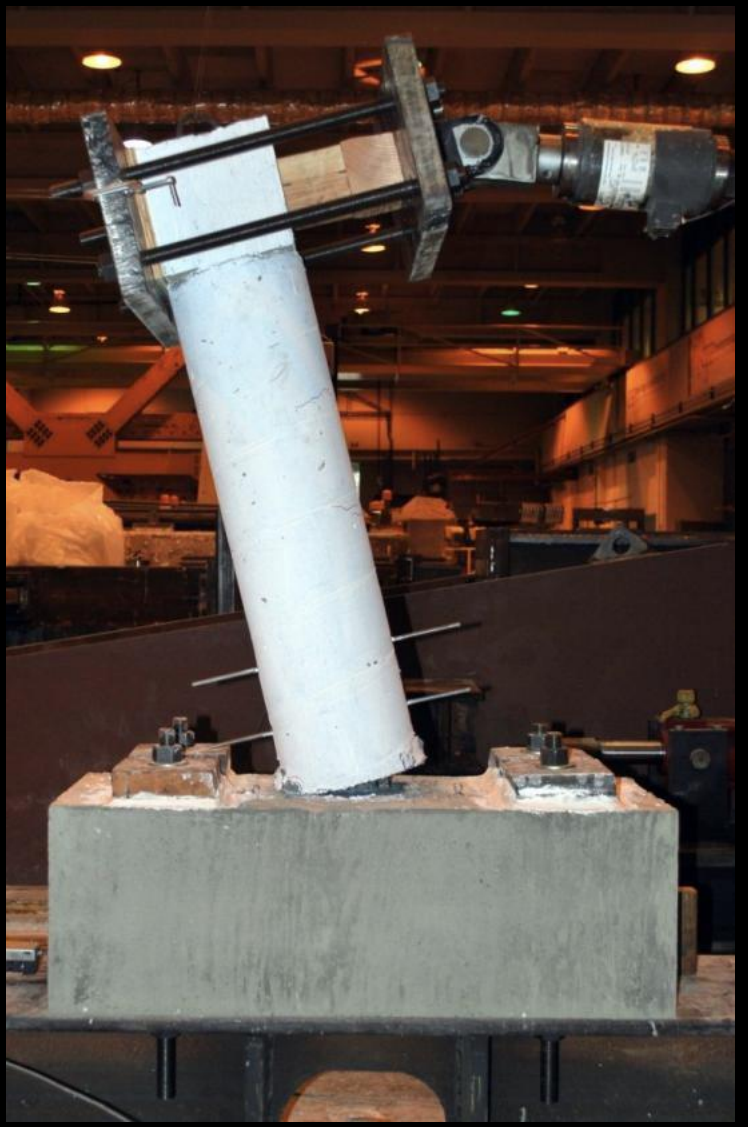
Massachusetts
Institute of
Technology

Massachusetts
Institute of
Technology



Massachusetts Institute of Technology

Research conducted with Dr. Ochsendorf and Dr. Dejong

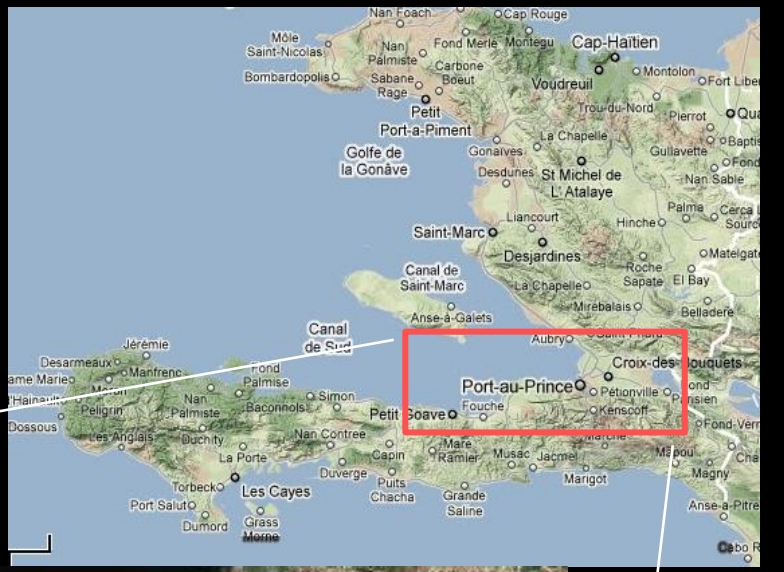


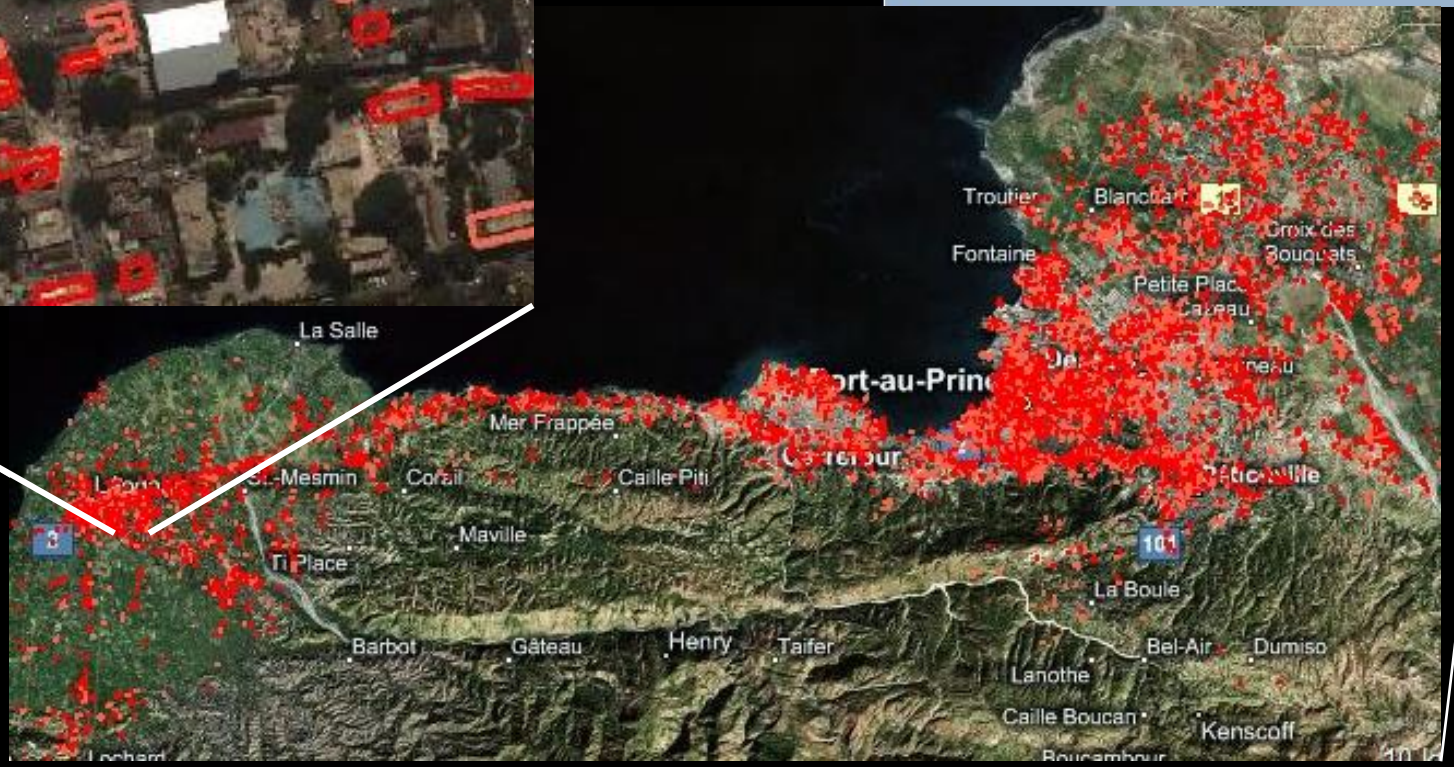
Berkeley
UNIVERSITY OF CALIFORNIA

Research conducted with Dr. Claudia Ostertag

Downtown Port-au-Prince, Haiti, 2010

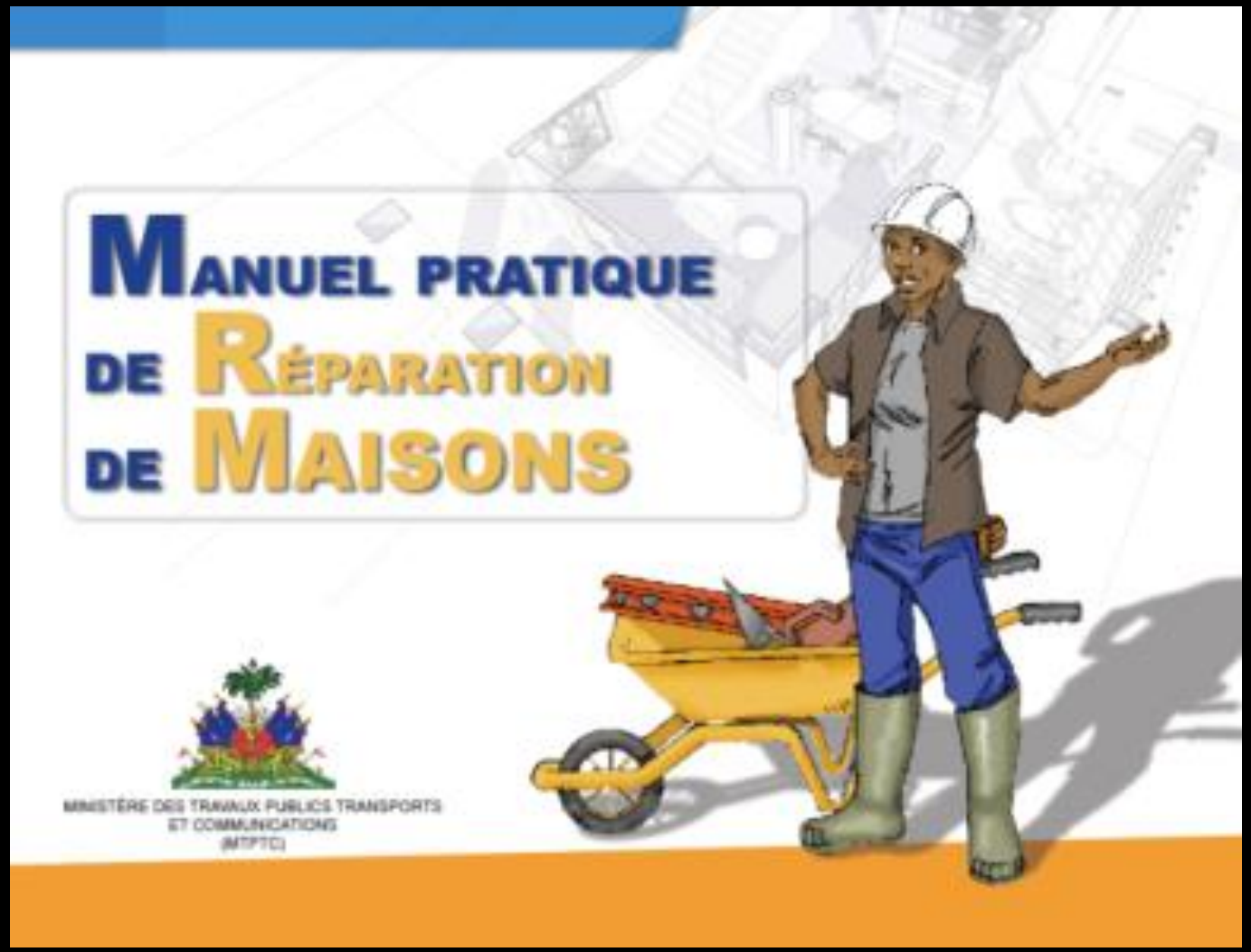
Image credit: David Lallemant, 2010

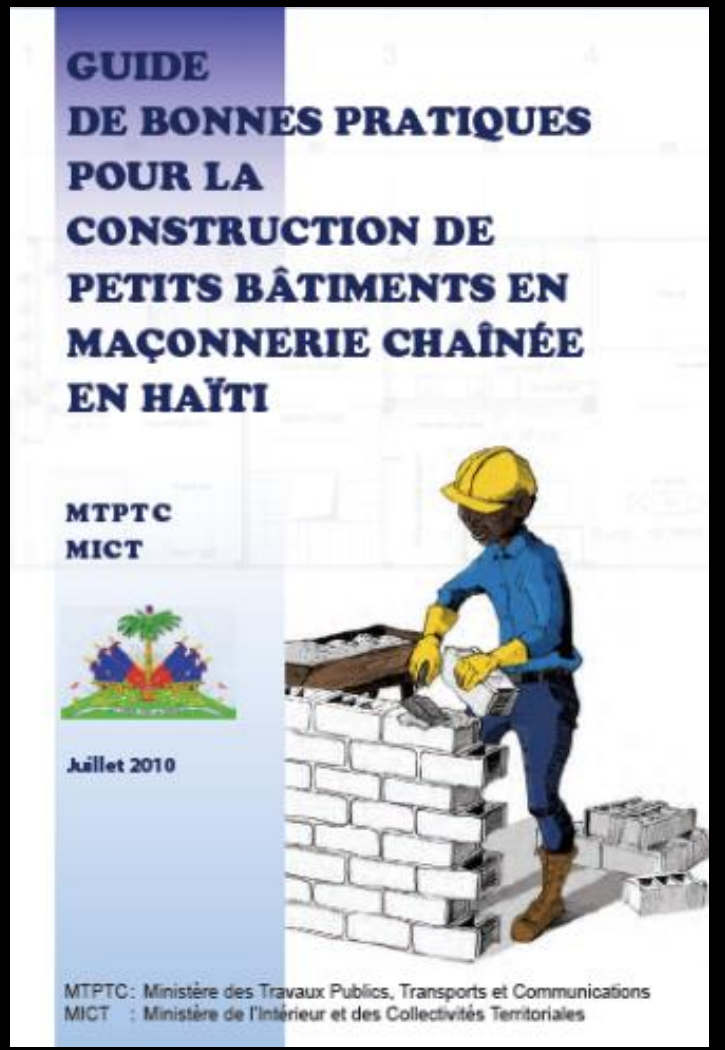




THE WORLD BANK

THE WORLD BANK


MANUEL PRATIQUE
DE RÉPARATION
DE MAISONS
MINISTÈRE DES TRAVAUX PUBLICS TRANSPORTS
ET COMMUNICATIONS
(MTPTC)


GUIDE
DE BONNES PRATIQUES
POUR LA
CONSTRUCTION DE
PETITS BÂTIMENTS EN
MAÇONNERIE CHAÎNÉE
EN HAÏTI
MTPTC
MICT
Juillet 2010
MTPTC: Ministère des Travaux Publics, Transports et Communications
MICT : Ministère de l'Intérieur et des Collectivités Territoriales

Stanford
University

Research conducted with Drs. Kiremidjian, Baker and Deierlein

‘Monkey temple’ following the Gorkha Earthquake 2015, Nepal

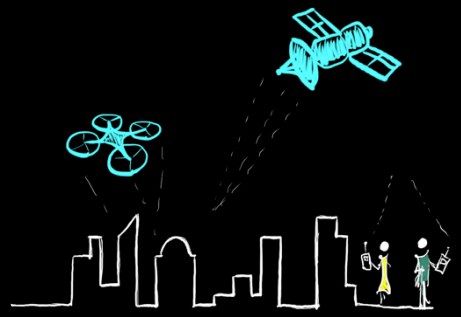
Image credit: Lallemant, 2015

Disaster Analytics for Society Lab (DASL)

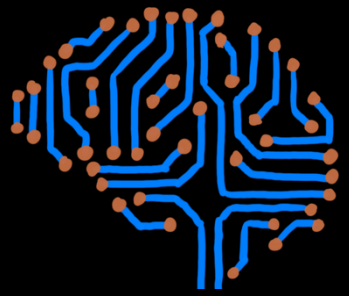
EARTH OBSERVATORY OF SINGAPORE

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

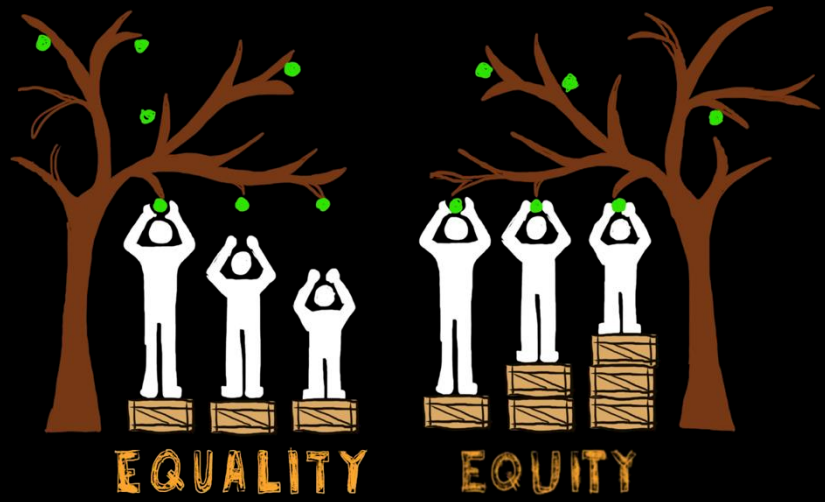
Disaster Analytics for Society Lab (DASL)



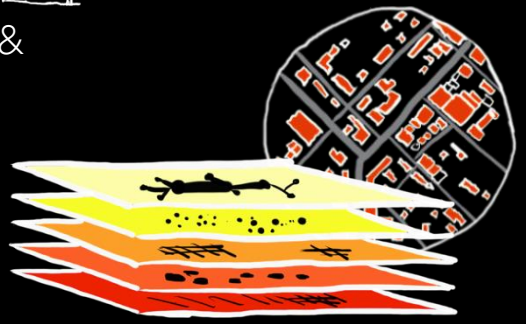
REMOTE SENSING &
CROWD-SENSING



MACHINE LEARNING &
ARTIFICIAL INTELLIGENCE

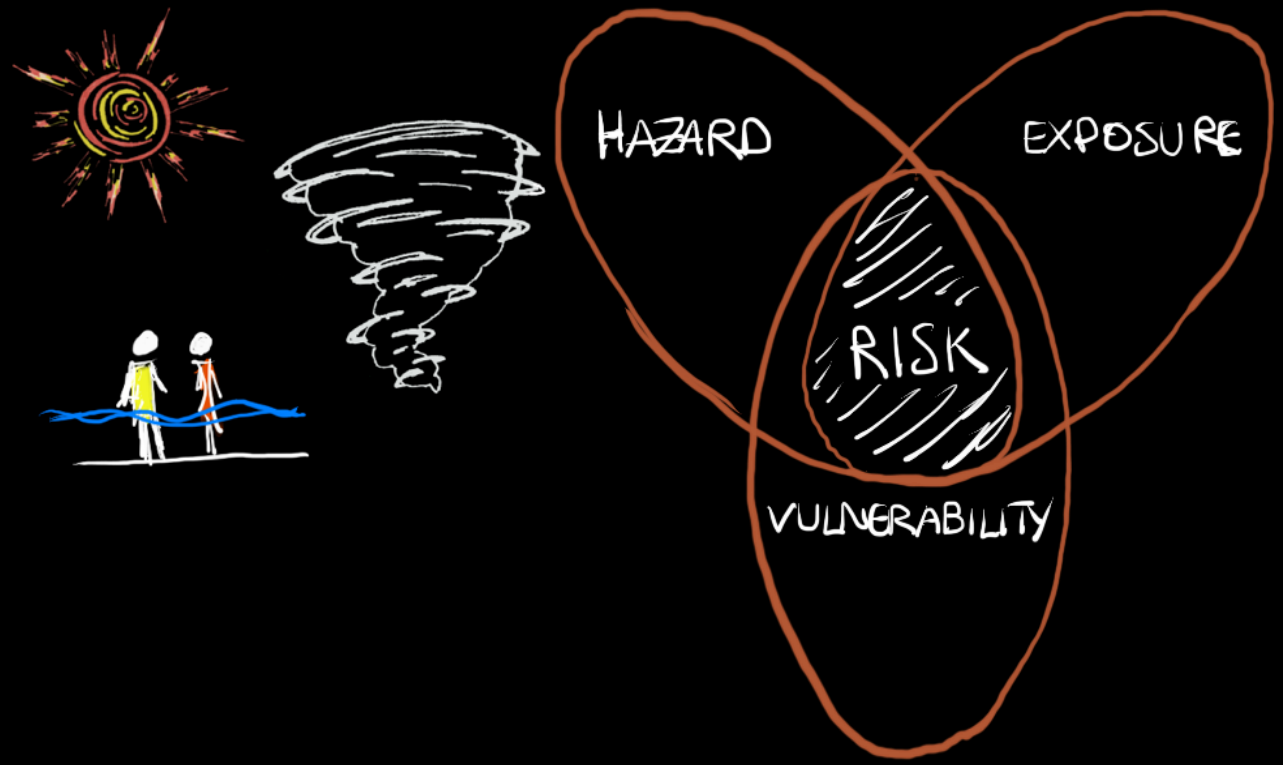


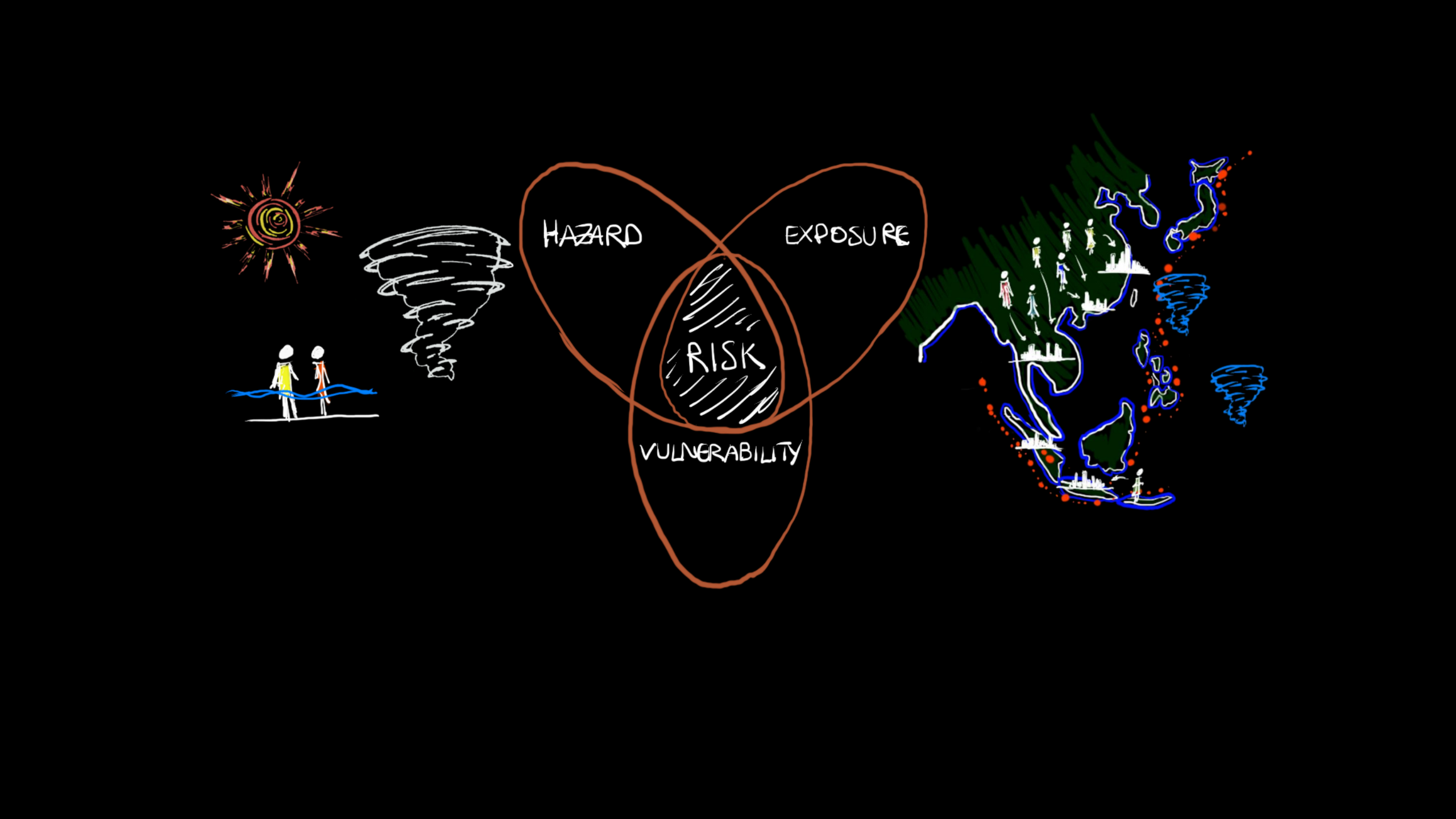
RISK ANALYSIS FOR
EQUITABLE OUTCOMES

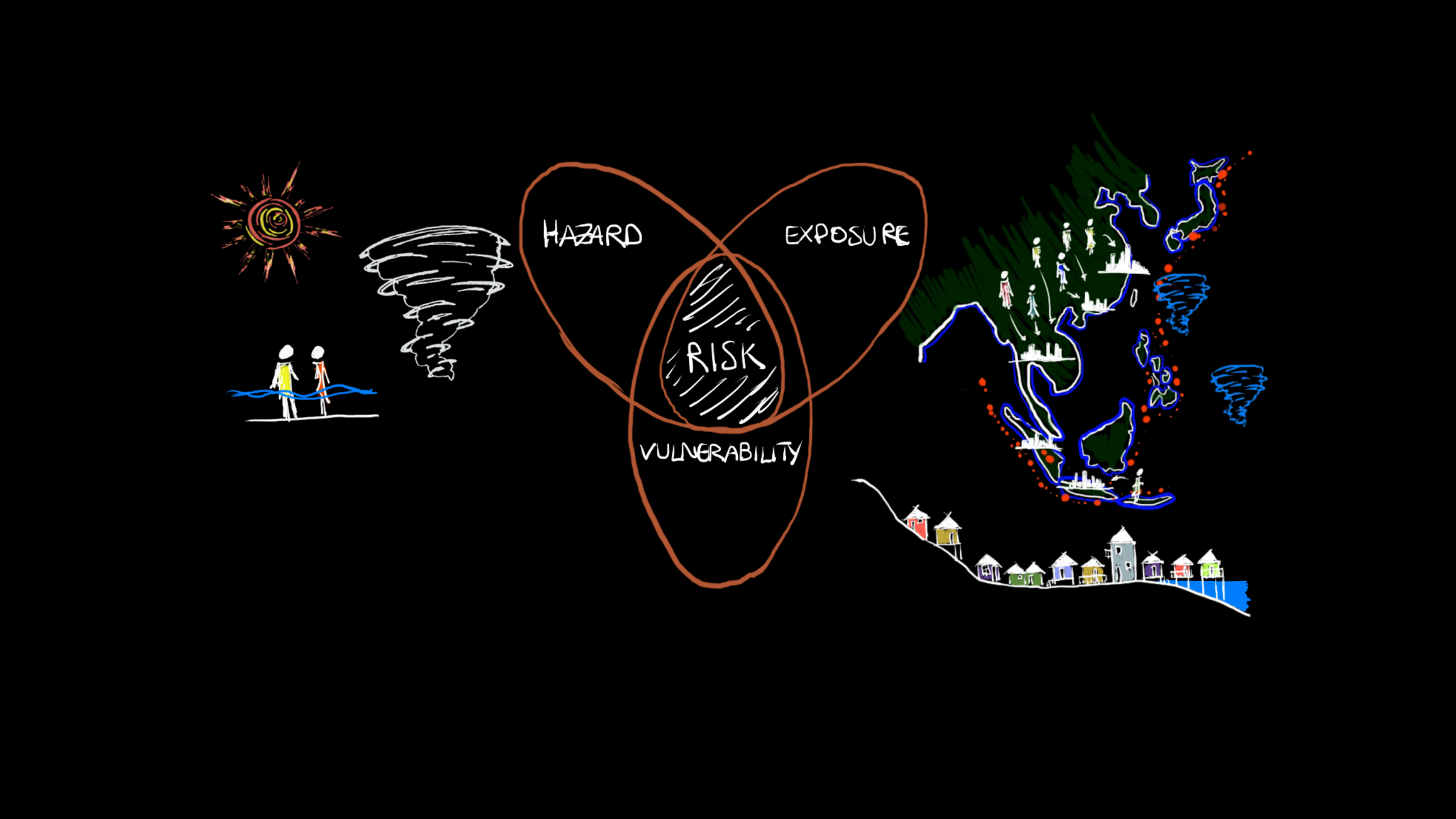


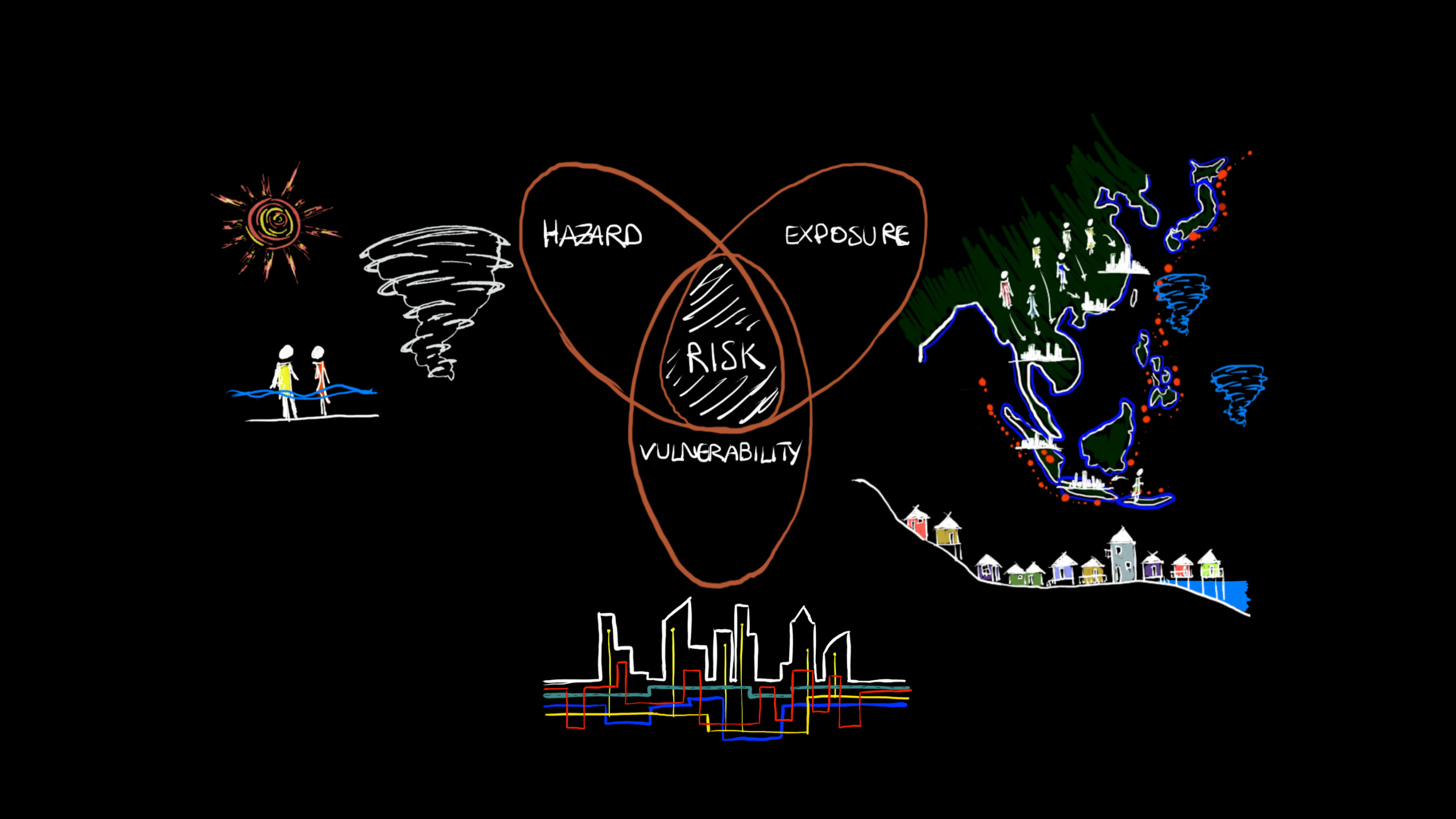
SPATIAL ANALYSIS

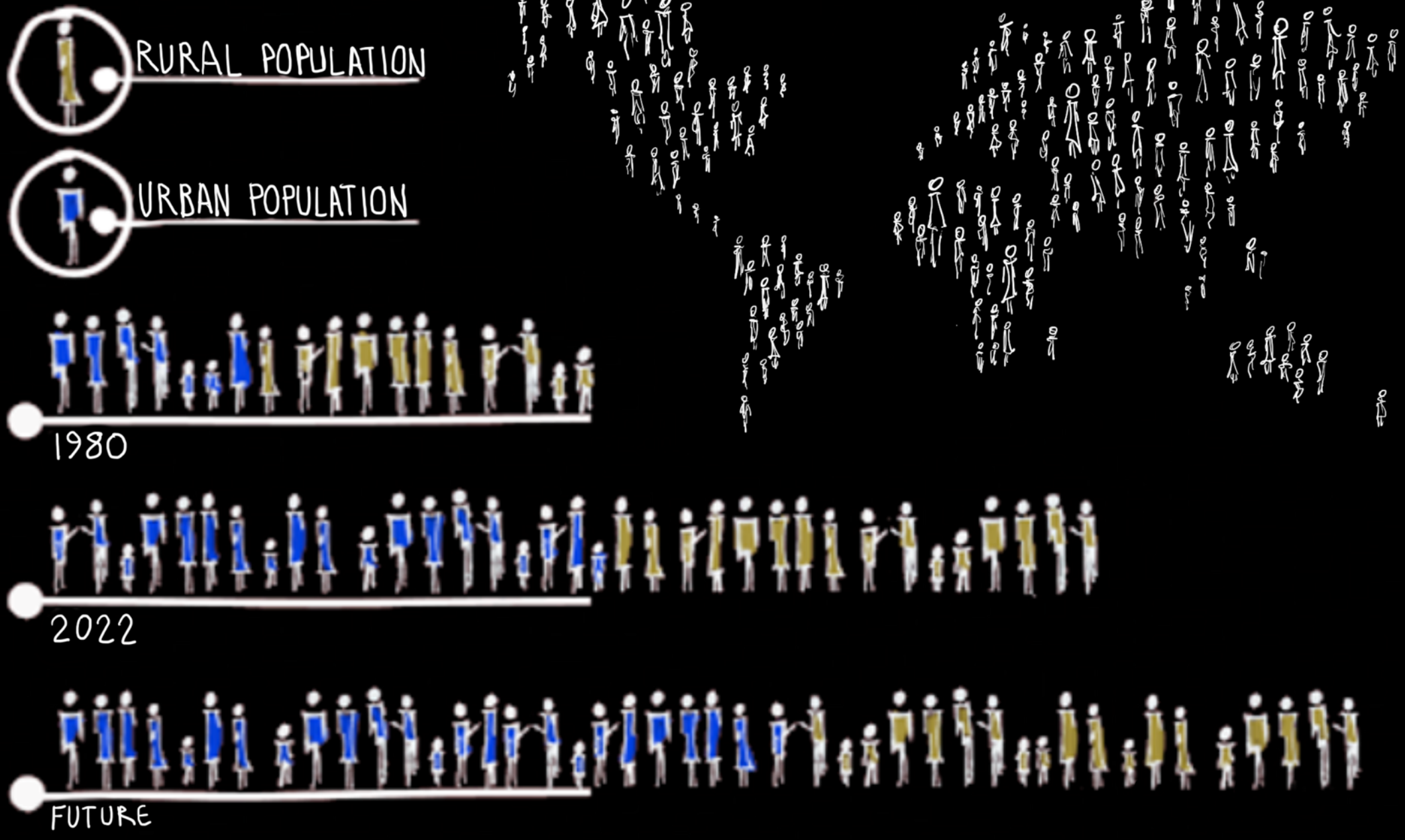

HAZARD
EXPOSURE
RISK
VULNERABILITY

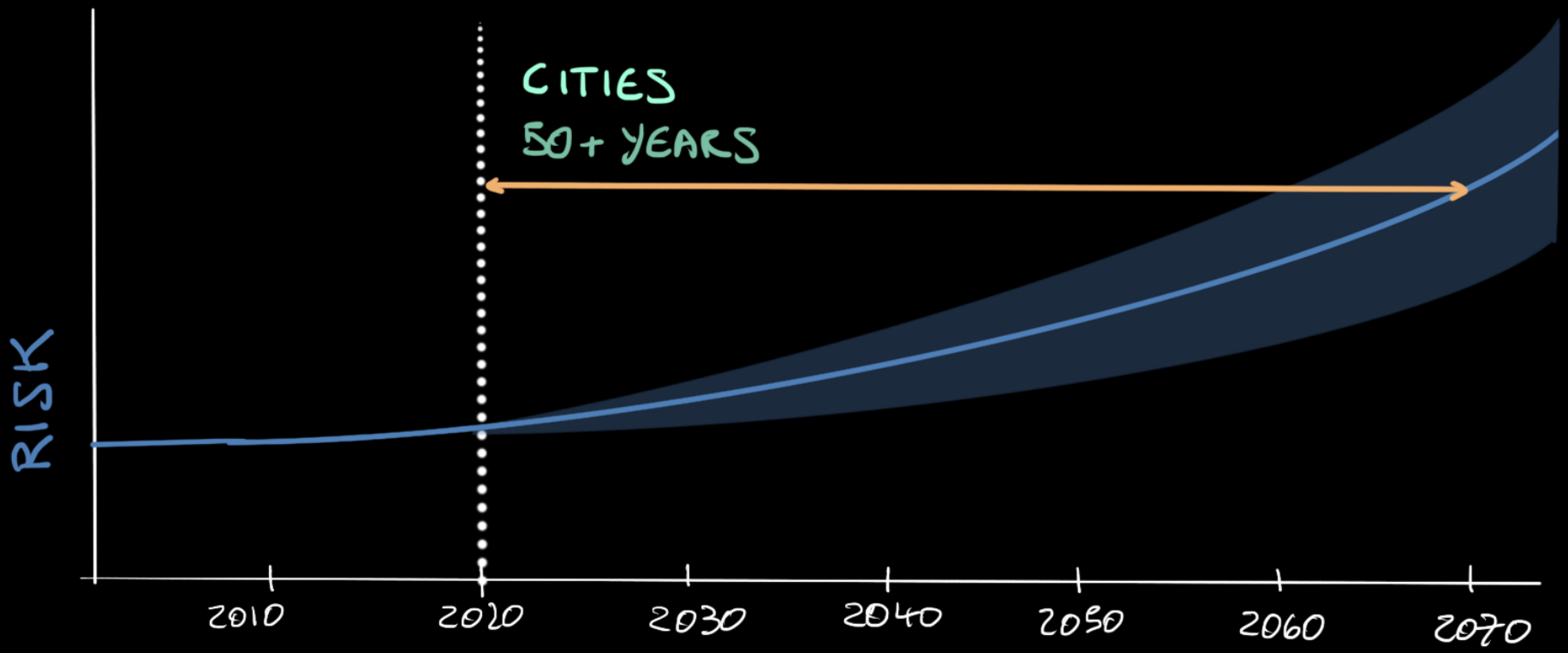

HAZARD
EXPOSURE
RISK
VULNERABILITY


HAZARD
EXPOSURE
RISK
VULNERABILITY


HAZARD
EXPOSURE
RISK
VULNERABILITY


HAZARD
EXPOSURE
RISK
VULNERABILITY

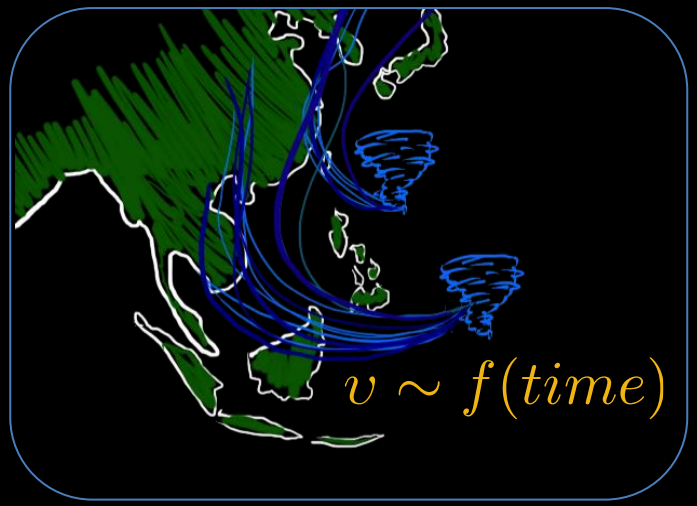

RURAL POPULATION
URBAN POPULATION
1980
2022
FUTURE



Cities need to make decisions on much longer time horizons, and therefore need analytical tools to do so.

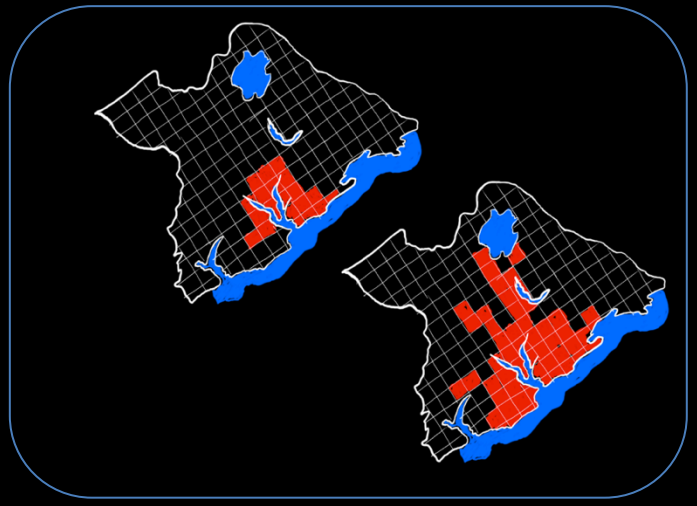
Dynamic risk modeling

Hazard



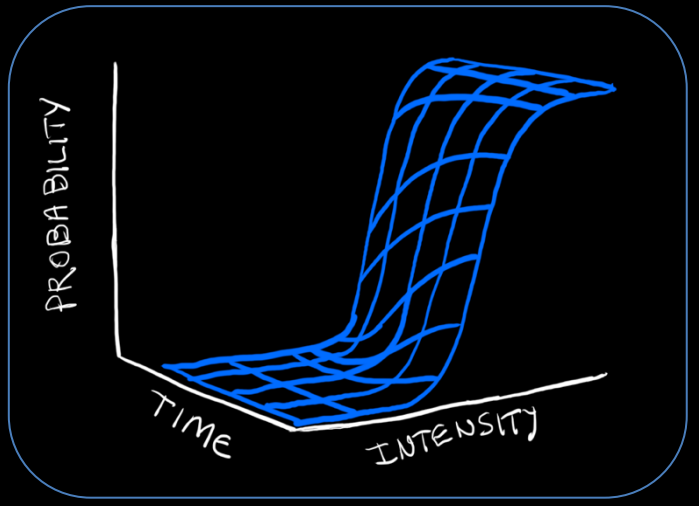
Time-varying hazard rate

Exposure



Urban growth simulation

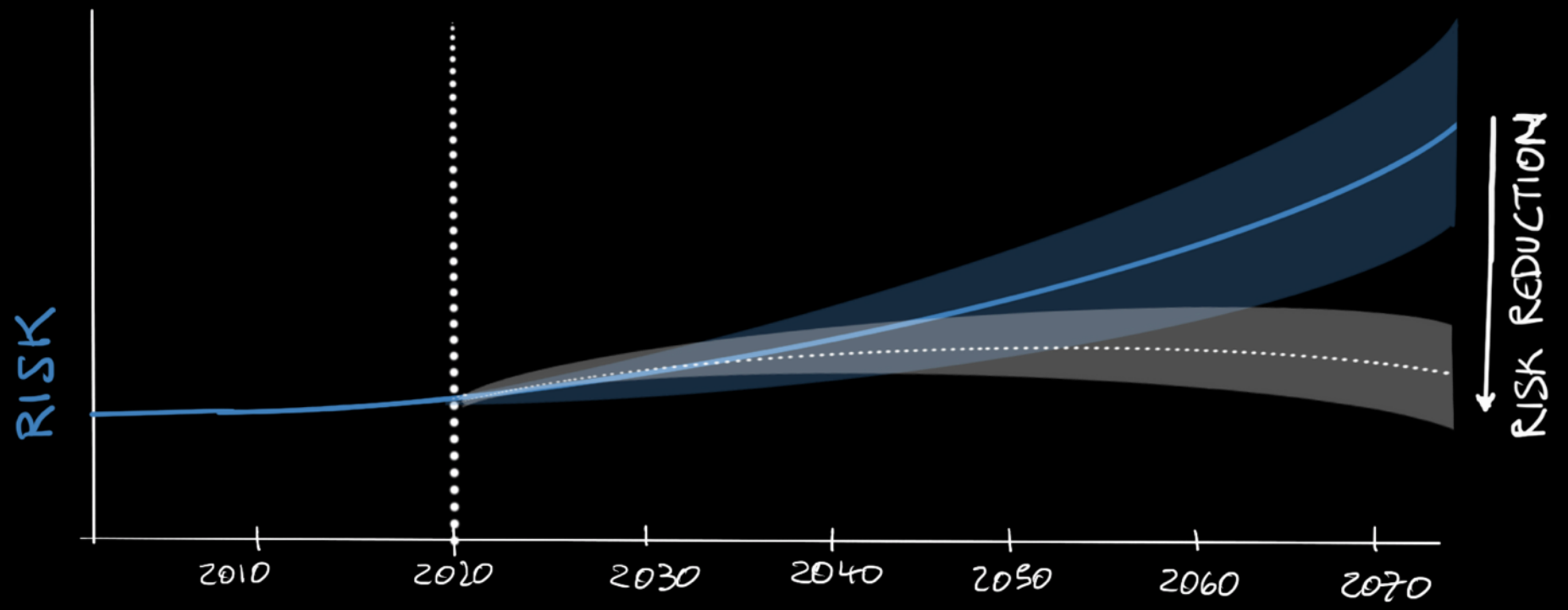
Vulnerability



Time-dependent fragility model

Dynamic probabilistic risk framework

Rabonza, M. & Lallemant, D., 2019; 2022 (in prep)



"If you do not change direction, you may end up where you are heading"

Lao Tzu, Chinese philosopher, 6th-5th century BC

Kathmandu, Nepal

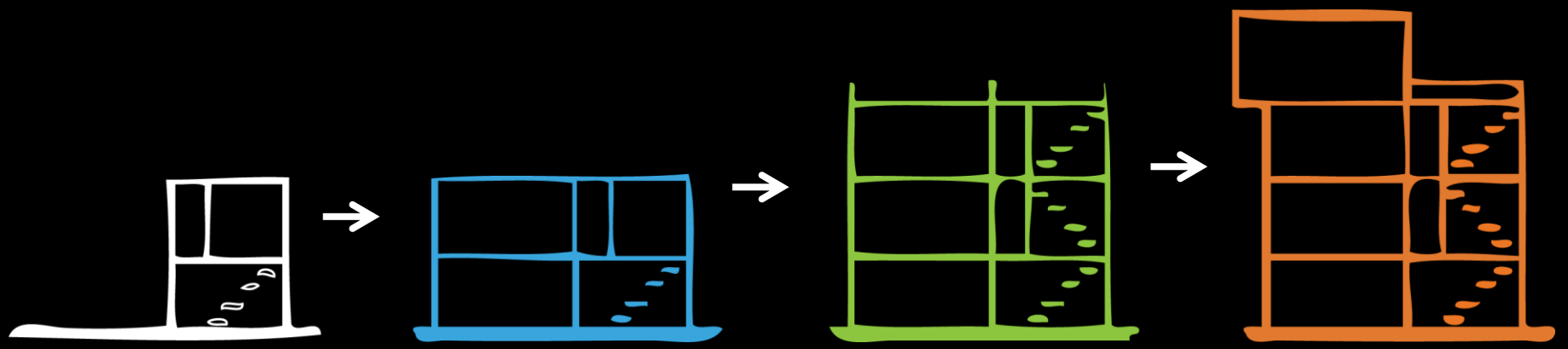
Photo credit: Dr. Anne Sanquini

Dynamic Exposure

1975 1990 2000 2018

Mesta et al. 2022

Dynamic Vulnerability

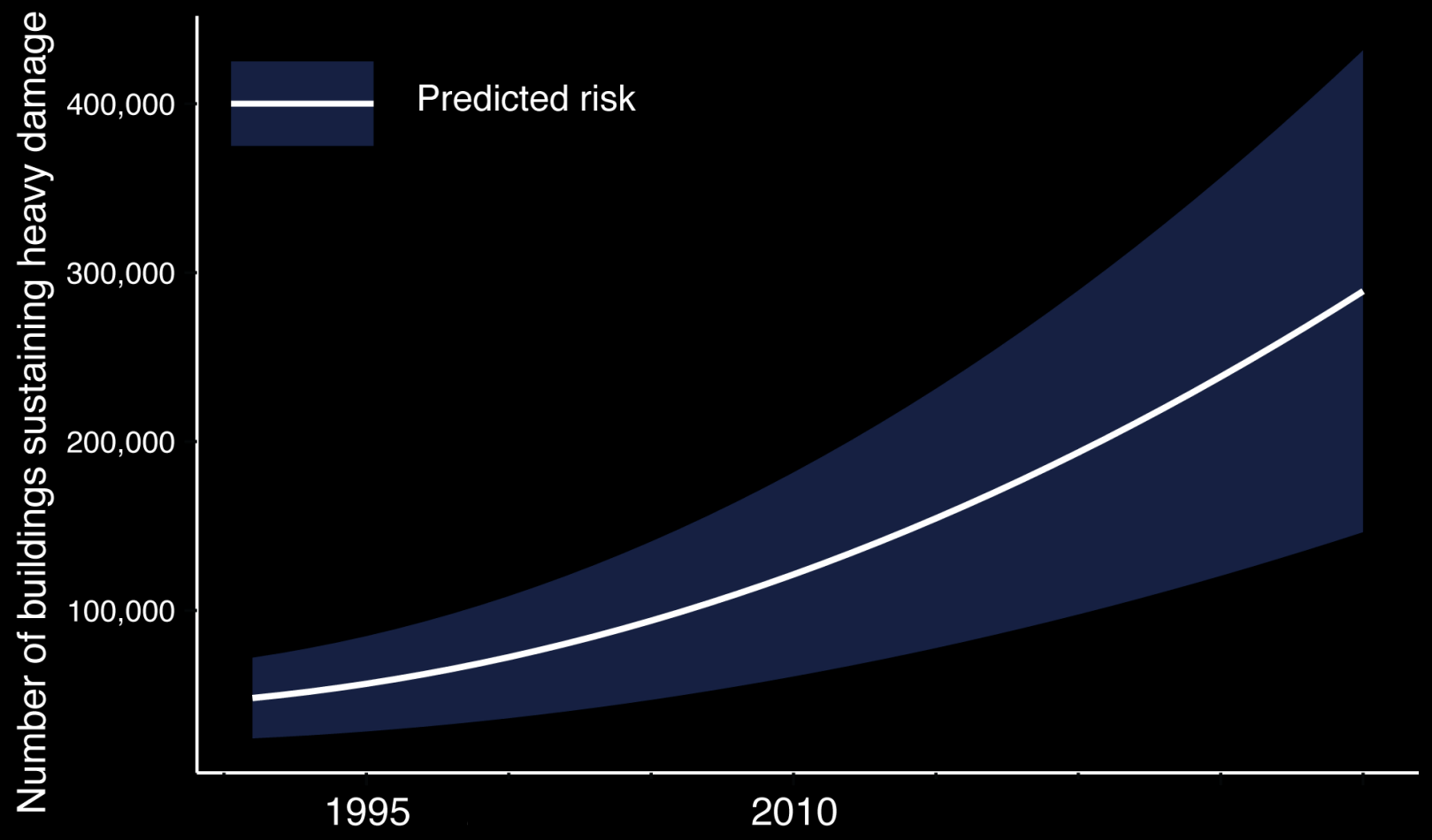


The add-hoc process of incremental construction is the default and most prevalent form of urban construction.

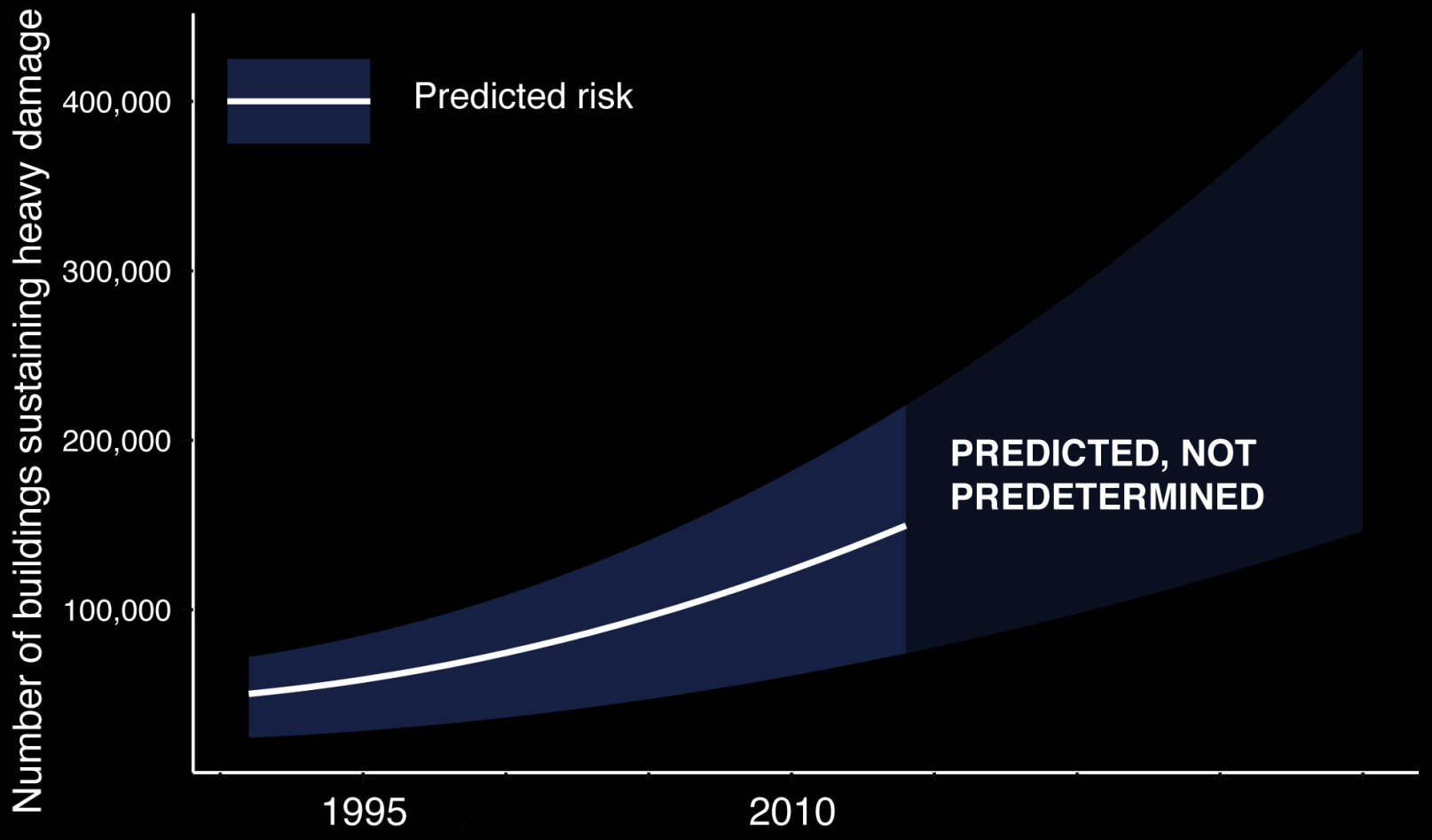
Incrementally increasing vulnerability

Photo credit: Dr. Anne Sanquini

Evolving Risk

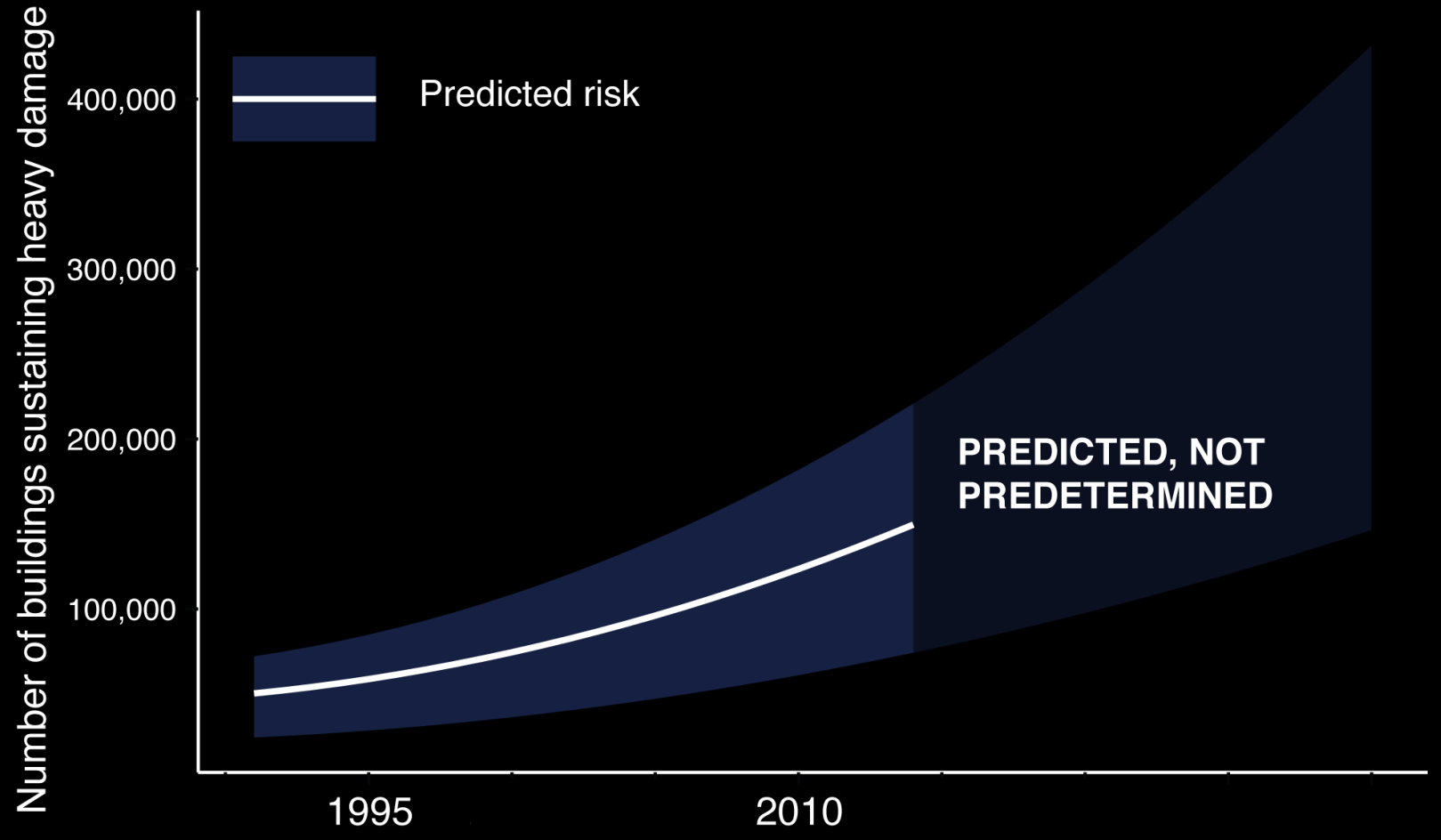


Evolving Risk



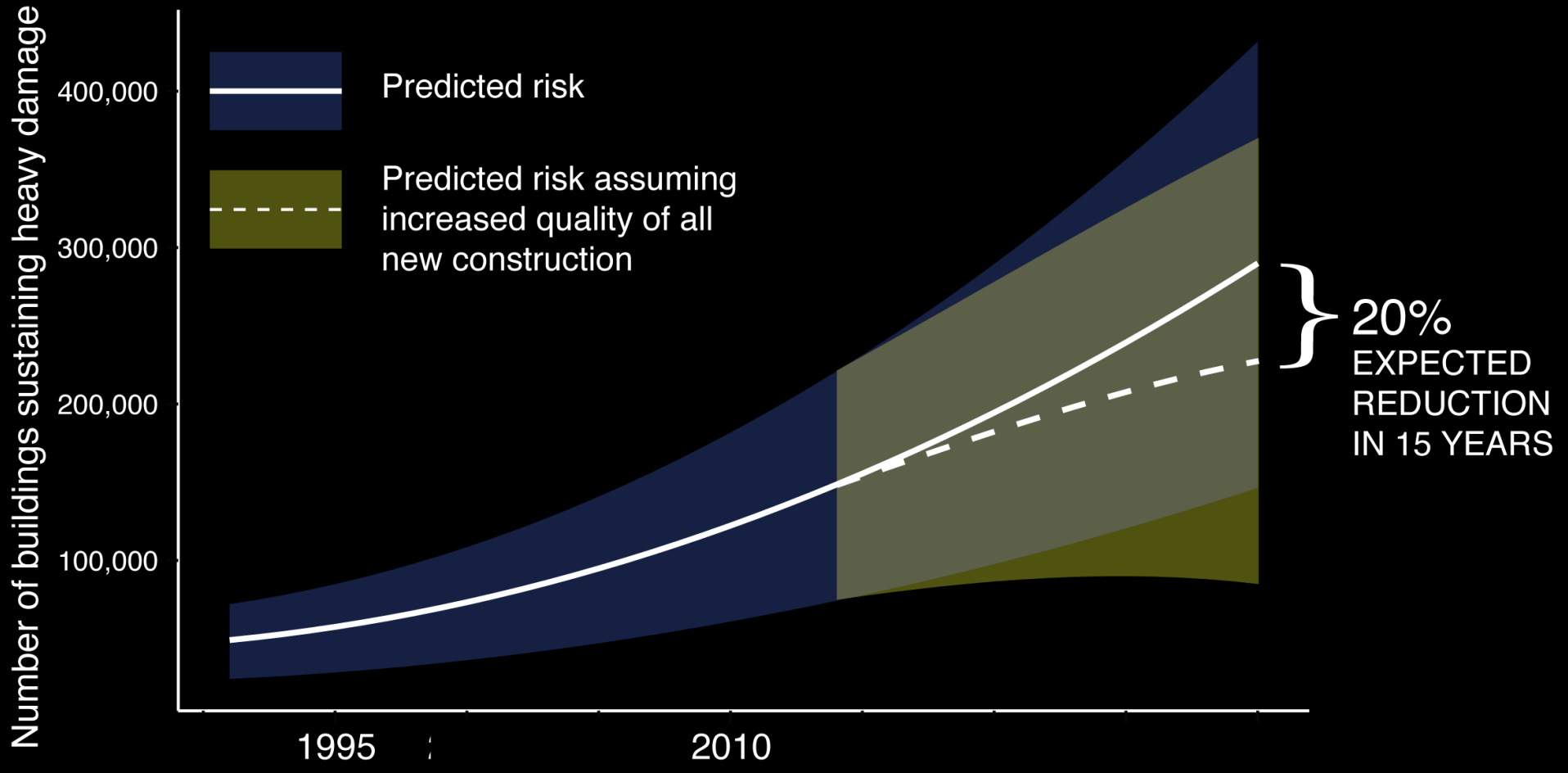
Evolving Risk

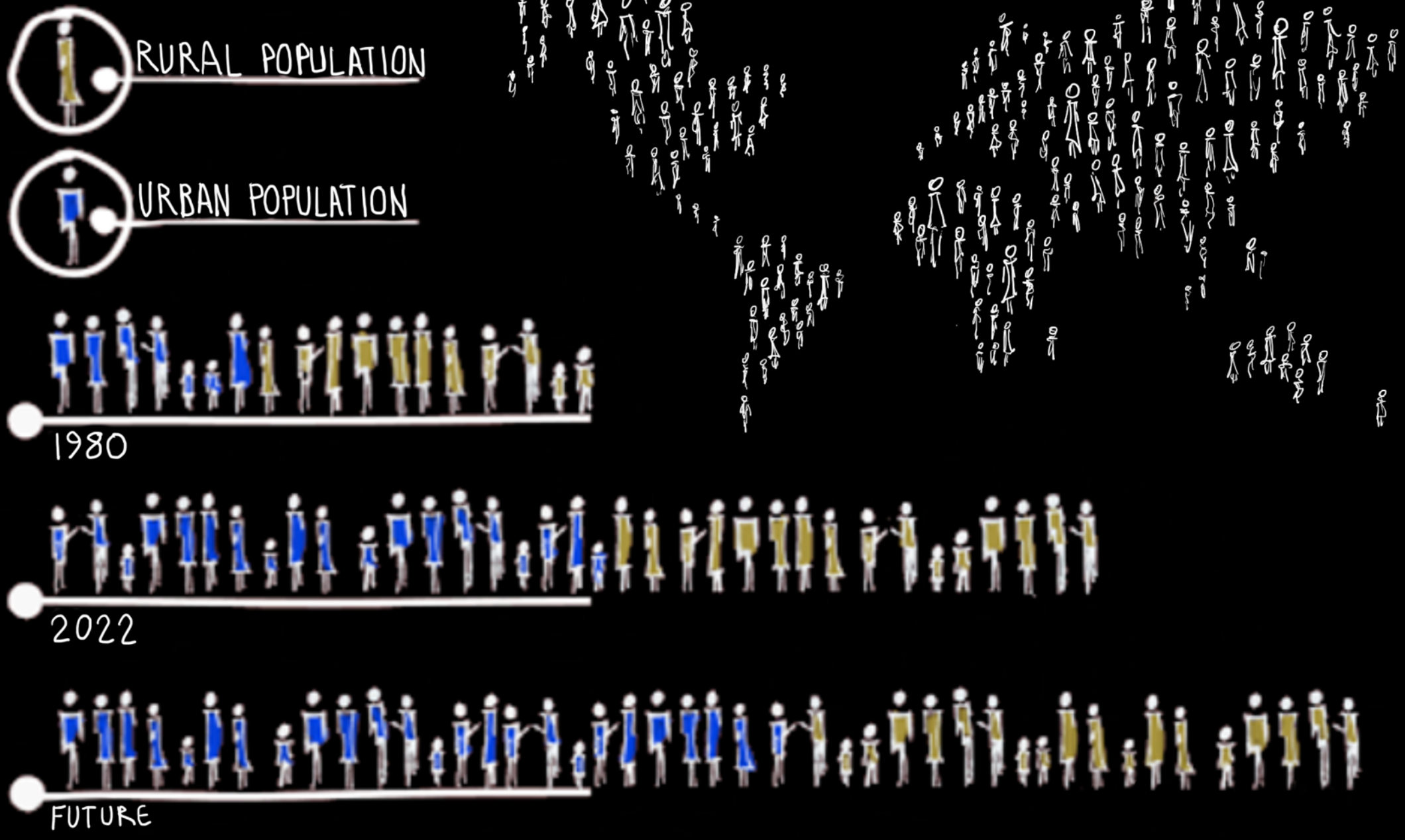
What if all new construction is better designed for earthquakes?

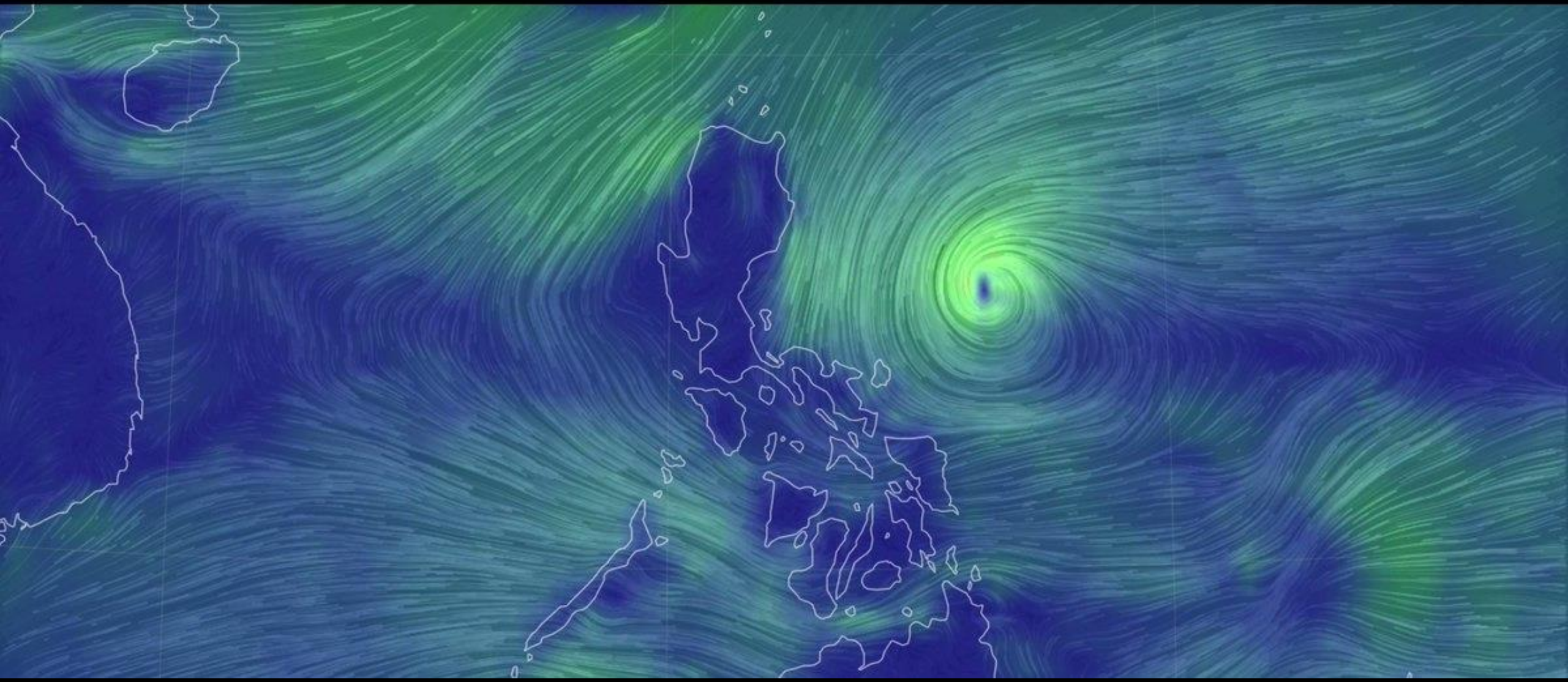


Controlling Evolving Risk

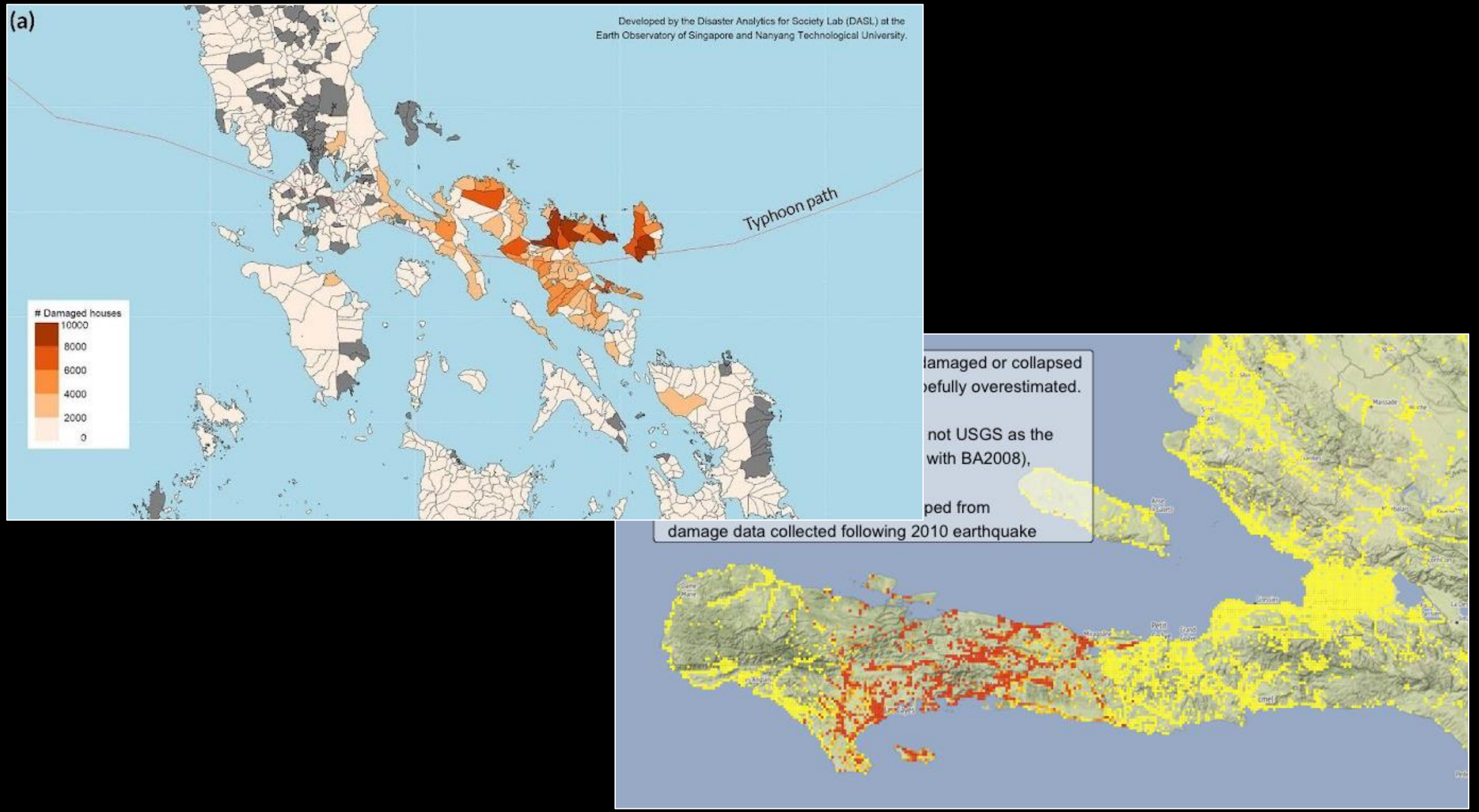
What if all new construction is better designed for earthquakes?

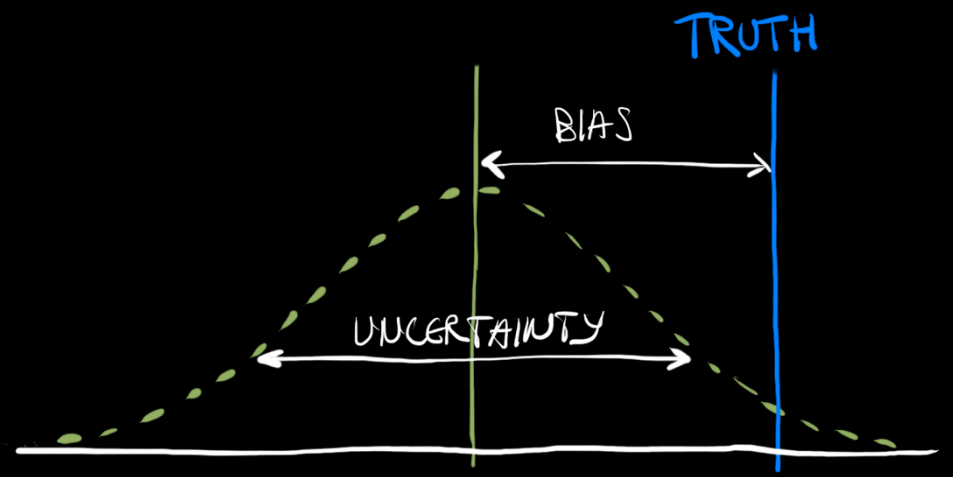



RURAL POPULATION
URBAN POPULATION
1980
2022
FUTURE

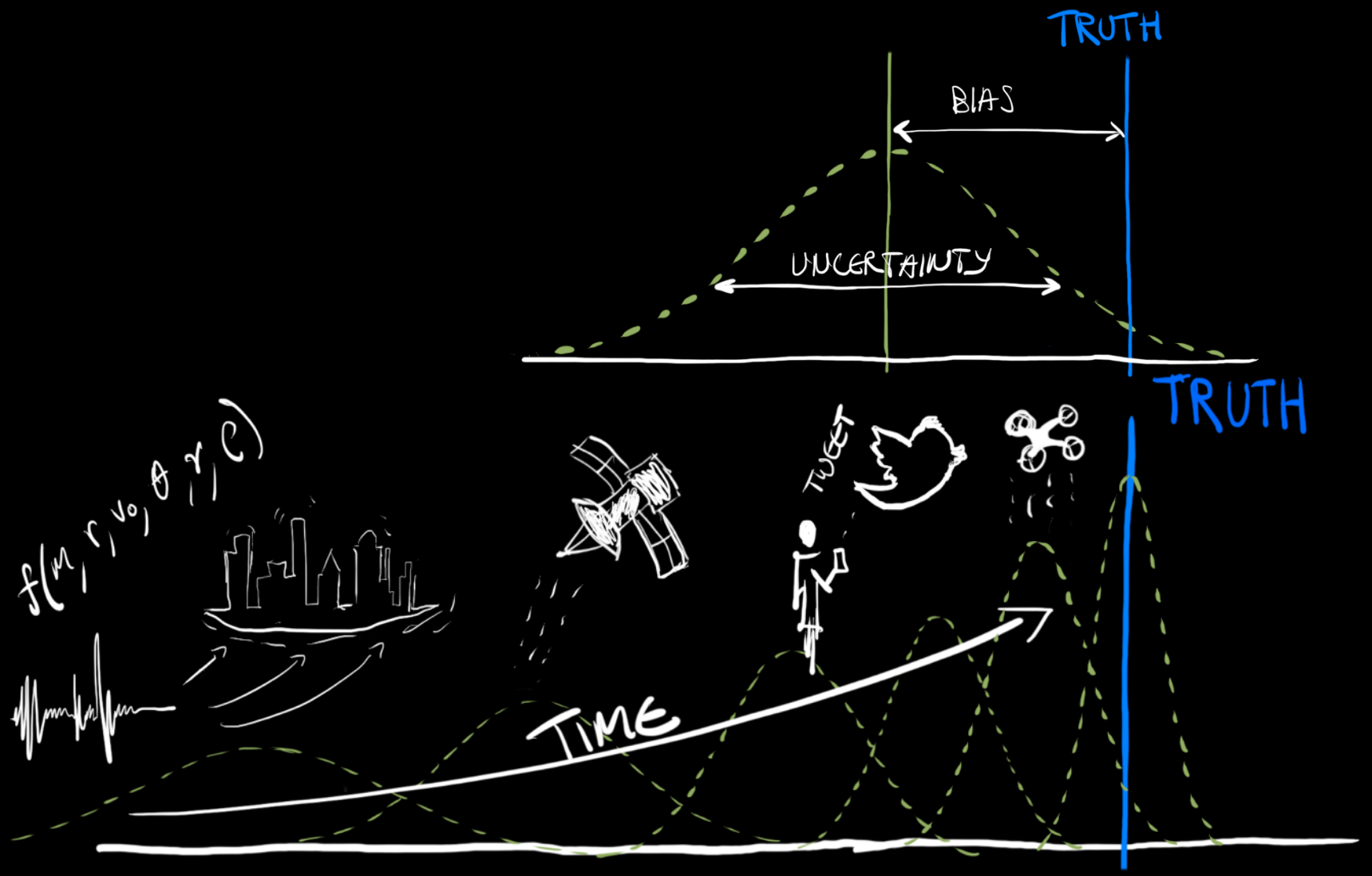


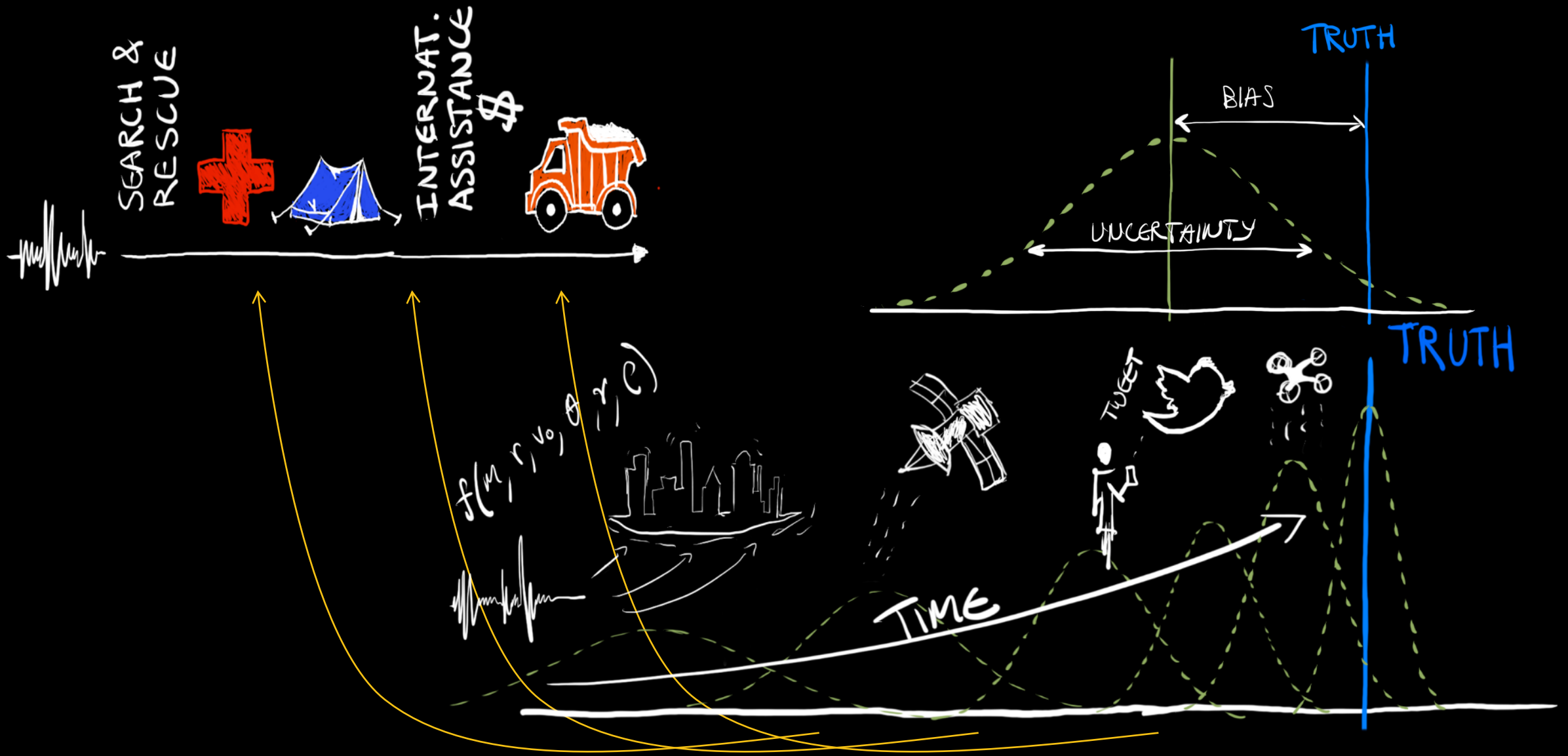
Typhoon Noru, Sept 2022 (obtained from earth.nullschool.net)


(a)
Developed by the Disaster Analytics for Society Lab (DASL) at the
Earth Observatory of Singapore and Nanyang Technological University.
Typhoon path
Damaged houses
10000
8000
6000
4000
2000
0
damaged or collapsed
efully overestimated.
not USGS as the
with BA2008),
ped from
damage data collected following 2010 earthquake



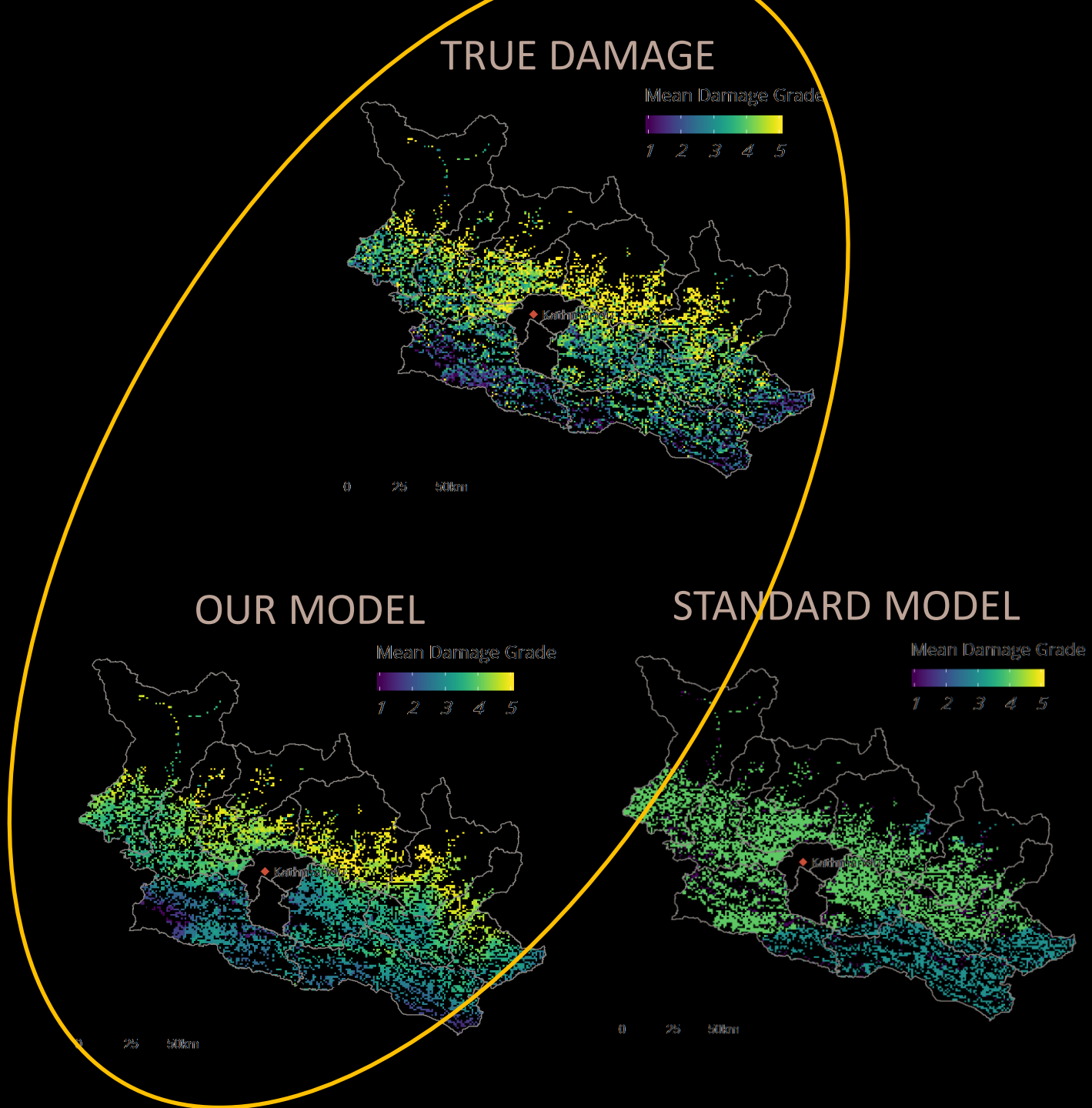
Global
Partnership
for Sustainable
Development Data

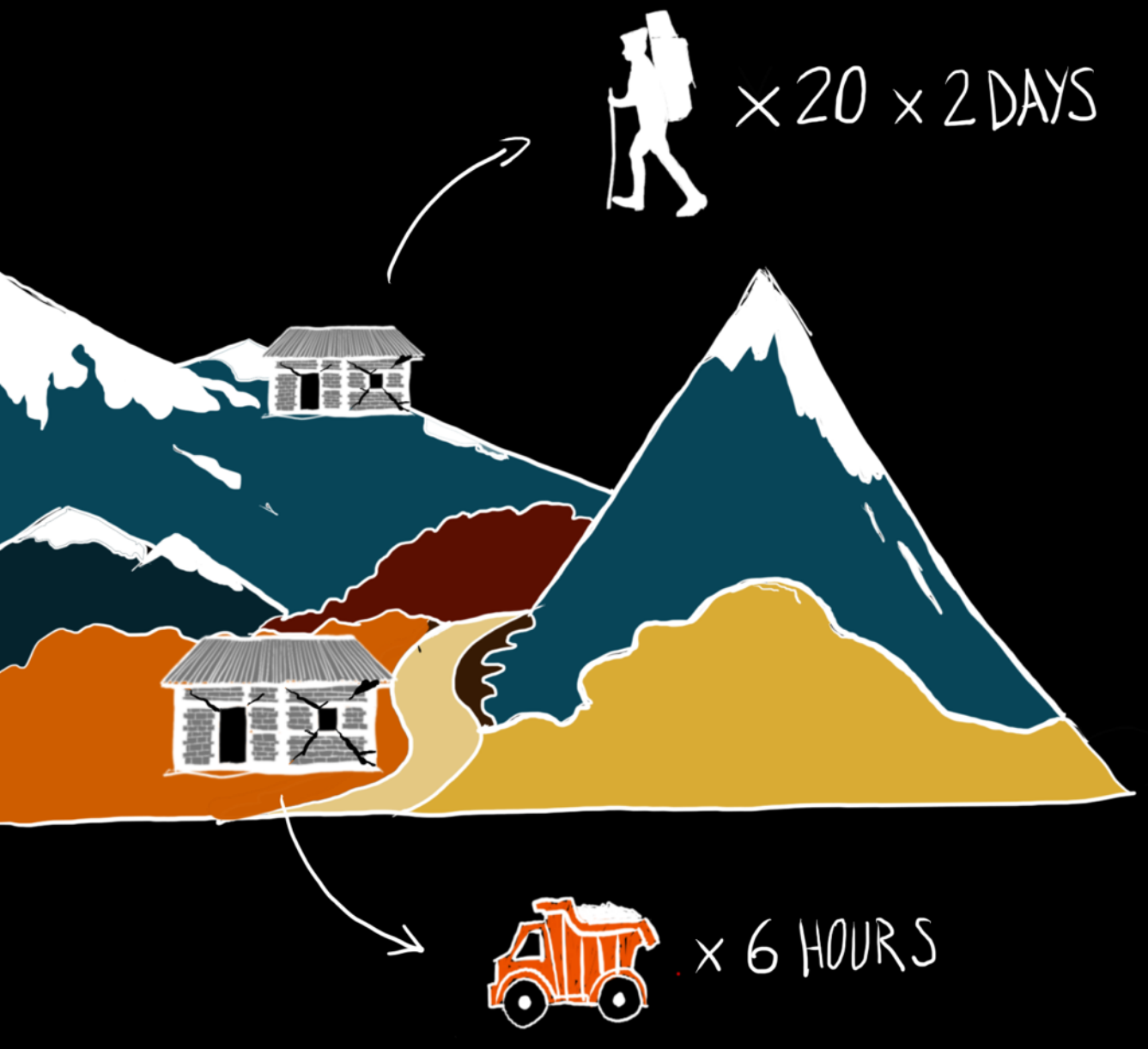

TRUTH
BIAS
UNCERTAINTY
TRUTH
TWEET
TIME

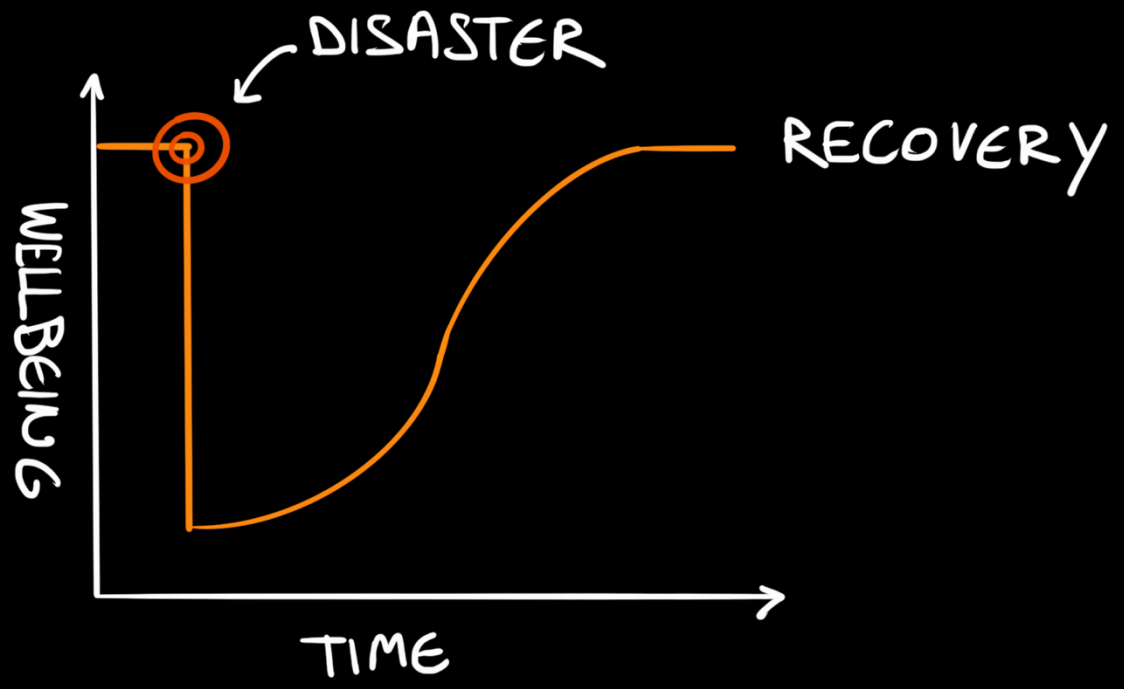

SEARCH &
RESCUE
INTERNAT.
ASSISTANCE
$
TRUTH
BIAS
UNCERTAINTY
TRUTH
TWEET
TIME

GEOSPATIAL DATA INTEGRATION FRAMEWORK (G-DIF)

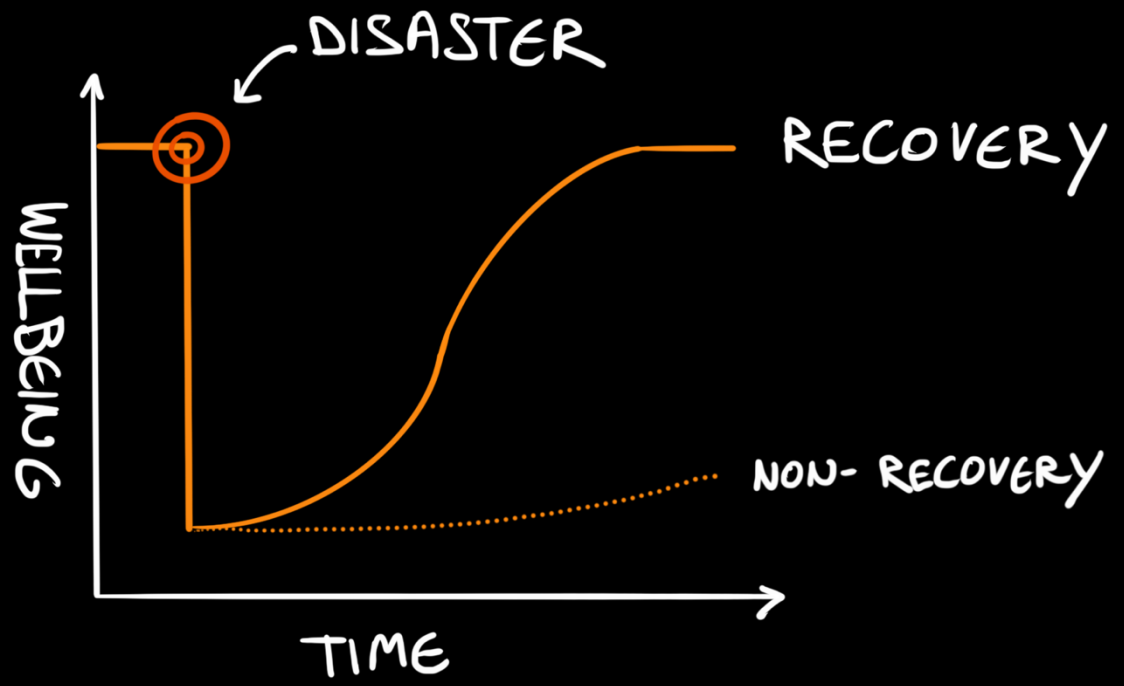
S. Loos, D. Lallemant, J. Baker, J.McCaughey, S. Yun, N. Budhathoki, F. Khan, R. Singh. "G-DIF: A geospatial data integration framework to rapidly estimate post earthquake damage." Earthquake Spectra. https://journals.sagepub.com/doi/10.1177/8755293020926190




×20 × 2 DAYS
× 6 HOURS



Loos et al. 2022 (in review)



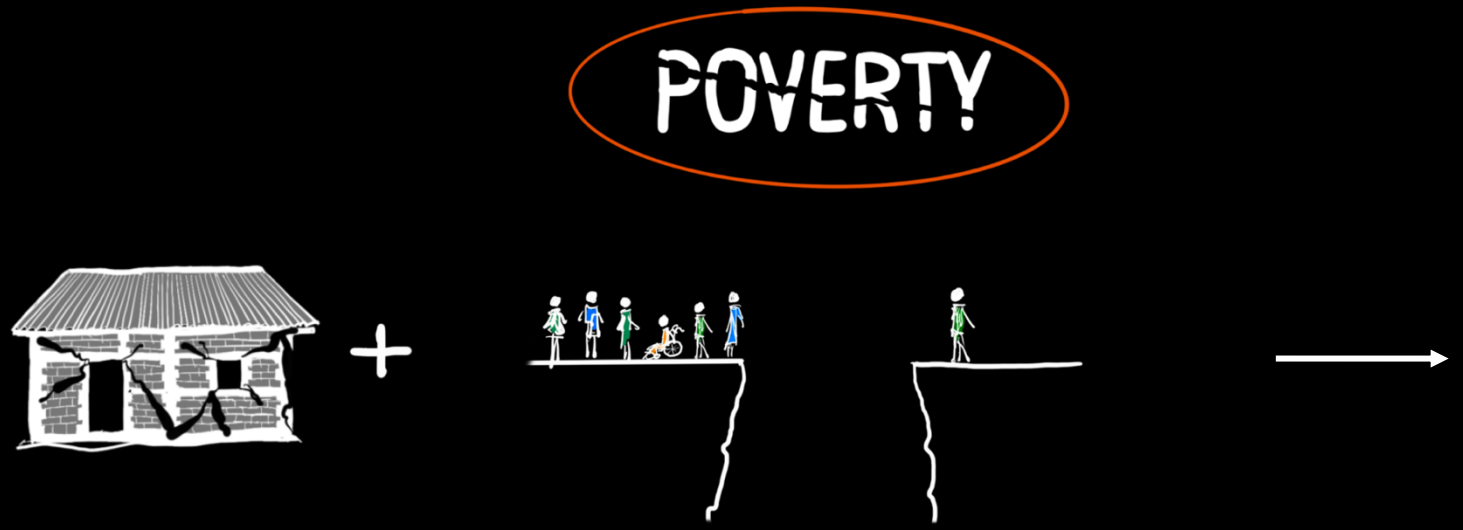
Loos et al. 2022 (in review)

POVERTY

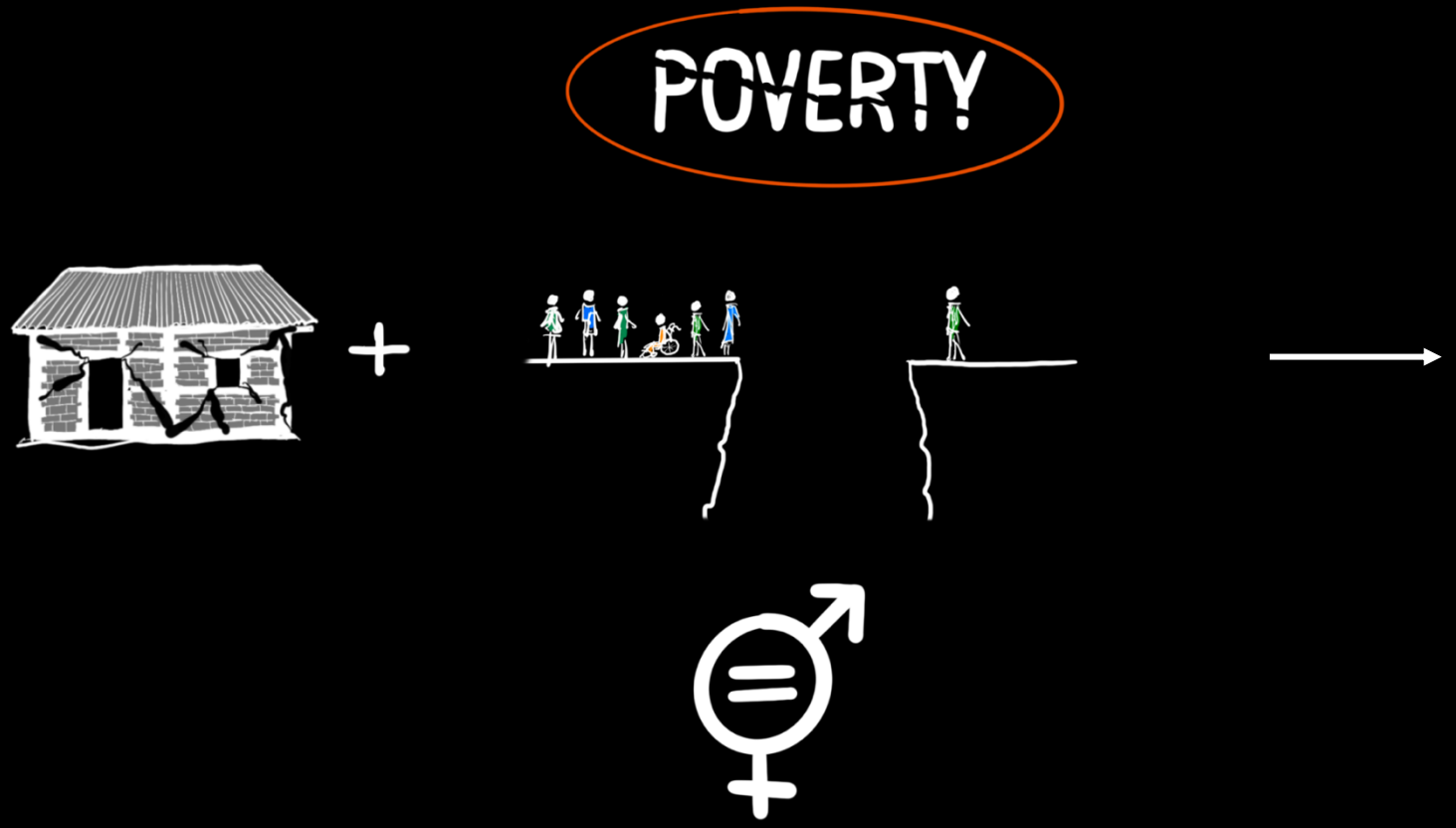
+

→

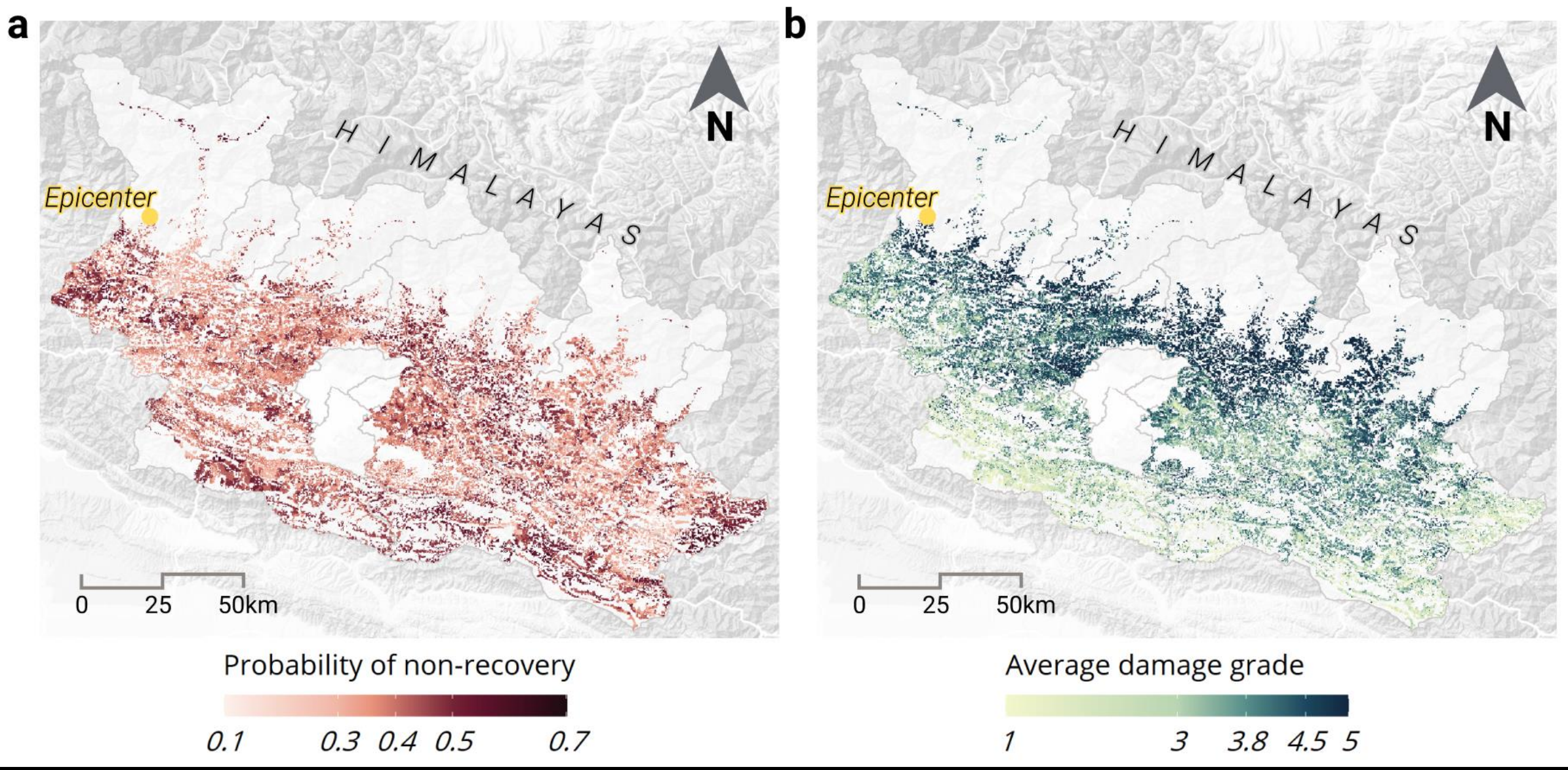
Ability to recover from disaster (resilience)



Ability to recover from disaster (resilience)

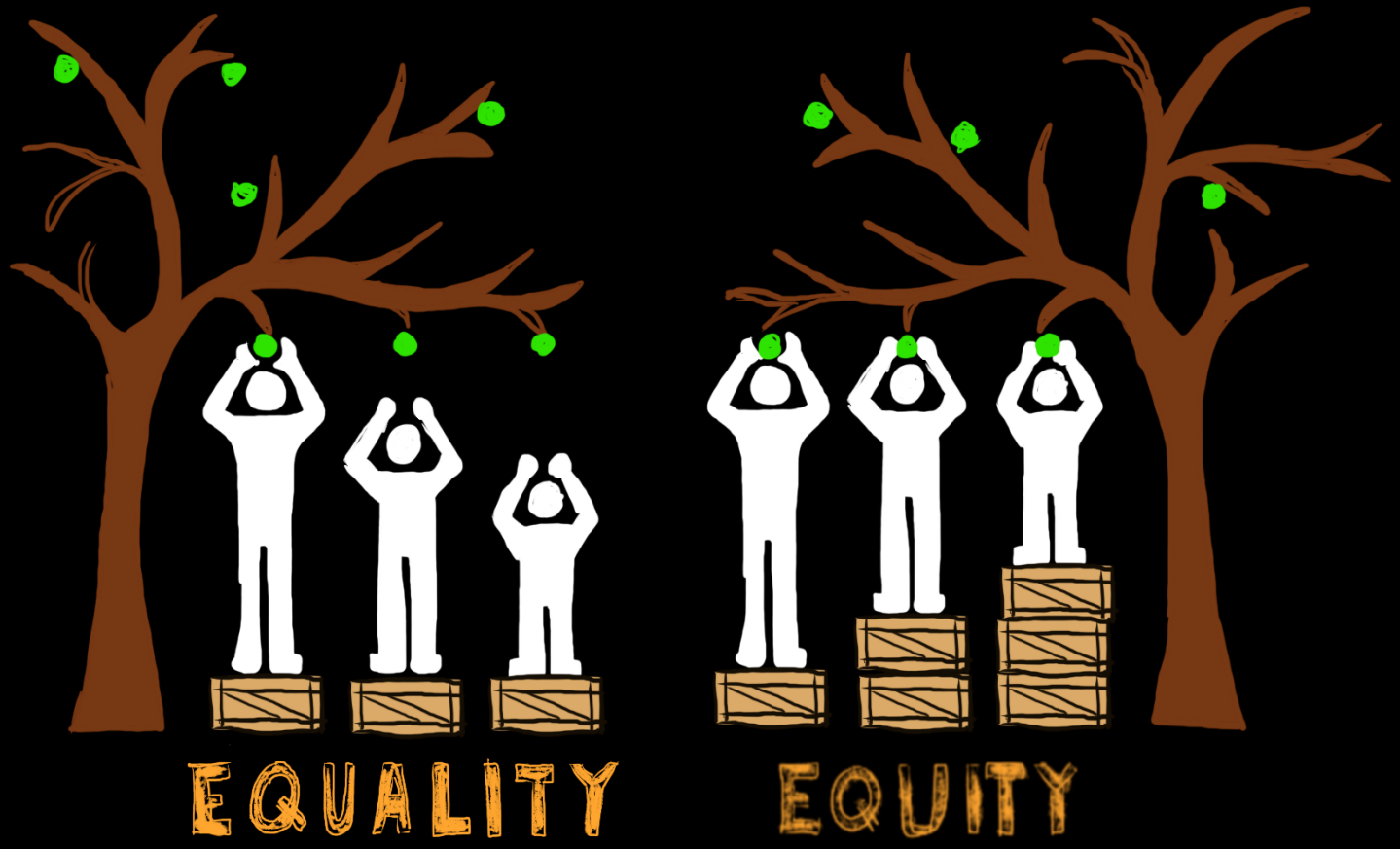


Ability to recover from disaster (resilience)



Loos et al. 2022 (in review)

RISK ANALYSIS FOR RESILIENT & EQUITABLE COMMUNITIES




HALF
EMPTY
HALF
FULL

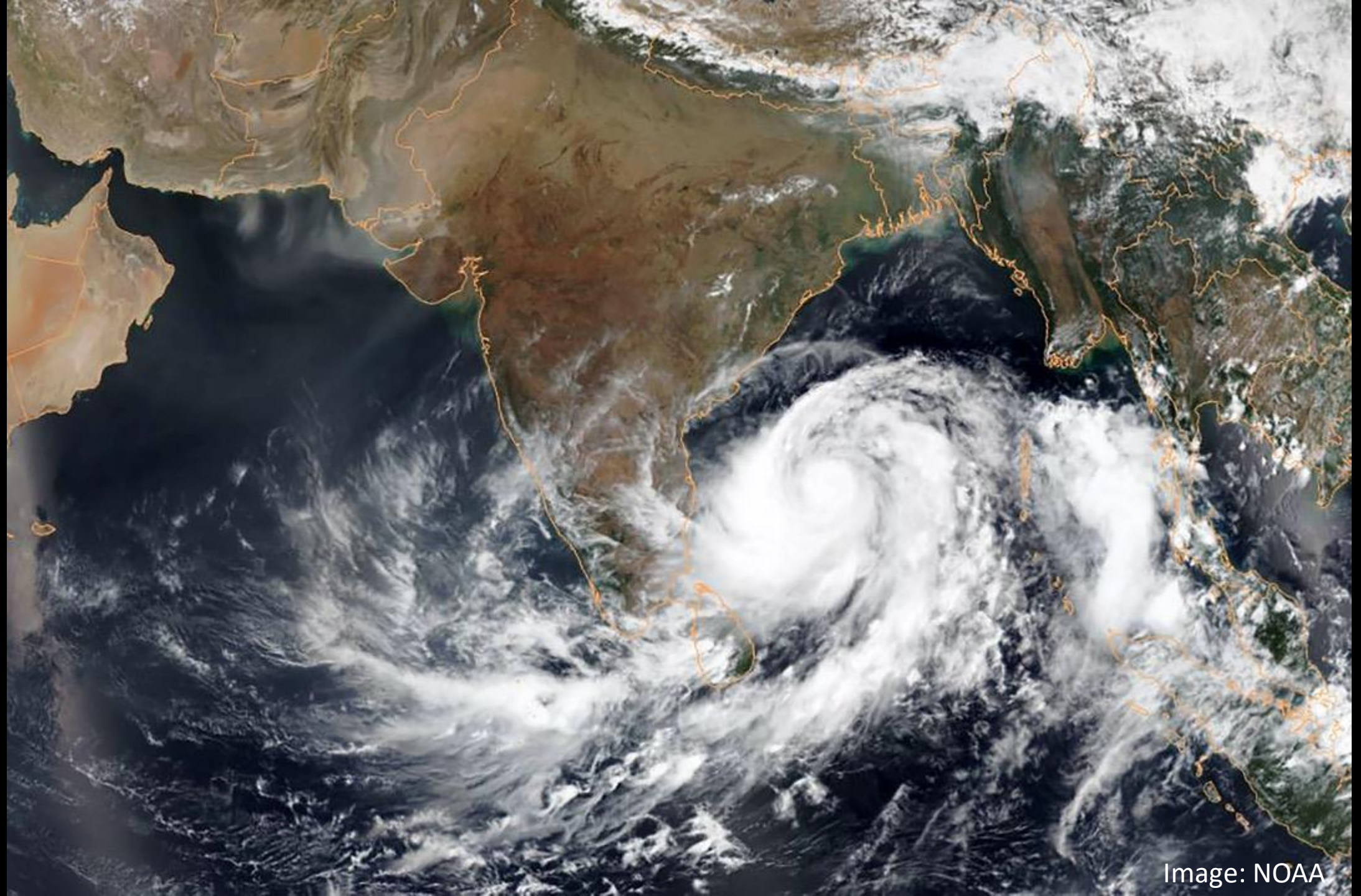


Image: NOAA

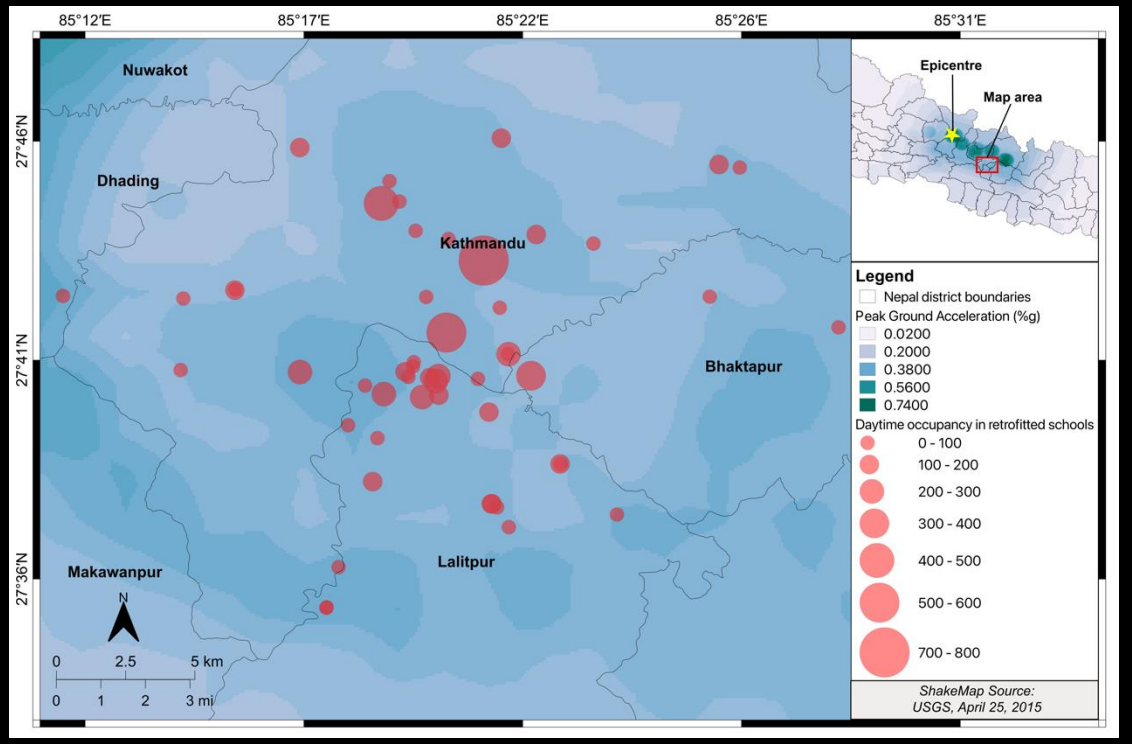
Image credit: Lallemant, 2015

PERCEPTION

WHAT WE SHED LIGHT ON

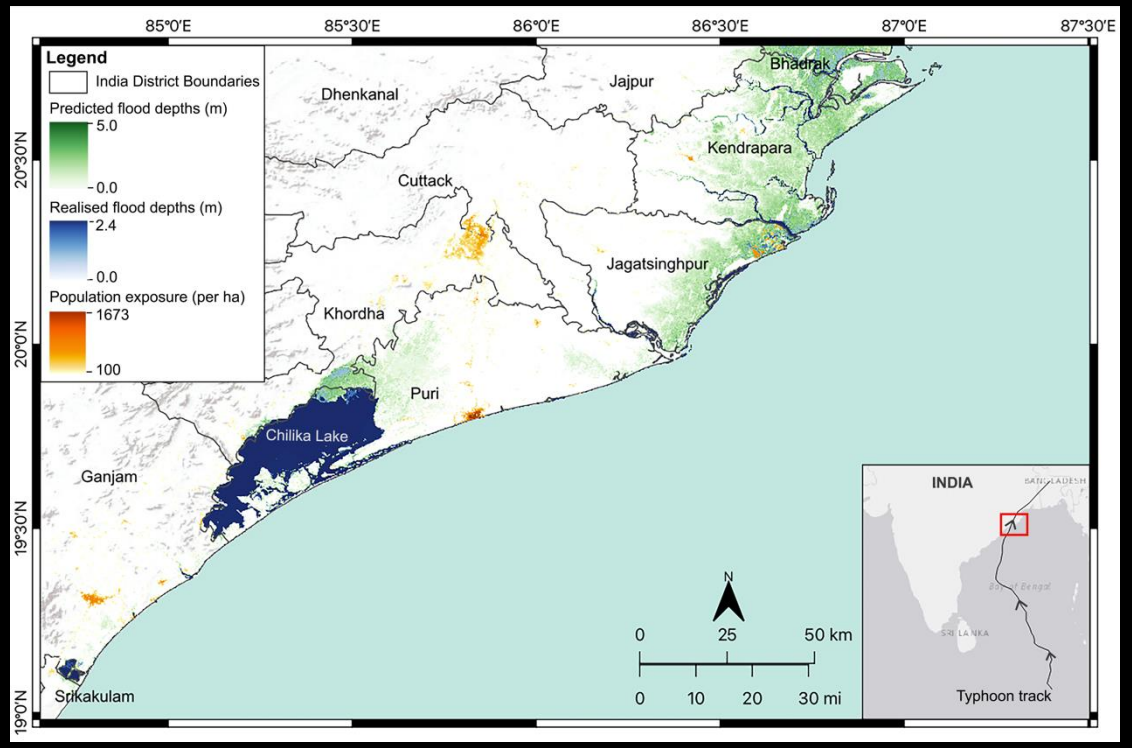
Probabilistic Downward Counterfactual Analysis

School retrofitting program in Nepal



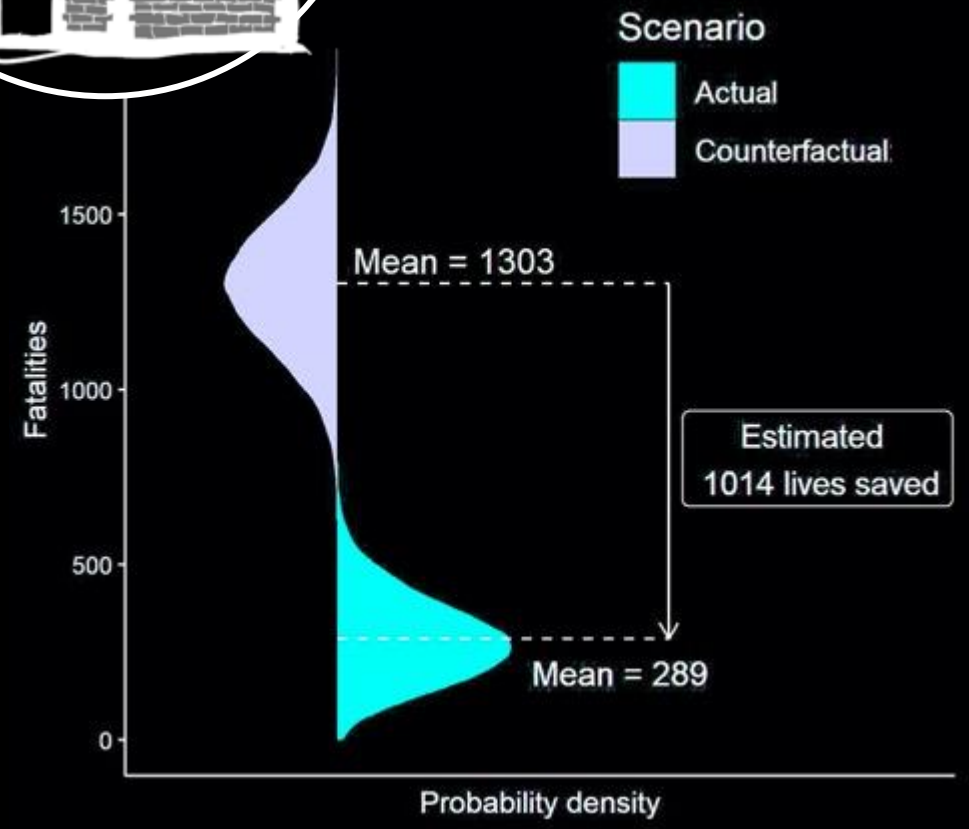
- Nepal School Earthquake Safety program retrofitted 300 schools between 1999-2015.
- 160 of those were in the area affected by the 2015 earthquake.

Evacuation prior to Cyclone Fani, 2019

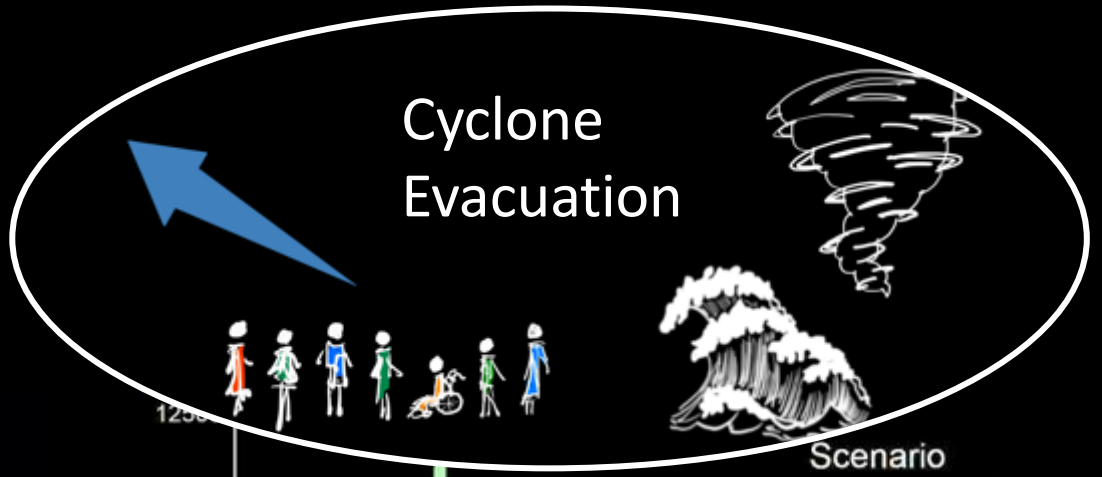


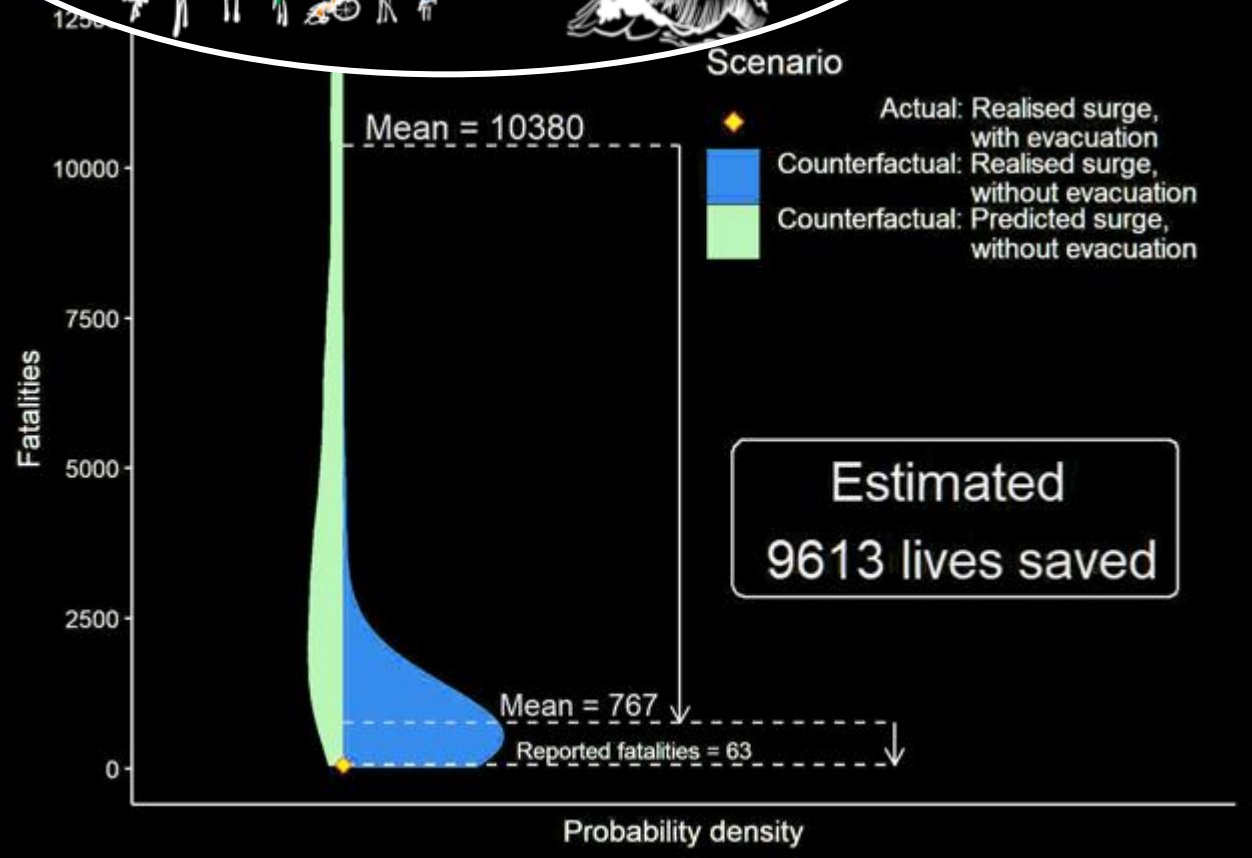
- One of the largest cyclones to hit India in past 20 years.
- 1.5 million people evacuated.

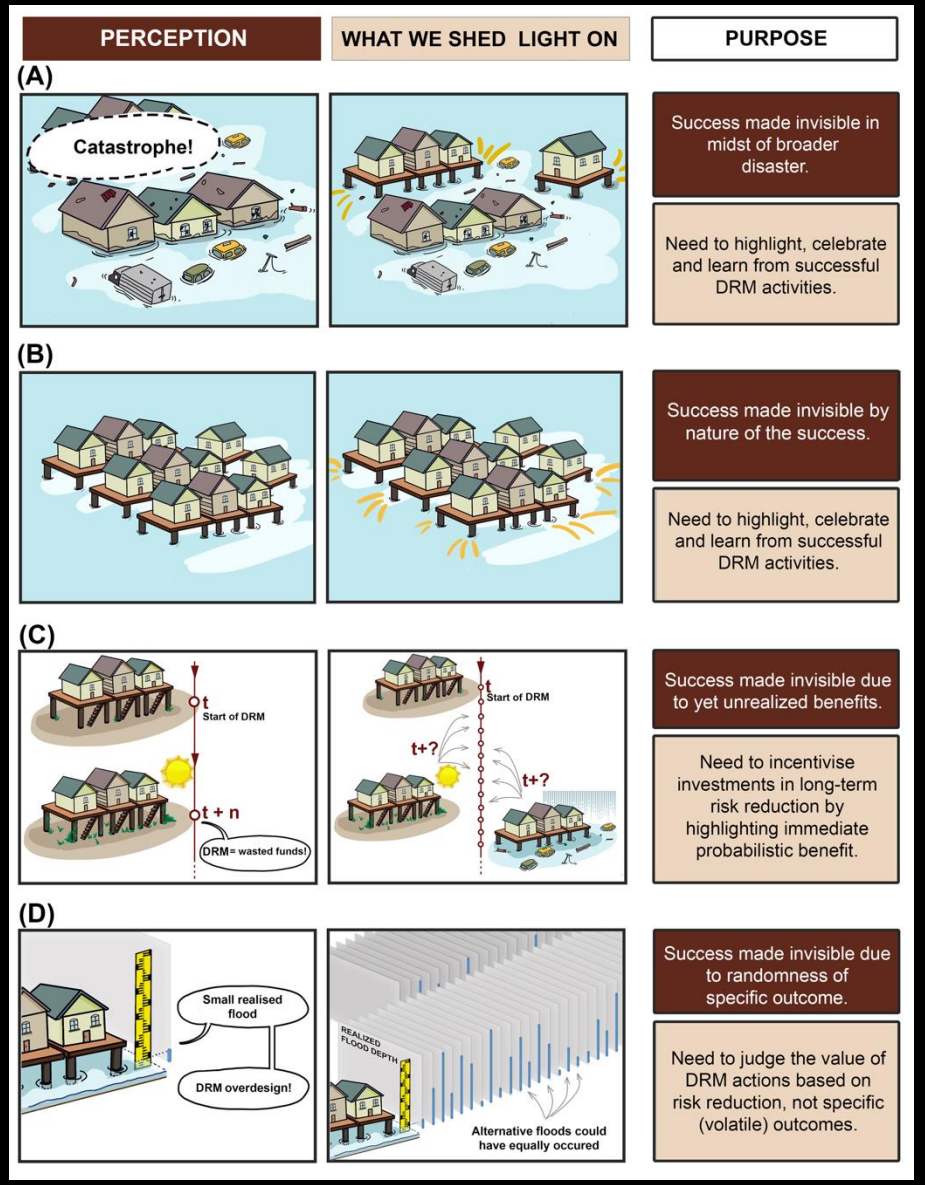
Earthquake
School Retrofit

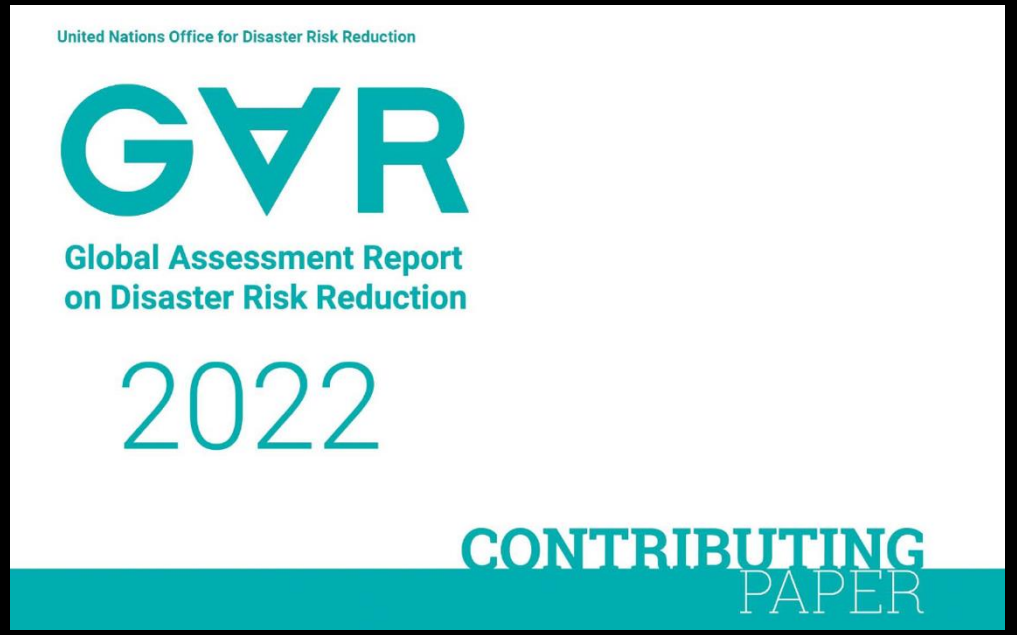


Cyclone
Evacuation







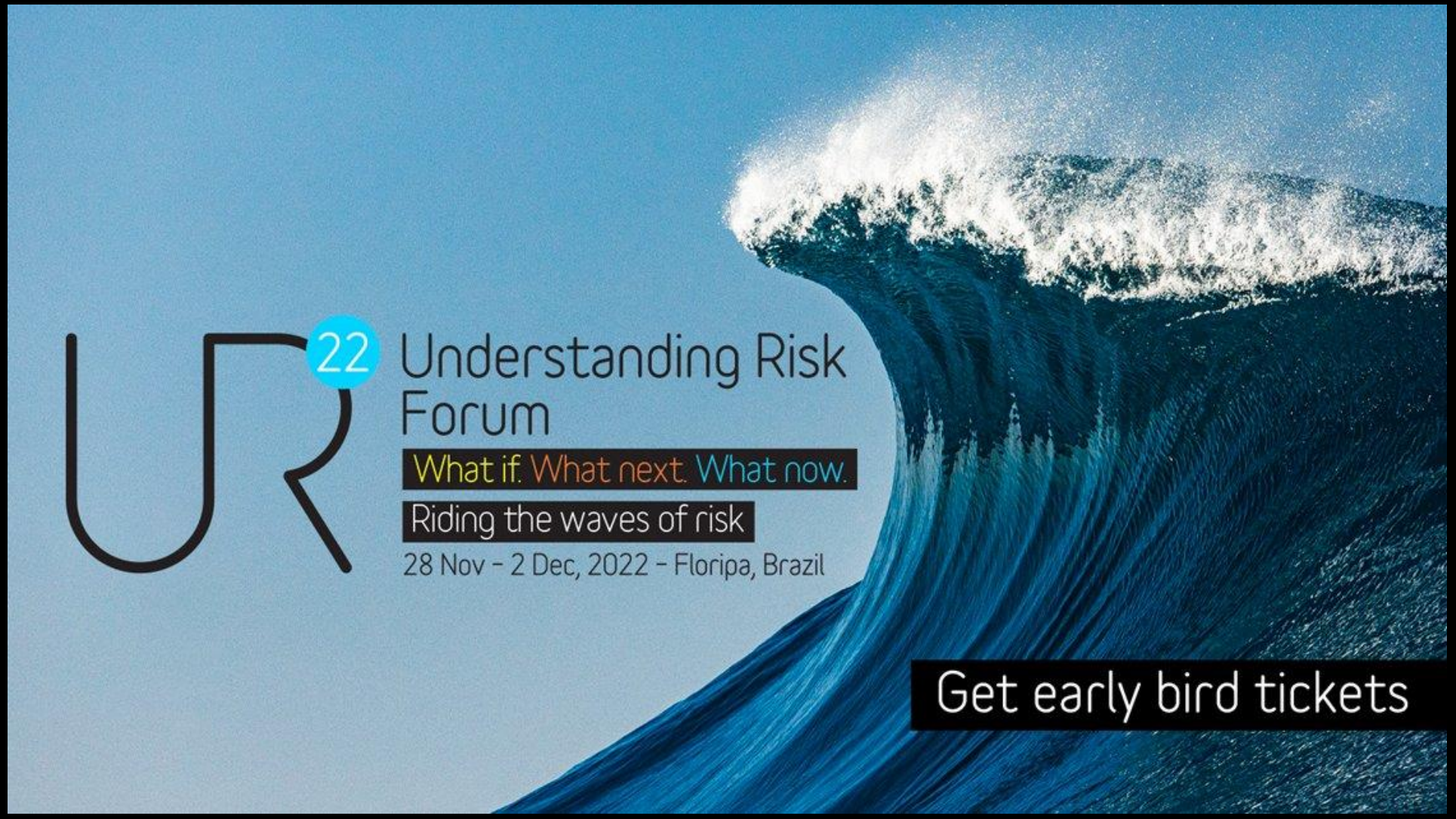


Shedding light on avoided disasters: Measuring the invisible benefits of disaster risk management using probabilistic counterfactual analysis

Rabonza M., Lallemant D., Lin Y., Tadepalli S., Wagenaar D., Nguyen M., Choong J., Liu C., Mestav G., Widawati B., Balbi M., Khan F, Loos S., Lim T.N.

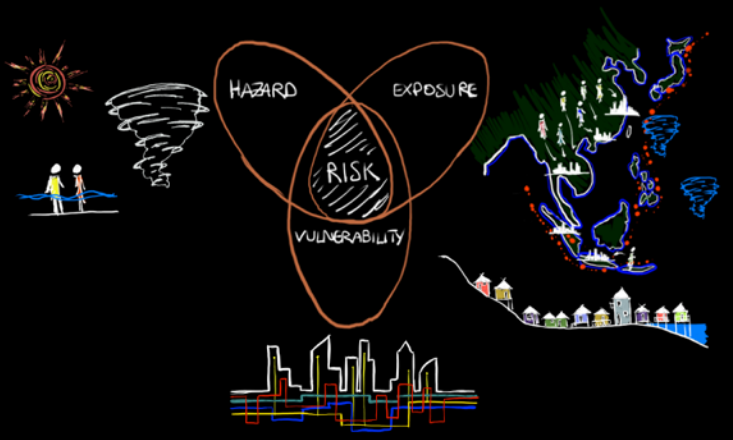
UNDRR Global Assessment Report 2022

https://averteddisasteraward.org

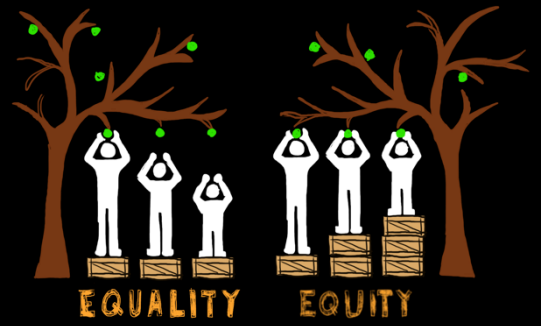


https://understandrisk.org/event/ur22/

Summary:



1. Risk is growing and cities need to account for changing risk.



2. Equitable disaster recovery requires looking at the physical impacts and social-economic obstacles.

3. Celebrating success in disaster risk management is necessary to share, learn, and scale solutions.

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