On the Role of Structural Engineering in Disaster Risk Reduction and Resilience Increase

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Disaster Risk Reduction DRR

- Risk Reduction
- Disaster Management (not only natural hazards)

- Risk = Hazard x Vulnerability x Values exposed to hazard
- Hazard = frequency (probability), intensity

IABSE Bangkok 2009
Bangkok, 9 Sept. 2009

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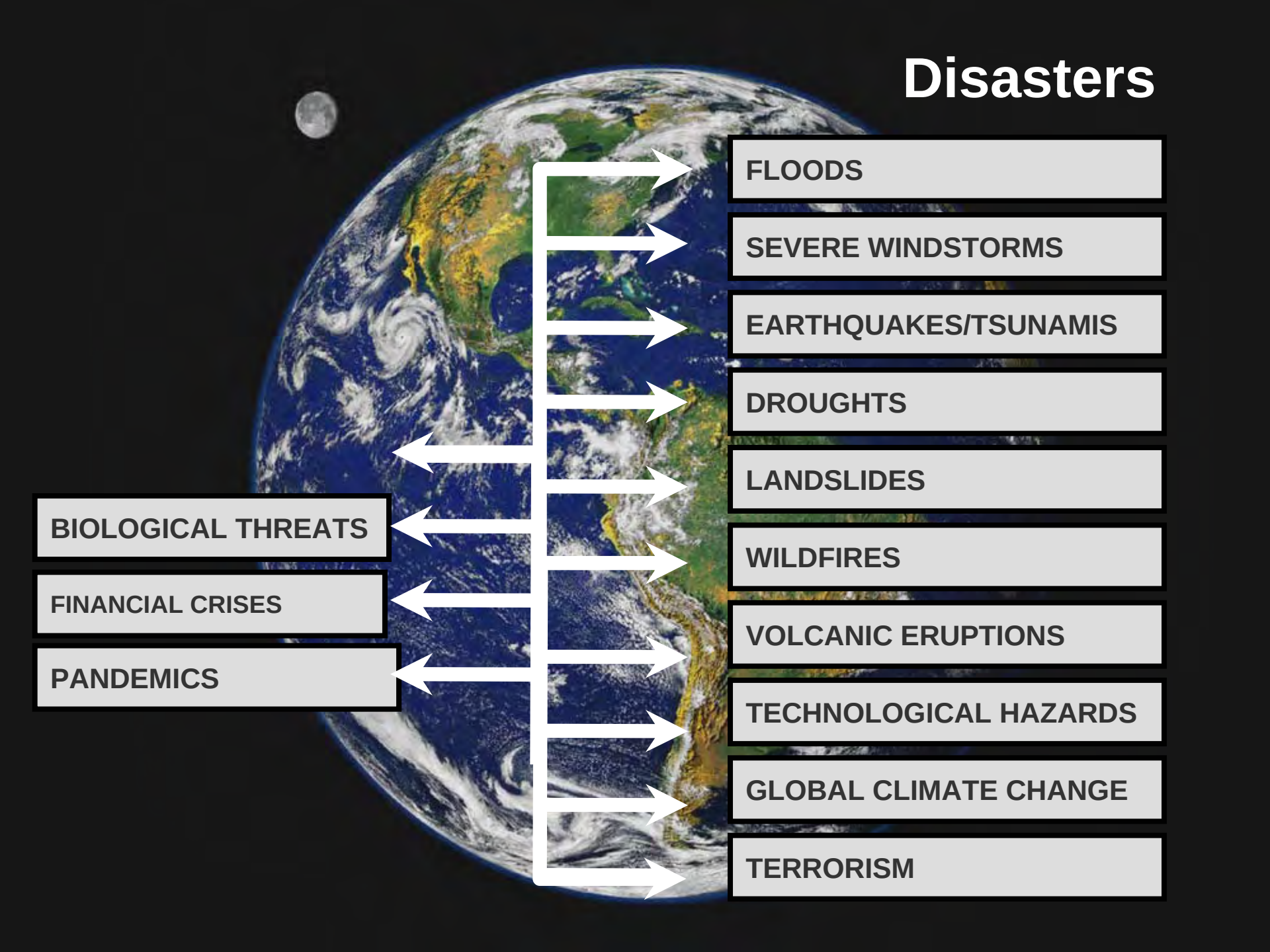
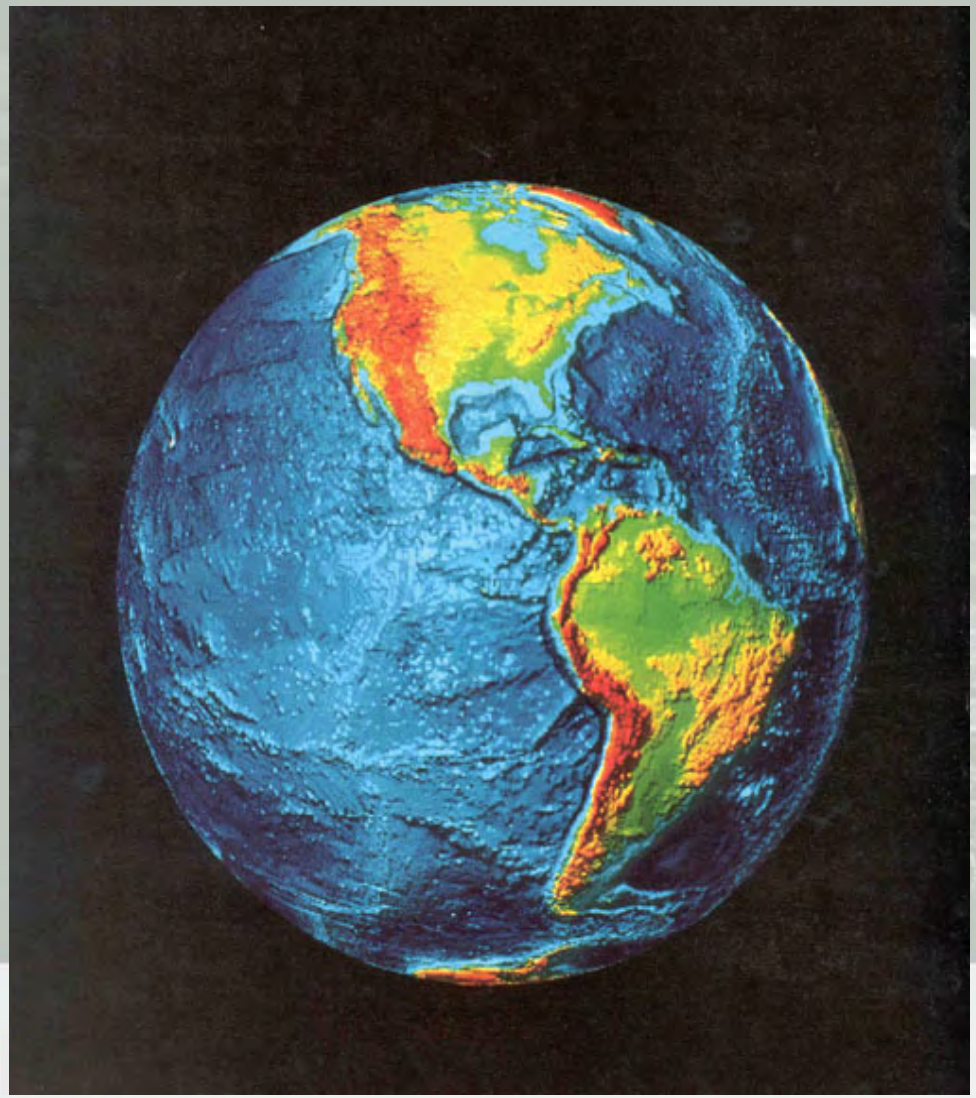
Disasters


FLOODS
SEVERE WINDSTORMS
EARTHQUAKES/TSUNAMIS
DROUGHTS
LANDSLIDES
WILDFIRES
VOLCANIC ERUPTIONS
TECHNOLOGICAL HAZARDS
GLOBAL CLIMATE CHANGE
TERRORISM
BIOLOGICAL THREATS
FINANCIAL CRISES
PANDEMICS

Mean annual losses

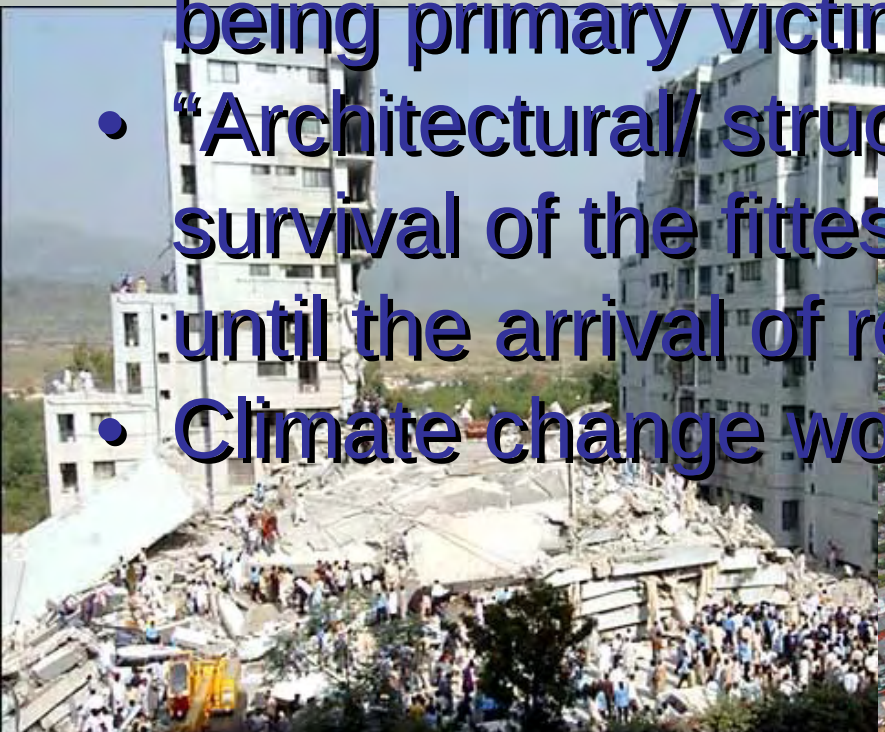


- 100‘000 deaths
- 150 bn US $

Gap between industrialized and developing countries


Social injustice

- Disasters are a problem of the poor and marginalised (therefore so is reconstruction)
- Rare instances of the middle/ upper class being primary victims
- “Architectural/ structural Darwinism", or the survival of the fittest buildings (was notable until the arrival of reinforced concrete).
- Climate change worthens the situation



Objectives of risk reduction and disaster management

- To reduce number, intensity and impact of disasters
- To reduce – or even better – to eliminate risks
- To reduce amount of human and economic losses

REDUCTION OF COMMUNITY VULNERABILITY

...INCREASING THE RISK AS NEW BUILDINGS AND LIFELINES ARE ADDED TO THE INVENTORY

REDUCTION OF COMMUNITY VULNERABILITY

...DECREASING THE RISK FROM EXISTING BUILDINGS AND LIFELINES

How to cope with risks: Key Questions

How safe is safe enough?

What can happen?

Hazard analysis (hazard intensity and exposure analysis, vulnerability assessment, Scenarios important

What is acceptable to happen?

What is an accepted safety level? (Protection goals, acceptable risk levels)

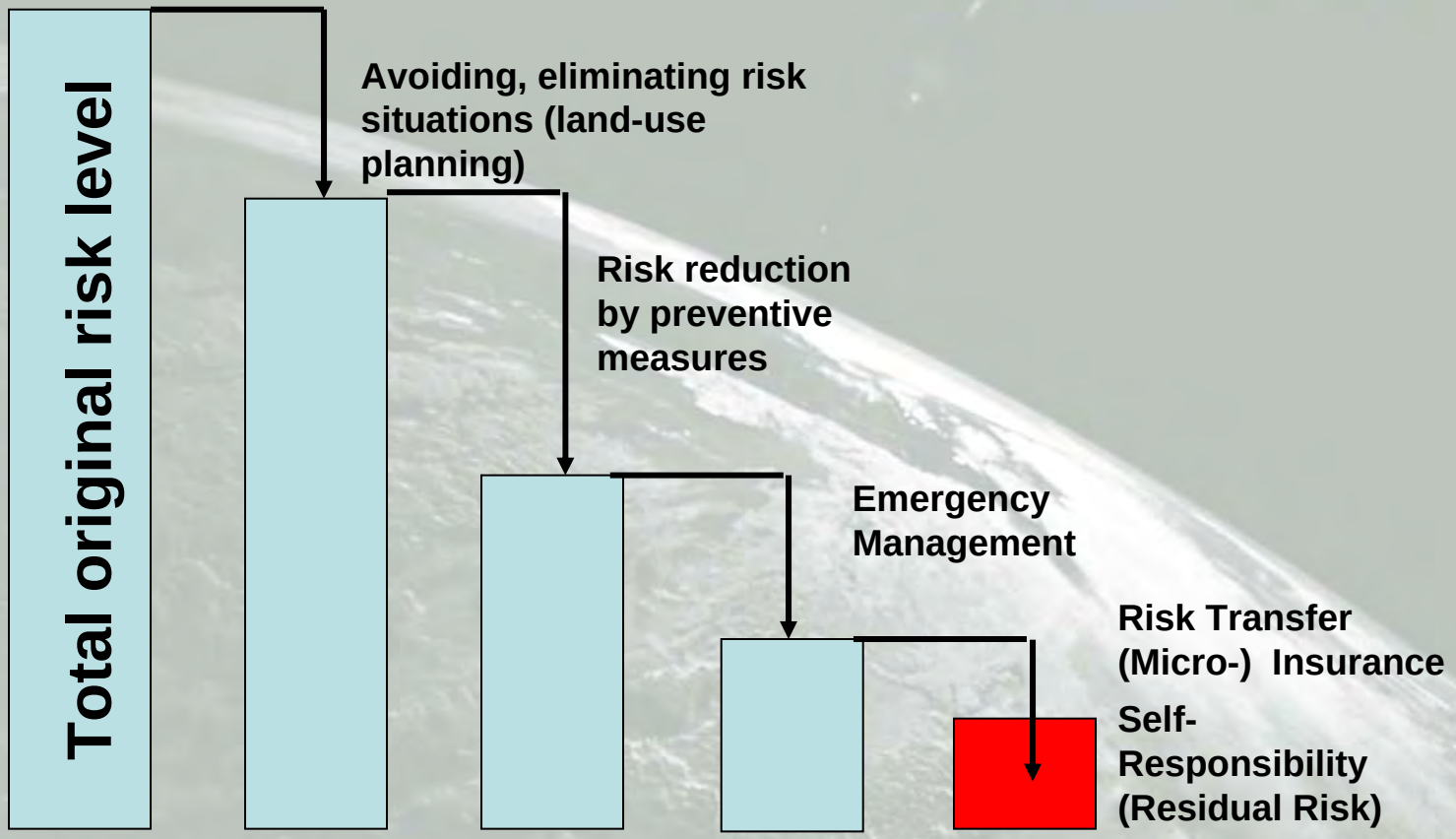
Risk Analysis

What has to be done?

Risk Assessment

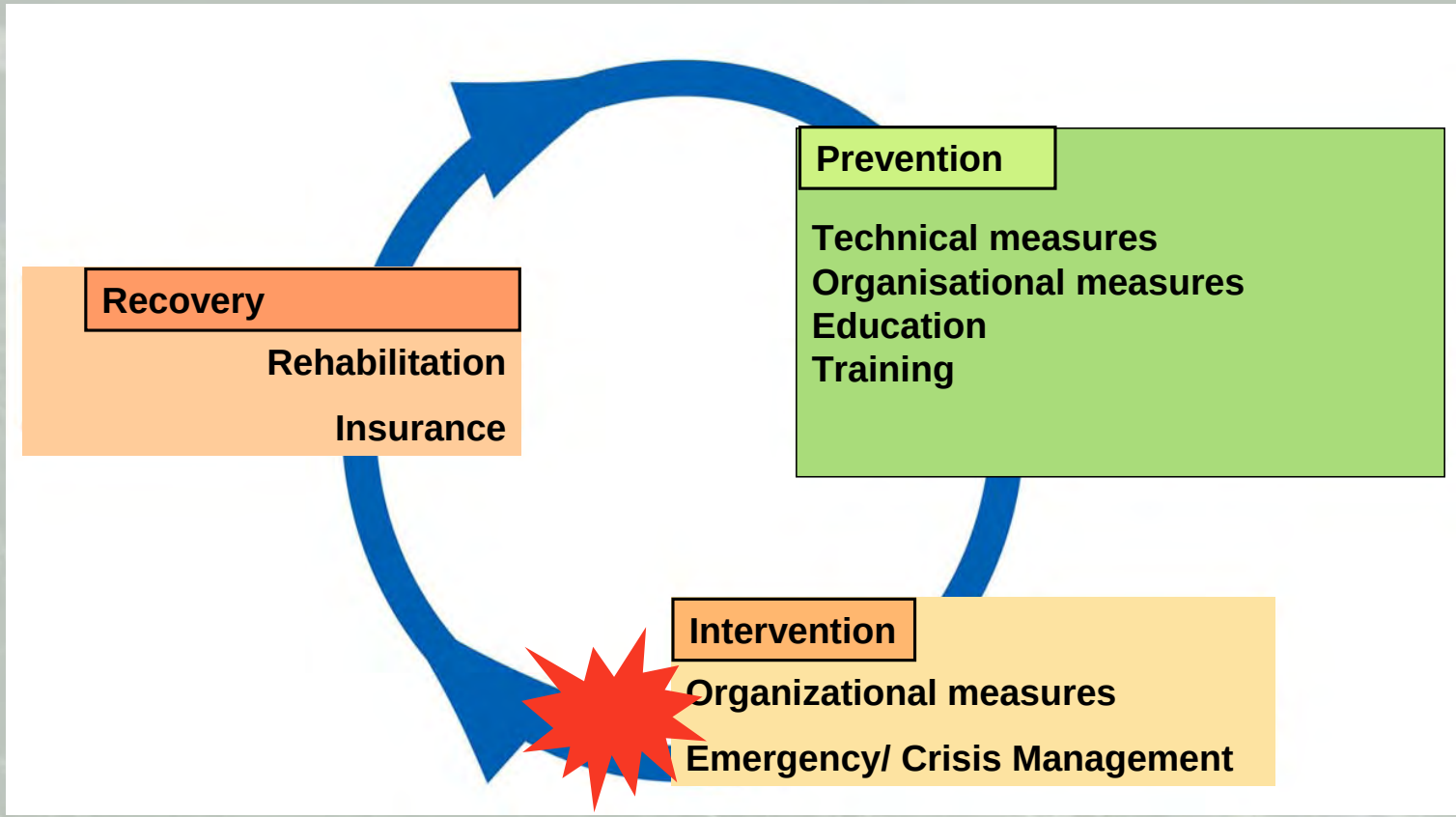
Measures to be taken

Risk Reduction - What possibilities exist?

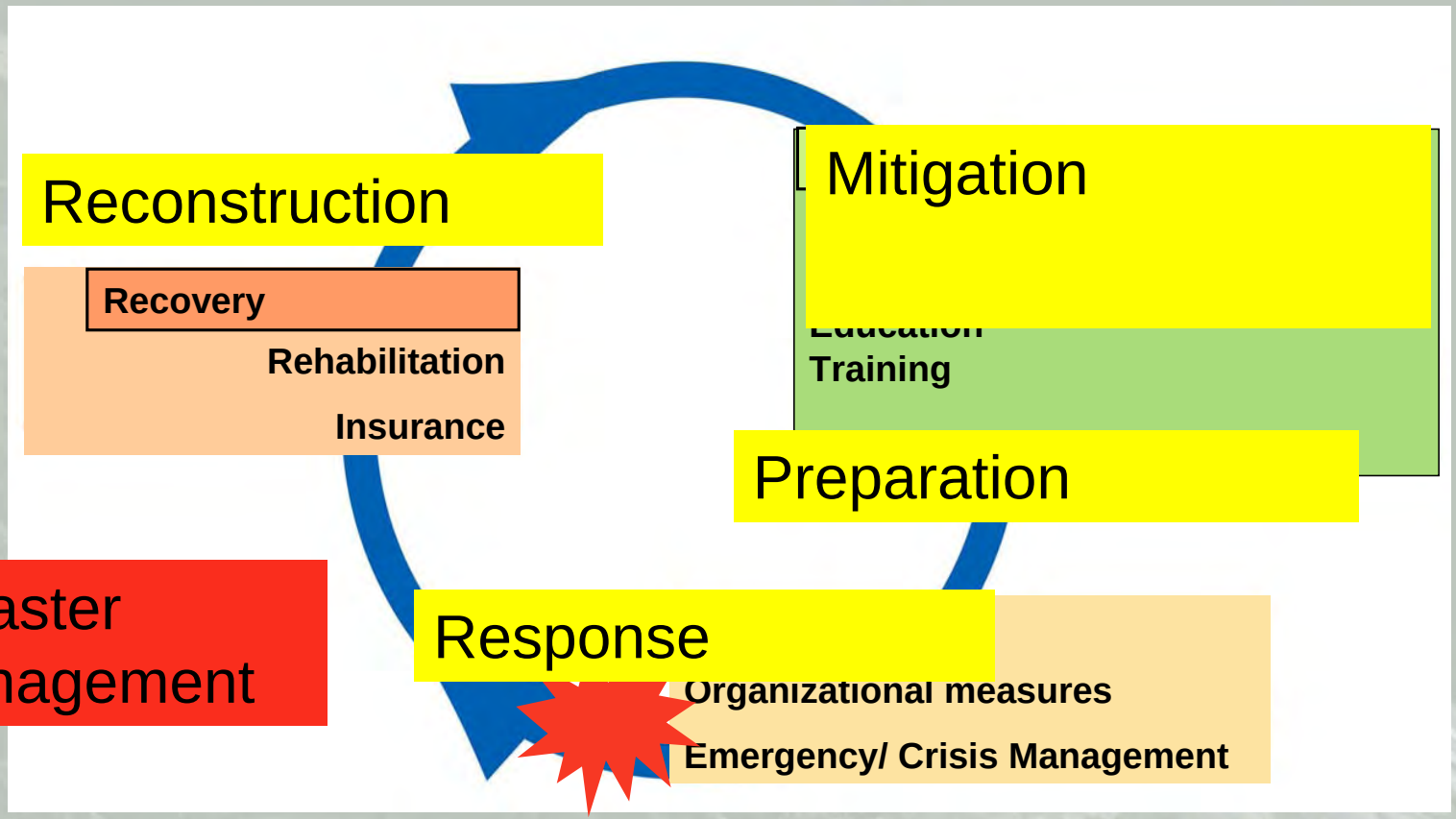


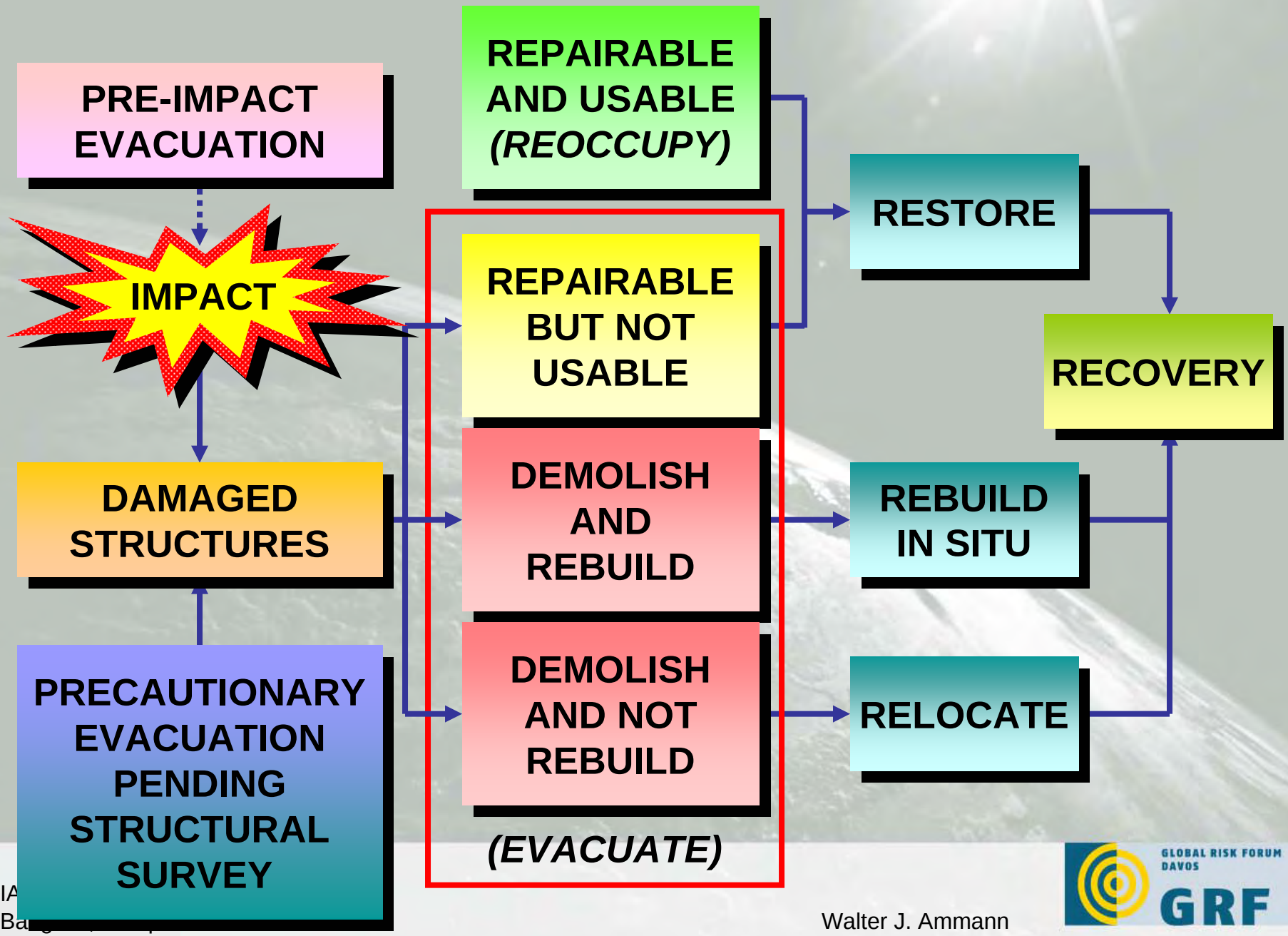
By means of ….

Integral risk management – an approach which concentrates equally on all phases of the risk cycle: intervention, recovery and prevention



Integral risk management: risk cycle other terminologies




PRE-IMPACT EVACUATION
IMPACT
DAMAGED STRUCTURES
PRECAUTIONARY EVACUATION PENDING STRUCTURAL SURVEY
REPAIRABLE AND USABLE (REOCCUPY)
REPAIRABLE BUT NOT USABLE
DEMOLISH AND REBUILD
DEMOLISH AND NOT REBUILD
(EVACUATE)
RESTORE
REBUILD IN SITU
RELOCATE
RECOVERY

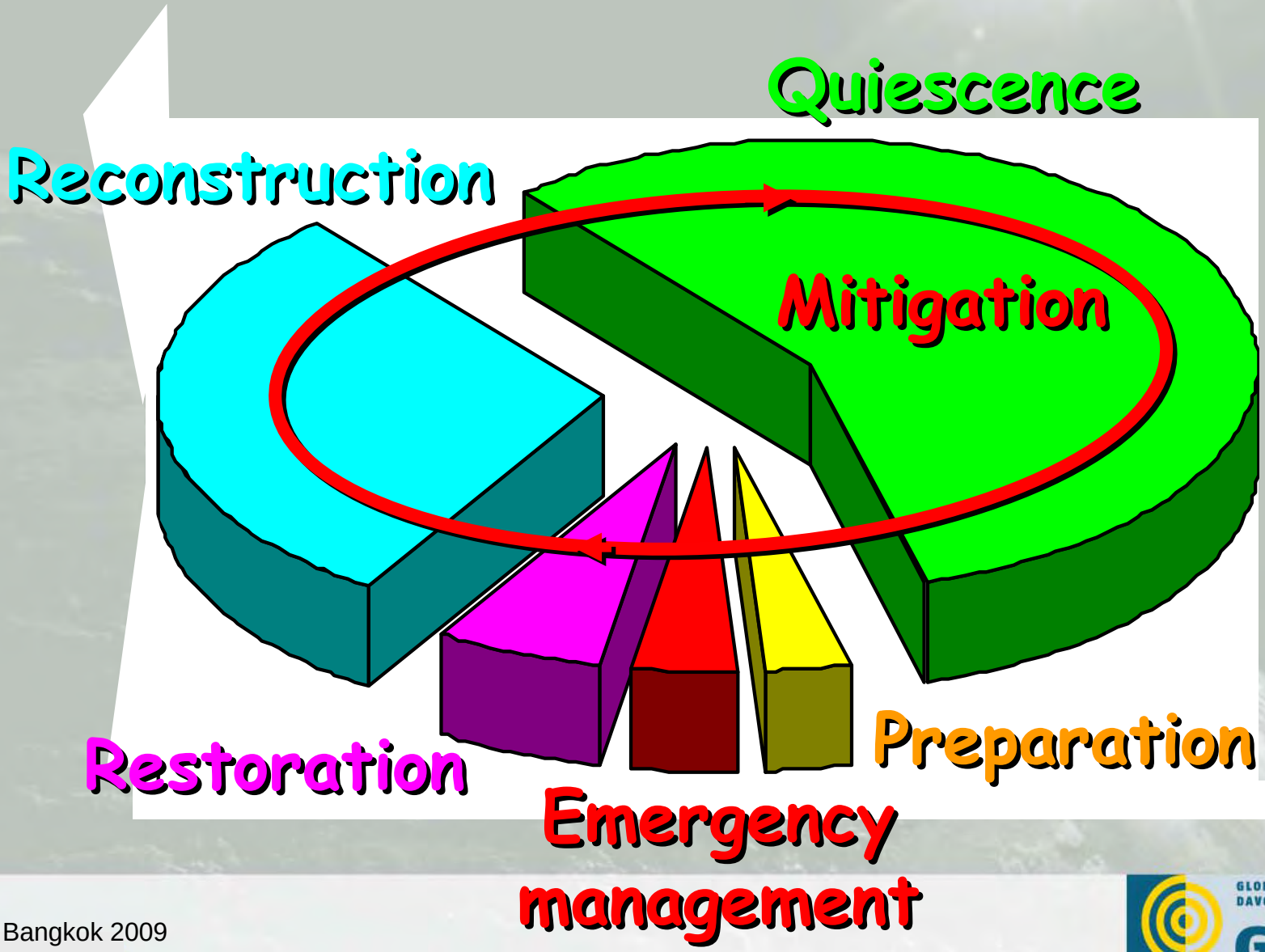
Integral risk and disaster management involves all sectors/ stakeholders

- Politics
- Governments, Administration
- Business world
- Science, education
- Technology
- Practitioners
- People, Society as a whole.

Importance of interdisciplinary, inter-sectorial gatherings/ conferences/ workshops like IDRC Chengdu 2009

Integral risk management

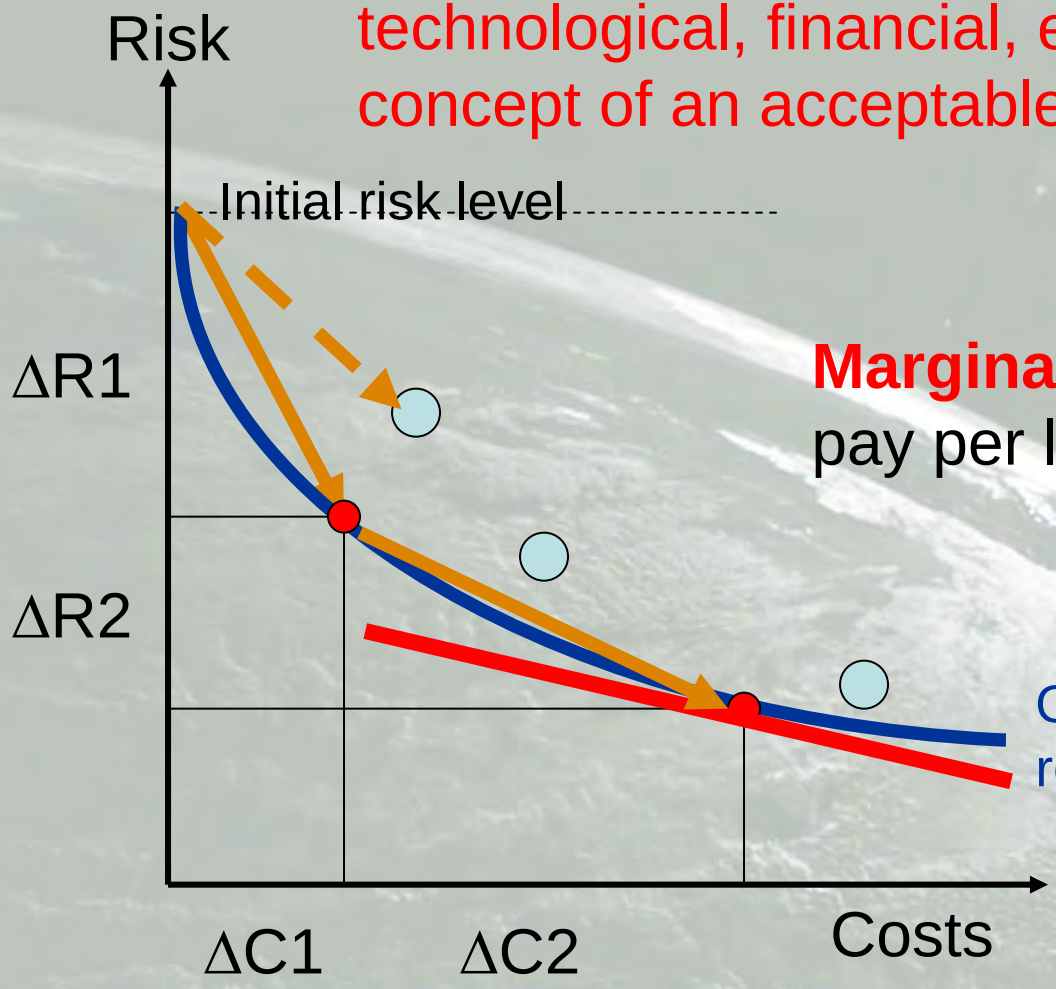
- Disaster management
- Vulnerability reduction (social, political, structural, economic, ecological, etc.)


Quiescence
Reconstruction
Mitigation
Restoration
Preparation
Emergency management


NATURAL DISASTER REDUCTION
MAKING THE RIGHT CHOICES IS THE KEY TO DISASTER REDUCTION
PREPARATION
PREDICTION
RECOVERY
RESPONSE
INTERVENTION/ SUPPRESSION

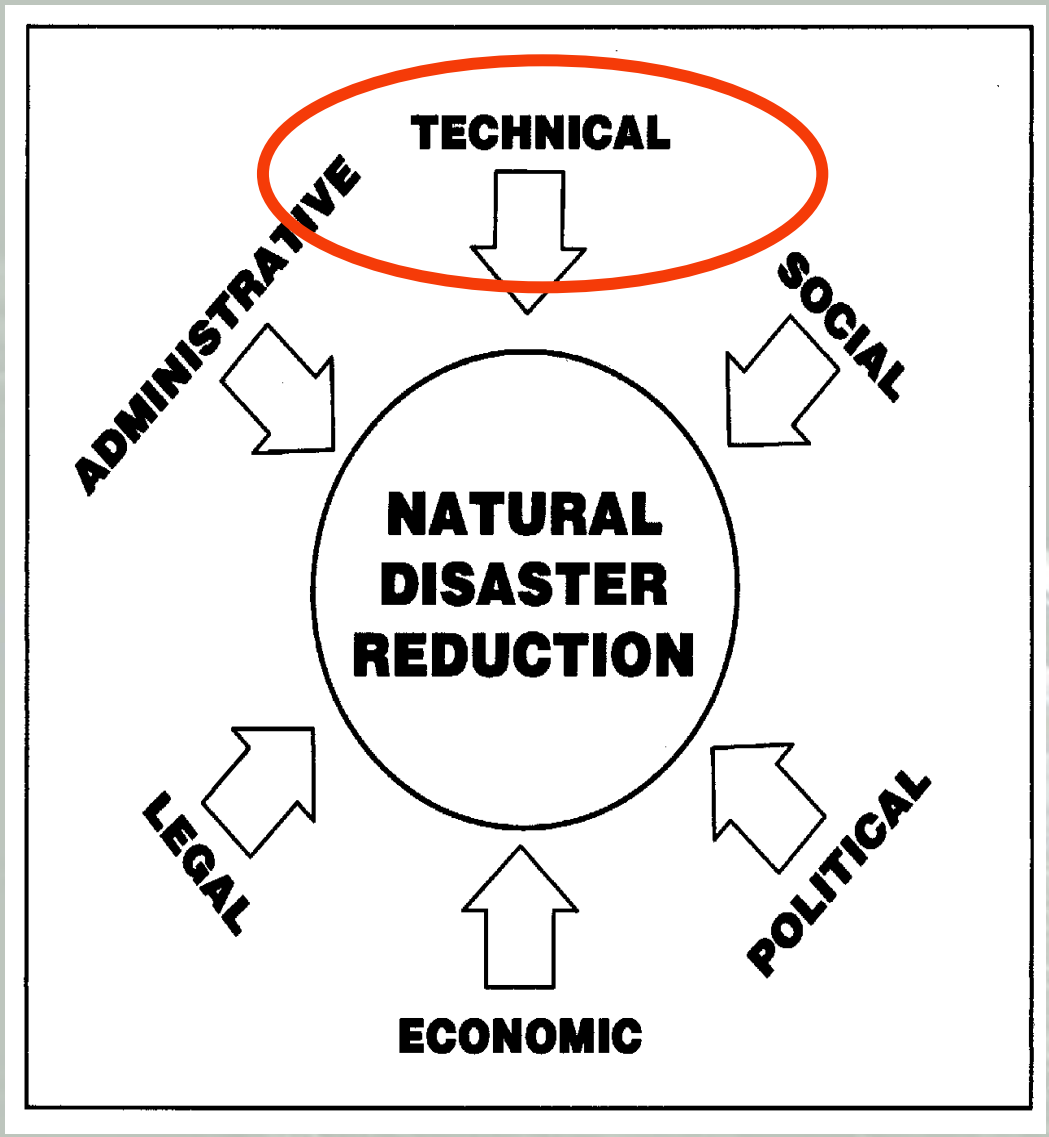
Economies of integral risk management

Practical limits to safety (restrictions to human, technological, financial, ecological ressources - concept of an acceptable level of risks/ safety



Marginal costs (willingness to pay per life saved)

Optimised curve for risk reduction costs



STAPLE -factors

(Walter Hays)

Depending on:

- Time
- Place
- Circumstances

Climate Change Adaptation

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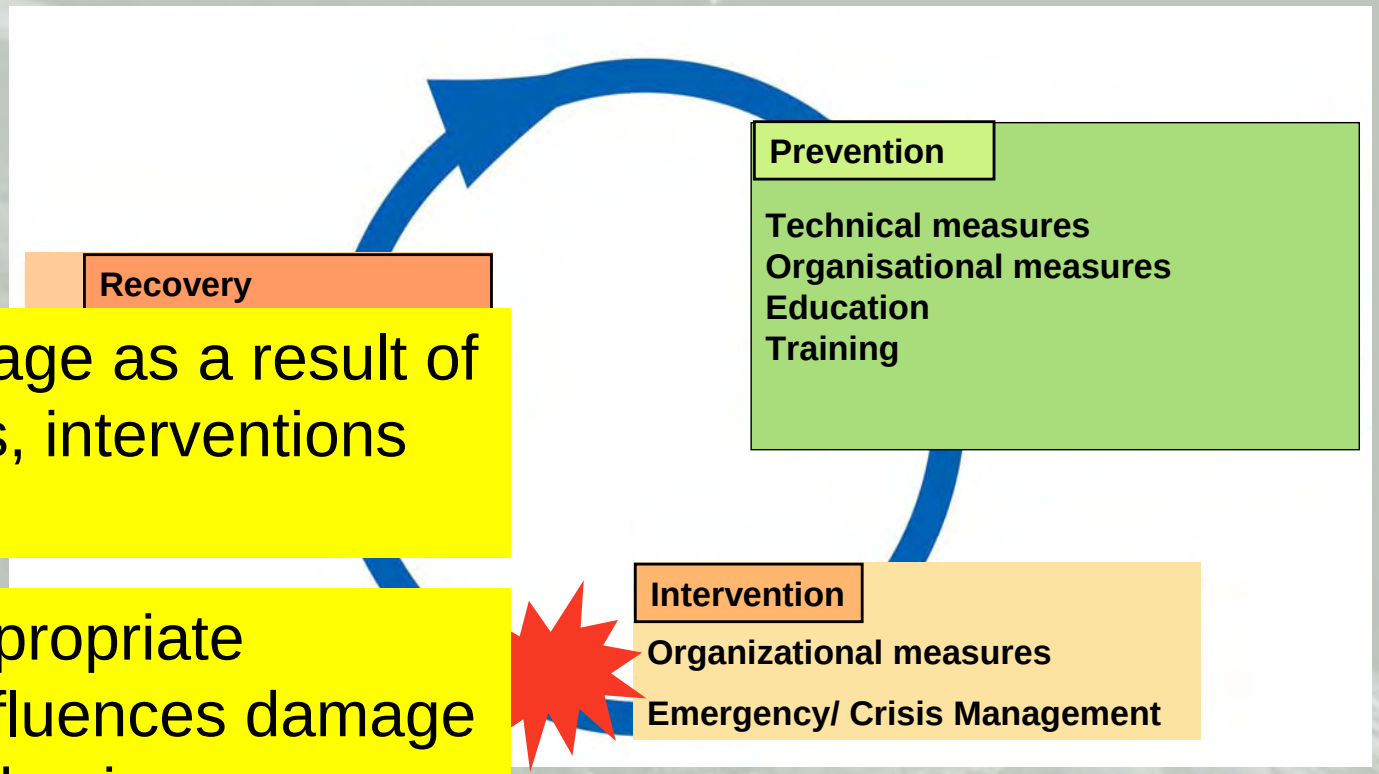
Integral risk management: risk cycle

Approach equally concentrates on all sectors of the risk cycle, on prevention, preparedness, intervention and recovery



Extent of damage as a result of human actions, interventions and behaviour

Timely and appropriate intervention influences damage and human behaviour

Integral risk management

- Disaster management
- Vulnerability reduction (social, political, structural, economic, ecological, etc.)
- Resilience building (capacity building, etc.)

Definitions of Resilience

Ecological - ..'ecological resilience is a characteristic of ecosystems to maintain themselves in the face of disturbance… relates to the functioning of the system.'

Engineering – ..'the reduced probability of system failure, reduced consequences due to failure, and reduced time to system restoration.'

Economic - ..'the inherent and adaptive responses to hazards that enable individuals and communities to avoid some potential losses. This is in contrast to the pre-event characteristic of mitigation.'

Social – ..'the capacity of social groups and communities to recover from, or respond positively to, crises… to withstand and recover from stresses'

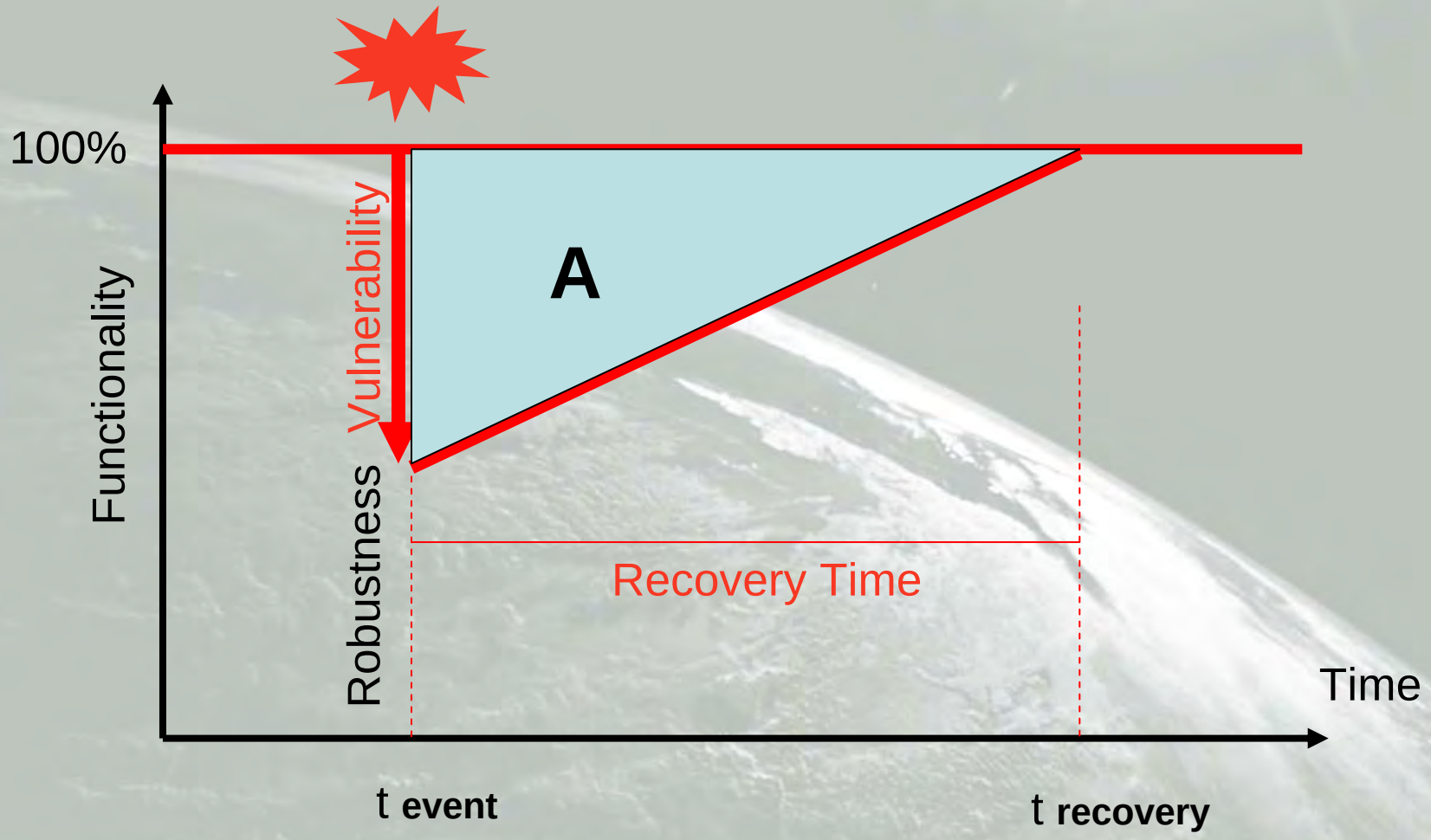
Business - ..'important to rapidly adapt and respond to risks… this represents a shift from the old paradigm of 'experience and react' to a new one of 'anticipate and adjust'… therefore aiming for **continuity of business operations**.'

Definitions of Resilience

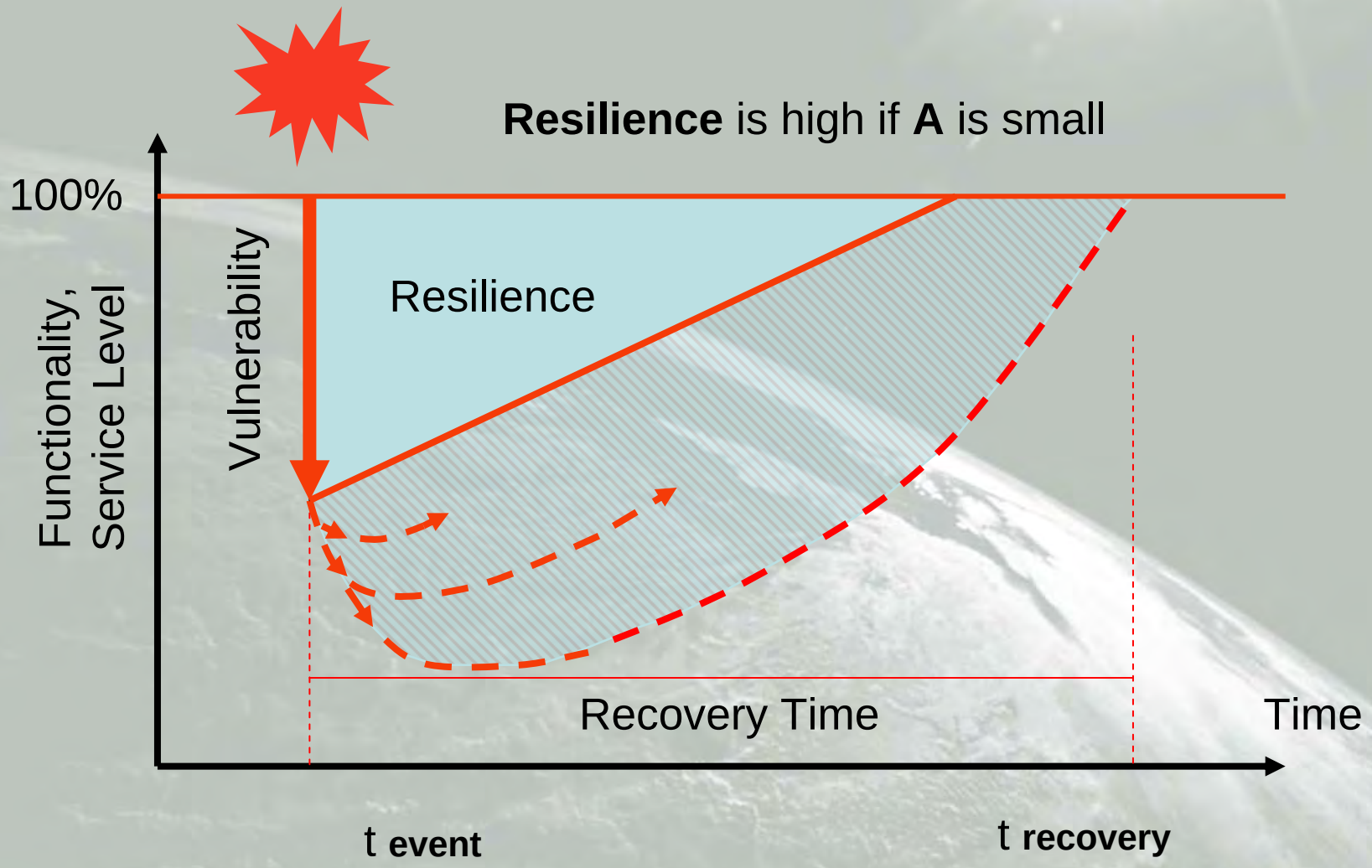
Development - ..'resilience reflects development. Resilience/development fails when the 'state' loses its capacity to abosrb disturbance or undergo change while still retaining essentially the same identity, functions, strucutres, and feedbacks.'

Critical Infrastructures - ..'capacity to absorb shocks while maintaining function… to minimize the societal impact of extreme events

Schematic of Resilience

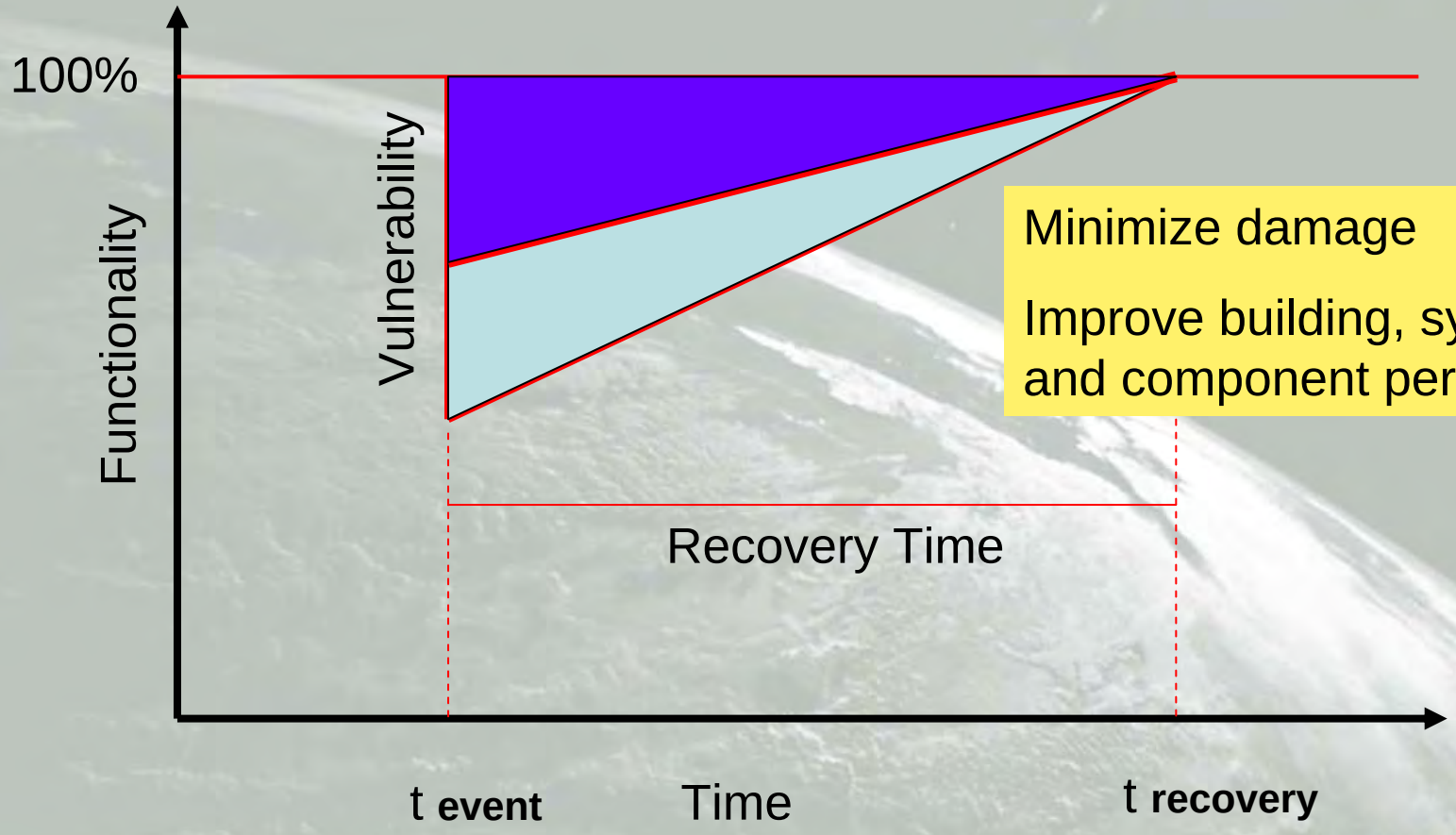


Resilience


Resilience is high if **A** is small
100%
Functionality, Service Level
Vulnerability
Resilience
Recovery Time
Time
t **event**
t **recovery**

Resilience

Reduce the probability of and consequences at failure

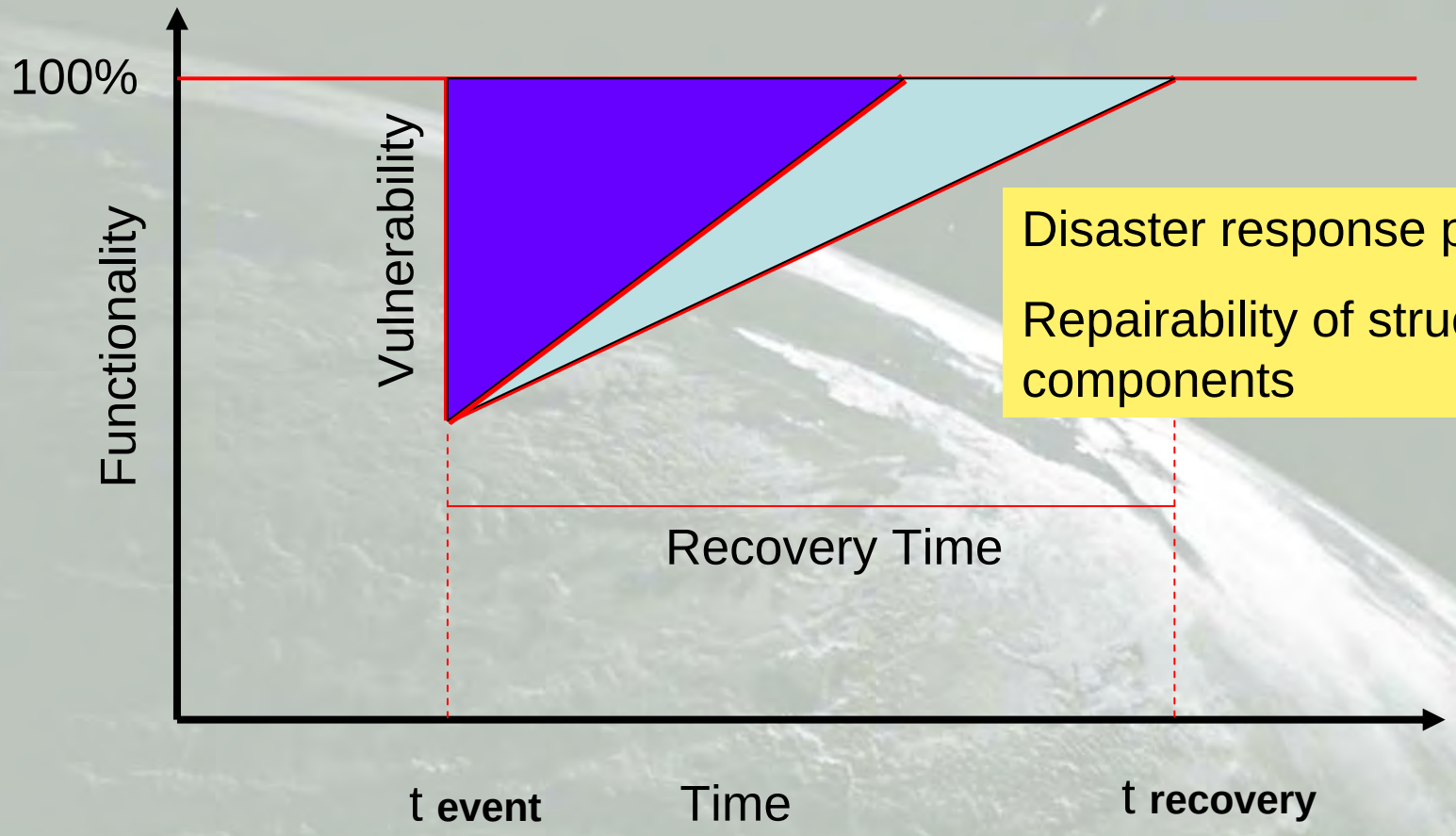


Minimize damage

Improve building, systems and component performance

Resilience

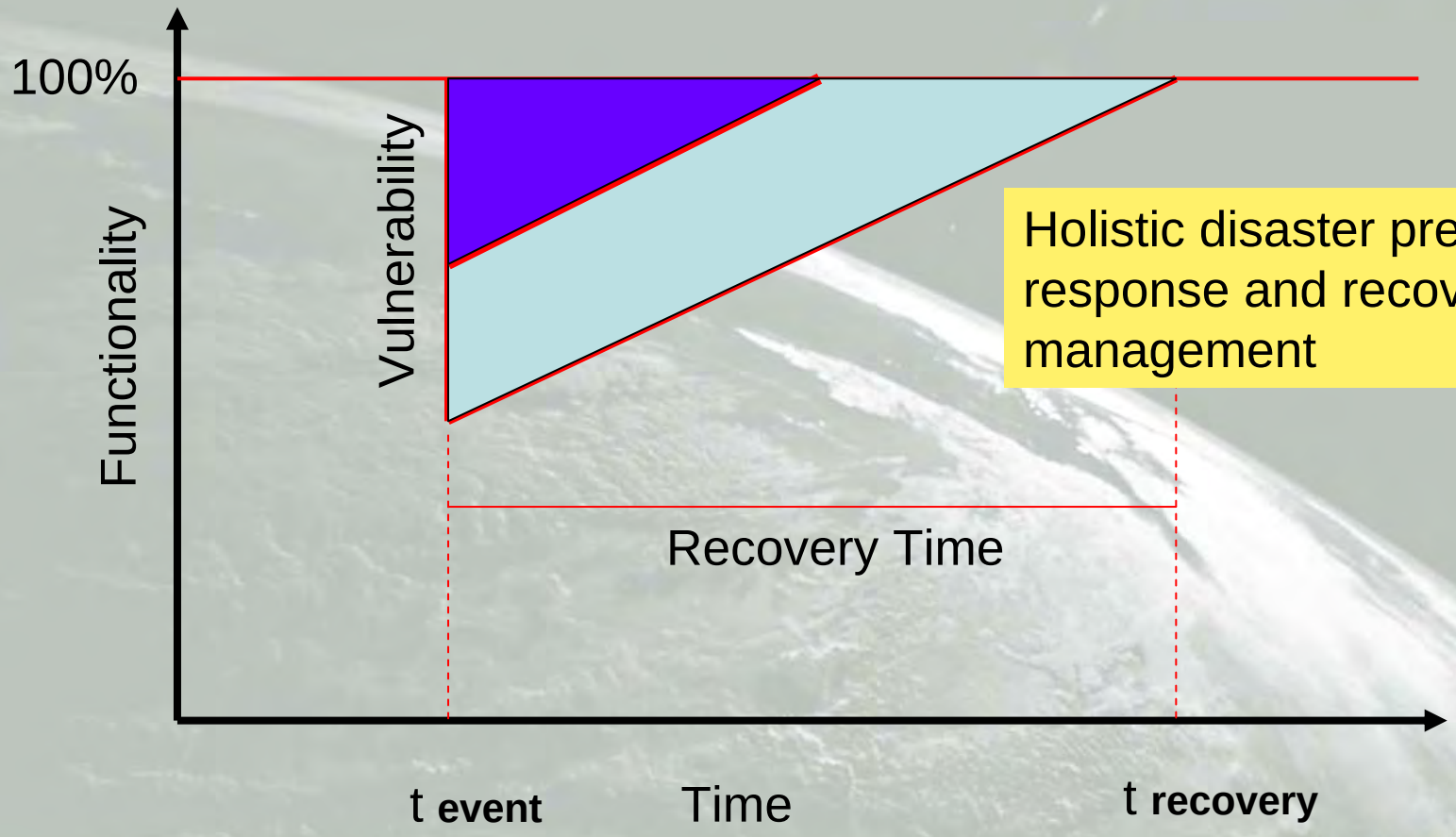
Reduce the time to recovery



Disaster response plan

Repairability of structures, components

Resilience



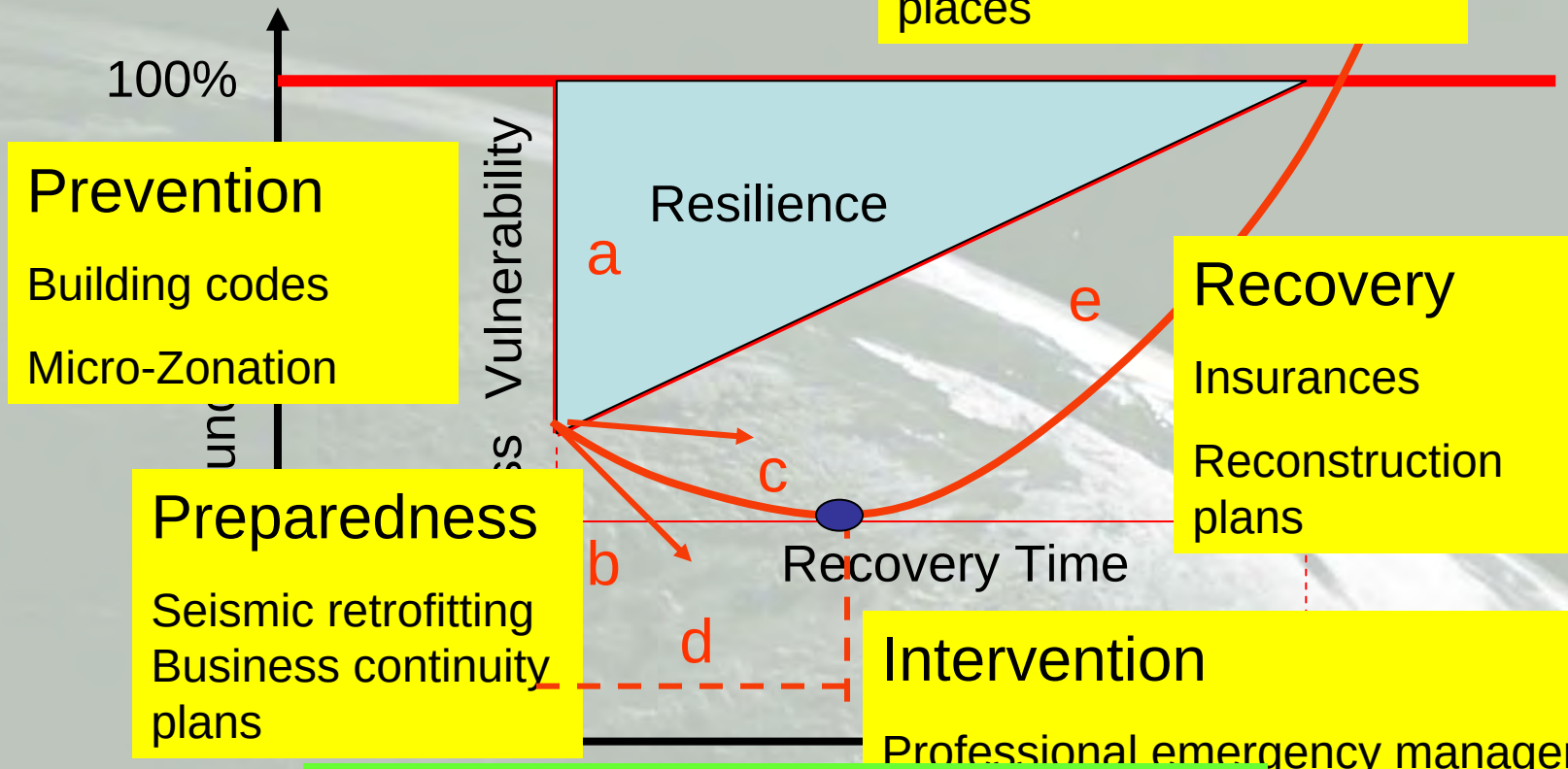
Holistic disaster prevention, response and recovery management

Resilience. ...?

Do it even better!

Improve building codes

Reconstruction at other places



Prevention

Building codes

Micro-Zonation

Preparedness

Seismic retrofitting
Business continuity plans

Recovery

Insurances

Reconstruction plans

Intervention

Professional emergency management

...essment

d to minimize

Politically most sensible domain

High visibility – high media coverages

How to measure resilience

- **Robustness:** ability of “systems” to withstand disaster forces without significant degradation or loss of performance
- **Redundancy**: the extent to which “systems” are substitutable in case of loss or significant degradation of functionality
- **Resourcefulness:** defines the ability to diagnose and prioritize problems and to initiate measures by mobilizing material, monetary, informational, and technological and human resources.
- **Rapidity:** is the capacity to restore functionality in a timely way, containing losses and avoiding disruptions

Conclusions

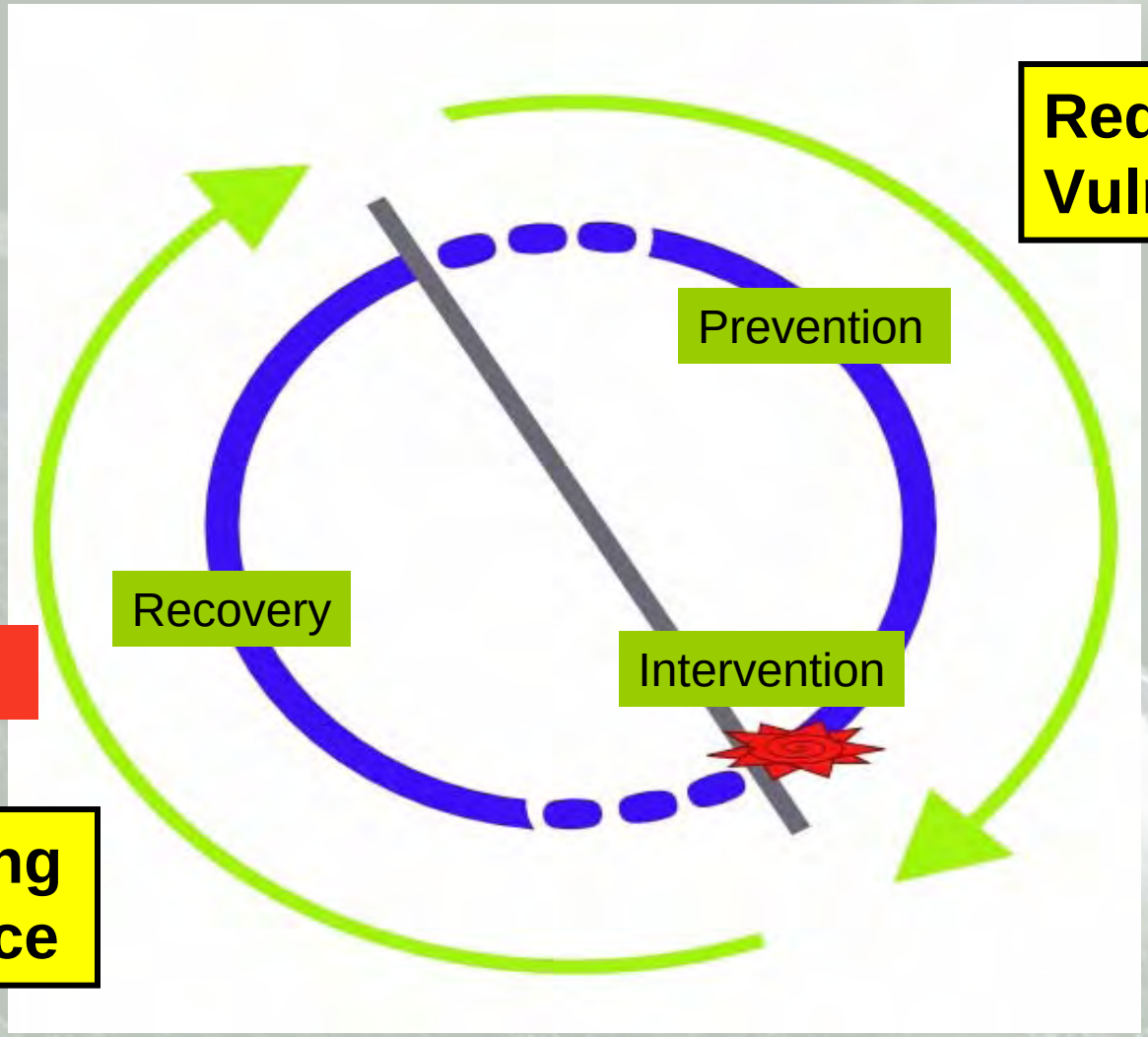
- The poorest are hit the most
- Integral disaster and risk reduction management is vulnerability reduction and resilience increase.
- Organisational measures (emergency planning, training, leadership, experience and information management, etc.) are essential for resilience increase
- Resilience measures for population and communities render social groups more adaptable to disasters.

Conclusions

- Resilience measures increase the capacity to reduce both direct and indirect economic losses resulting from disasters – most important for critical infrastructures.

- **Climate change adaptation CCA** and risk reduction/ disaster management (**DRR**) to **harmonize**.

Conclusions: Integral risk management

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„From Thoughts to Action“

Thank you for your attention!

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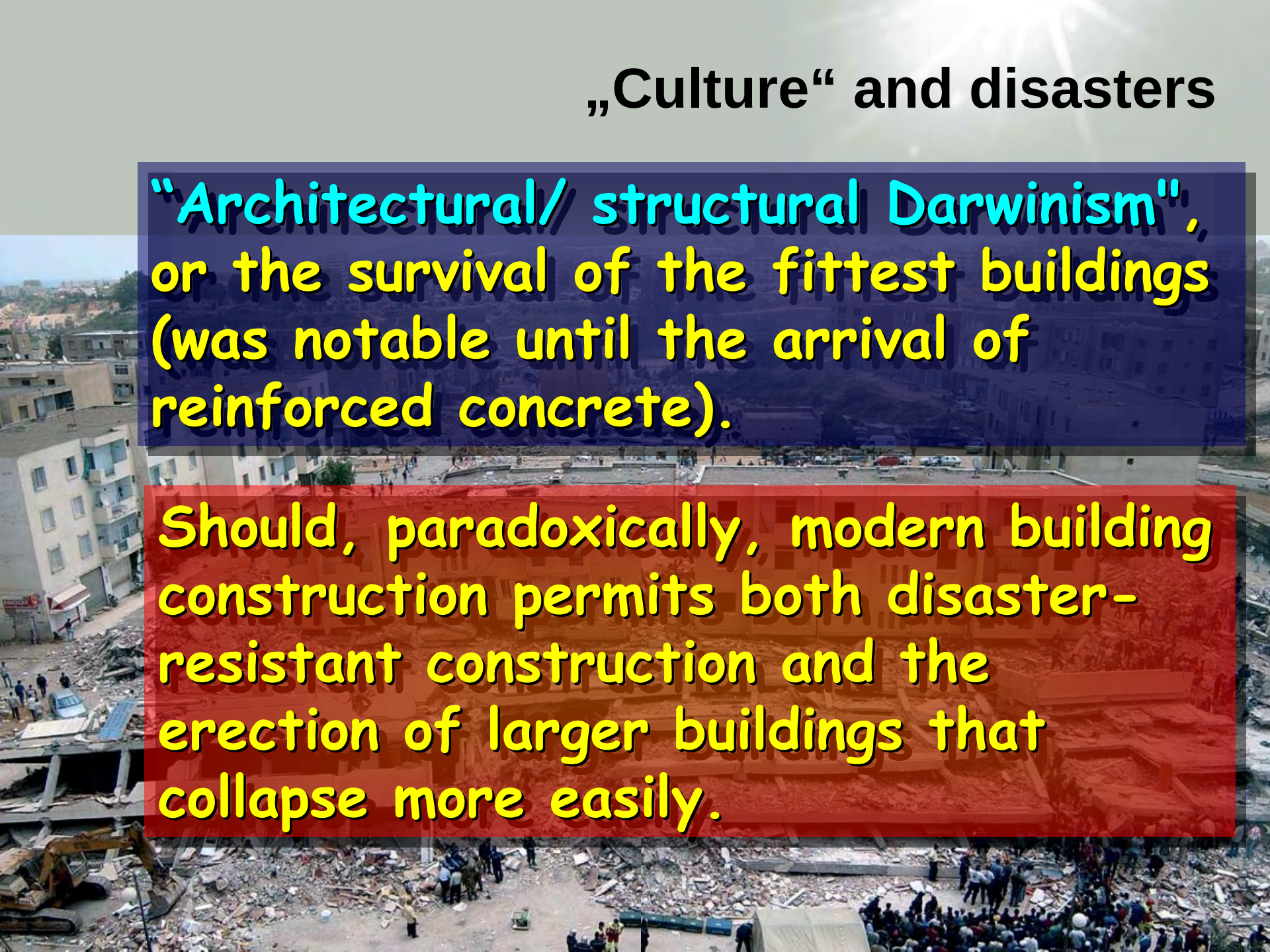
„Culture“ and disasters



"Architectural/ structural Darwinism", or the survival of the fittest buildings (was notable until the arrival of reinforced concrete).

Should, paradoxically, modern building construction permits both disaster-resistant construction and the erection of larger buildings that collapse more easily.