

# Looking through the Resilience Lens

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**Caltech**

Natural hazards are natural processes - and you have a lot of choices

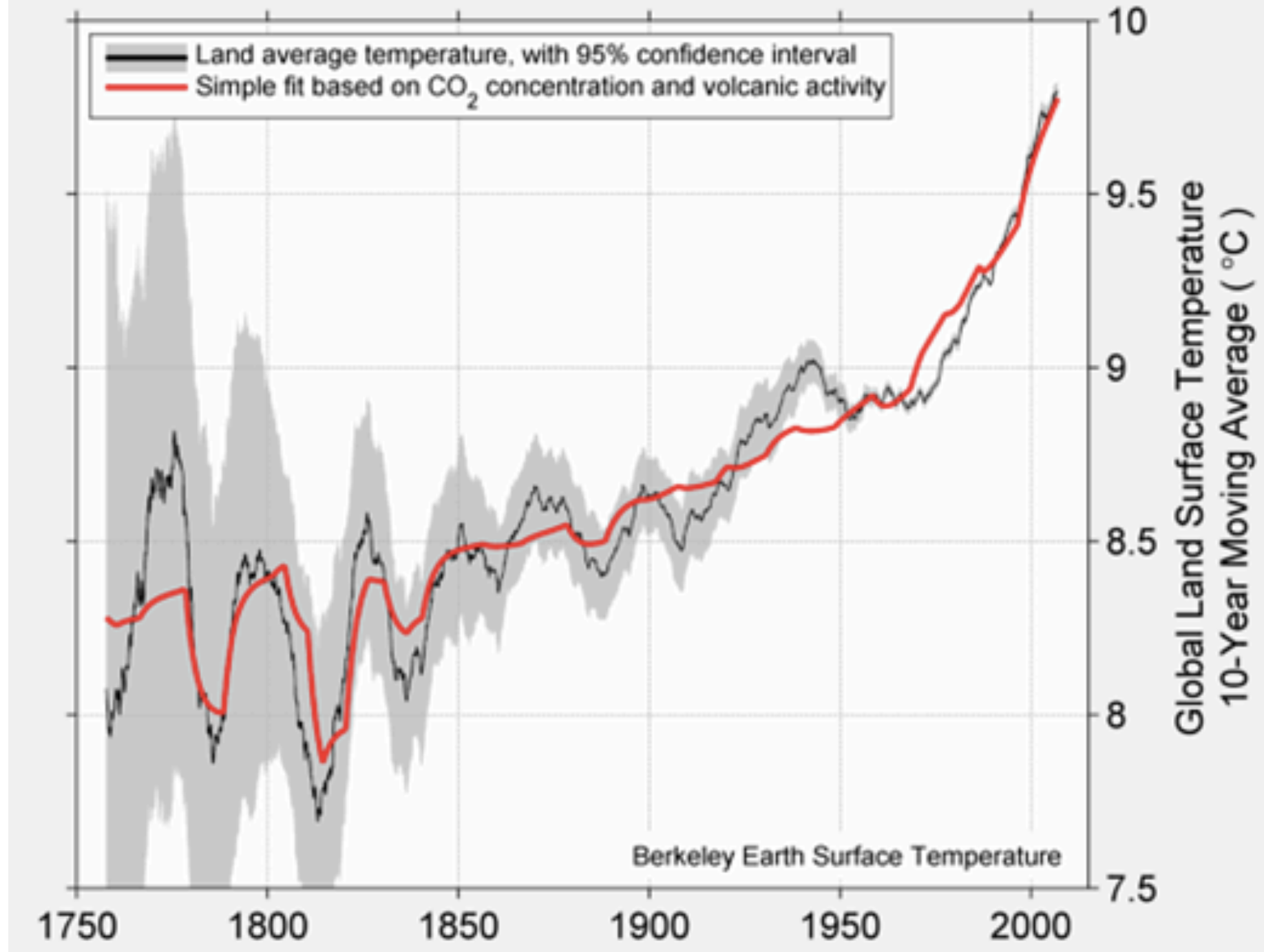


Natural hazards are natural processes - and you have a lot of choices



# The changing climate

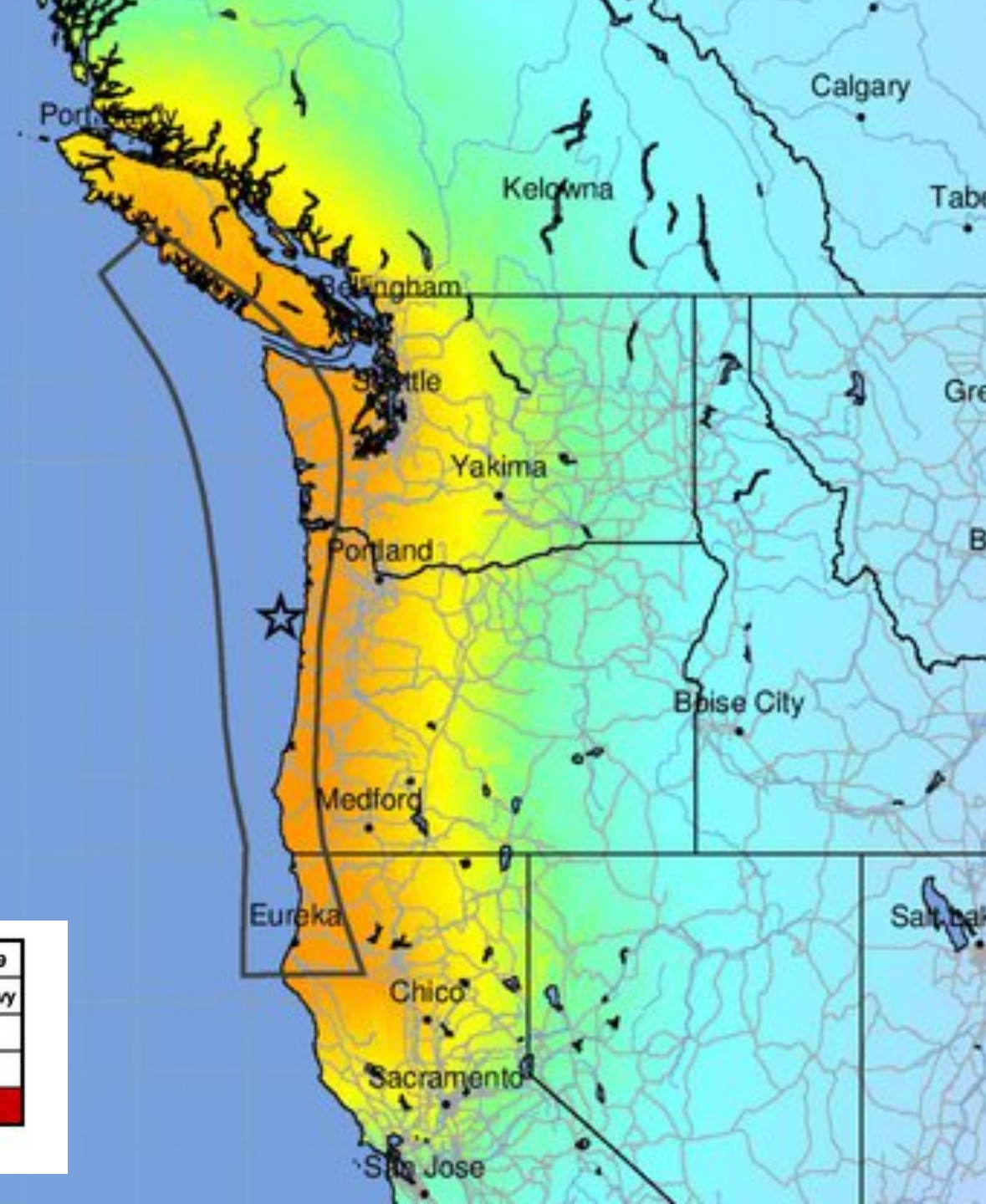
We cannot assume that what we have seen in the past is all we will see in the future



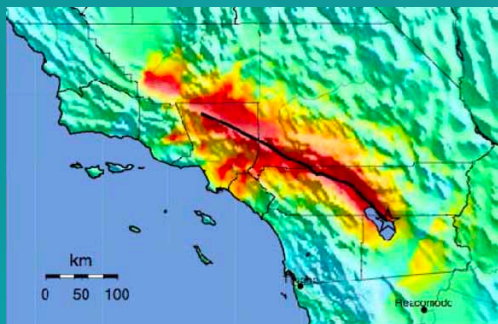
# Cascadia

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	<0.02	0.1	1.4	4.7	9.6	20	41	86	>178
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

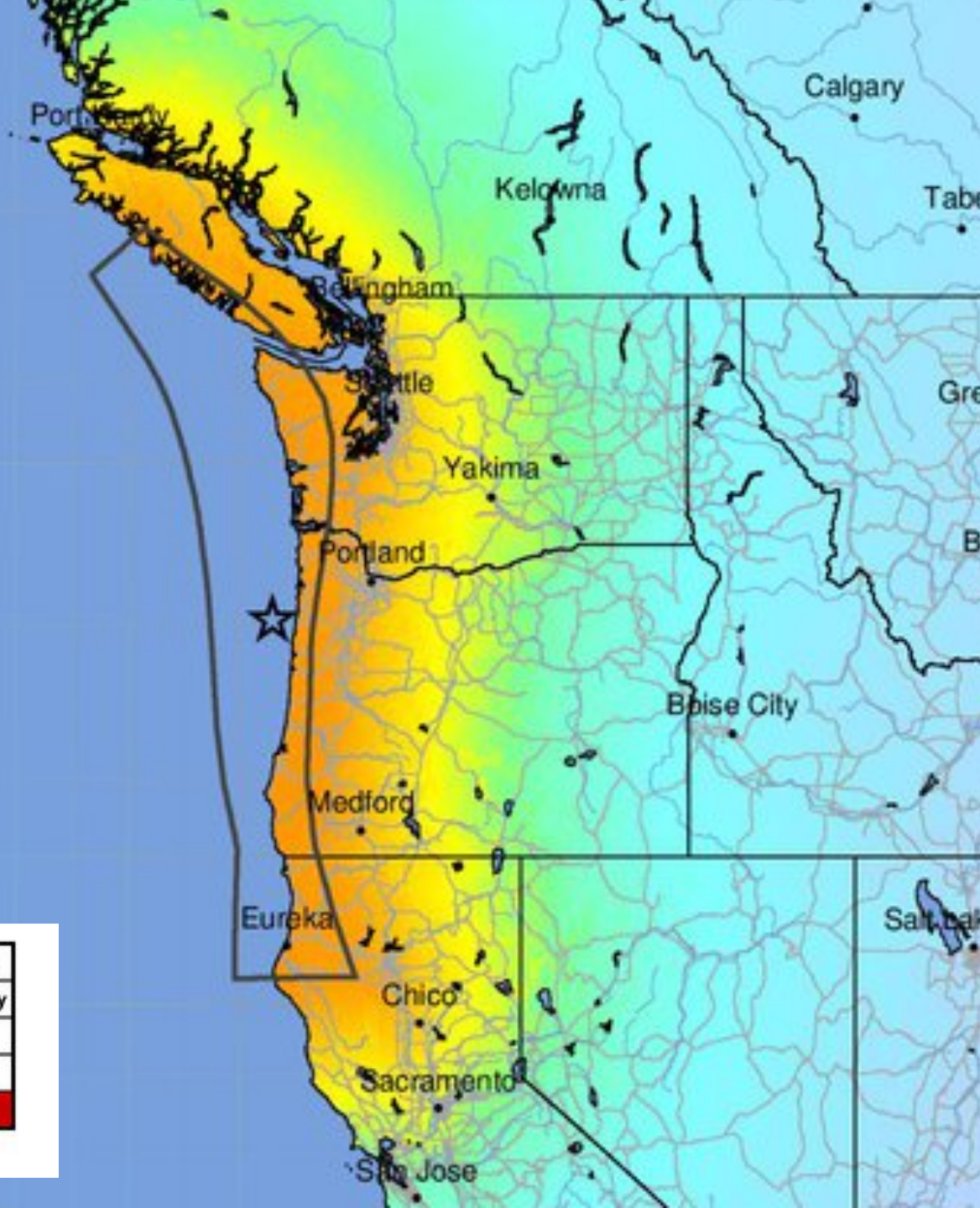


# Cascadia vs ShakeOut



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$$\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Fragility} \div \text{Response} \div \text{Recovery}$$

What is  
your  
earthquake  
risk?



$$\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Fragility} \div \text{Response} \div \text{Recovery}$$

Faulting, shaking,  
landsliding,  
liquefaction



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Extent & density  
of built  
environment



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Structural  
weaknesses



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Ability to  
respond



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What is  
your  
earthquake  
risk?



Will to recover

Ability to  
respond



# Exposure



Stay off the faults

Exposure



Stay off the faults

Exposure

Too late!



# Response





Collaboration  
helps



Response



# Fragility



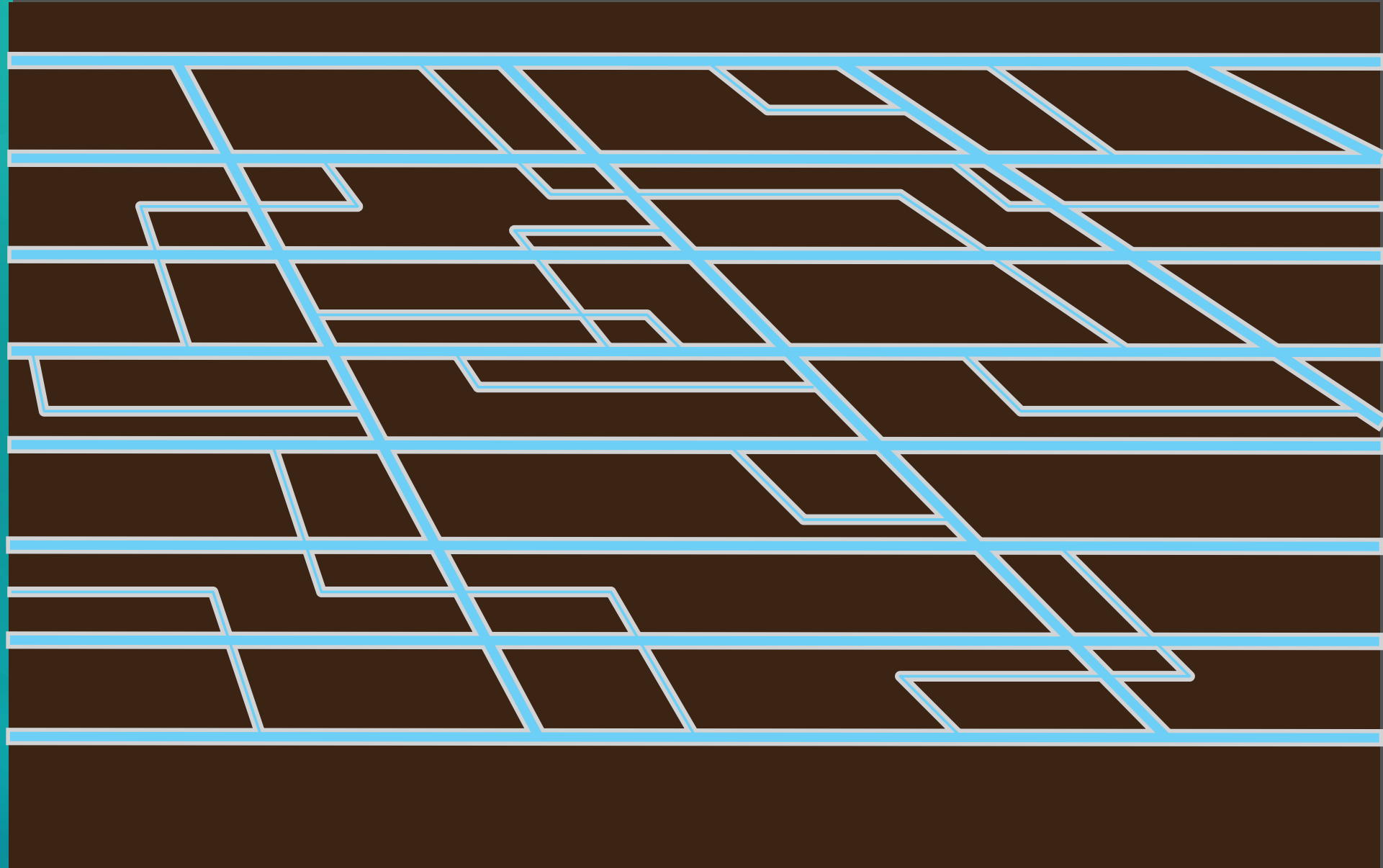
**Disaster Resilience** is having a society that functions after the disaster

Fragility



# A System of Systems

# A System of Systems



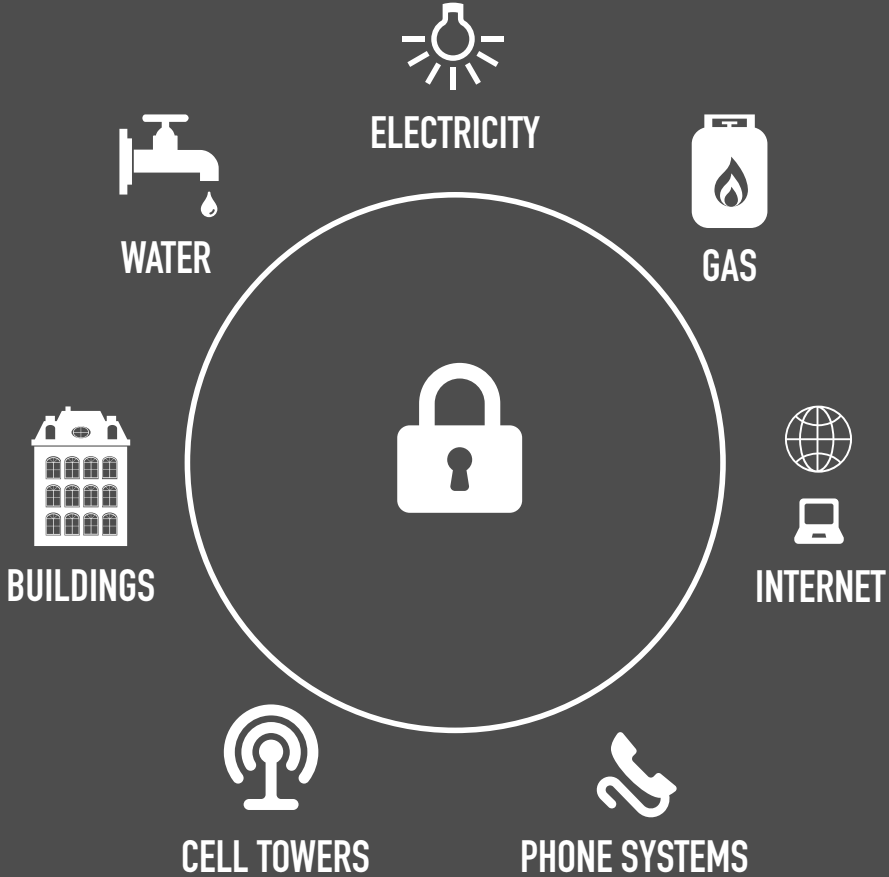
# A System of Systems



# Critical Infrastructure

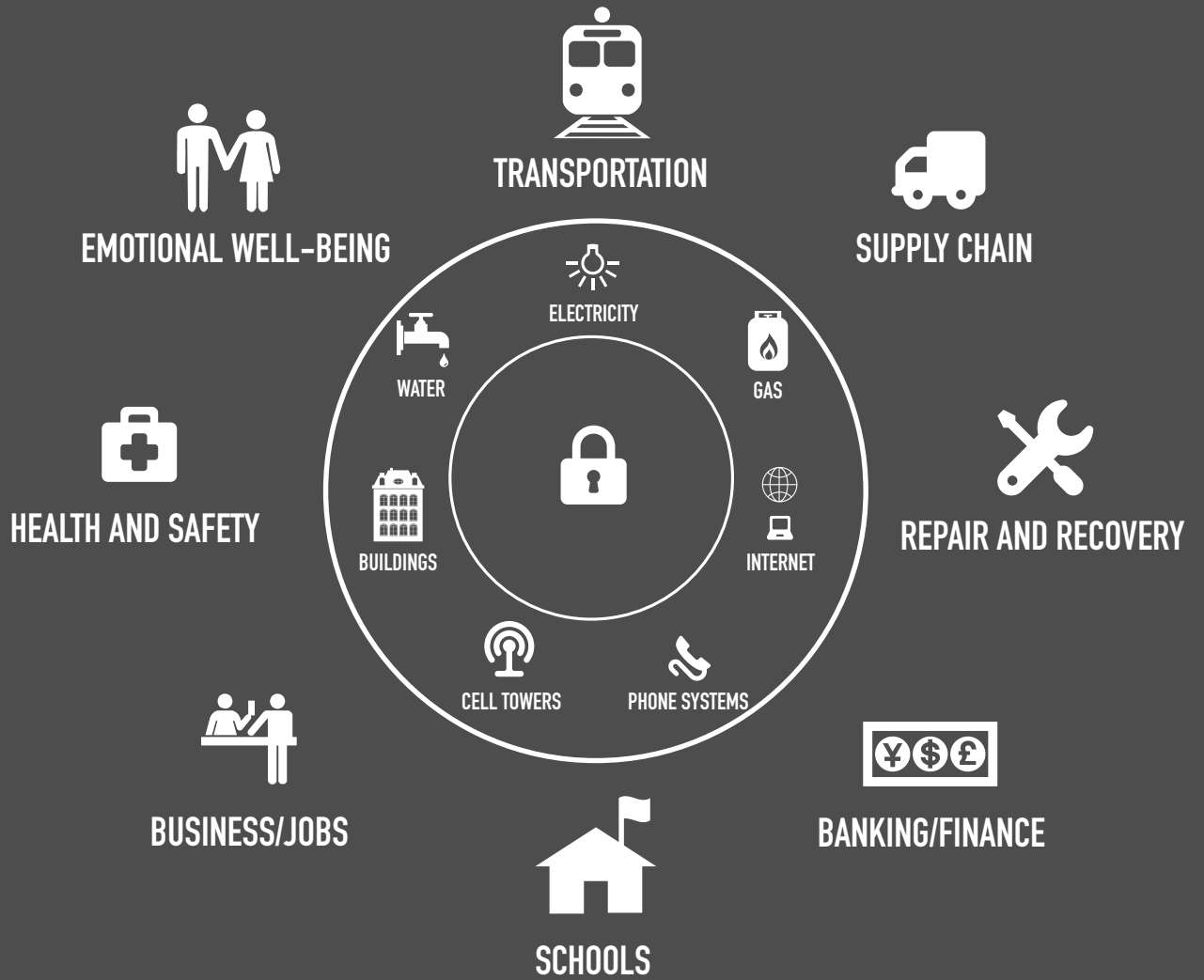


# Critical Infrastructure





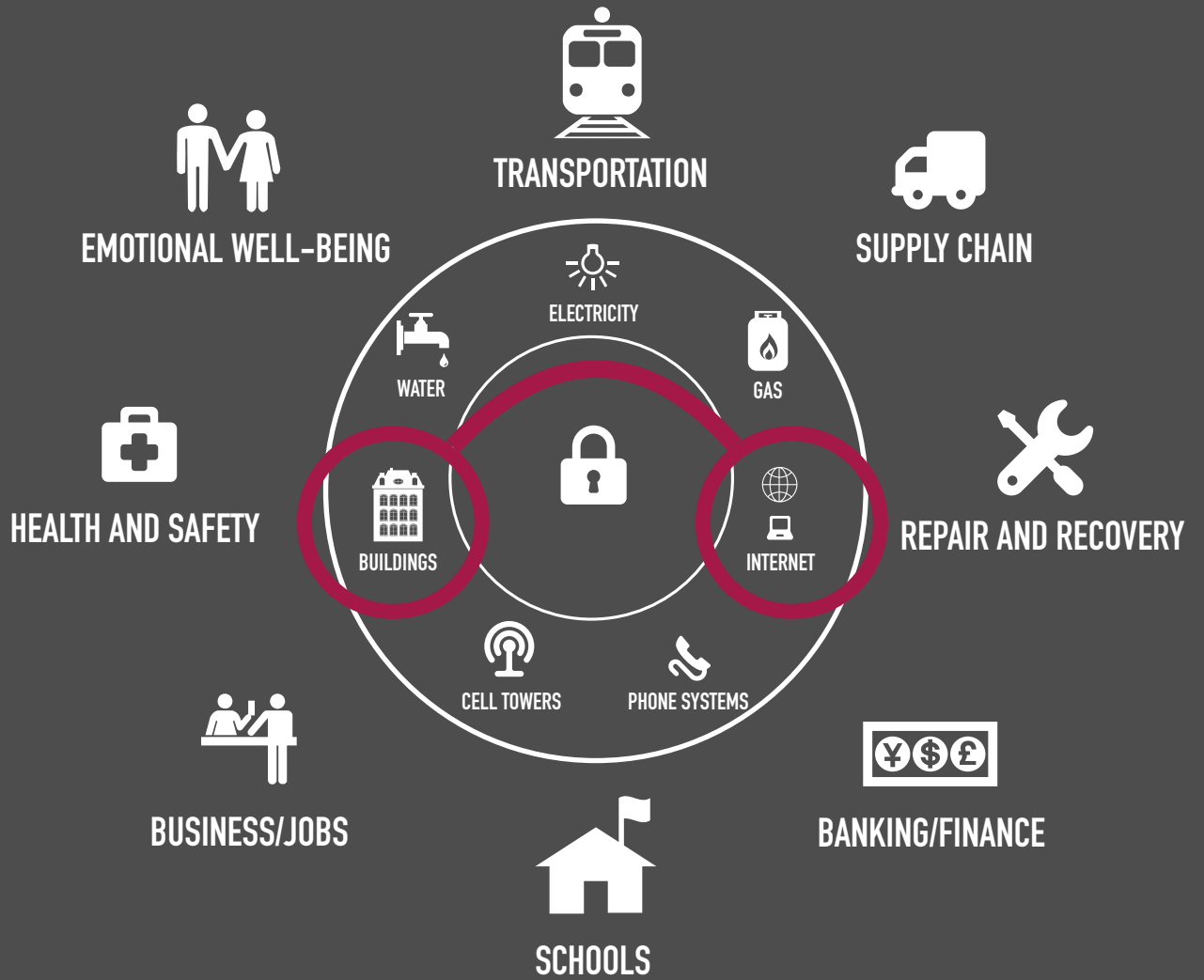
# Necessary Systems



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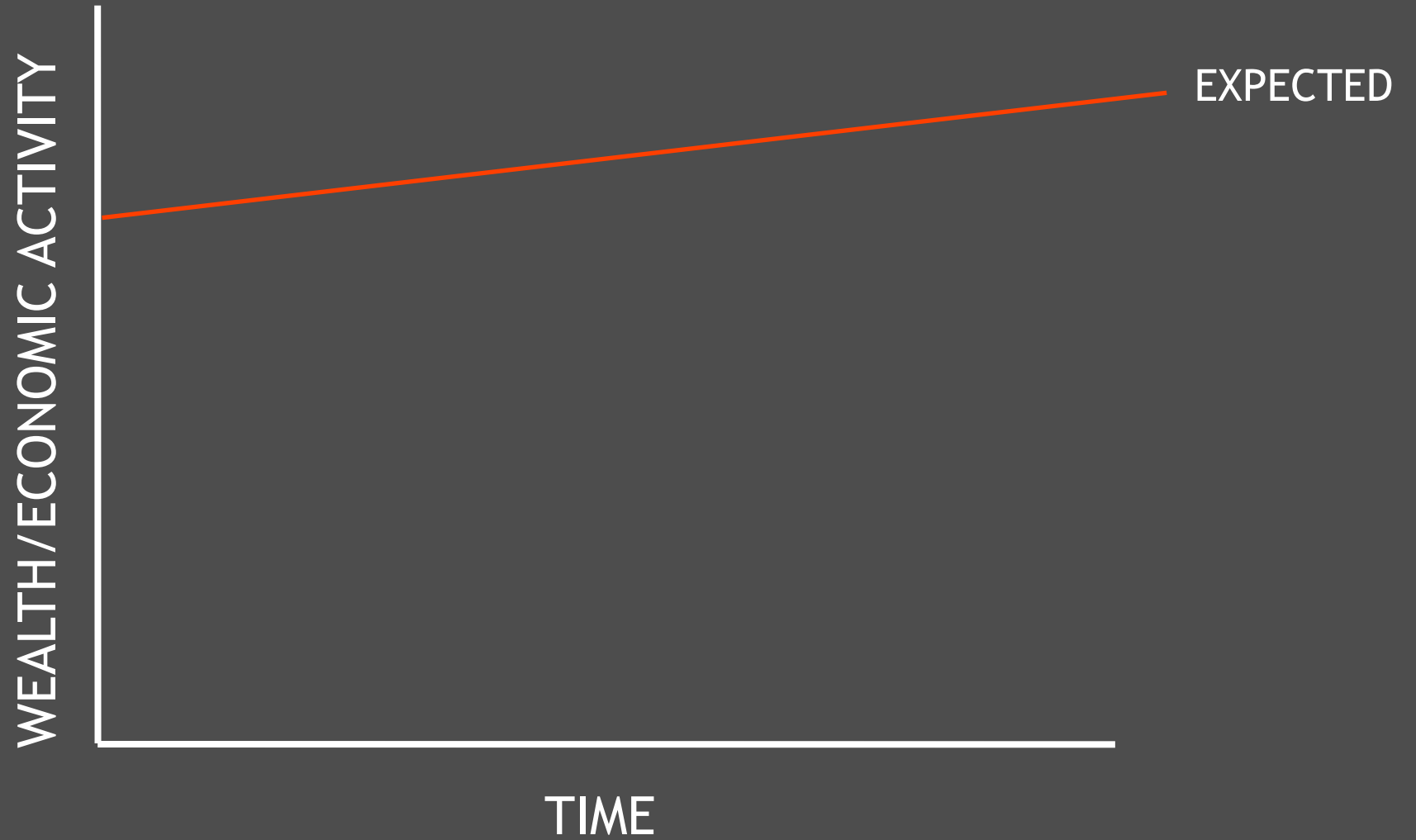


# Impacts of the Cascadia earthquake

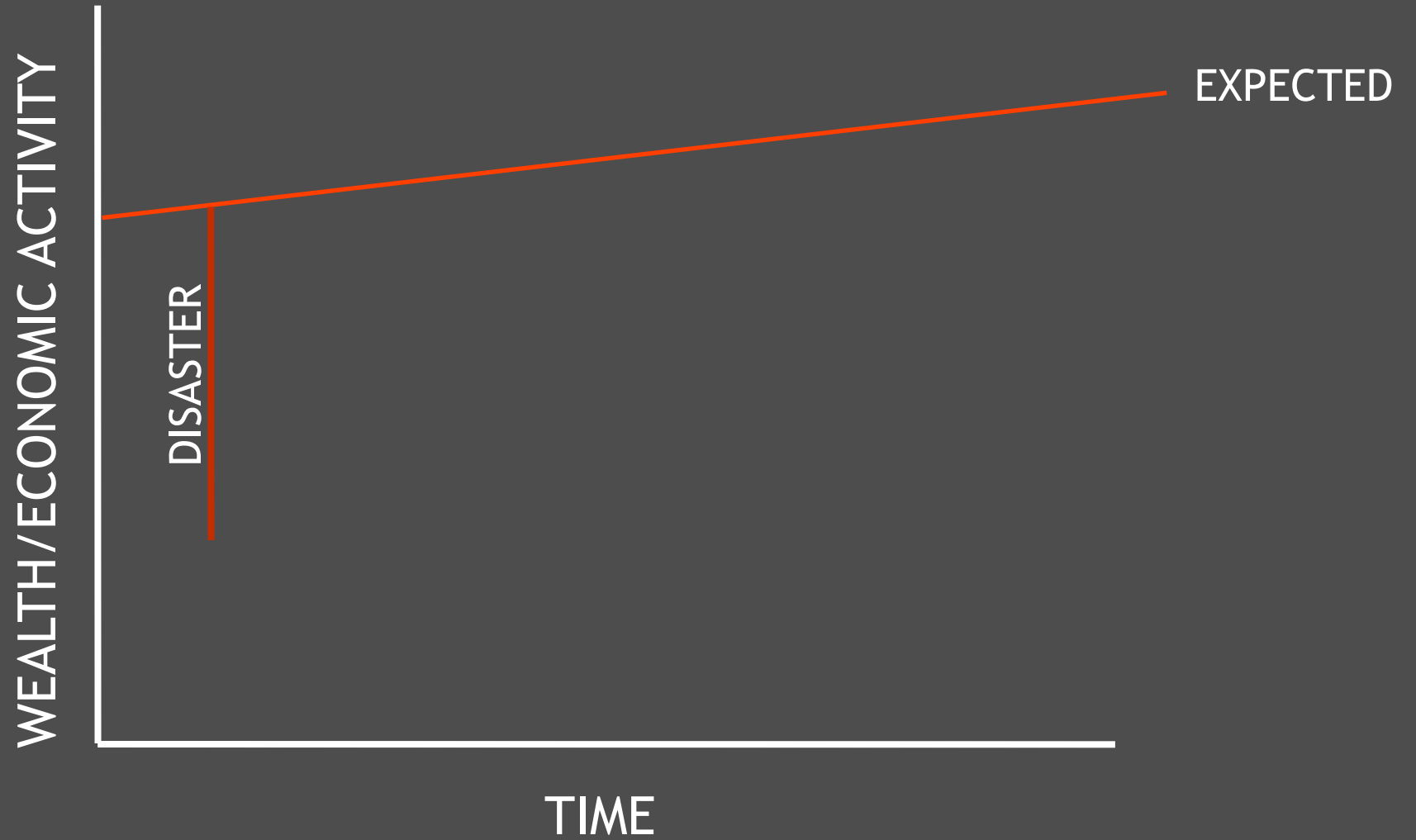
Numbers from Cascadia Rising

- Fatalities/Total population = 0.1%
  - (ShakeOut Fatalities/population = 0.01%)
- Made homeless by event = 10%

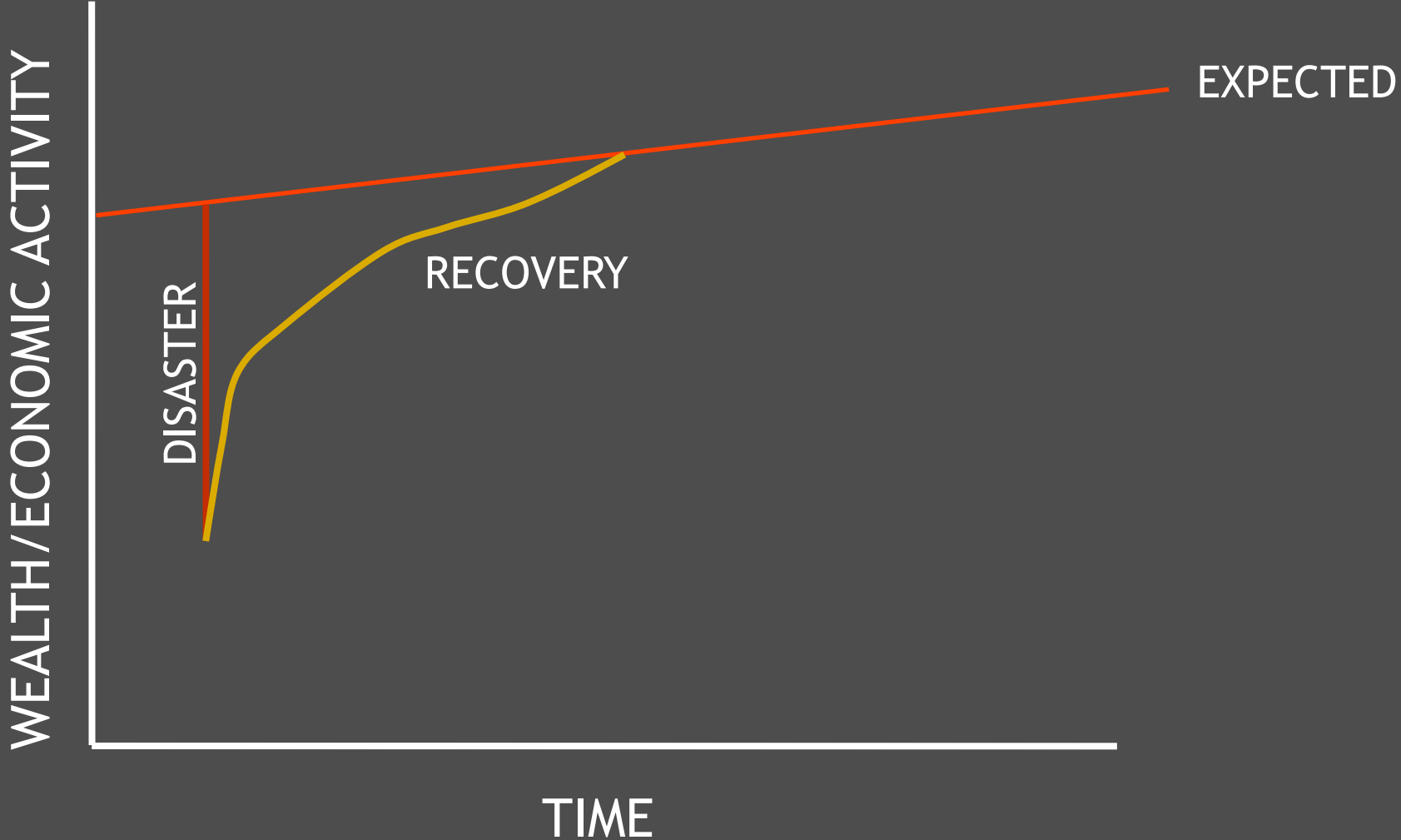
# What is Recovery?



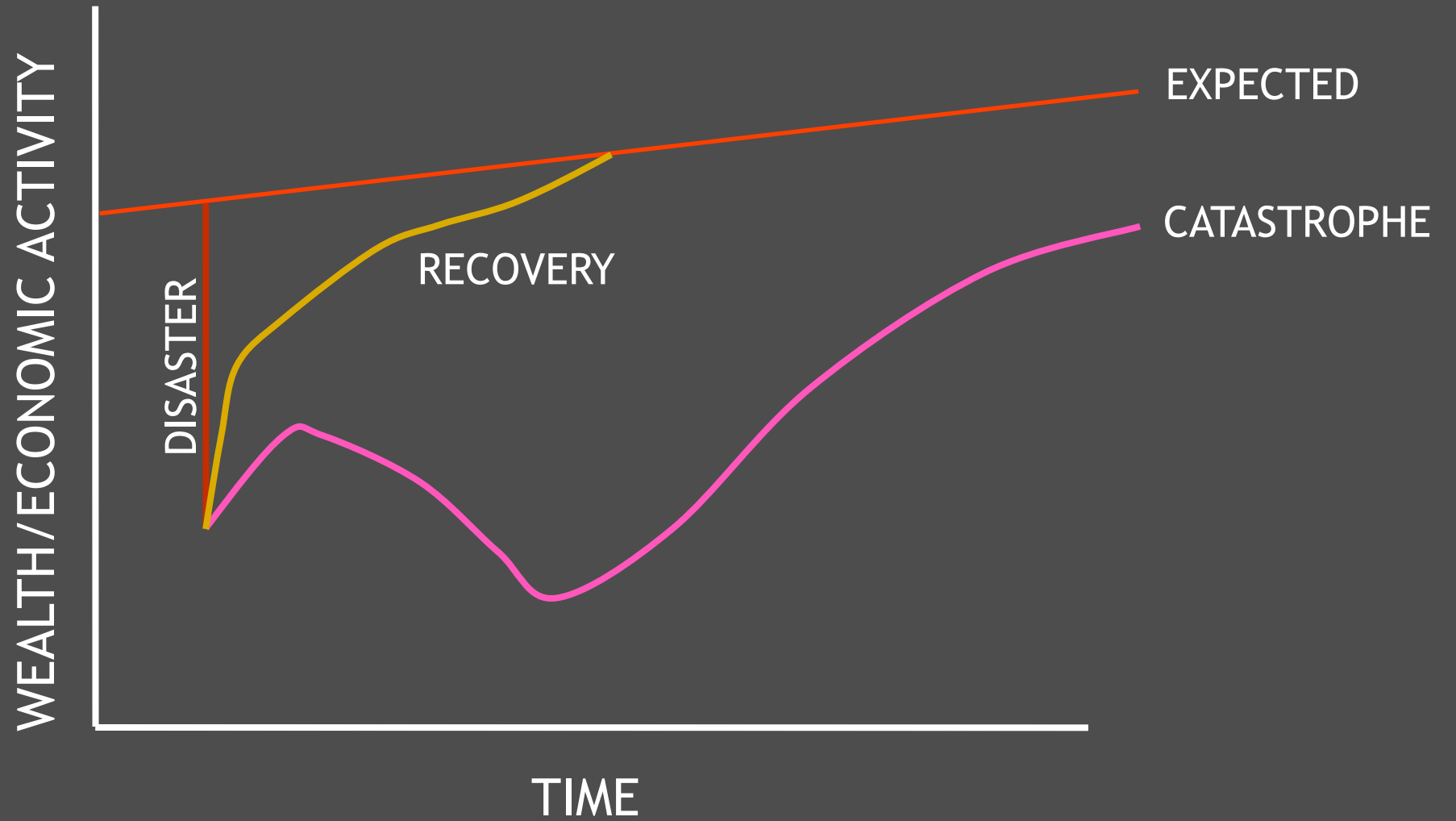
# What is Recovery?



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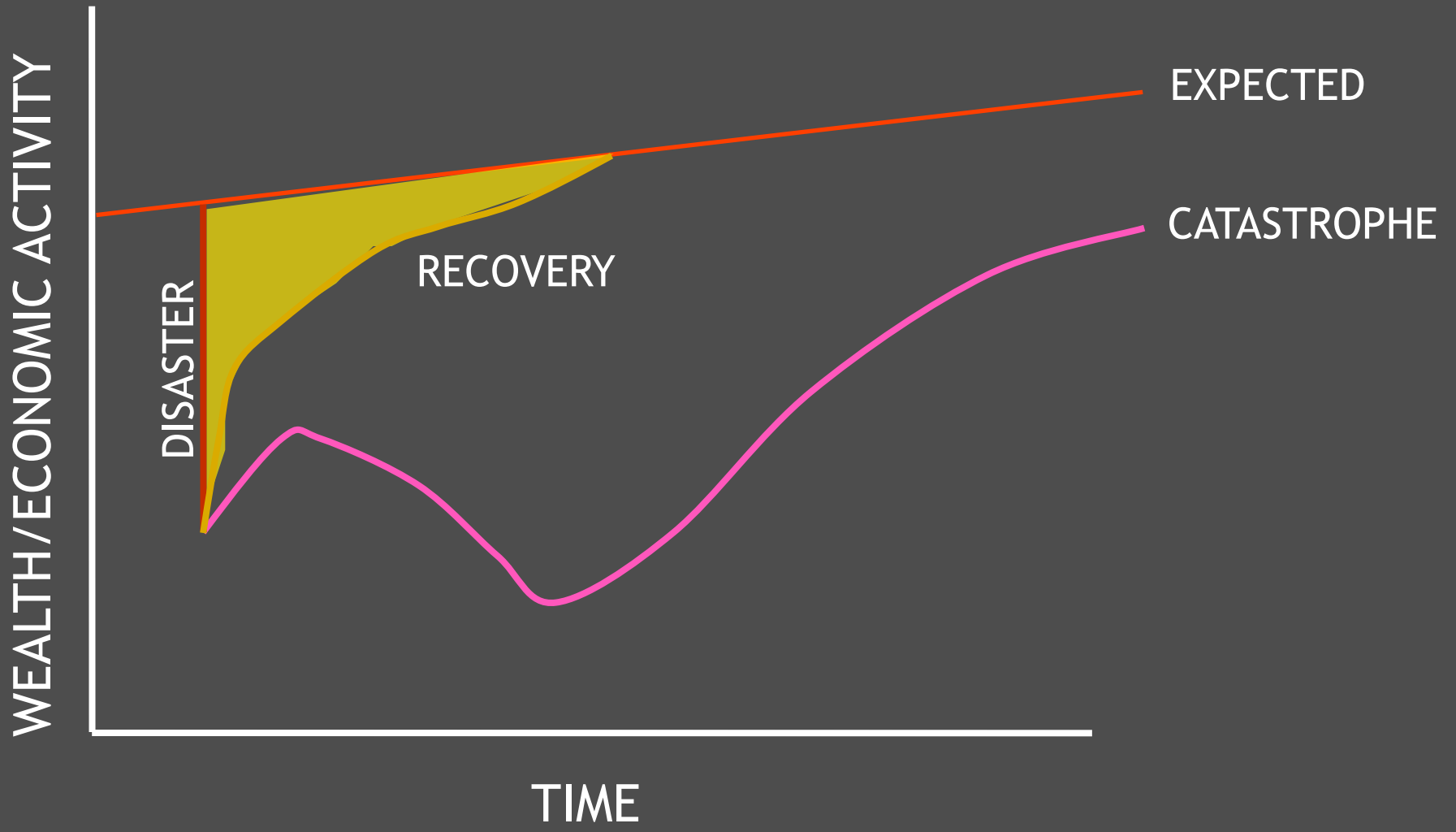


# What is Recovery?

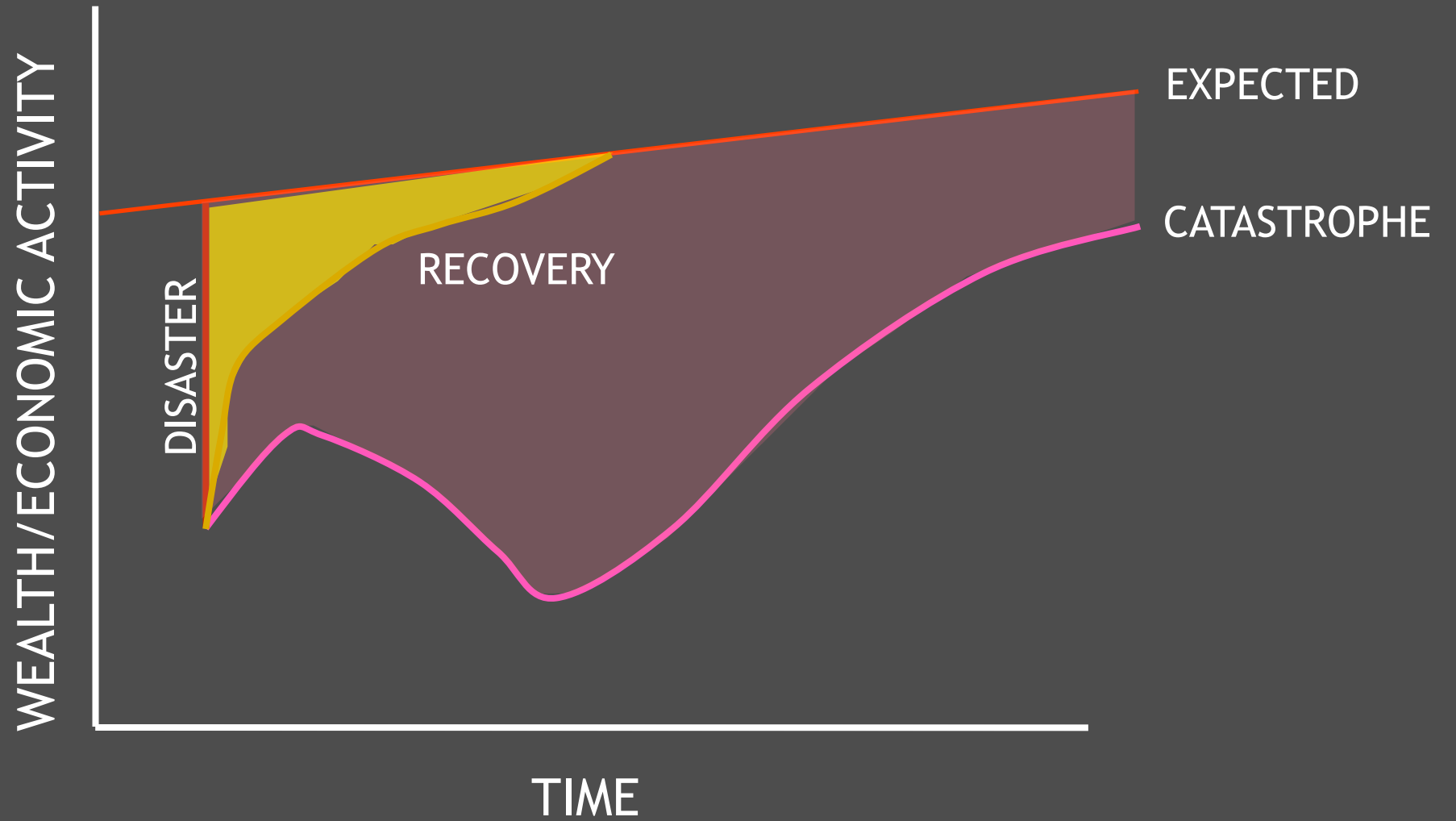




# What is Recovery?



# What is Recovery?



# Social Repercussions



# Social Repercussions



Christchurch  
2010



Christchurch  
Feb. 22, 2011  
M6.3



Christchurch  
Feb. 22, 2011  
M6.3

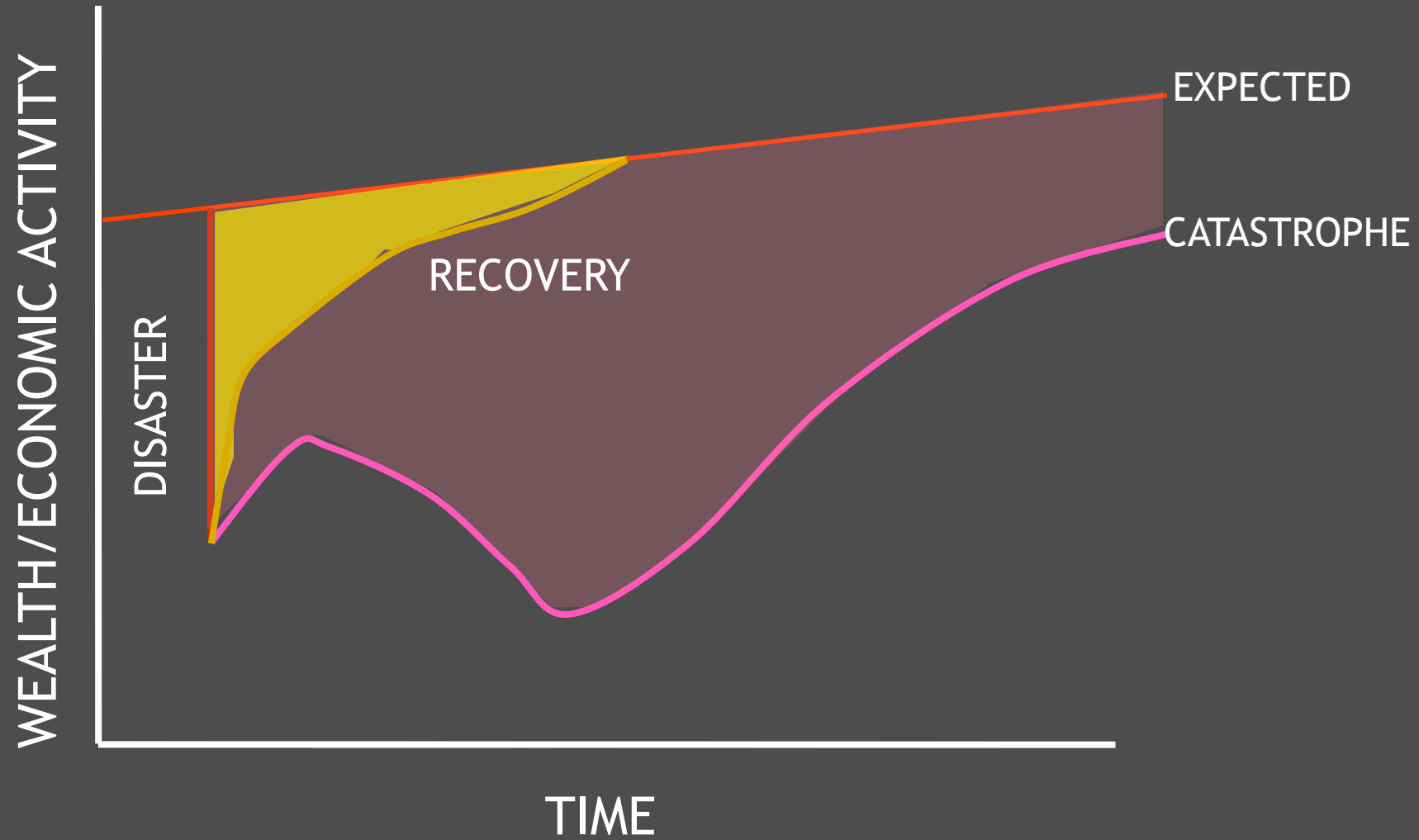




Christchurch  
2015

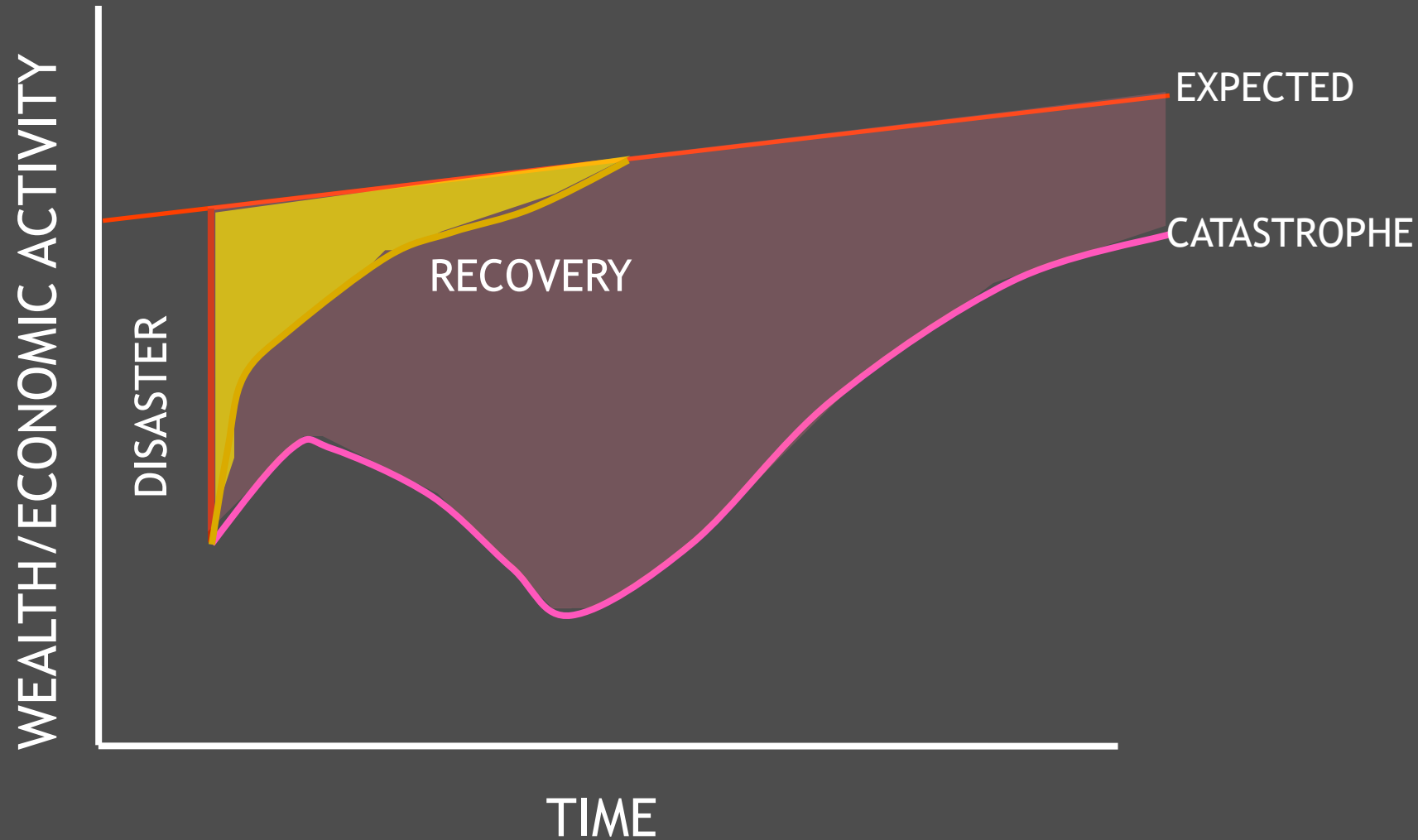


How do we speed up recovery?



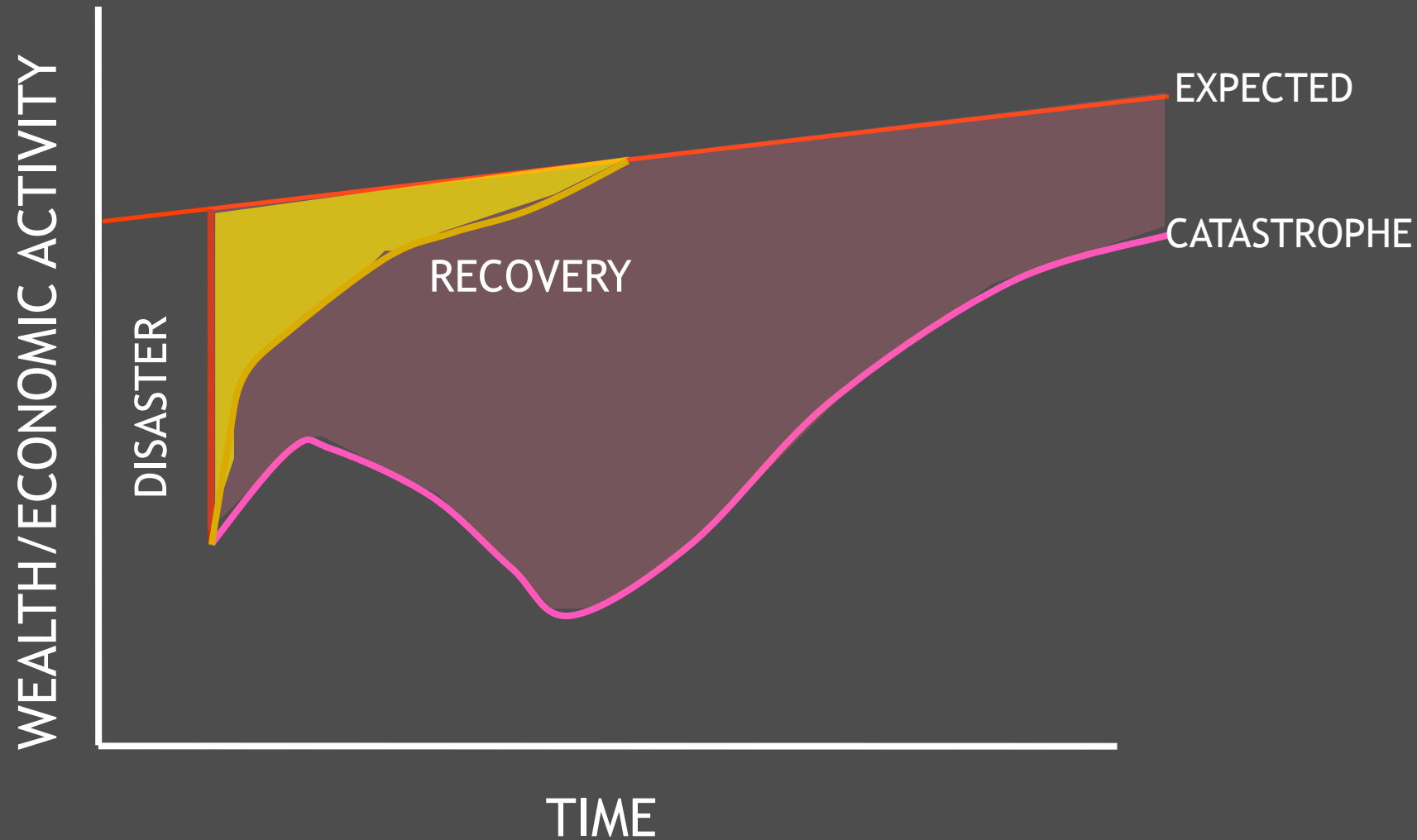
# How do we speed up recovery?

- Mitigation prevents damage, reducing need for response



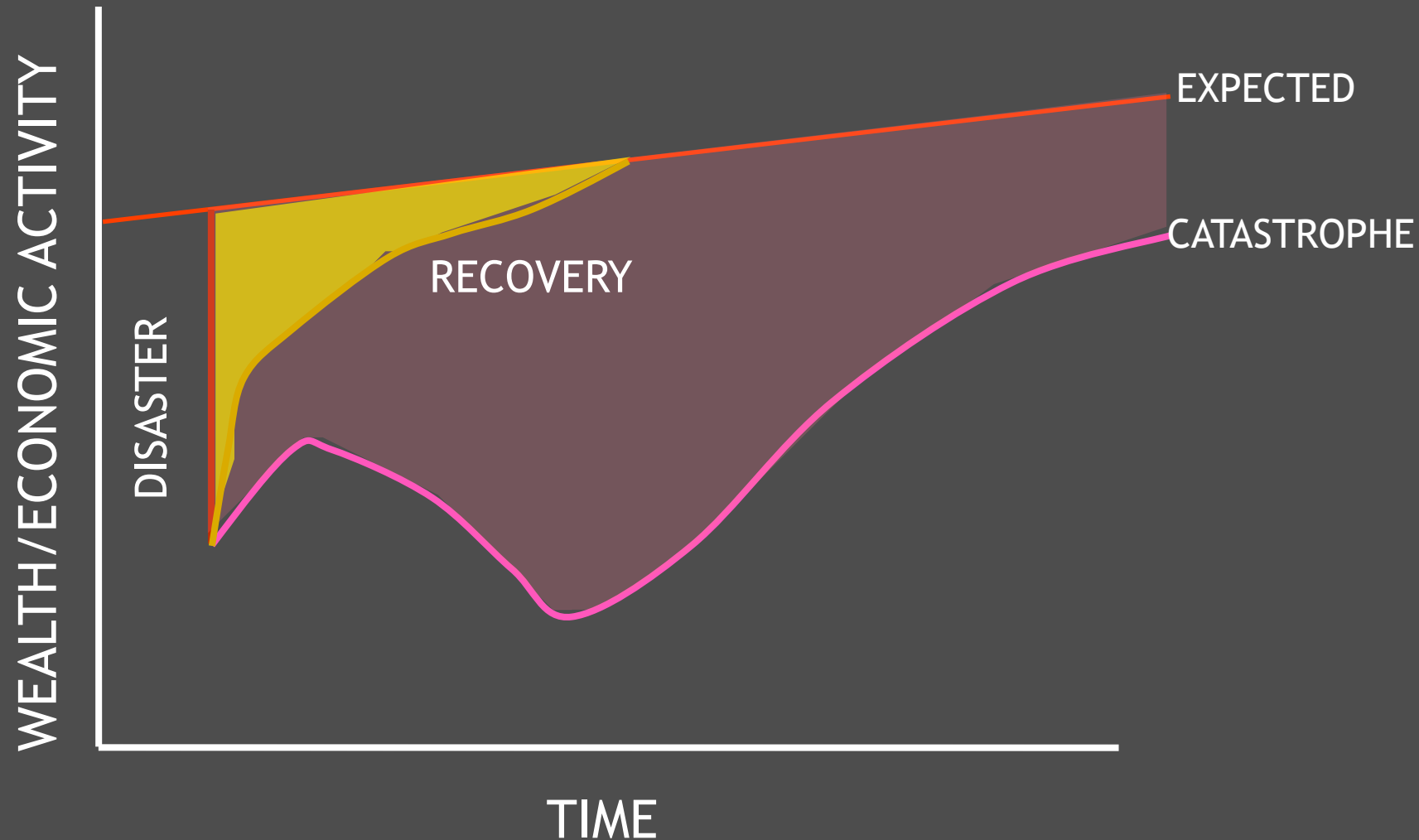
# How do we speed up recovery?

- Mitigation prevents damage, reducing need for response
- Planning improves response and recovery



# How do we speed up recovery?

- Mitigation prevents damage, reducing need for response
- Planning improves response and recovery
- Better response improves recovery



# Moving towards resilience

1

2

3

4



# Moving towards resilience

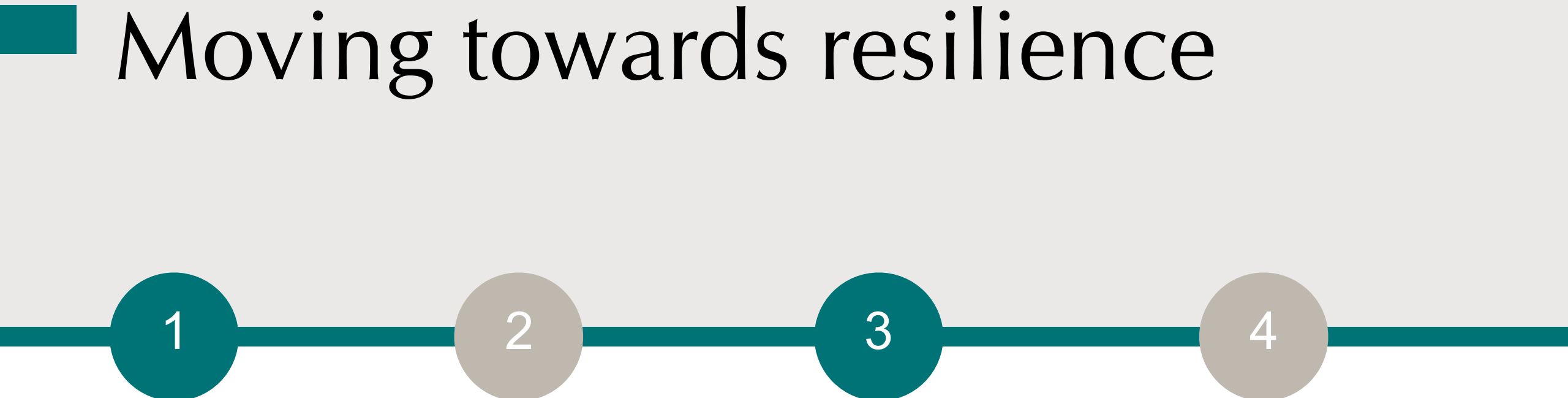
1

Understand  
the problem

2

3

4



# Moving towards resilience

1

Understand  
the problem

2

Find  
solutions

3

4



# Moving towards resilience

1

Understand  
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Find  
solutions

3

Create  
solutions - in  
the context of  
all your other  
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4



# Moving towards resilience

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Understand  
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Gather  
support for  
the new  
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# Moving towards resilience

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Understand  
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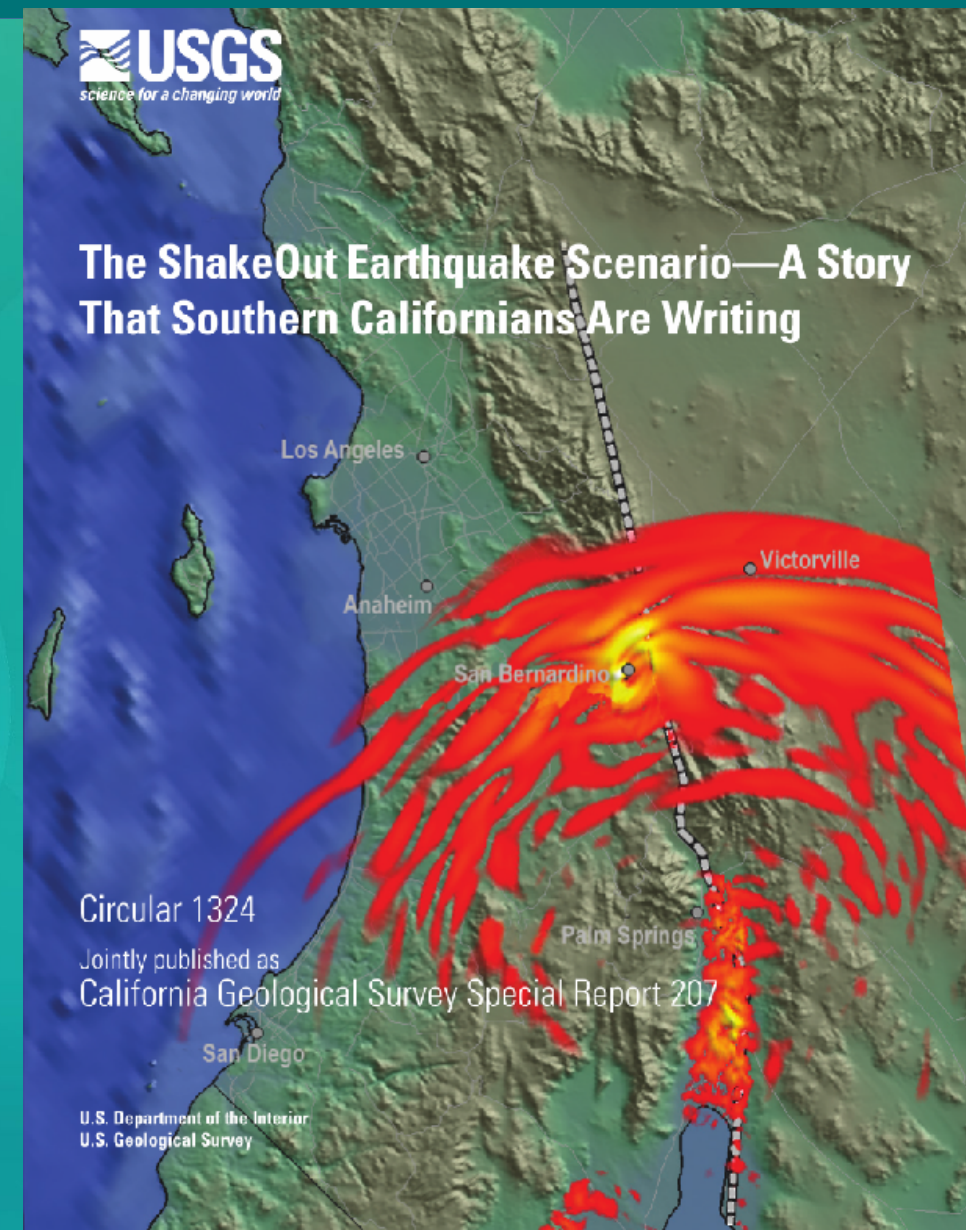
Role of scientific information



# Resilience by Design

## Los Angeles seismic safety plan 2014

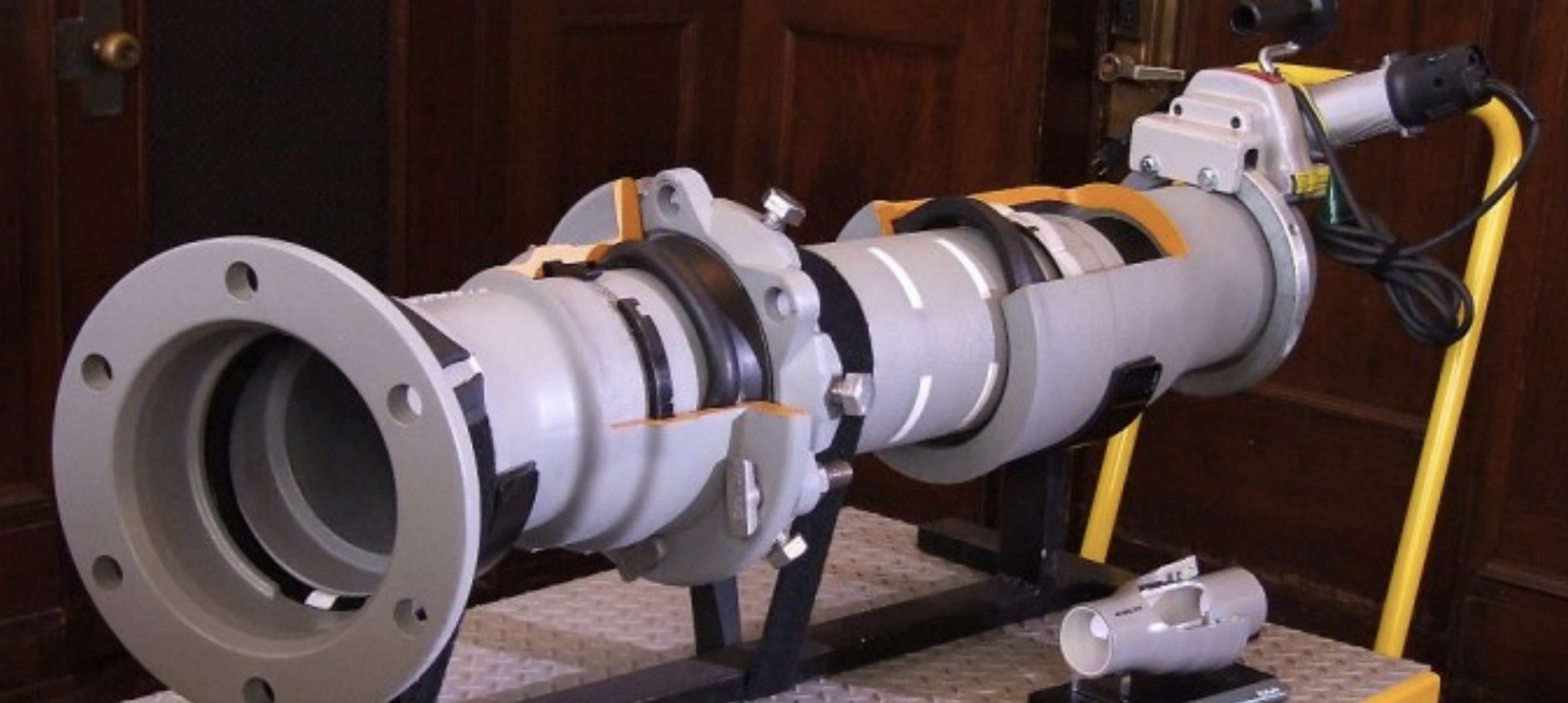
- Technical Assistance Agreement between the Mayor's Office and the USGS



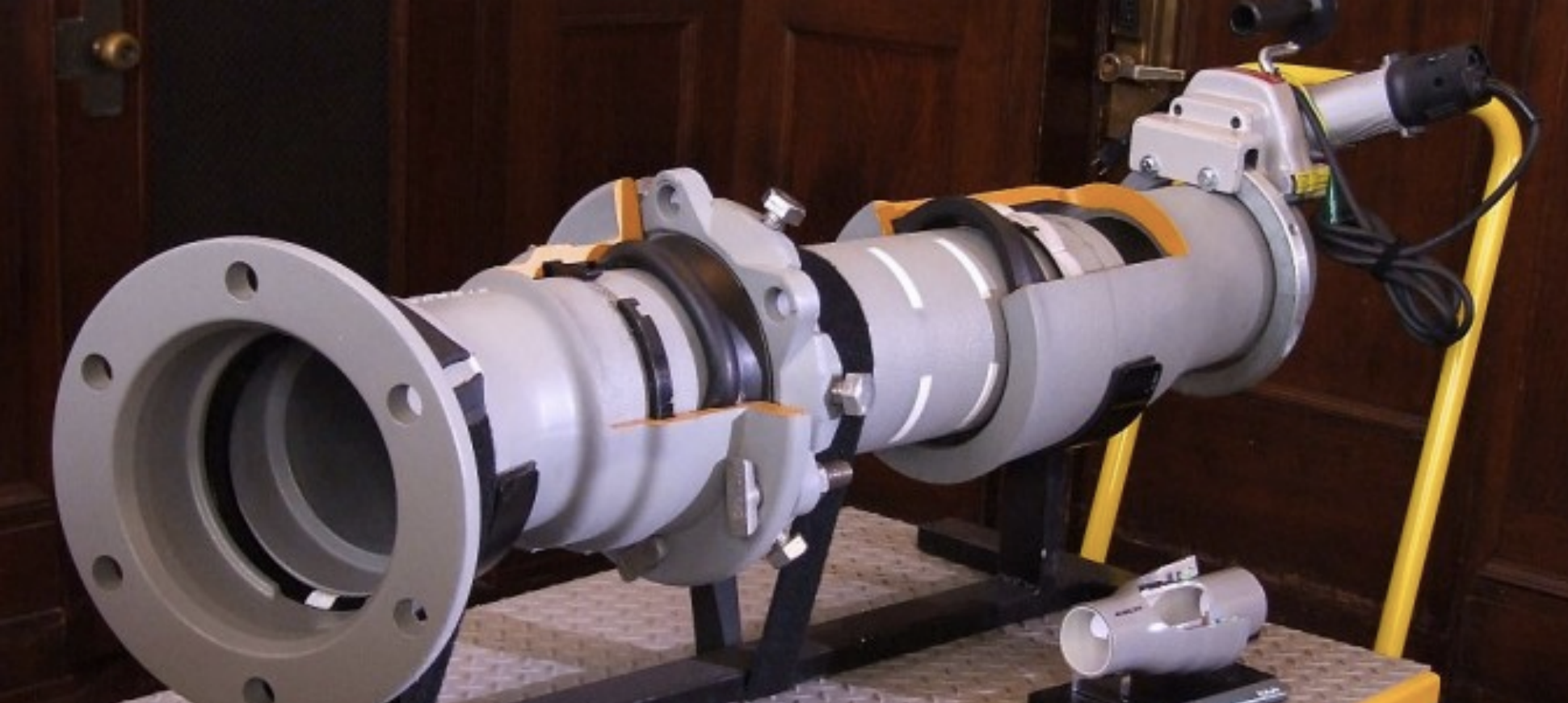


15,000+  
dangerous  
buildings  
will be  
retrofitted

- Strengthen Our Buildings
- Mandatory retrofit of soft-first story buildings
- Mandatory retrofit of concrete buildings
- “Back to Business” inspection program
- Excessive Damage ordinance



Commits to  
a seismic  
resistant  
water  
system



Commits to  
a seismic  
resistant  
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system

- **Fortify Water System**

- Protect aqueducts as they cross San Andreas
- Seismic resistant distribution pipes
- Alternative firefighting capability
- Resilience by Design in LADWP



Developing  
partnership of  
Southern  
California  
lifelines to  
work together  
to strengthen  
lifelines



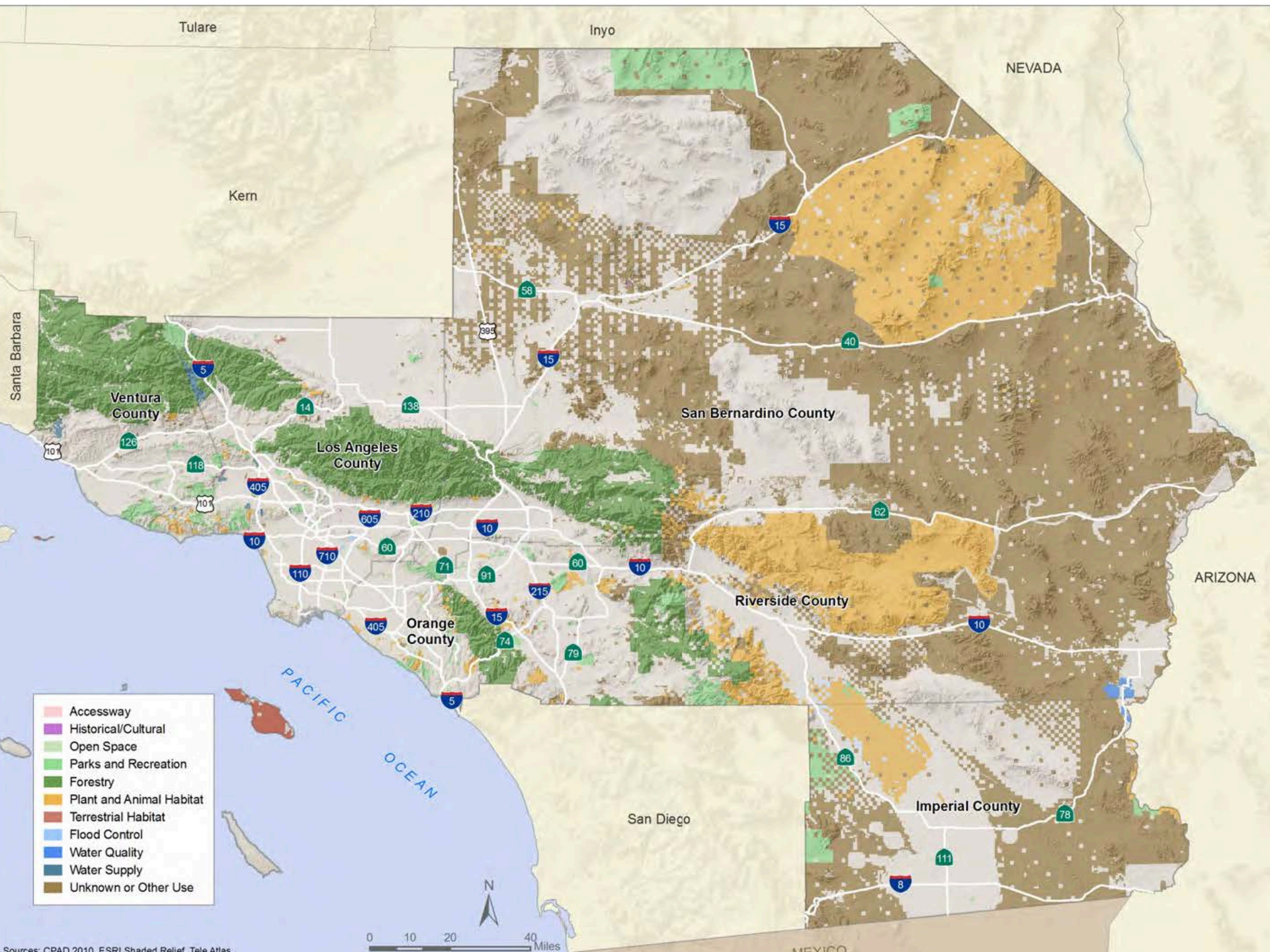
Developing partnership of Southern California lifelines to work together to strengthen lifelines

- **Enhance Telecommunications**
  - MOU with service providers to manage emergencies
  - More resilient power
  - Promote City-wide Wifi access
  - Stronger towers



Every city council ordinance passed unanimously





Spreading  
to 191  
other  
cities



Sources: CPAD 2010, ESRI Shaded Relief, Tele Atlas



# Southern California earthquake safety initiative

- Began with seminars for elected officials
- 40 Cities entered cohorts
- Support the city in what they want to do
- Educate about actual risk

Why is it working?

?

?

?

?

We didn't  
discuss  
uncertainty

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discuss  
uncertainty

- Detailed discussion of probabilities and uncertainties can increase fear and reduce action

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- Detailed discussion of probabilities and uncertainties can increase fear and reduce action
- Focused on impacts not on the unknown time

We found a new way of communicating





We also keep science and policy separate



## We also keep science and policy separate

- Scientists and engineers show the consequences of decisions



## We also keep science and policy separate

- Scientists and engineers show the consequences of decisions
- Policy makers make decisions



# Relationships matter



— We are all in this together

