

Sustainability and Resiliency: Mitigation and Adaptation

Cameron Bernhardt, Amy Syvrud, Alyssa Zamora

Outline

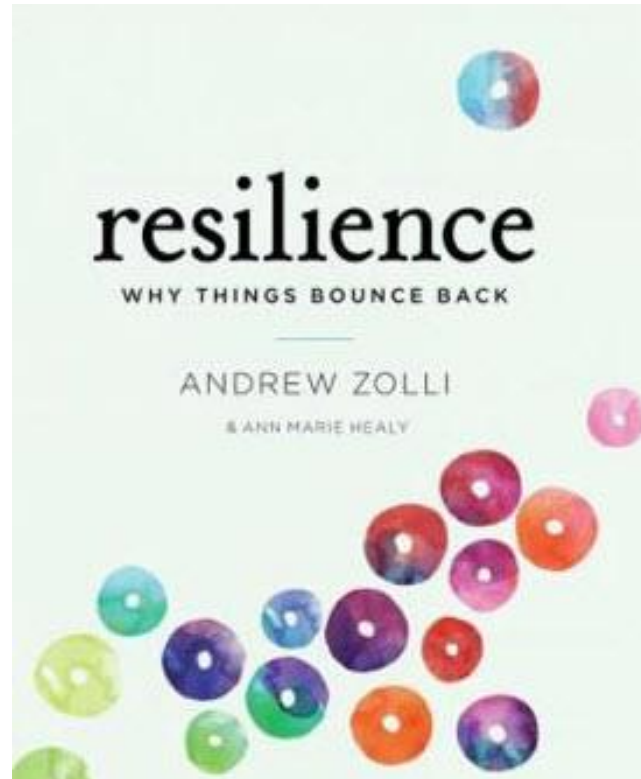
- ▶ Sustainability
 - ▶ Being rendered obsolete
 - ▶ Need to develop resiliency
- ▶ Resiliency
 - ▶ Paradigm shift
- ▶ Application
 - ▶ San Diego

Resilience vs. Sustainability

Andrew Zolli

Author of “Resilience: Why Things Bounce Back”

<http://vimeo.com/43178267>



Sustainability

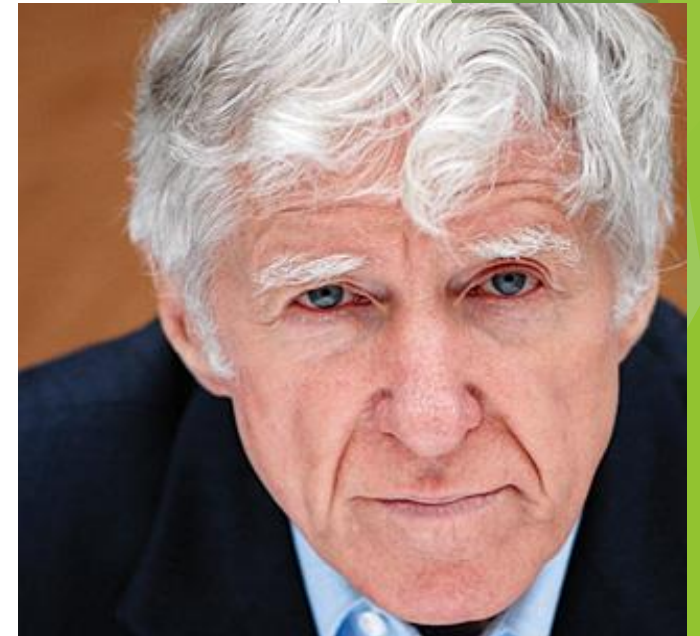
Maintaining the conditions
of productive harmony

Sustainability



- ▶ *“Meeting the needs of the present without compromising the needs of future generations.”*
- ▶ Brundtland Report, United Nations, U.S. Environmental Protection Agency

- ▶ *“We do not inherit the Earth from our fathers; we borrow it from our children.”*
- ▶ Lester Brown’s “Building a Sustainable Society”



Sustainability

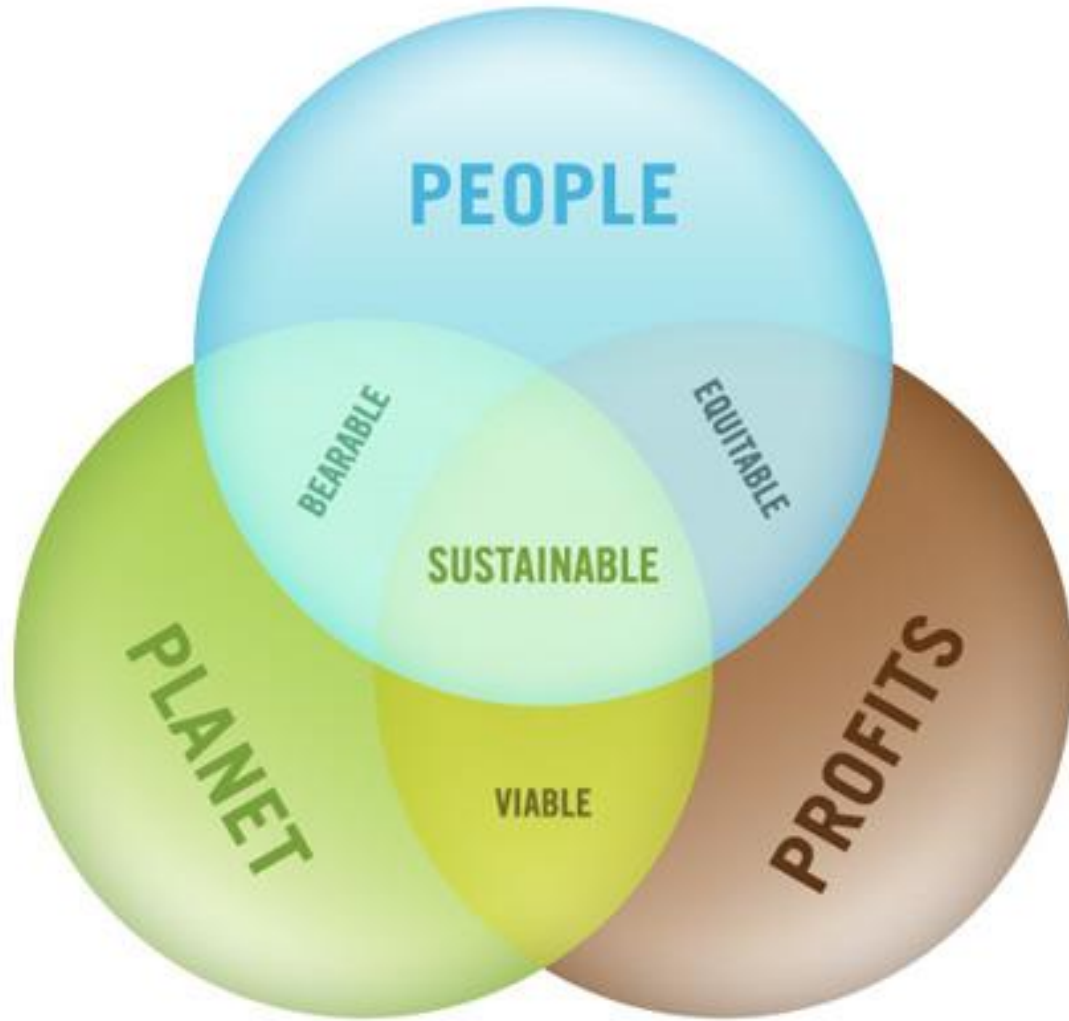
- ▶ *“We cannot simply think of our survival; each new generation is responsible to ensure the survival of the seventh generation... Indigenous people are the poorest of the poor and the holders of the key to the future survival of humanity.”*
 - ▶ Authors of “Our Responsibility to the Seventh Generation”, 1992

iisd

International
Institute for
Sustainable
Development

Institut
international du
développement
durable

What Is Sustainability?



Three Spheres of Sustainability



Source: University of Michigan
Sustainability Assessment

What Does Sustainability Look Like?



50% of the population commutes by bicycle.
Copenhagen, Denmark

“Wood Cube” building has a zero-sum CO₂ balance and is 100% bio-recyclable.
Hamburg, Germany



Sustainable...But Is It Resilient?

- ▶ What happens when there is a huge snow storm?

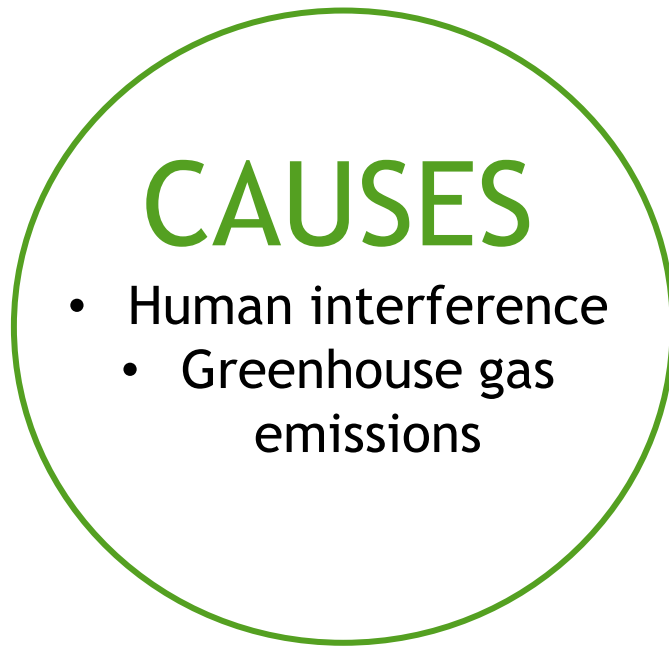


- ▶ What happens if there is a fire? Or if termites appear?

Sustainability and Mitigation

▶ Mitigation

- ▶ The action of reducing the severity, seriousness or painfulness of something.



**CLIMATE
CHANGE**

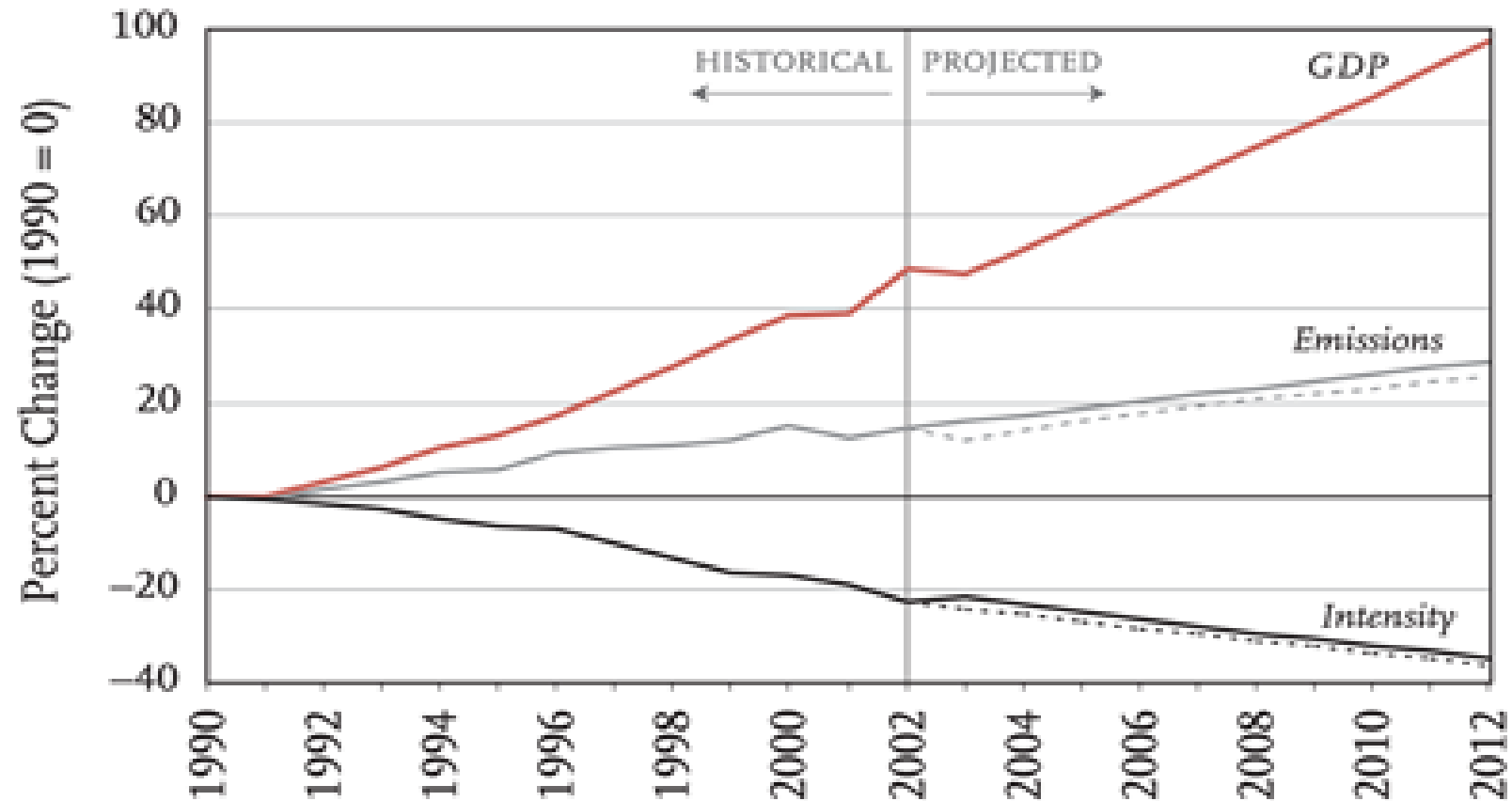


CONSEQUENCES

Mitigation Methodologies

- ▶ Intensity-based greenhouse gas reduction targets
 - ▶ Reduce amount of GHGs produced per unit
- ▶ Absolute greenhouse gas reduction targets
 - ▶ Reduce total amount of GHGs produced

U.S. HISTORICAL AND FUTURE TRENDS: GHGs, GDP, AND INTENSITY



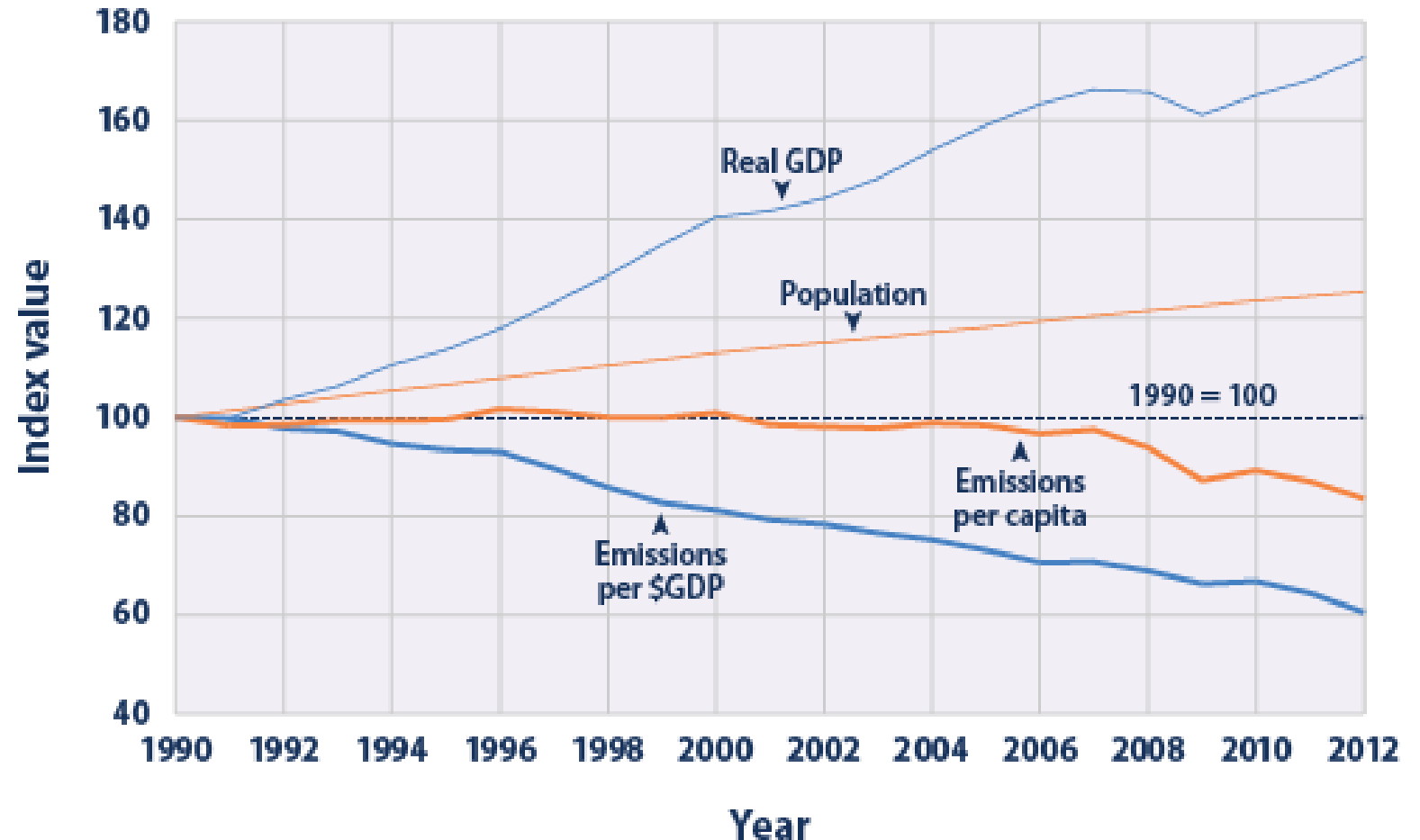
Source: WRI 2002 (Based on US Gov't Projections)

What Actually Happened...

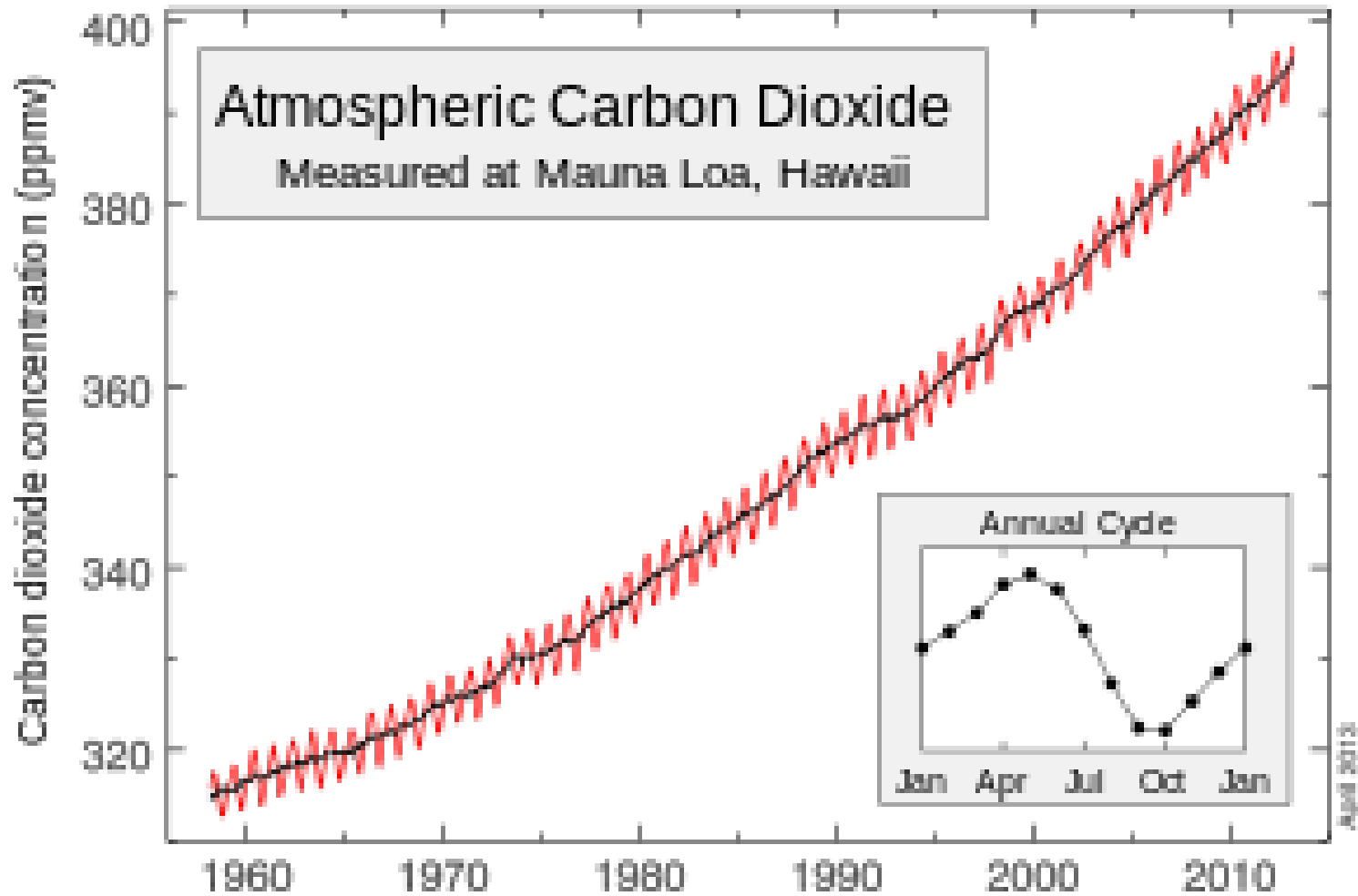
- ▶ From 1990 to 2012...
 - ▶ GHG emissions per dollar of GDP declined by 39%
 - ▶ Total GHG emissions increased by 5%

Source: EPA Indicators of Climate Change

Figure 3. U.S. Greenhouse Gas Emissions per Capita and per Dollar of GDP, 1990–2012



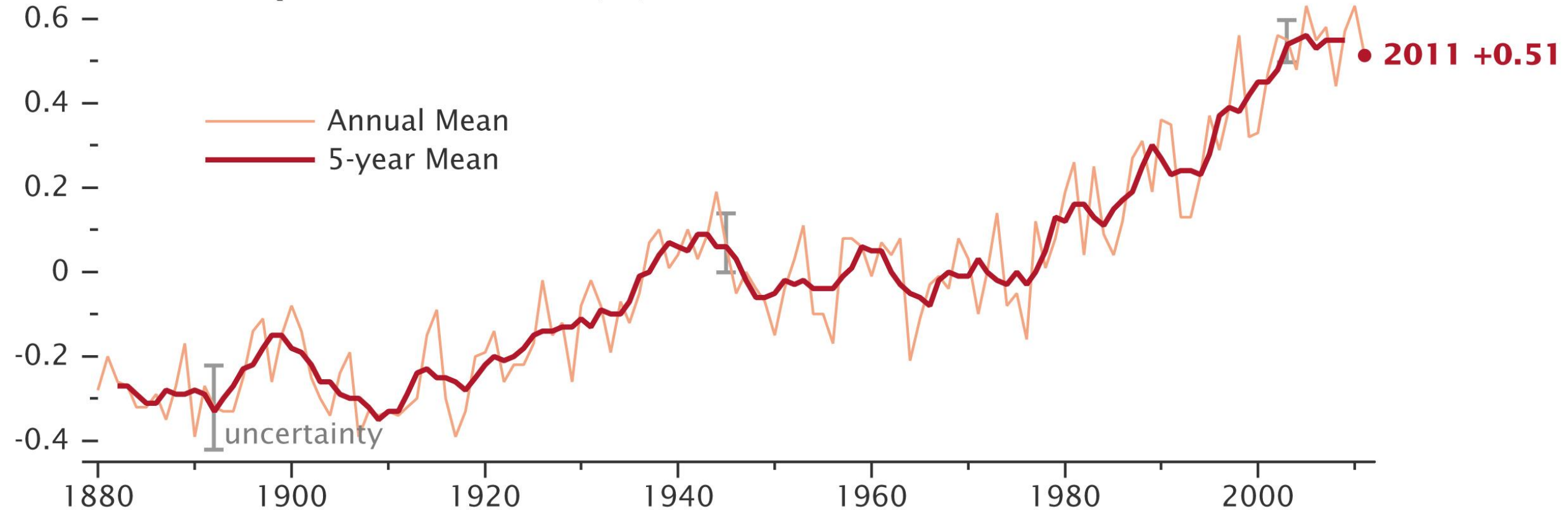
Effect of Increasing GHG Emissions



Source: Keeling Curve, Scripps Institution of Oceanography

Global Mean Surface Temperature

Global Temperature Difference (°C)

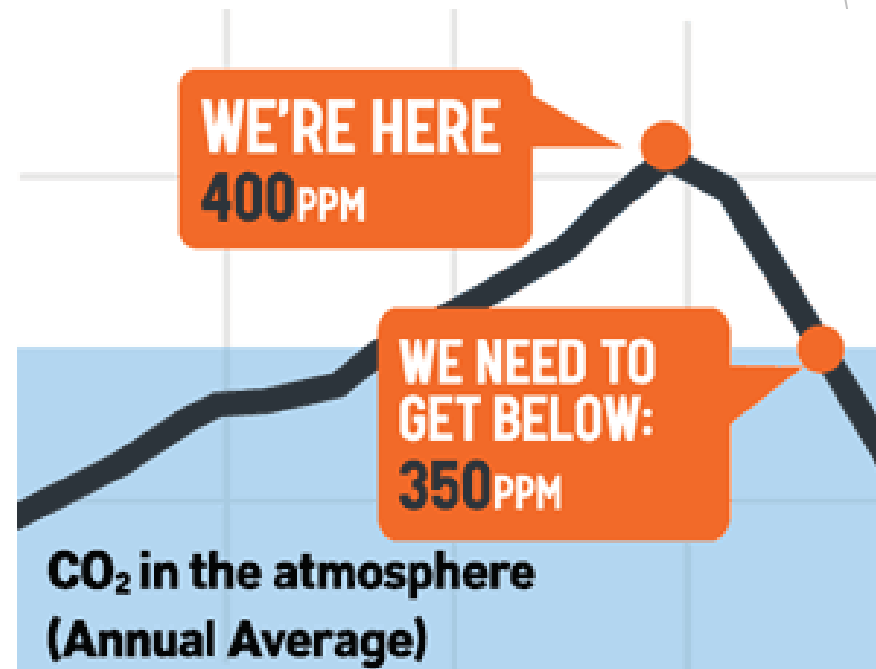


Source: NASA, Goddard Institute for Space Studies

If We Do Nothing About Our Expanding GHG Emissions...

► *“If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO₂ will need to be reduced [from current levels] to at most 350 ppm.”*

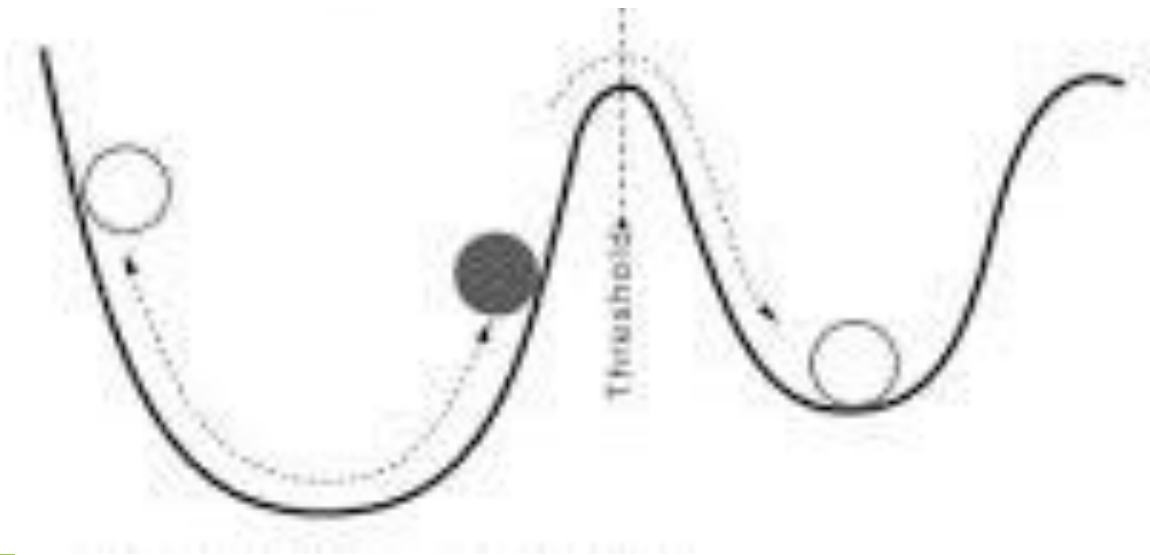
► Dr. James Hansen



Source: 350.org

Crossing A Threshold

Ecological Resilience Concept



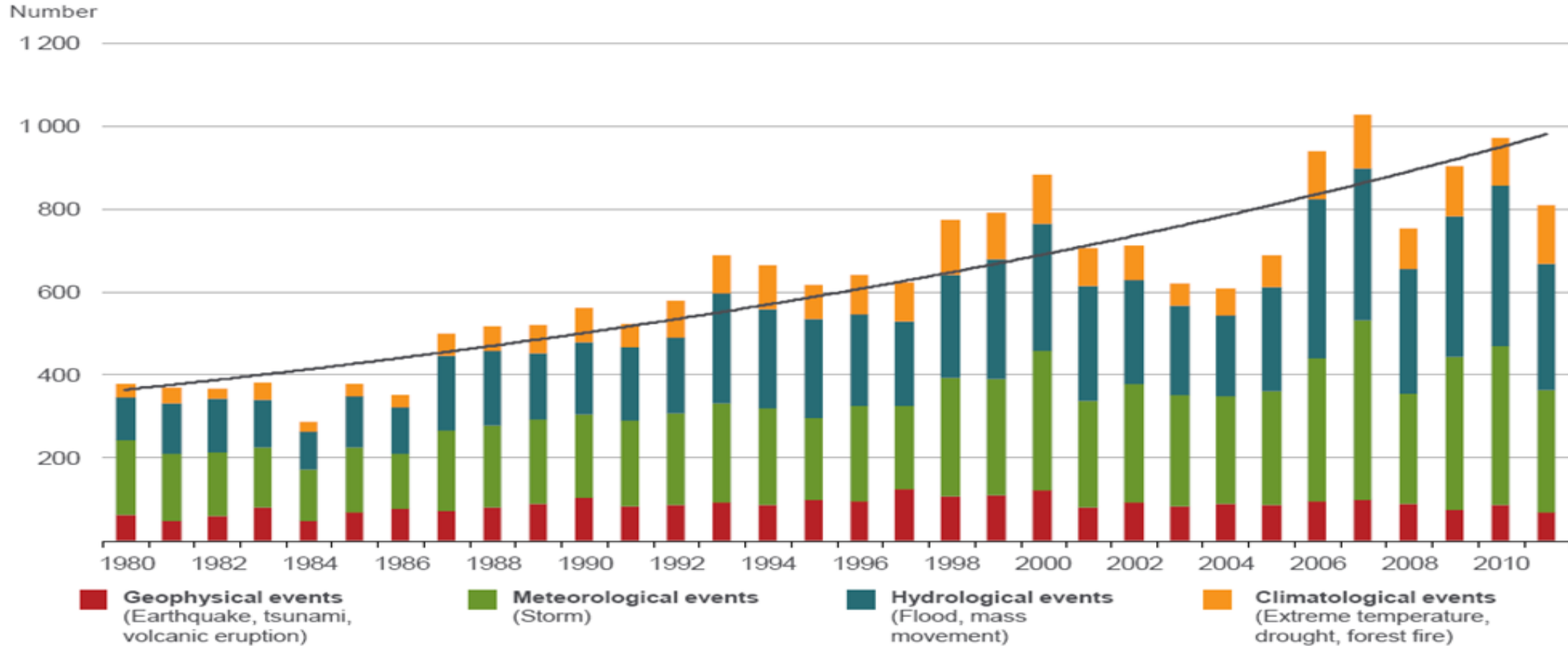
Source: C.S. Holling, 1973



Johan Rockström at
TED on “Planetary
Boundaries”

Natural catastrophes worldwide 1980 – 2011

Number of events with trend



© 2012 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE – As at January 2012

What Does This Mean For Our Future?



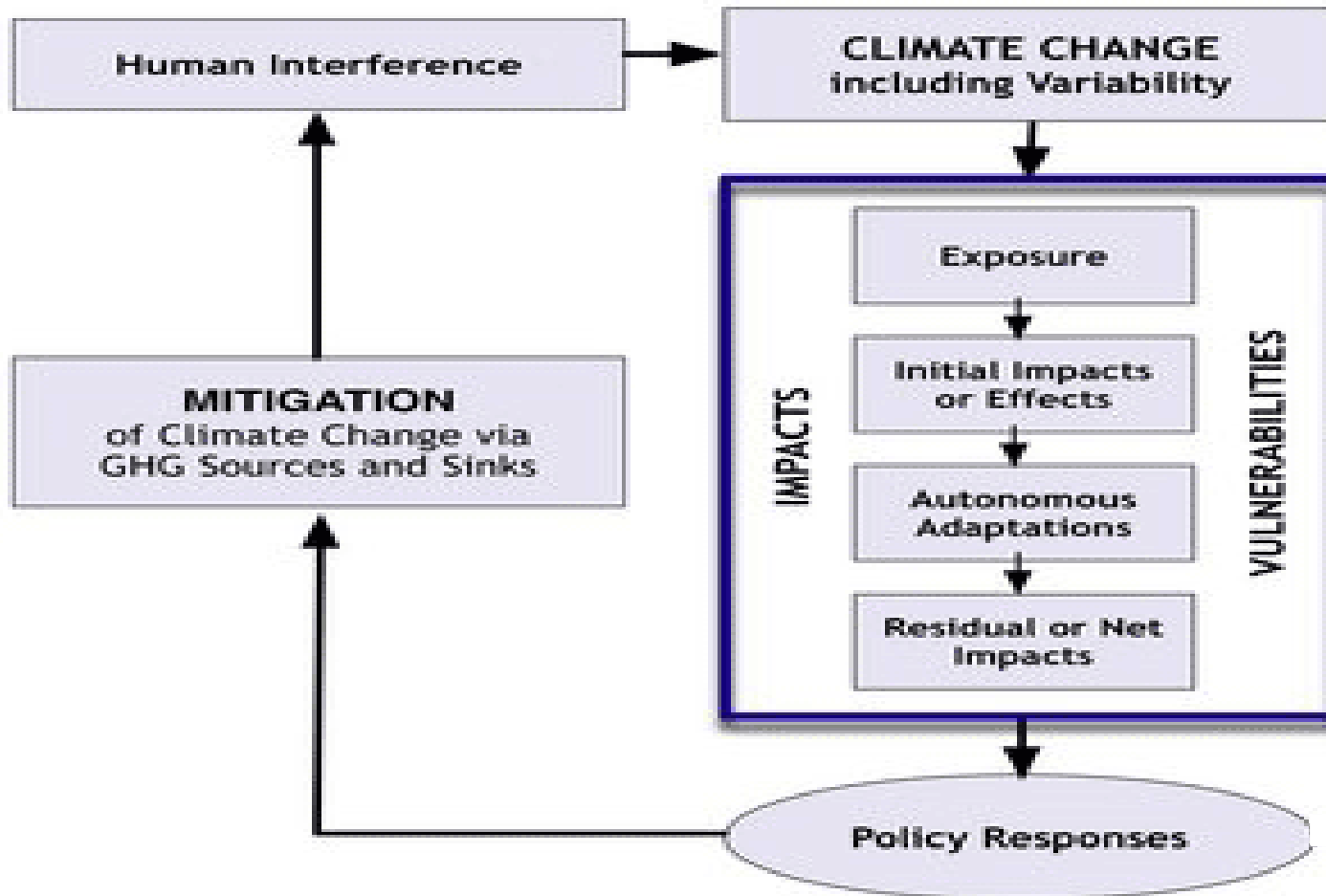
Source: The San Diego Wildfires Education Project
San Diego, May 2014

- ▶ *"We're now in a situation where there is a year-round risk of fire in San Diego County."*
 - ▶ Diane Jacob, Chairwoman of the Board of Supervisors of SD County

▶ This could become the new 'STABLE' state...

What Should We Do?

The place of adaptation in responses to climate change

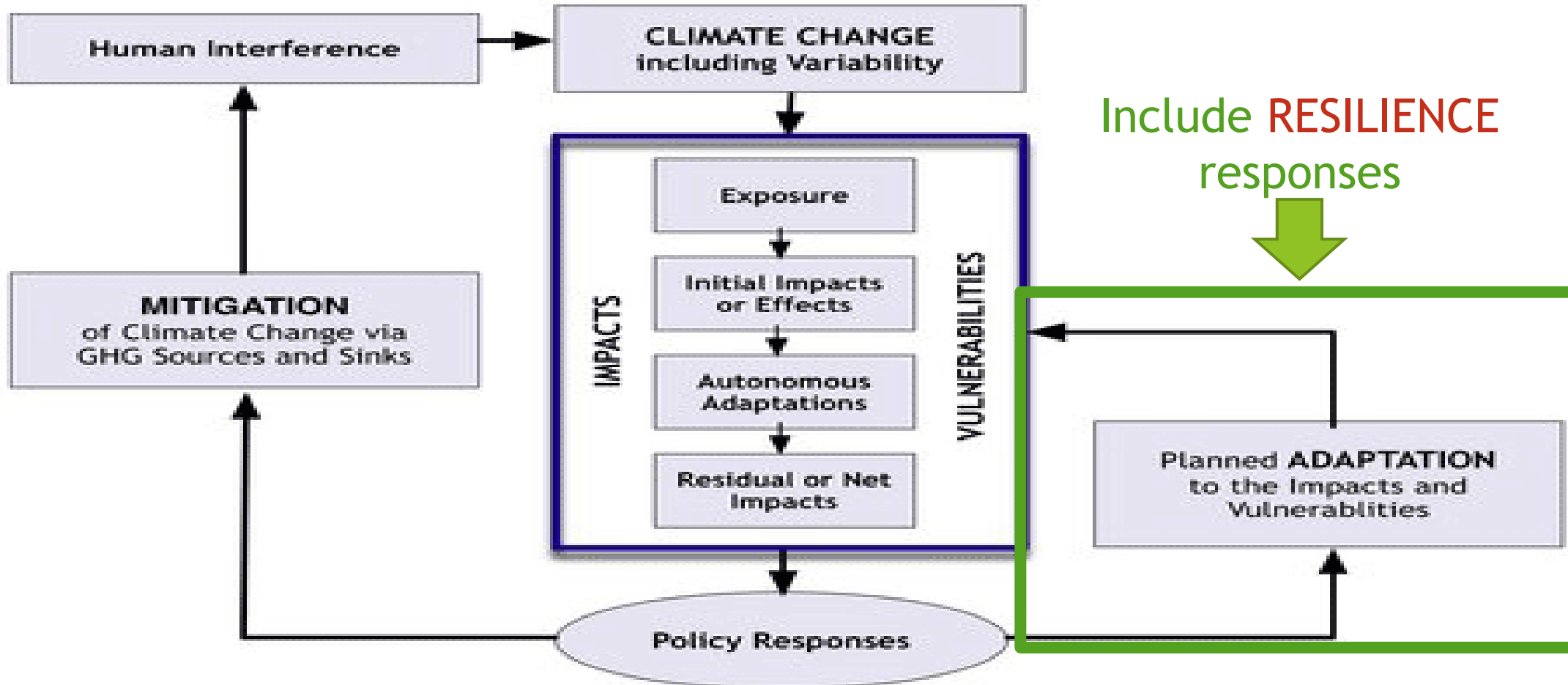


Source: IPCC Report Working Group II: Impacts, Adaptation, & Vulnerability

A New Paradigm

Source: IPCC Report Working Group II: Impacts, Adaptation, & Vulnerability

The place of adaptation in responses to climate change



Resiliency

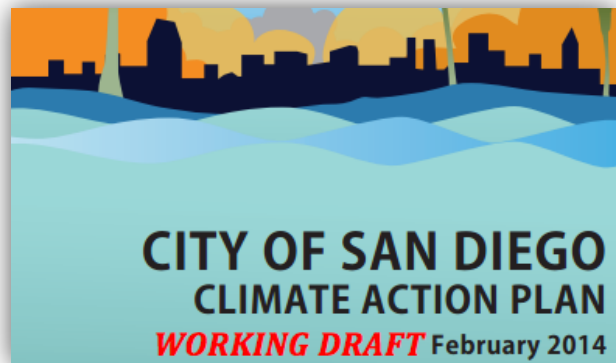
Addressing vulnerabilities
through adaptive approaches

What Is Resiliency?



“able to become strong, healthy, or successful again
after something bad happens””

“the capacity of individuals, communities, institutions, businesses and systems within a city **to survive, adapt, and grow** no matter what kinds of chronic stresses and acute shocks they experience”



“the capacity of a system to absorb disturbance and reorganize while undergoing change and still **retain essentially the same function, structure and feedbacks, and therefore identity”**”

Resiliency

Bouncing back from impacts

- ▶ Establishing disaster protection and management plans
- ▶ Redesigning or implementing new infrastructure to withstand severe climate impacts

Bike path integrated into flood control plan



Boulder, Colorado

Sustainability

Reducing the damage of impacts

- ▶ Reducing greenhouse gas emissions
- ▶ Implementing more energy efficient technologies
- ▶ Conserving resources & utilizing green energy sources

Incentives to use green vehicles

Federal Tax Credits for Plug-in Hybrids

Vehicle Make & Model	Full Credit
Honda	Jan. 1, 2010, to Present
 2014 Honda Accord Plug-in Hybrid	\$3,626
Toyota	Jan. 1, 2010, to Present
 2012-14 Toyota Prius Plug-in Hybrid	\$2,500

US Department of Energy, fuelconomy.gov

Resiliency & Sustainability

Stability

Maintaining conditions for consistent production

Stability

Sustainability

Lessening the frequency and severity of disturbances

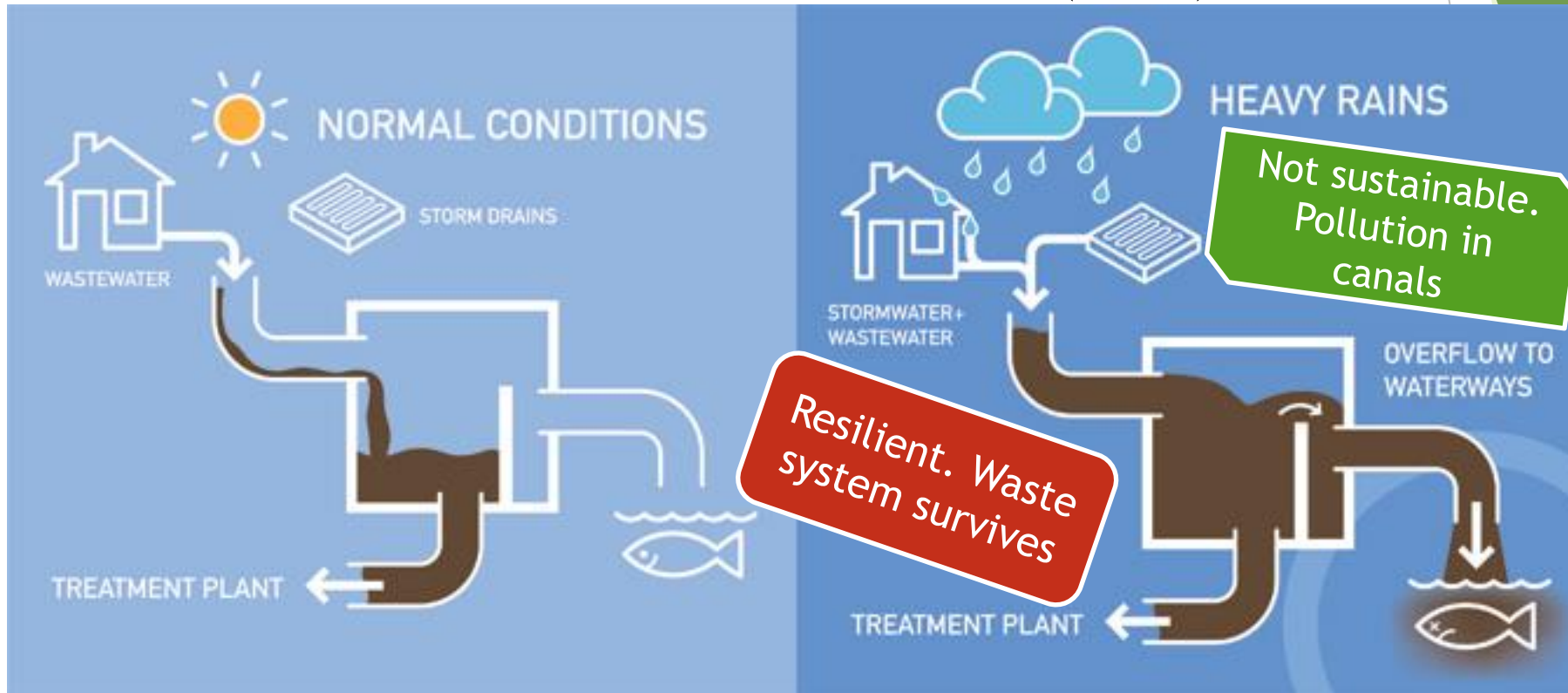
Sustainability

Resiliency

Resisting disturbances by preparing for their impacts

Are **resilient** actions
always **sustainable**?

New York City's Combined Sewer Outflows (CSO's)



Rainfall can flood sewers & waste treatment plants are unable to cope.

CSO's are opened so mixed rainwater & sewage are released.

The Gowanus Canal

holds a large CSO outfall in NYC, but is already one of the most polluted areas in the city.

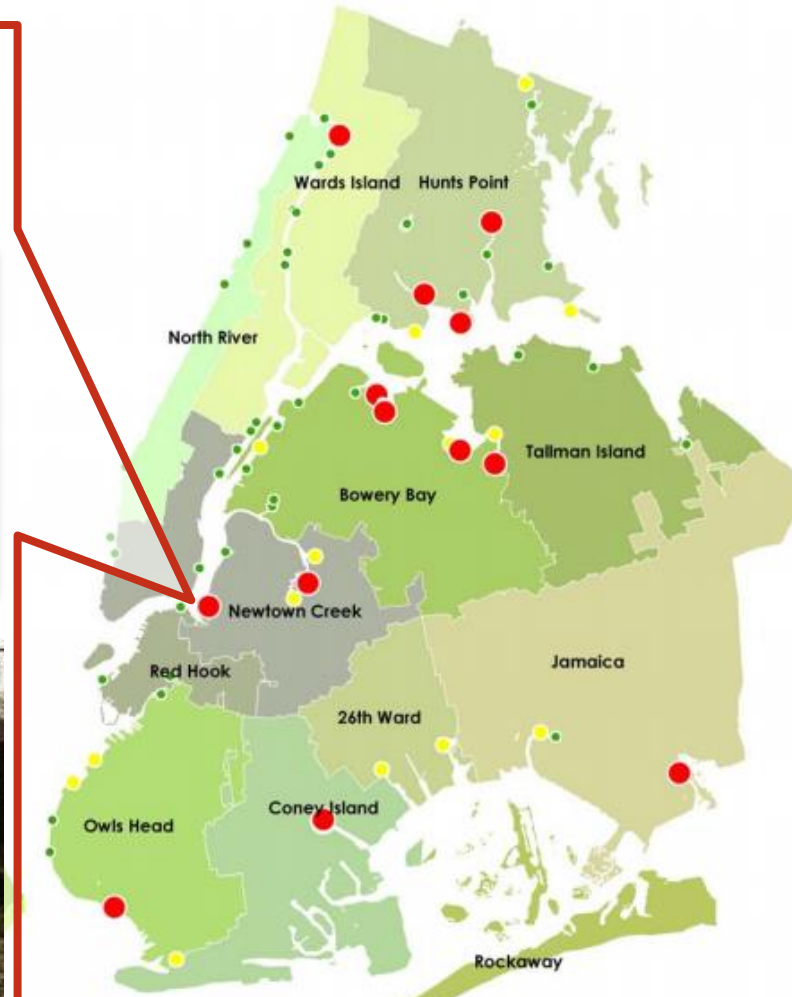
Main Sources of Pollution in Canal

(Gowanus Canal Conservancy, gowanascanalconservancy.org)

1. Industrial Pollution from factories
2. Combined Sewer Outflows
3. Surface Runoff



After Hurricane Sandy, 2012



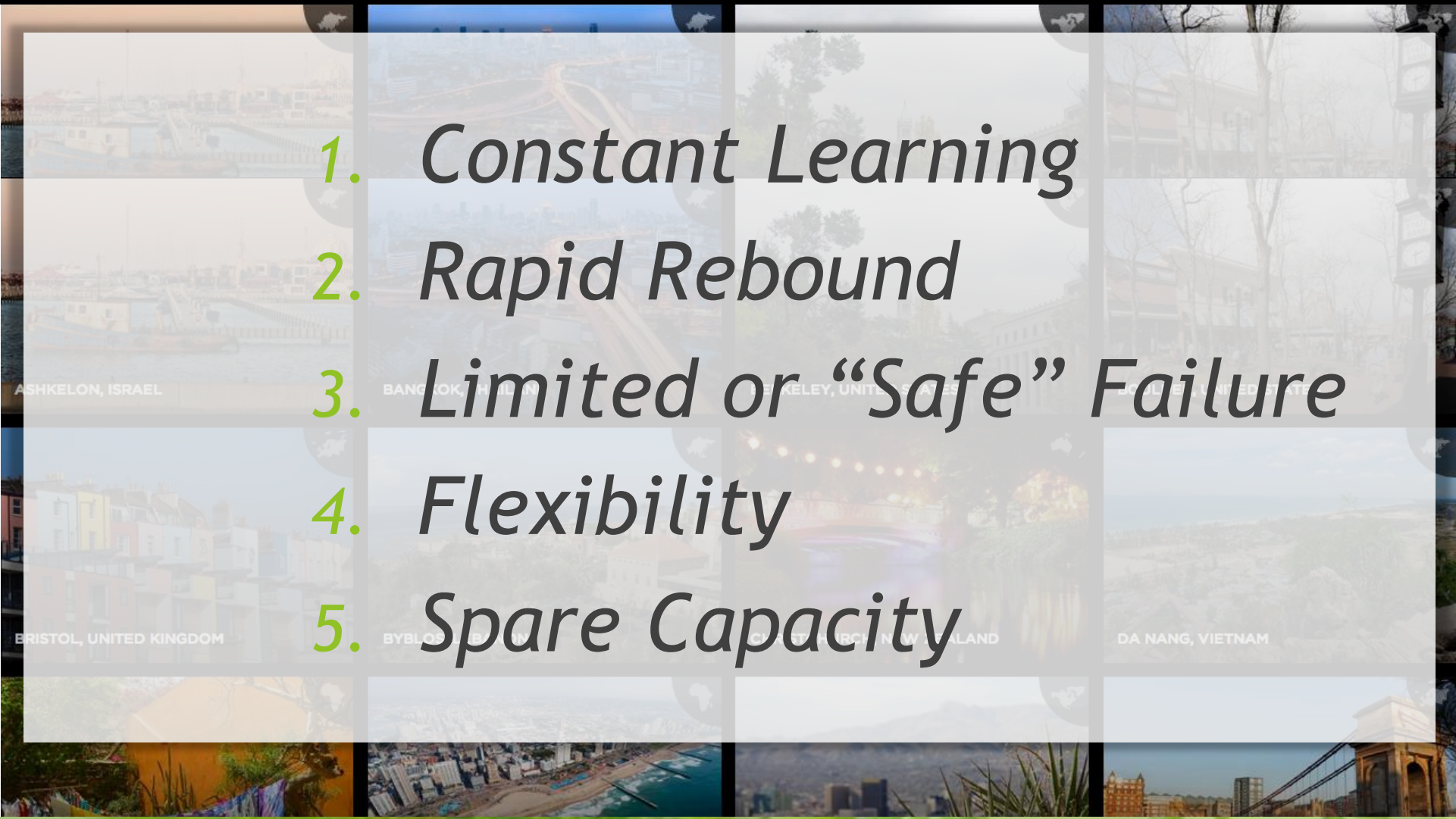
Combined Sewer Overflow Tiers

Map of CSO Outfalls
NYC Department of
Environmental Protection

- Tier 1
- Tier 2
- Tier 3

Rockefeller Foundation's "Pillars of Resiliency"

1. *Constant Learning*
2. *Rapid Rebound*
3. *Limited or "Safe" Failure*
4. *Flexibility*
5. *Spare Capacity*



Pillar 1: Constant Learning

“The ability to internalize past experiences linked with robust feedback loops that sense, provide foresight, and allow new solutions.”



London, UK

Improves Traffic Flow & Reduces Carbon Emissions

- Real time data used to help commercial drivers avoid traffic jams
- Large vehicle drivers can arrive only when there space

Issues

Air Pollution

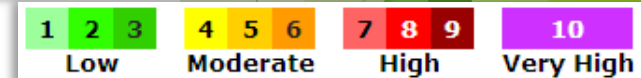
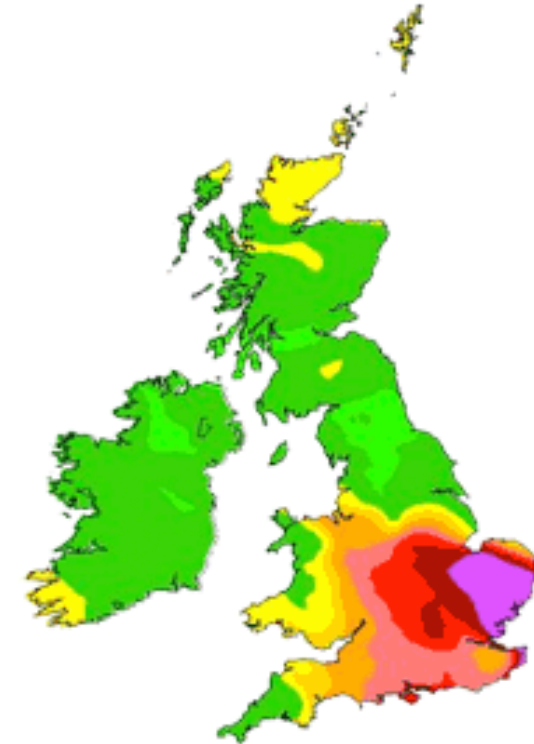
- Air pollution had *hit record highs in London*
- Main source: *motor vehicles*

Traffic Congestion/Inefficiency

- 66,000 taxis and private-hire vehicles in London are empty **45%** of the time

Air pollution forecast

Wednesday 2 April 2014



(Defra, Met Office
uk-air.defra.gov.uk)

Pillar 2: Rapid Rebound

“The capacity to re-establish function, re-organize, and avoid long-term disruptions.”

**Life Safety Learning Center
Tokyo, Japan**

Natural disaster simulations educate visitors with safety actions & practices

Simulations Include:

Fire/Smoke

Typhoon

Earthquake

Urban Flooding



Fire Simulation

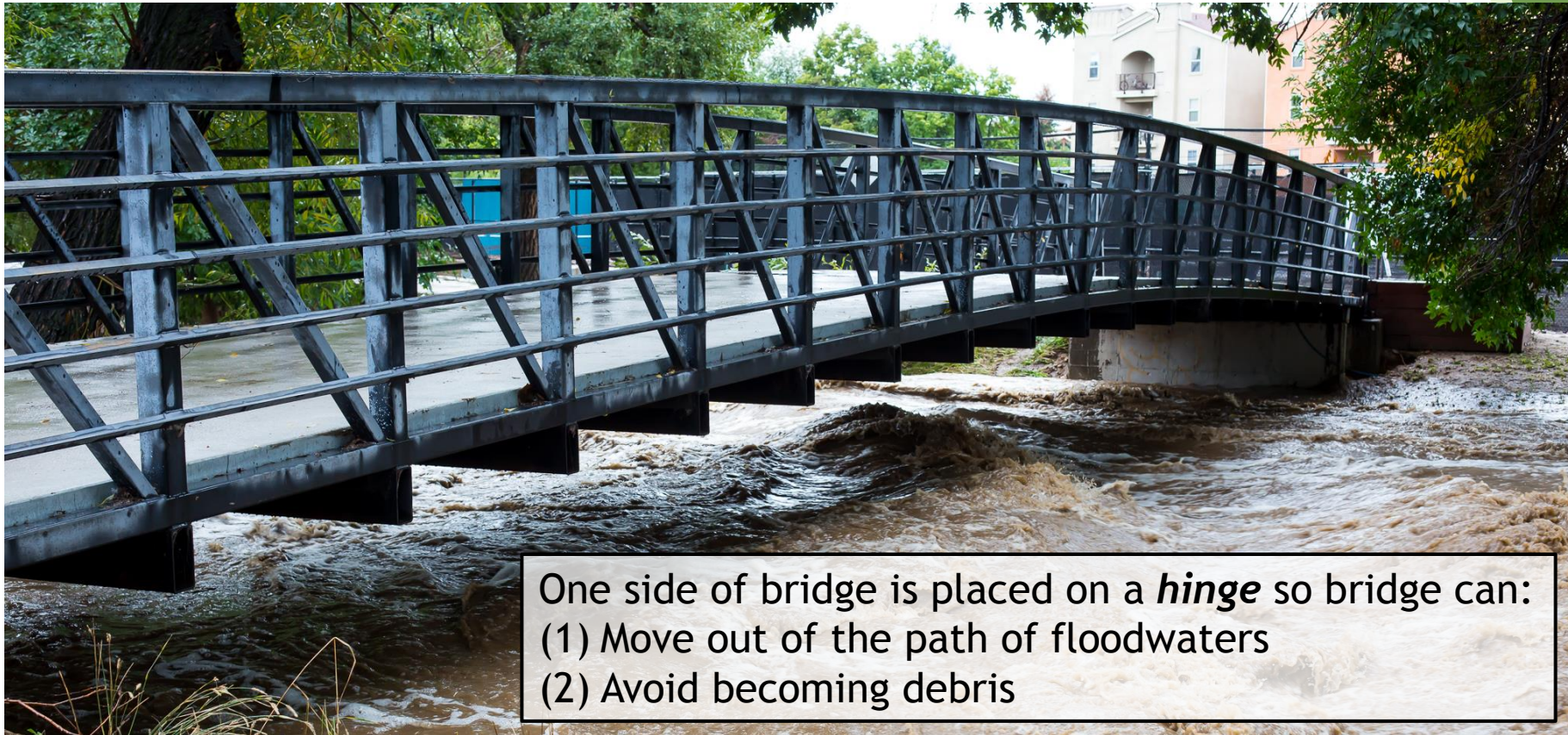


Earthquake Simulation

Pillar 3: Limited or “Safe” Failure

“Prevents failures from rippling across systems.”

Floodplain Management on Boulder Creek Bridge
Boulder, Colorado



One side of bridge is placed on a *hinge* so bridge can:
(1) Move out of the path of floodwaters
(2) Avoid becoming debris

Pillar 4: Flexibility

“The ability to change, evolve, and adapt to alternative strategies in the face of disaster.”

Materials Recovery Facility (MRF)
Barangay Fort Bonifacio, Philippines
Launched in April 2013

Slum transformed to
sorting center!

Ecological Solid Waste Management Act (2000)
called for sanitary landfills over open dumps

Benefits of MRF's

- Reduce pollution by waste
- Employment opportunities
- Education on waste management



Baling Section sorts garbage

(Fort Bonifacio, 100resilientcities.org)



Materials are then sold to recycling centers

(Marikina City, traveloscopic.blogspot.com)

Pillar 5: Spare Capacity

“Ensures that there is a back-up or alternative available when a vital component of a system fails.”

Urban Farms, “Organoponicos”

Vivero Alamar, Havana, Cuba



Alamar District, Havana, Cuba (Google Maps)

Improves food security

Provides 90% of vegetables consumed in Havana

Employs 17% of working population

Urban farmers are allowed 50% of profits

(FAO of the United Nations, fao.org)

Resiliency & Adaptation

What does “adaptation” mean?



“the process of changing to *fit some purpose or situation*”

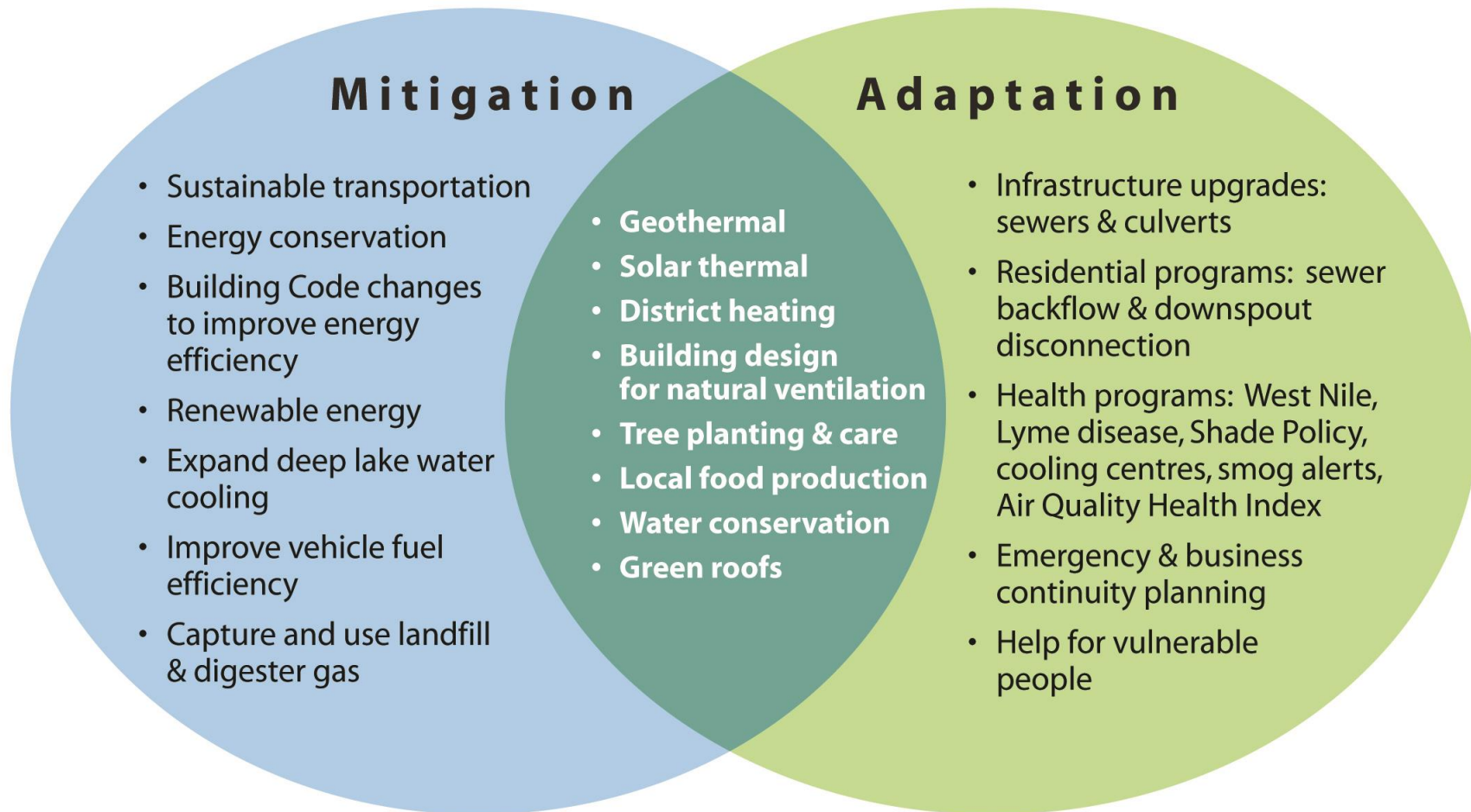
“adjustment or preparation of natural or human systems to a new or changed environment which *moderates harm or exploits beneficial opportunities*”



“The ability or potential of a system to successfully respond to climate variability and change; a response *to reduce vulnerability and enhance resilience*”

Dr. Sarah Burch

Research Associate at Environmental Change Institute



Mitigation: the globally responsible thing to do

Actions that reduce the emissions that contribute to climate change.

Adaptation: the locally responsible thing to do

Actions that minimize or prevent the negative impacts of climate change.

Types of Adaptation

Reactive

Informed by direct experience

Common form of adaptation

- ▶ Crop diversification
- ▶ Water management



Proactive



Uses predicted impacts

Currently lacks information as we are beginning to understand climate change impacts



(Projected Carlsbad Desalination Plant, carlsbaddesal.com)

General Adaptation Strategies

Ecosystem conservation



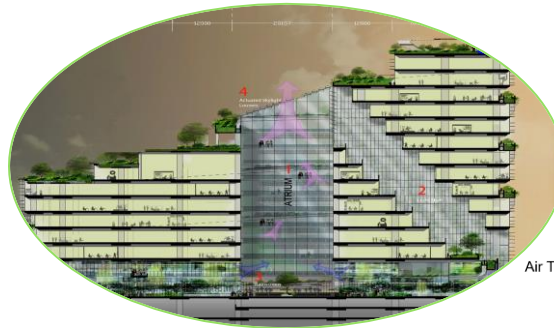
RHS Greenhouse
Wisley, England

Developing support

Promote community-based efforts to support developing countries



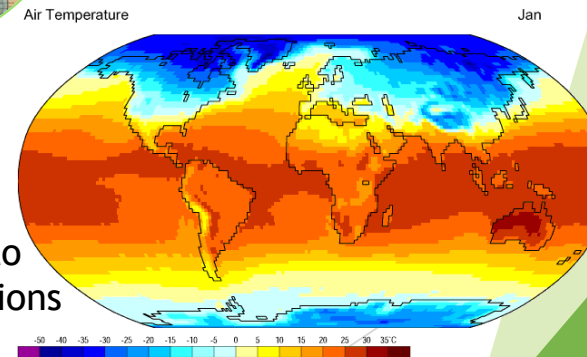
Preparing through infrastructure



Eco-infrastructure
design by Ken Yeang

Learning more about what is happening

Gather data to make predictions



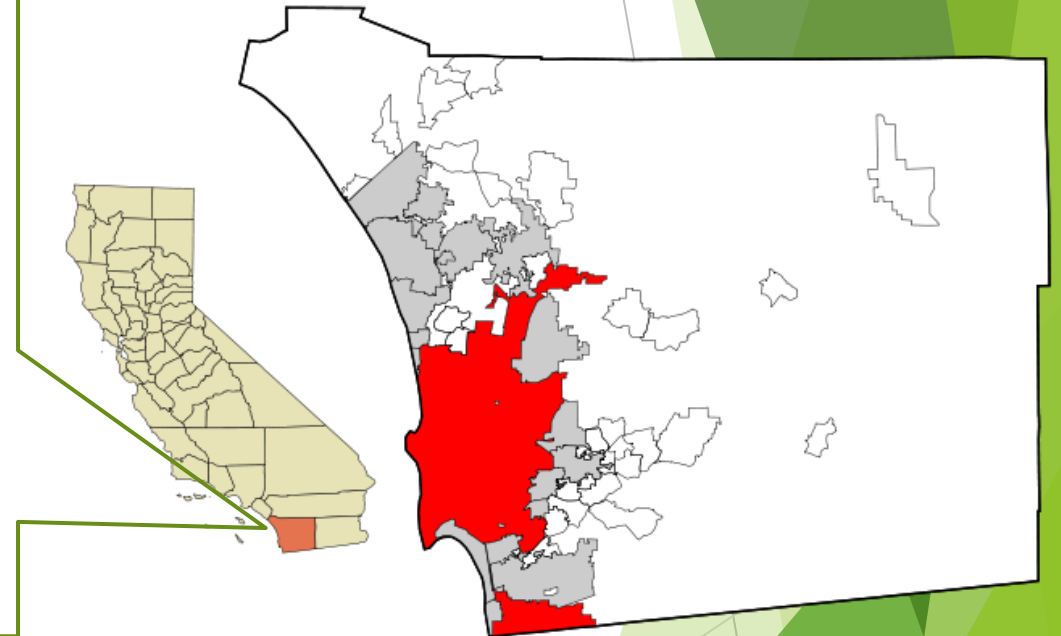
Data: NCEP/NCAR Reanalysis Project, 1959-1997 Climatologies
Animation: Department of Geography, University of Oregon, March 2000

San Diego's Resiliency

State of internal affairs
and potential for growth

Geography and Demographics

- ▶ California's second largest city
 - ▶ US's eighth largest city
 - ▶ 1.3 million residents in 2013
- ▶ County encompasses 18 cities
 - ▶ Over 3.2 million residents



SD County within CA &
SD City within SD County

Resilience Planning

- ▶ Prior commitment to leadership



**Rockefeller
Foundation**

- ▶ Rockefeller's 100 Resilient Cities
 - ▶ Initiative for preparation



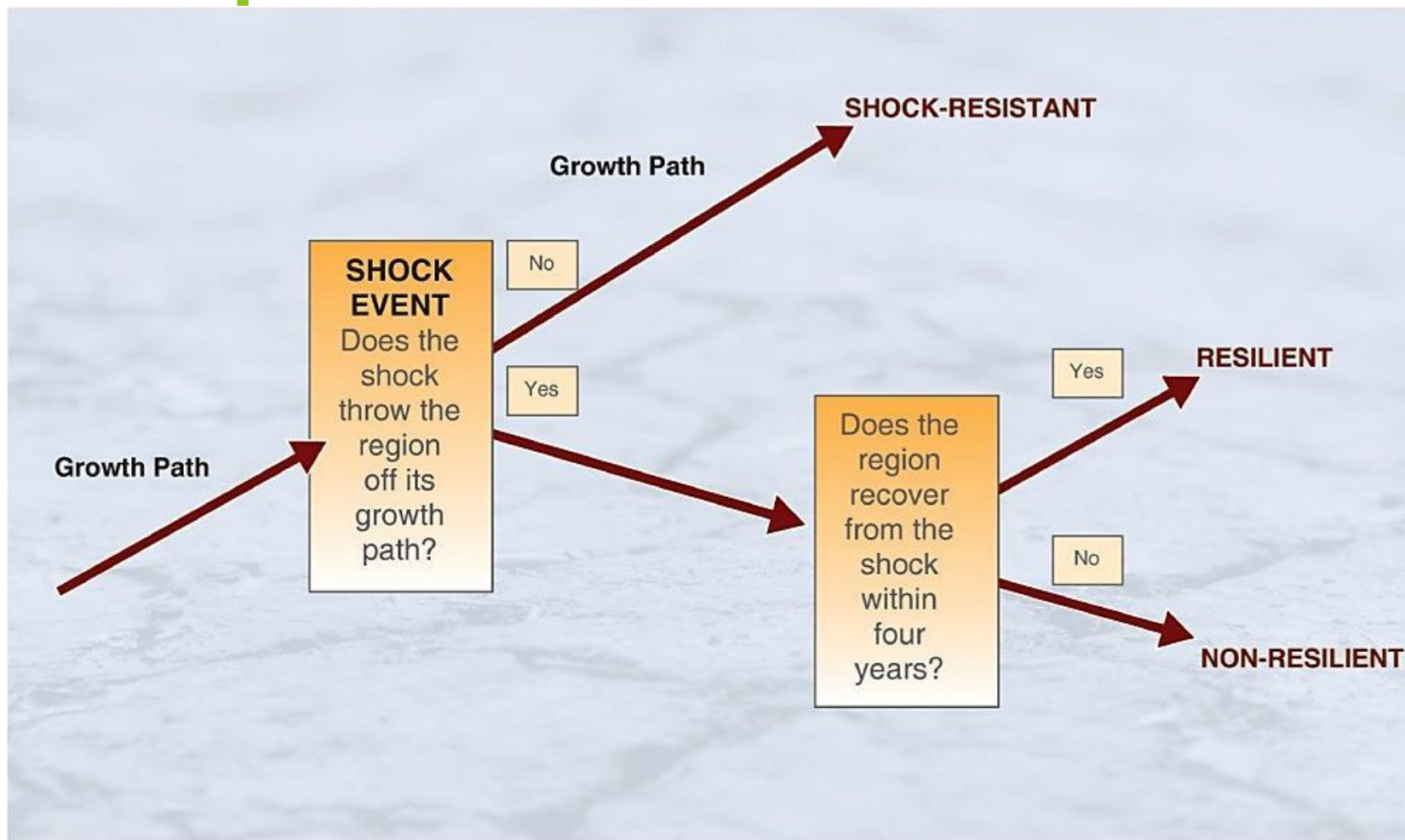
- ▶ Sea Level Rise Adaptation Strategy
 - ▶ Highlights vulnerabilities
 - ▶ Formulates responses

Application of Resiliency

- ▶ Variety of term's implications calls for...
 - ▶ Development of consistent model
 - ▶ Tangible, measurable integration
- ▶ Macarthur Research Network analysis found...
 - ▶ Success of horizontal and vertical assimilation
 - ▶ Cooperation within government hierarchy
 - ▶ San Diego needs support of state and federal policies



Sample Resilience Model



Source: Macarthur Foundation Research Network on Building Resilient Regions, University of California, Berkeley

Shock events have already occurred, and are inevitable. Will we be *resilient*?

Our Motivations For Resiliency

- ▶ Leadership opportunity
- ▶ History of disaster
- ▶ Potential for future catastrophe
 - ▶ Range of extreme weather events
 - ▶ Earthquakes, Santa Ana winds, flash floods, sea level rise, El Niño, droughts, wildfires



Naval Weapons Station, Fallbrook, CA
May 2014

Resilient Systems

- ▶ Infrastructure
- ▶ Water
- ▶ Energy
- ▶ Transportation
- ▶ Waste



Resilient Infrastructure

- ▶ American Society of Civil Engineers (ASCE)
 - ▶ 2012 San Diego County Infrastructure Report Card
 - ▶ *“San Diego’s grades are still not acceptable.”*

Infrastructure Category	2005	2012
Aviation	-	C+
Bridges	-	C+
Land and Sea Ports of Entry	C	C-
Levees/Flood Control/Urban Drainage	C-	C-
Parks/Recreation/Environment	B-	C
School Facilities	C+	C
Solid Waste	-	B
Surface Transportation	C	D+
Wastewater – Collection Systems	C+	B
Wastewater – Treatment	B	B+
Water	B	B
Overall	C+	C

Water Supply Deficiency

- ▶ *“If we had to rely on our local resources alone, we could support our county’s 3 million residents at current use rates for only two and a half months.”*

EQUINOX
CENTER



Carlsbad
Desalination
Plant, 2014

Resilient Water Systems

- ▶ Making inflexible infrastructure **dynamic**
 - ▶ **Diversification** of source options
 - ▶ **Connectivity** between suppliers
 - ▶ Advance allocation **flexibility**
 - ▶ CALFED Bay-Delta Program case study
- ▶ “Water Resilience for Human Prosperity”
 - ▶ Johan Rockström, **Stockholm Resilience Centre**



**San Diego County
Water Authority**



Resilient Energy Production

- ▶ **Mandate to reduce GHG emissions**
- ▶ **Problematic reliance on fossil fuels**
 - ▶ **Volatility of natural gas**

AB 32

- ▶ **Current production rates not sustainable**
 - ▶ **SANDAG recommends 20% reduction in energy consumption per capita by 2030**
 - ▶ **Less energy for expanding population**

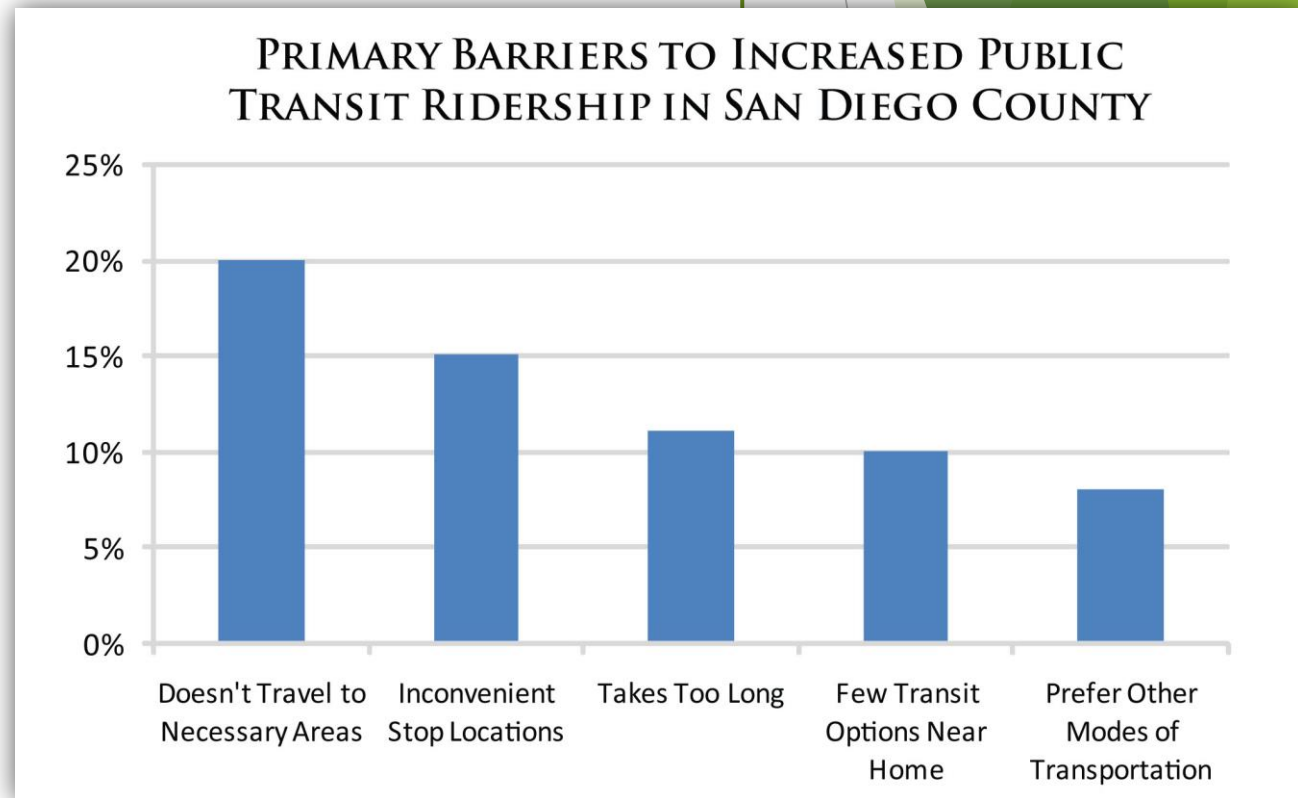
California Assembly Bill



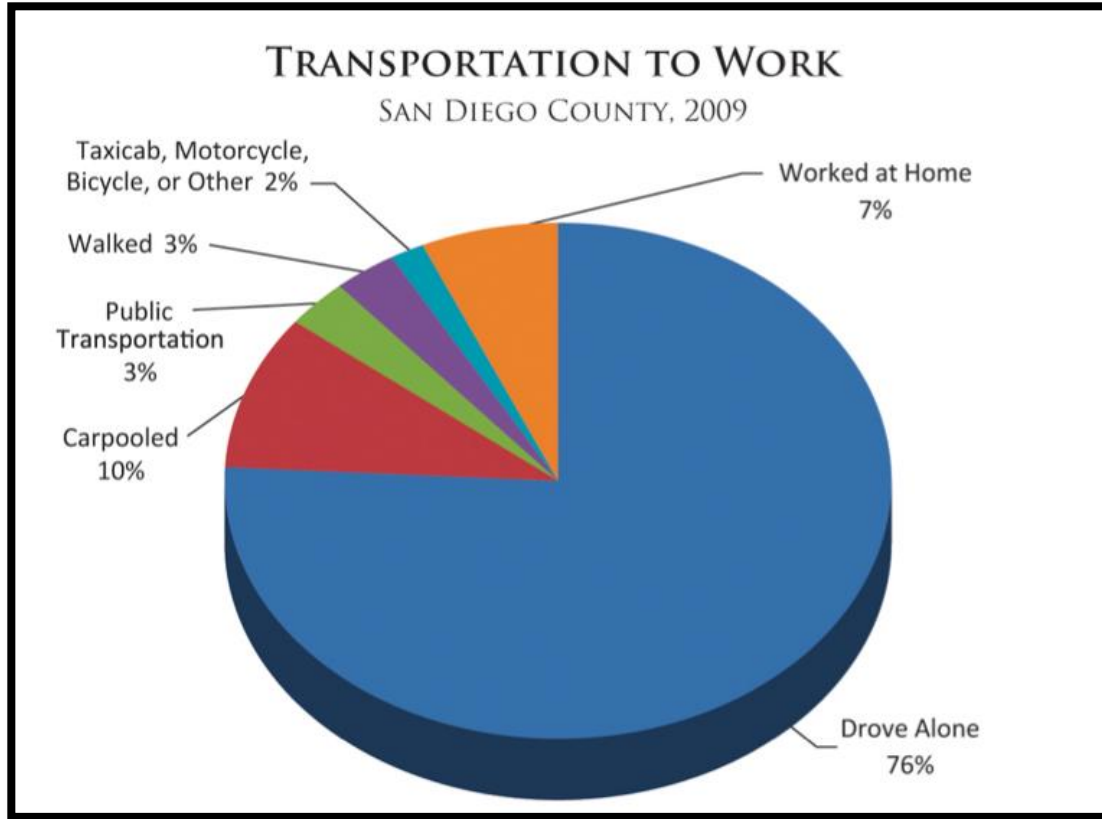
Resilient Transportation

Source: Regional Transportation Public Opinion Study, 2008

- ▶ Increasing traffic congestion and costs of delays
- ▶ Develop infrastructure to encourage cycling and walking
- ▶ Minimize distances

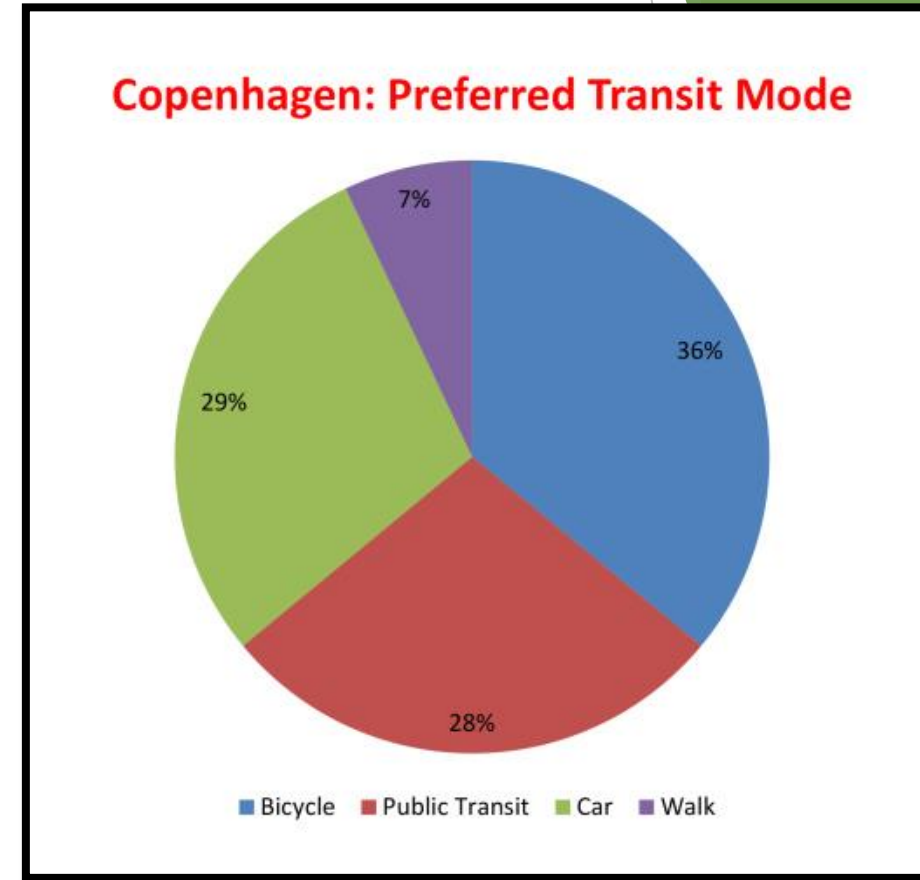


Preferred Transportation Method



Source: American Community Survey

Are we being sustainable?



Source: Washington D.C., District Department of Transportation
2013 Five-Day Study

Resilient Waste Management

- ▶ Waste Management Board
 - ▶ No-waste goal, **only 52% diversion**
 - ▶ San Francisco has 80% diversion
- ▶ Miramar Landfill
 - ▶ San Diego's **only operating landfill**
 - ▶ Threat of **earthquakes** and **fires**



Miramar Landfill

Perspective

- ▶ The United States, California, and San Diego all have limited budgets.
- ▶ However, our planet has finite space and resources as well.
- ▶ Current population and economic growth rates are not sustainable. Since society and policy are not adjusting accordingly, these growth rates are expected to continue, with dire consequences.

Conclusion

- ▶ Our systems need to be cost effective and operationally efficient. They must be resilient to economic and natural disasters.



View from San Diego Bay

Host and Sponsor






Hosted by:



Sponsored by:



Partners

<h2>Department of Geography</h2>		 SAN DIEGO STATE UNIVERSITY
		San Diego World Affairs Council
 	<h3>UNITED NATIONS ASSOCIATION <i>of the United States of America</i></h3> <hr/> <p>A PROGRAM OF THE UNITED NATIONS FOUNDATION SAN DIEGO CHAPTER</p>	

Further Information

▶ Contact Information

- ▶ Cameron Bernhardt: cbernhardt15@cmc.edu
- ▶ Amy Syvrud: ajs8at@virginia.edu
- ▶ Aly Zamora: zamoraa@sandiego.edu