

Engineering for Sustainable Human Development

Bernard Amadei
Mortenson Center in Engineering for Developing Communities
University of Colorado, Boulder

NEA, Kathmandu
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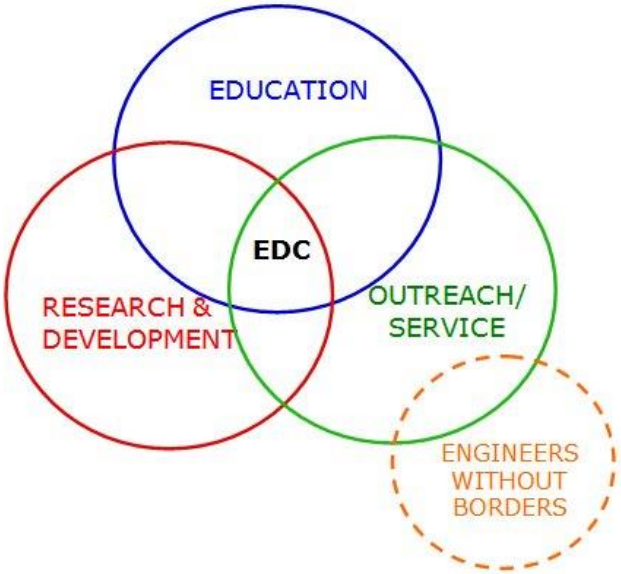
San Pablo, Belize (2001)

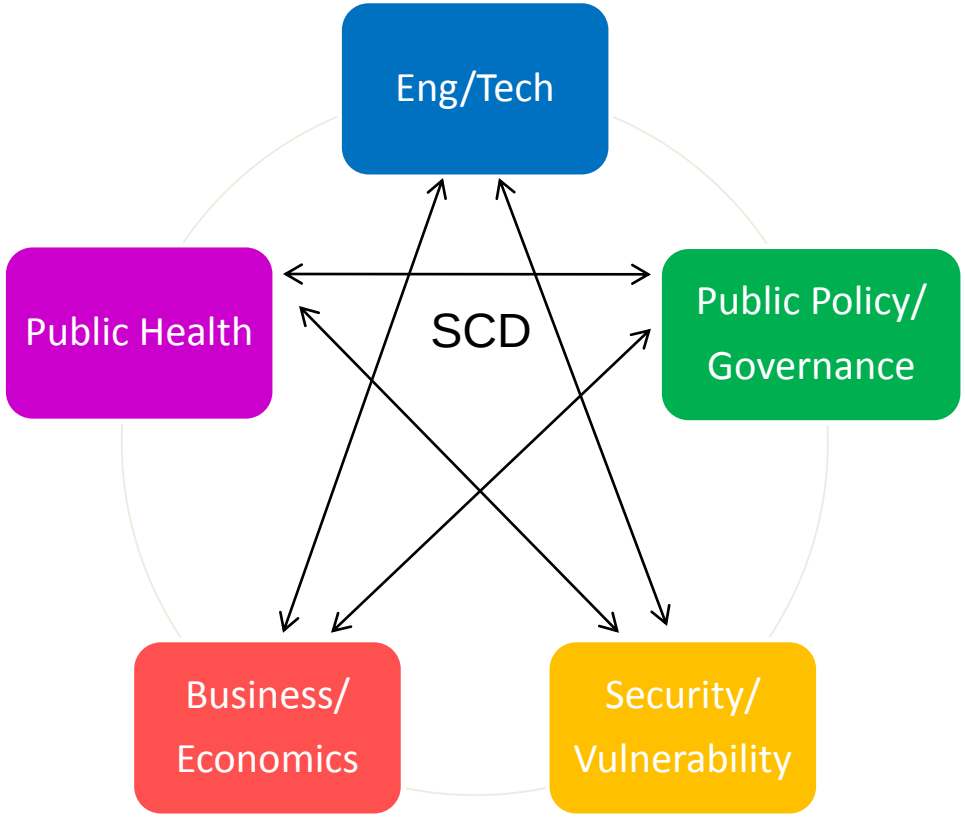
Engineers Without Borders - USA

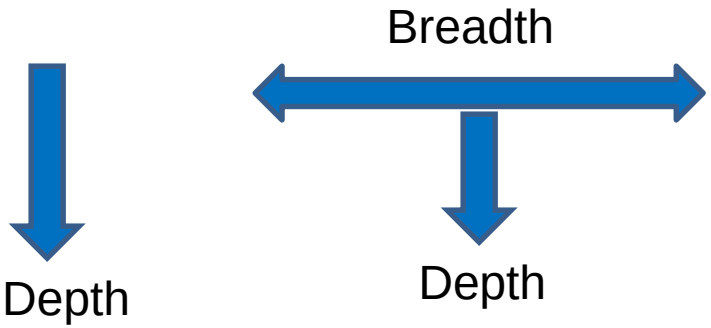
- Partners with disadvantaged communities to improve quality of life
- Implements environmentally and economically sustainable engineering projects
- Develops internationally responsible engineers and engineering students
- Involves 15,000 members, 325 chapters, 400+ projects in 45 countries, 200+ projects completed.

ENGINEERS WITHOUT BORDERS™ USA

Mortenson Center in Engineering for Developing Communities







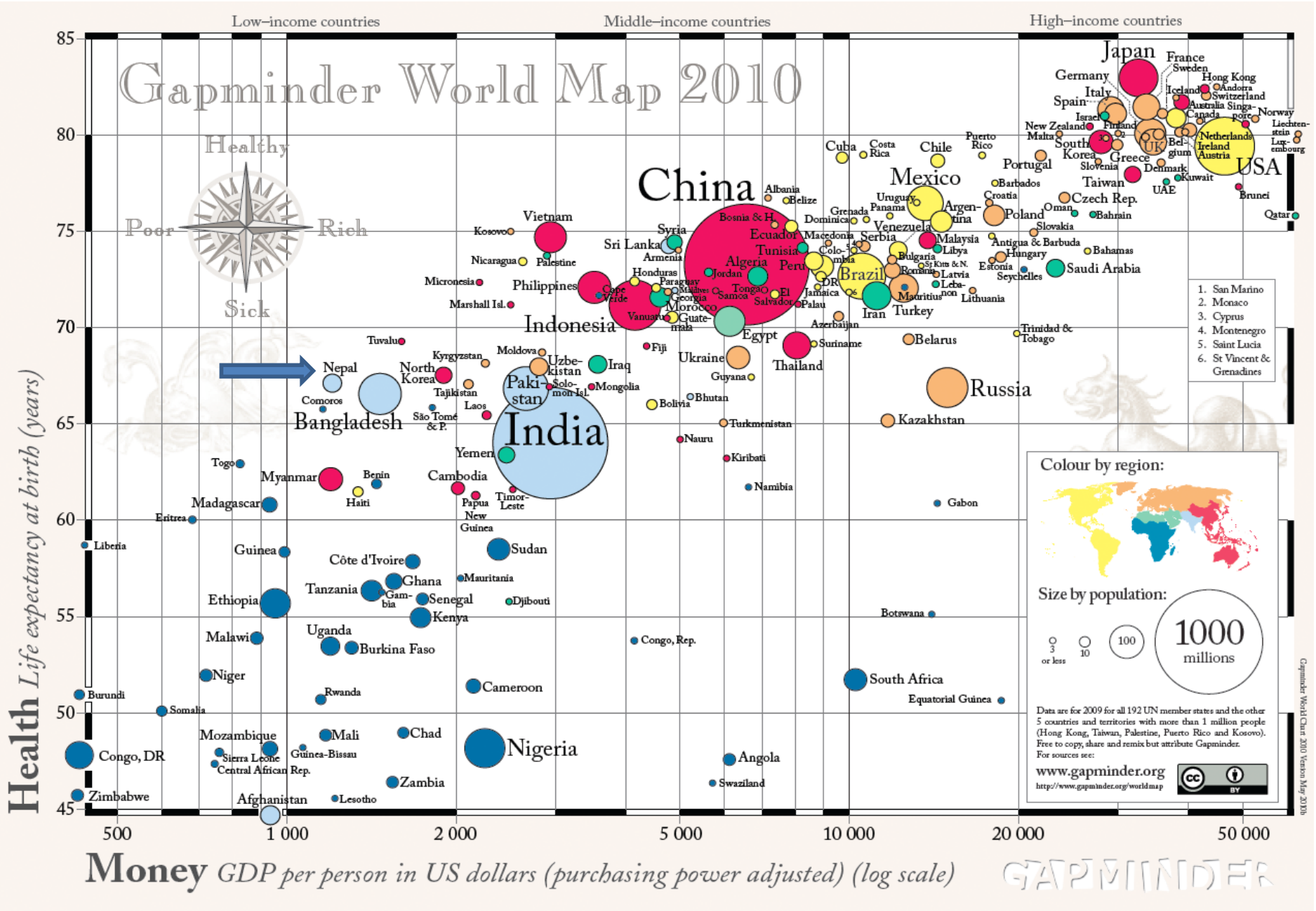
- 0.78 billion lack clean water
- 2.5 billion lack adequate sanitation
- 2.4 billion are at risk for malaria
- 2.0 billion with no access to low cost essential medicines

Why engineering for the developing world?

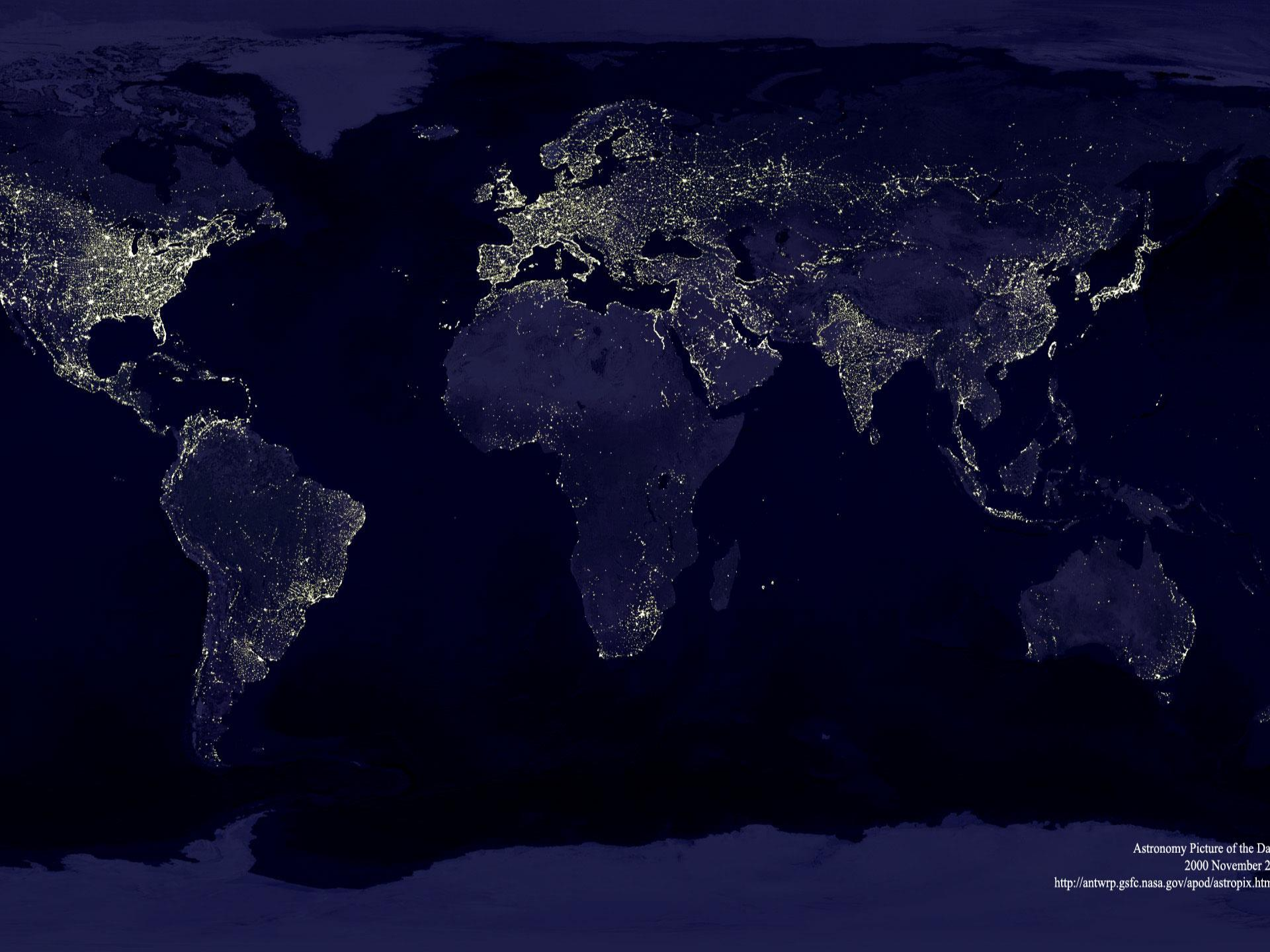
- 1.2 billion lack adequate housing
- 1.6 billion have no access to electricity
- 1.3 billion are illiterate
- 1.8 billion live in conflict zones, in transition, or in situations of permanent instability

Different Challenges

- In the developed world, the challenge is to consume less and more intelligently, and be respectful of natural and human systems
- In emerging markets, the challenge is to grow economically while respecting human and natural systems
- In the developing world, the challenge is to ensure that proposed economic solutions address the basic needs of people and are good to the environment



http://www.gapminder.org


Astronomy Picture of the Da
2000 November 2
http://antwrp.gsfc.nasa.gov/apod/astropix.htm

Different Adverse Events

Internal or external to the community, small or large, short term or long term:

- Everyday events (e.g. lack of water and sanitation, poor shelter, living conditions, livelihood, illness, economy, etc.)
- Extreme events (e.g. floods, volcanoes, earthquakes, landslides, wildfires, hurricanes, etc).
- Several small-scale or periodic medium scale events: drought (periodic, chronic), soil degradation, deforestation, epidemics, health risks and hazards, etc.
- War or breakdown of governments that may have disastrous consequences at the local and global levels.

Different Impact

"The least developed countries represent 11% of the population exposed to hazards but account for 53% of casualties.....

the most developed countries represent 15% of human exposure to hazards, but account for only 1.8% of all victims."

Peduzzi et al. (2009)

How can *all* humans have fulfilling lives, meet their basic needs, and live with dignity and at peace?

- How do we educate a global community?
- How do we feed a global community?
- How do we power a global community?
- How do we safely hydrate a global community?
- How do we communicate and connect in a global community?
- How do we integrate Science, Technology, and Engineering (STE) in political, social, and economic decisions?
- How do we create a peaceful global community?


Mashhad
Sharif
Herāt
Kabul
Peshawar
Islamabad
Srinagar
Jammu
Gujranwala
Amritsar
Lahore
Kandahār
Quetta
Multan
Chandigarh
Dehra Dun
Meerut
New Delhi
Bareilly
Faridabad
Jaipur
Agra
Lucknow
Gorakhpur
Kathmandu
Thimphu
Jodhpur
Gwalior
Kanpur
Patna
Hyderabad
Kota
Allahabad
Varanasi
Karāchi
Muscat
Dhanbad
Ranchi
AFGHANISTAN
PAKISTAN
NEPAL
TIBET
GILGIT AND BALTISTAN
NORTH-WEST FRONTIER
AKSAI CHIN
JAMMU AND KASHMIR (STATE)
HP
PUNJAB
HARYANA
BALUCHISTAN
SINDH
RAJASTHAN
MADHYA PRADESH
BIHAR
RĀPTĪ GANDAKĪ
KOSHI
SETI
SK

Creating Healthy, Stable, Equitable, Safe, Prosperous Sustainable Communities

Developing a new generation of global engineers for the 21st century

Engineers are called to be CHANGE-MAKERS, peace-makers, social entrepreneurs, and facilitators of sustainable human development

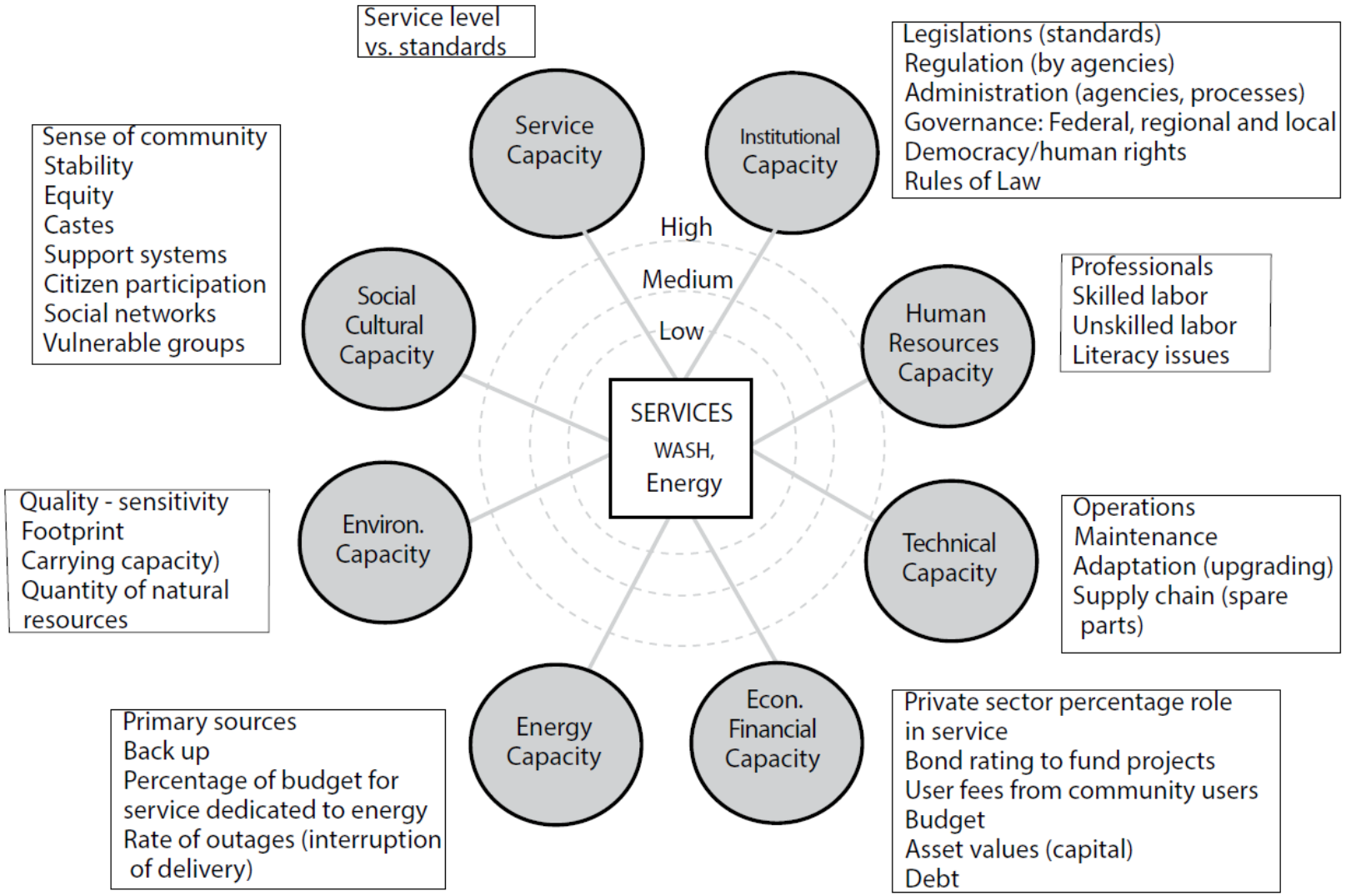
Risk and Resilience

- Effective risk management and capacity building lead to community resilience

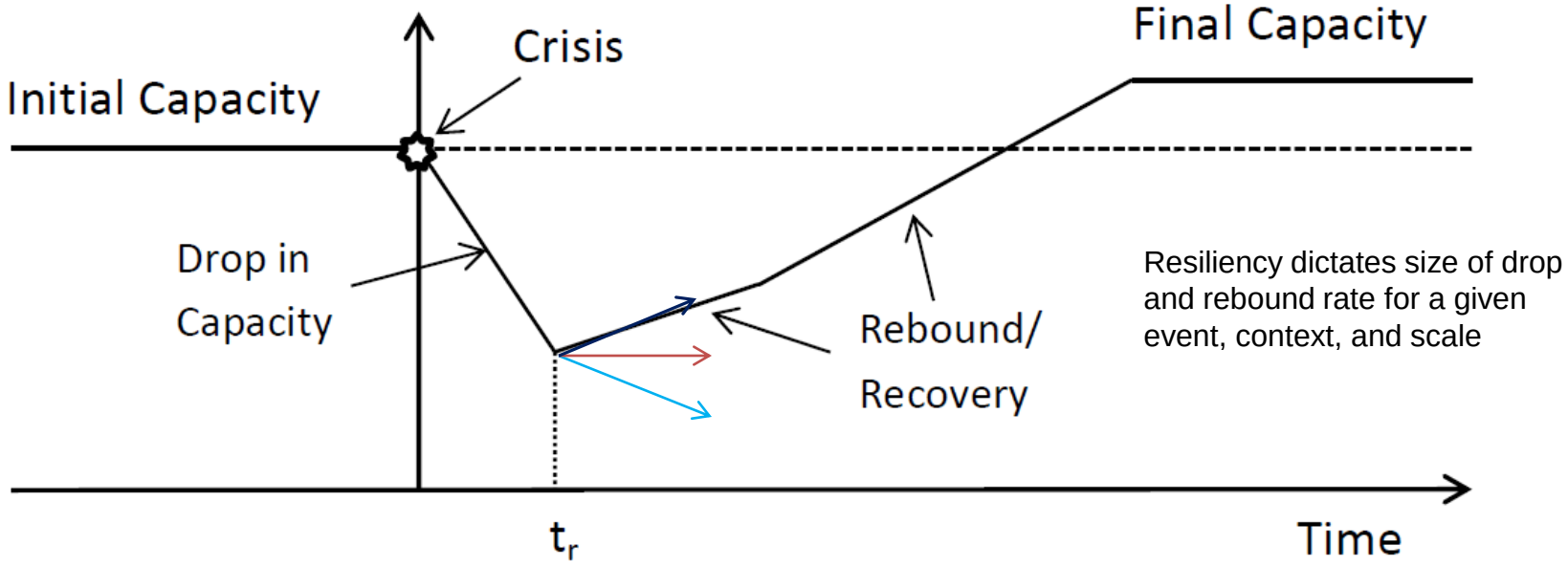
Risk = Event x Exposure x
(Vulnerability – Capacity)

- In developing world, vulnerability (lack of security) is high and capacity is low.

Capacity


Service level vs. standards
Service Capacity
Institutional Capacity
Legislations (standards)
Regulation (by agencies)
Administration (agencies, processes)
Governance: Federal, regional and local
Democracy/human rights
Rules of Law
Sense of community
Stability
Equity
Castes
Support systems
Citizen participation
Social networks
Vulnerable groups
High
Medium
Low
Social Cultural Capacity
Human Resources Capacity
Professionals
Skilled labor
Unskilled labor
Literacy issues
SERVICES
WASH,
Energy
Quality - sensitivity
Footprint
Carrying capacity)
Quantity of natural resources
Environ. Capacity
Technical Capacity
Operations
Maintenance
Adaptation (upgrading)
Supply chain (spare parts)
Primary sources
Back up
Percentage of budget for service dedicated to energy
Rate of outages (interruption of delivery)
Energy Capacity
Econ. Financial Capacity
Private sector percentage role in service
Bond rating to fund projects
User fees from community users
Budget
Asset values (capital)
Debt

Capacity and Resilience



- What level of disruption is acceptable?
- What level of protection are we willing to pay for?
- Critical vs. non-critical

“Do today’s engineering graduates and engineers have the skills and tools to address the global problems that our planet and humans are facing today, or will be facing within the next 20 years?”

Peace/Conflict, Climate Change, Poverty Reduction, Water, Energy, Shelter, Communication, Etc.

Attributes of the Global Engineer of 2020

- ❑ Strong analytical skills
- ❑ Practical ingenuity
- ❑ Creativity
- ❑ Good communication
- ❑ Business & management skills
- ❑ Leadership
- ❑ High ethical standards
- ❑ Resilience & flexibility
- ❑ Lifelong learners

- Global Awareness
- Personal Awareness
- Teamwork
- Experience & Application

Solutions:

- With a Human Face
- Appropriate
- Done right and rightly done

Governments

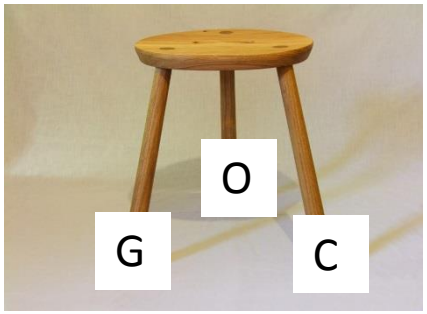
Top-Down

Development Projects

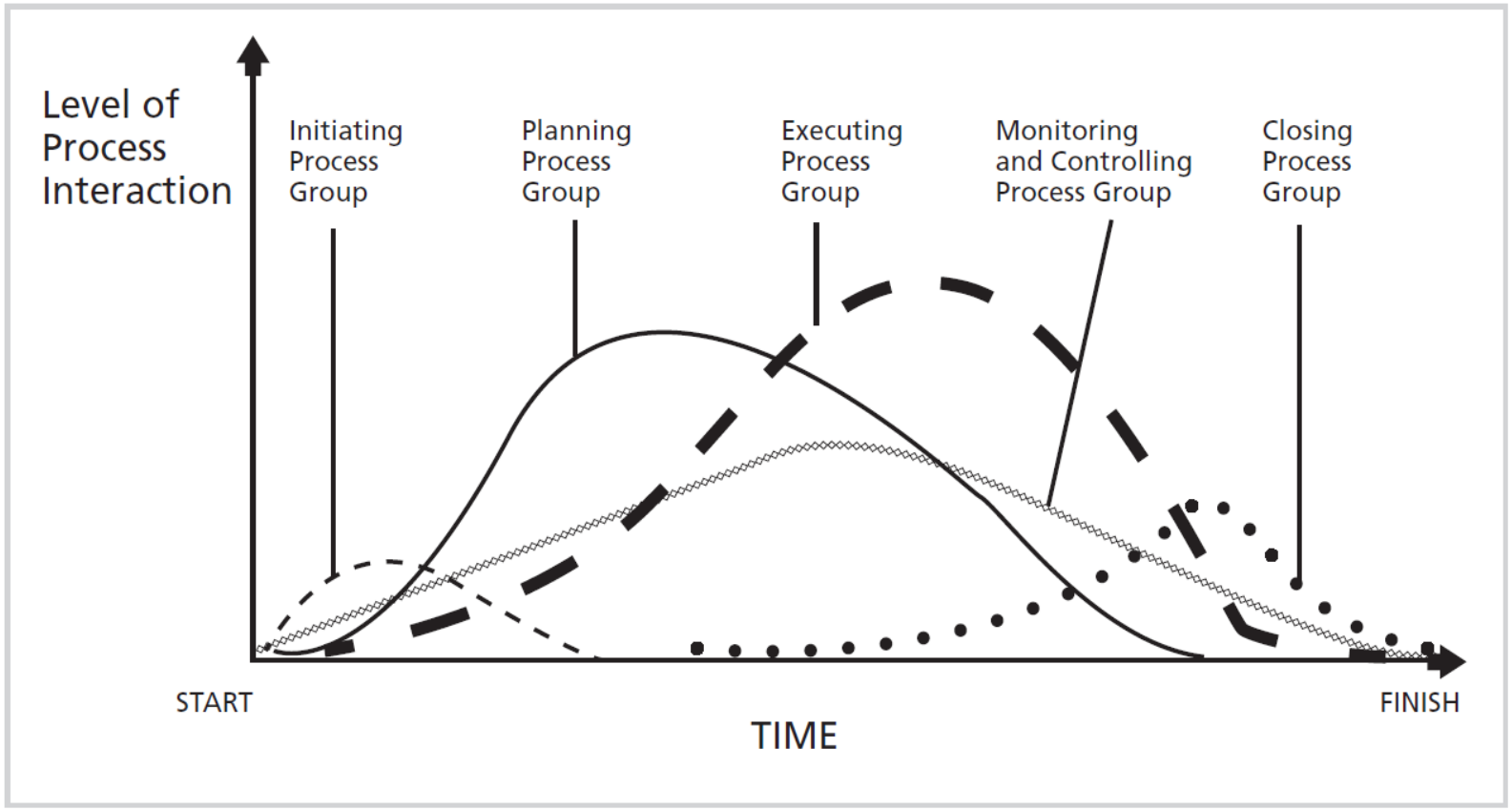
Outsiders:
NGOs,
Industry,
Professional
Organizations,
etc.

Bottom-Up

Community

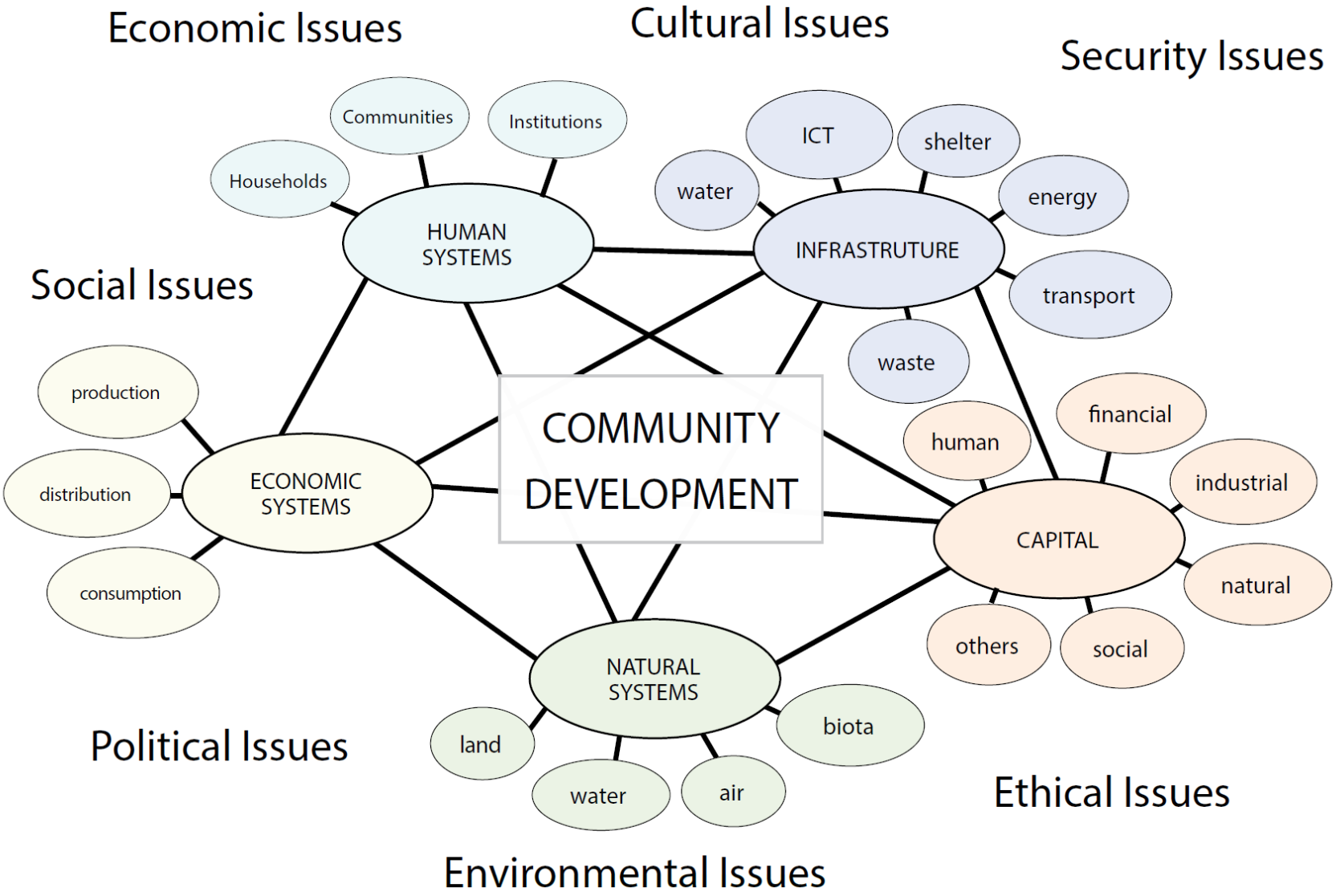


Project Life-Cycle



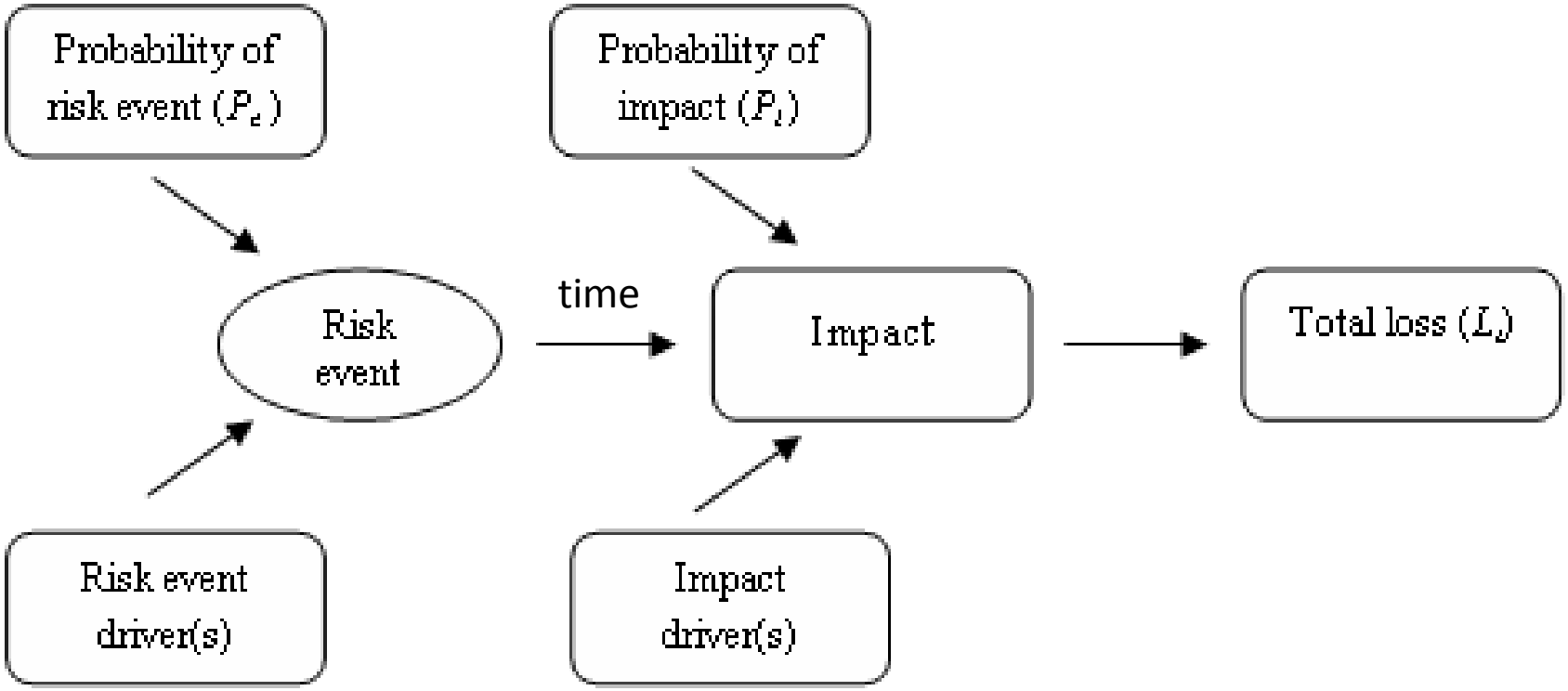
PMI, 2008

Systems Approach



Standard Risk Model

Expected loss: $L_e = L_t * P_e * P_i$

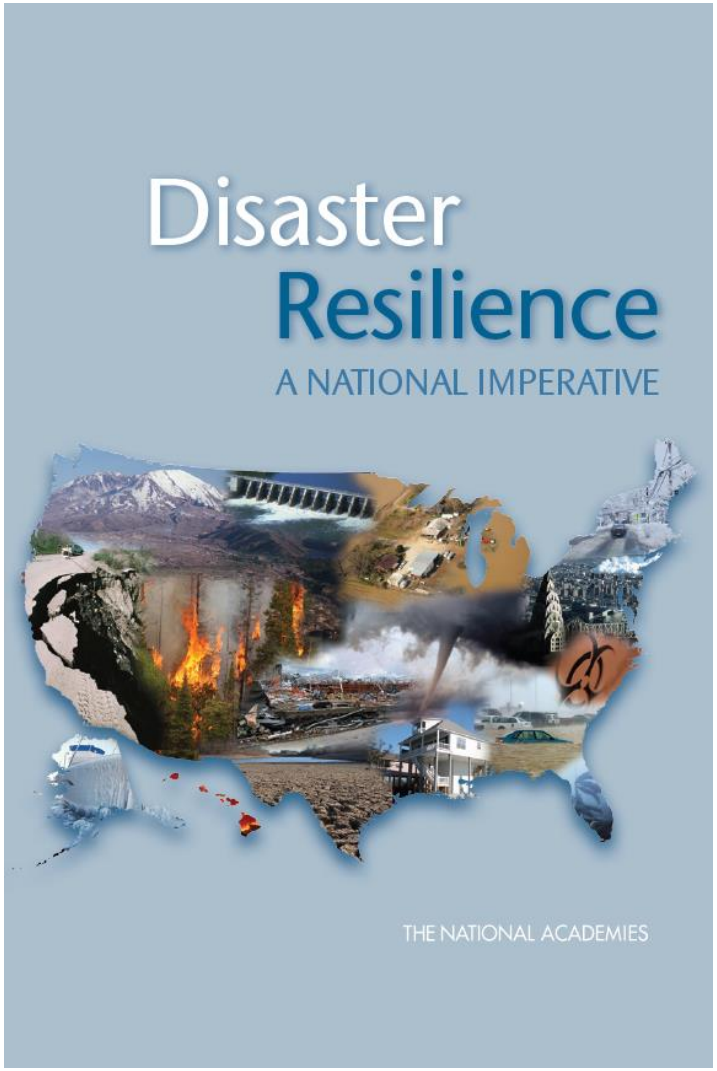


Smith and Merritt, 2002

Appropriate & sustainable technology

"Find out what people do and help them do it better." E.F. Schumacher

Adapted from ITDG



Disaster Resilience: A National Imperative

Sponsors
Department of Agriculture Forest Service
U.S. Army Corps of Engineers
Department of Energy
U.S. Geological Survey
Department of Homeland Security and
Federal Emergency Management Agency
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration
Oak Ridge National Laboratory and the Community and Regional Resilience Institute

Overseen by the Committee on Science, Engineering, and Public Policy and the Disasters Roundtable of the National Research Council

July 2012

Attributes of resilient communities

- Hazard events have been identified and made aware to the entire community.
- Governance is in place at the local level with policy measures.
- Governance at the local level is in tune with that at the regional and country levels
- The community is capacity ready to prepare for, face, and recover from an event

Attributes of resilient communities (2)

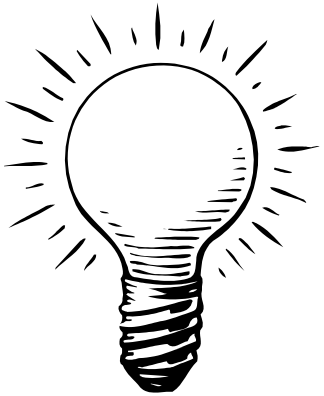
- A strategy is in place; the community has addressed land use, hazard mitigation, and critical infrastructure
- Community engagement and strong social networks are present
- An action plan and resolution of risks are in place and are clear to individual community members.

Attributes of resilient communities (3)

- All community sectors are involved in preparedness and response planning
- Community members work together (collective resilience).
- Incentives in integrating resilience in the community are in place and are perceived as an added value and an investment.

"The significant problems we face cannot be solved by the same level of thinking that created them."

Albert Einstein



Contact: amadei@colorado.edu