Measuring the unmeasured: Vulnerability, resilience and implications for adaptation

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Definitions of resilience

The National Academy of Sciences (NAS) defines resilience as “the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events” (NRC, 2012)

The IPCC defines resilience as “the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation” (AR5 Glossary, 2014)

Both definitions emphasize the notion of capacity and ability to recover – properties intrinsic to the system; and yet capable of being influenced through action

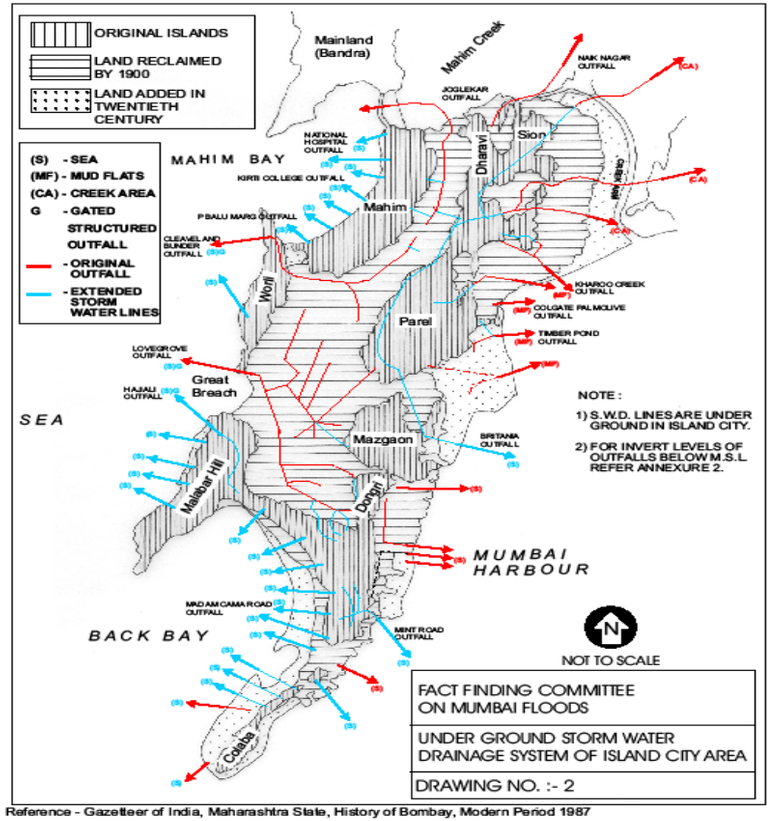
But what is the “system” – resilience of what, and to what?

The problem

- We manage what we measure
- In the context of losses due to climate related hazards, what is observed is usually insured loss and mortality – stocks of natural, manufactured and human capital
  - Insured losses are a small part of the total loss that is experienced – even more so in the developing world where insurance markets are limited
  - Resilience and vulnerability is not only about the loss of capital (impact), but also the flows of economic goods and services (recovery)
- When we think about response, we usually think about state (or public-sector response)
  - But response to climate risks takes place at all levels – from the individual to the household. This response is neither costless nor automatic
- So, if we wish to promote resilience, we need a richer characterization both of *outcomes* and *actions*

Informal sector vulnerability and private adaptation in Mumbai

- Financial capital of India with 12 million people in residence and 5-6 million transit per day – Density of 28404 people per sq.km
- Surrounded by sea on 3 sides and acutely vulnerable to floods, cyclones storm surges and sea level rise
- Most parts of the city built on reclaimed land and only 10-12 meter above sea level
- Major residential and commercial areas situated in low lying areas and flood prone
- 55% people are living in slums or squatter settlements
- Acute income inequalities with 50% population earning below $330 and top 10% earning between $1700-200 per month



Reference - Gazetteer of India, Maharashtra State, History of Bombay, Modern Period 1987

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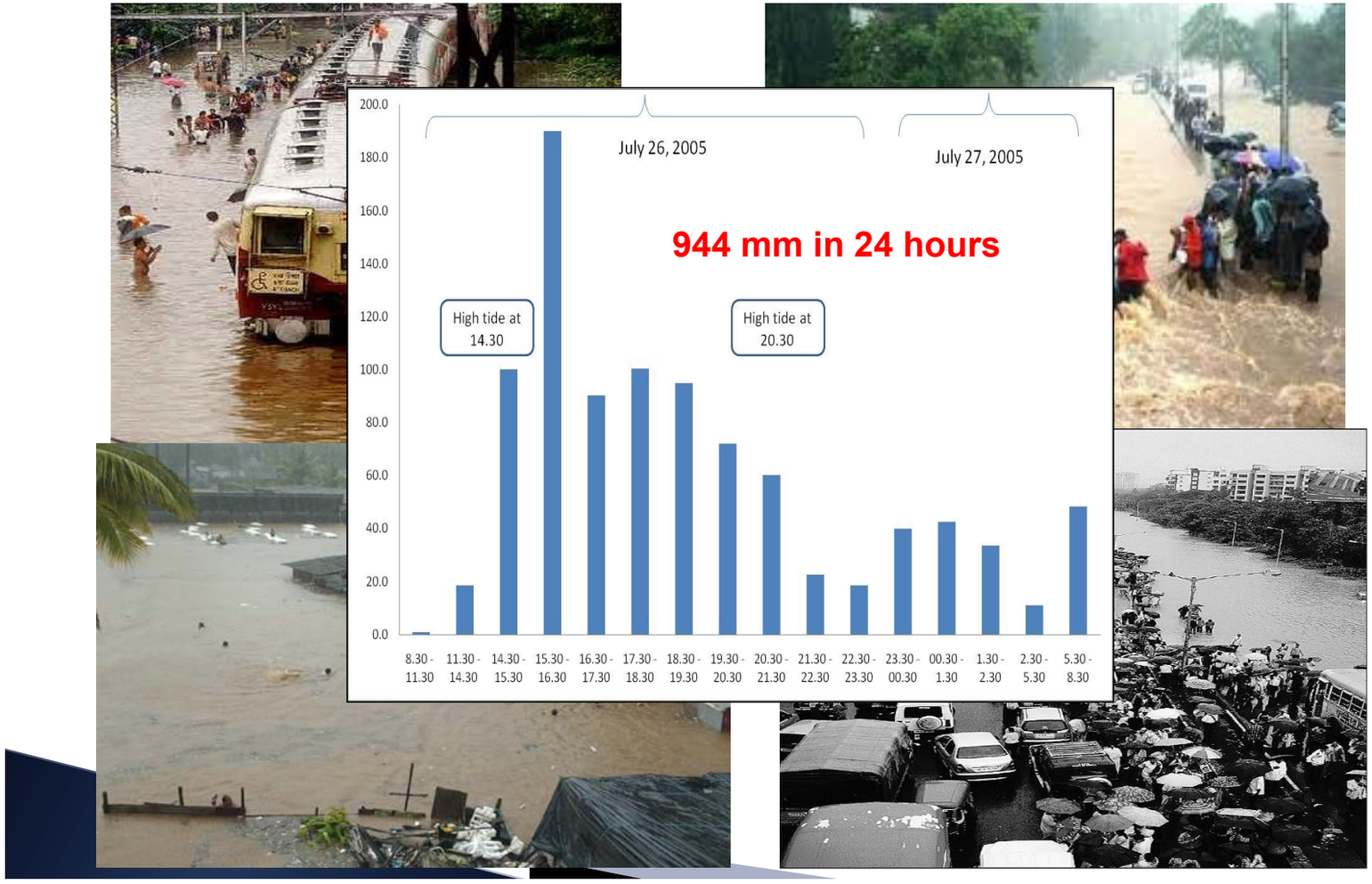
Extreme event of July 26, 2005



Research Methodology

- Primary survey focusing on impacts, responses and recovery in the aftermath of flooding events
  - 1168 households surveyed across six flood-affected wards
  - Questionnaires focused on impacts of floods, costs of damage/repairs/replacements, experience in subsequent flood events, community response and relocation as an option
- Unstructured interviews of local government officials, Disaster Management Teams and city planners
- Secondary data gathered from local government departments, damage assessment reports, private utilities and other sources

Estimates of uninsured losses per HH

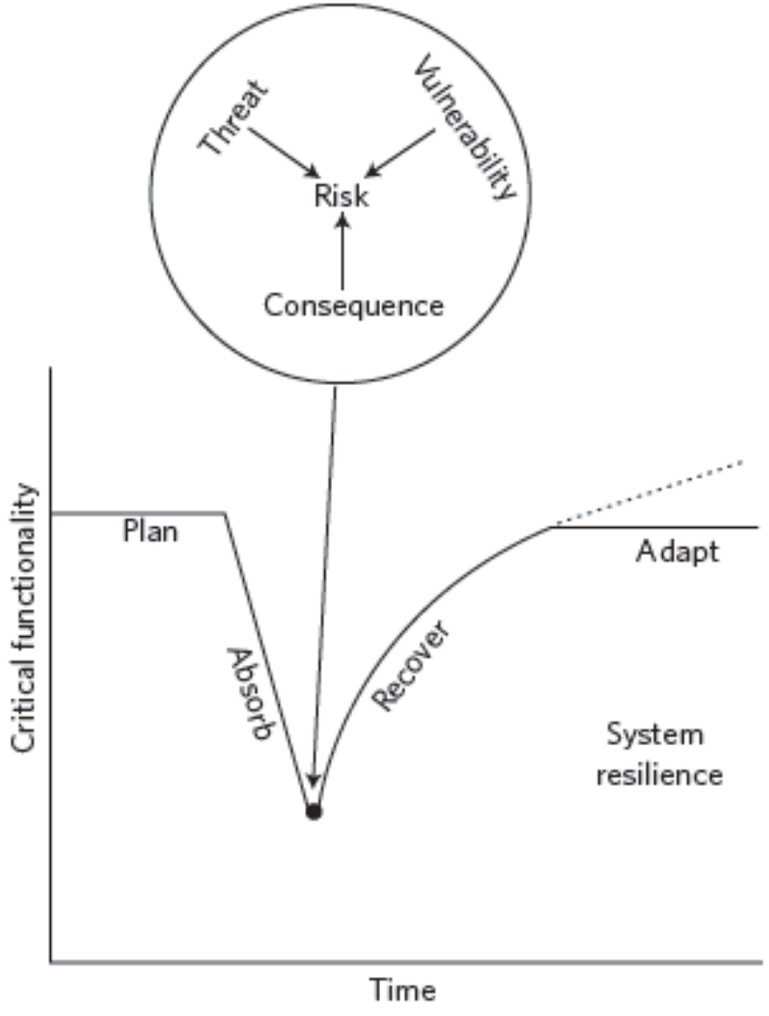
	K East	H East	F North	F South	L Ward	P North
	(Figures in bracket as % of average household monthly income)					
Income loss due to floods	10474 (69.8)	8543 (57.0)	5164 (25.8)	8323 (41.6)	22578 (112.9)	14894 (74.5)
Amount spent to repair/rebuild damaged structures	22270 (148.5)	26191 (174.6)	34335 (171.7)	42967 (214.8)	22457 (112.3)	27118 (135.6)
Losses due to damage to household appliances (TV, refrigerator, music system, desktop, laptop, washing machine, stove)	13190 (87.9)	15469 (103.1)	13442 (67.2)	10081 (50.4)	11325 (56.6)	23923 (119.6)
Losses on account of damage to household assets (Furniture and utensils)	9735 (64.9)	11061 (73.7)	11756 (58.8)	6602 (33.0)	7121 (35.6)	10417 (52.1)
Losses due to damages to vehicles (Car, Motorcycle, Bicycle)	12974 (86.5)	9153 (61.0)	11833 (59.2)	1250 (6.3)	5478 (27.4)	7232 (36.2)
Average estimated losses per household (% of monthly income)	**68644 (457.6)**	**70417 (469.4)**	**76530 (382.7)**	**69224 (346.1)**	**68958 (344.8)**	**83584 (417.9)**
Source: Authors' calculations based on primary data						

Indirect (and non-monetized) impacts

Problem	% among surveyed HHs
House flooded with water	70
Non-availability of local transportation	87
Price rise of essential commodities	67
Non-availability of food and other supplies	62
Disruption in communication services	61
Disruption of electricity	83
Non-availability of clean drinking water	75
House flooded with sewerage/garbage	80
Non-availability of fuel	51

Household response – examples of private adaptation

Measures after 2005 floods (% of HH's adopting)	BPL (< Rs. 5000)	LIG (Rs. 5000-15000)	MIG (Rs. 15001-30000)	Higher MIG (> Rs. 30000)
Increasing height of surrounding ground	57.5	52.9	59.4	73.3
Reconstruction within the house/parking	14.5	12.2	12.1	6.7
Repairing & elevating electrical meters	45.1	30.1	34.7	26.7
Repairs inside house to elevate furniture	45.1	40.2	54.0	80.0
Repairs inside house to elevate electronic gadgets	44.6	32.6	37.1	26.7
Repairing/ modifying toilets	8.3	5.3	11.3	13.3
Source: Calculated from the primary data				

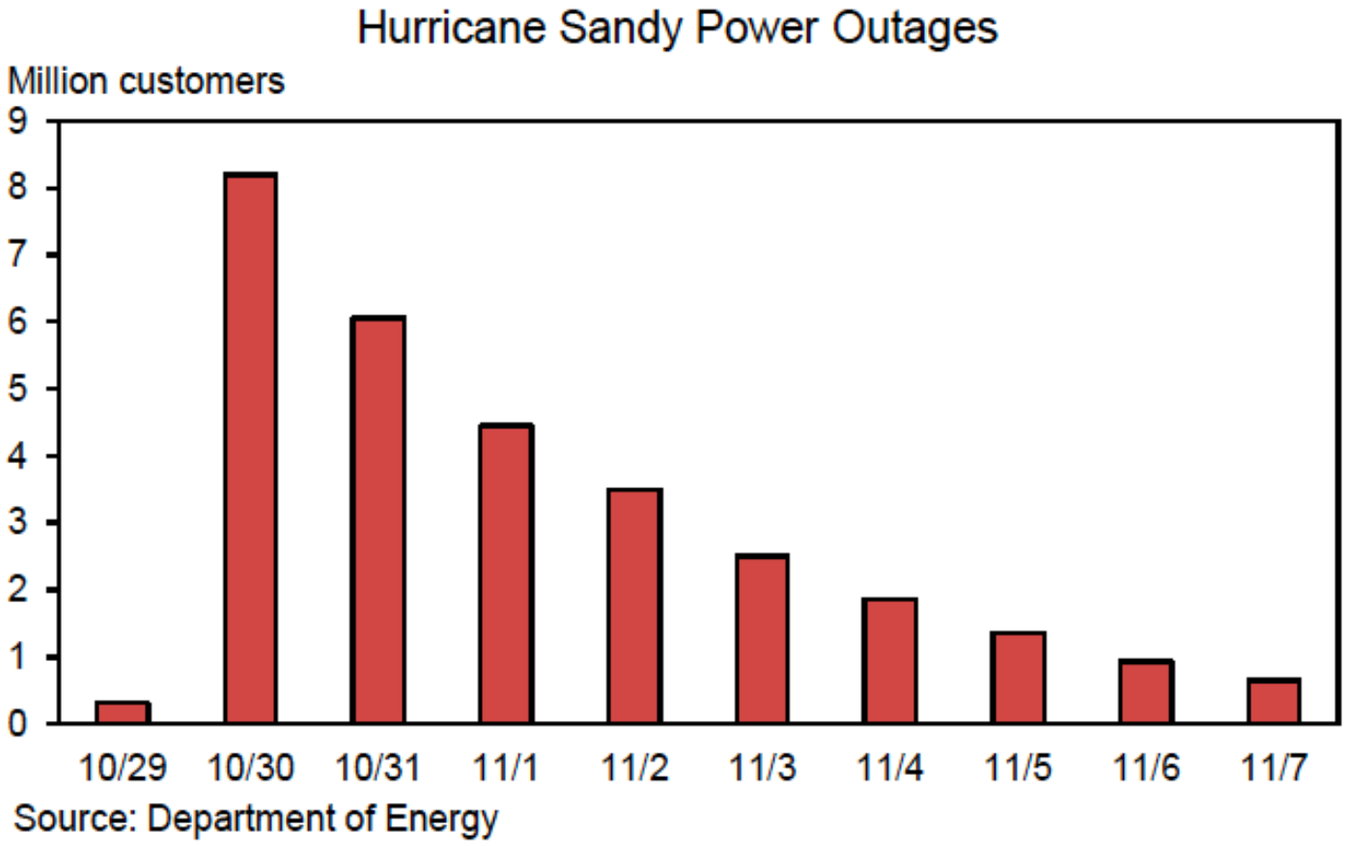


Connecting impacts, recovery and resilience

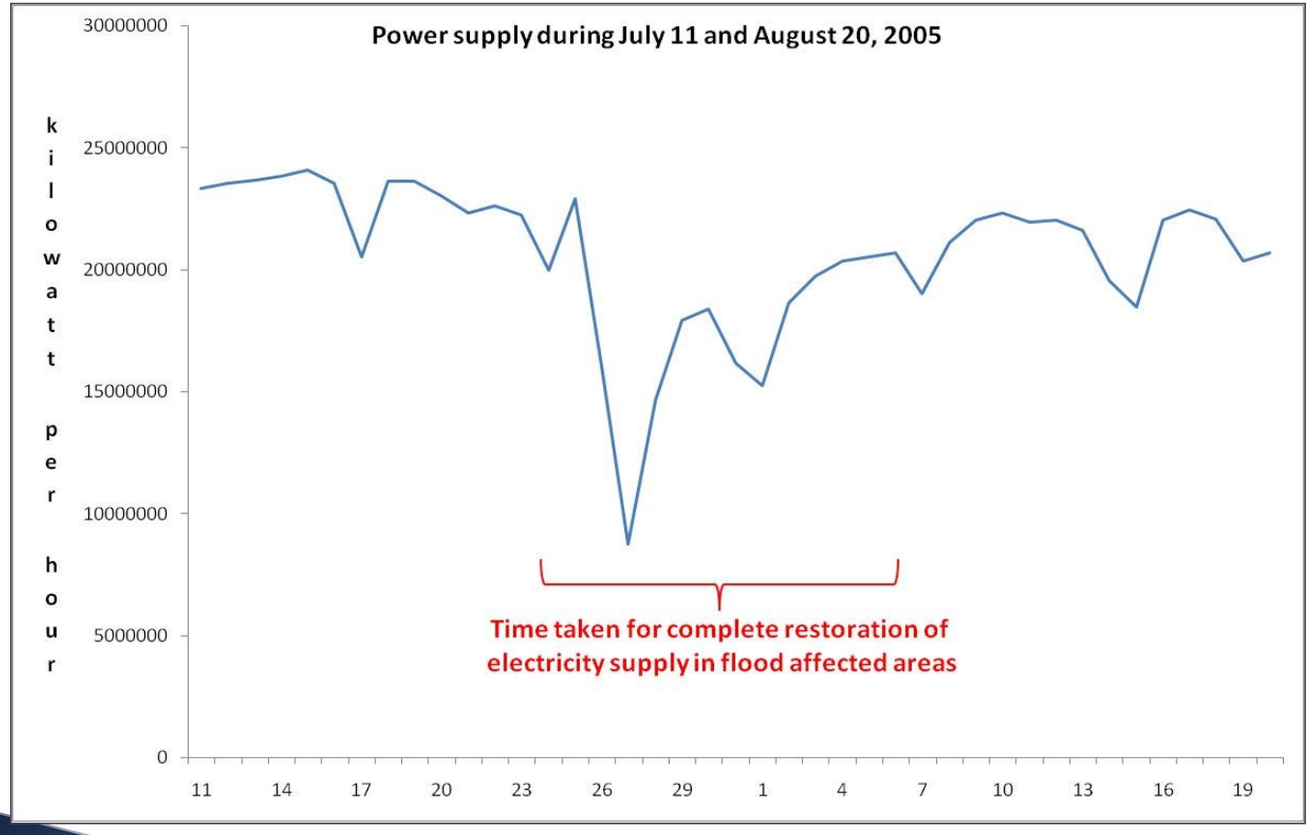
Source: Linkov, et al, Nature Climate Change (2014)

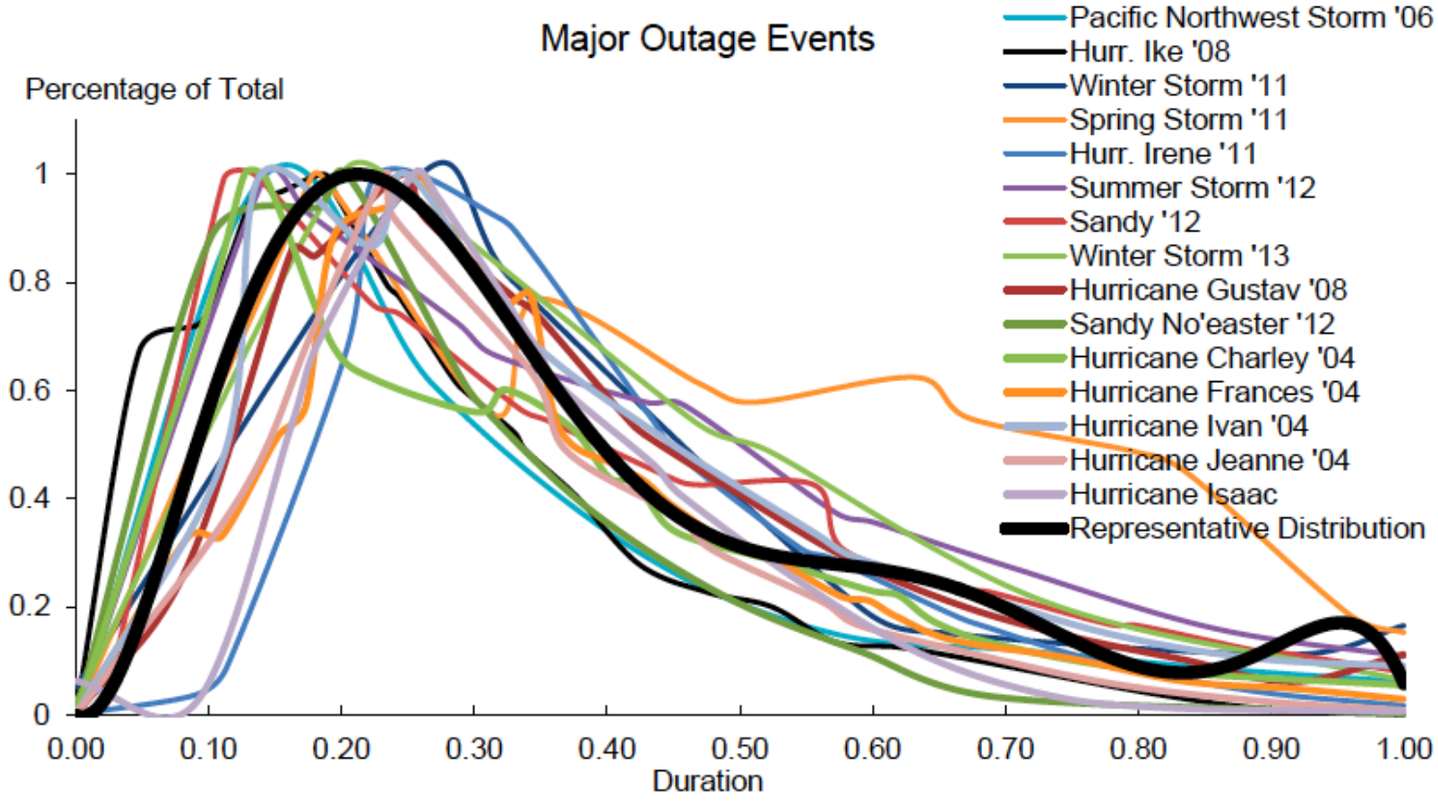
Assessing recovery

- Need to choose the right metrics and look for appropriate proxy measures
- For example, outage time can be a useful proxy for electric utilities
- What do we do with outage times? Many utilities assess their storm responses based on median outage time, but does this tell the whole story?
- Who is at the tail of the distribution and how are they affected?


Hurricane Sandy Power Outages
Million customers
9
8
7
6
5
4
3
2
1
0
10/29
10/30
10/31
11/1
11/2
11/3
11/4
11/5
11/6
11/7
Source: Department of Energy

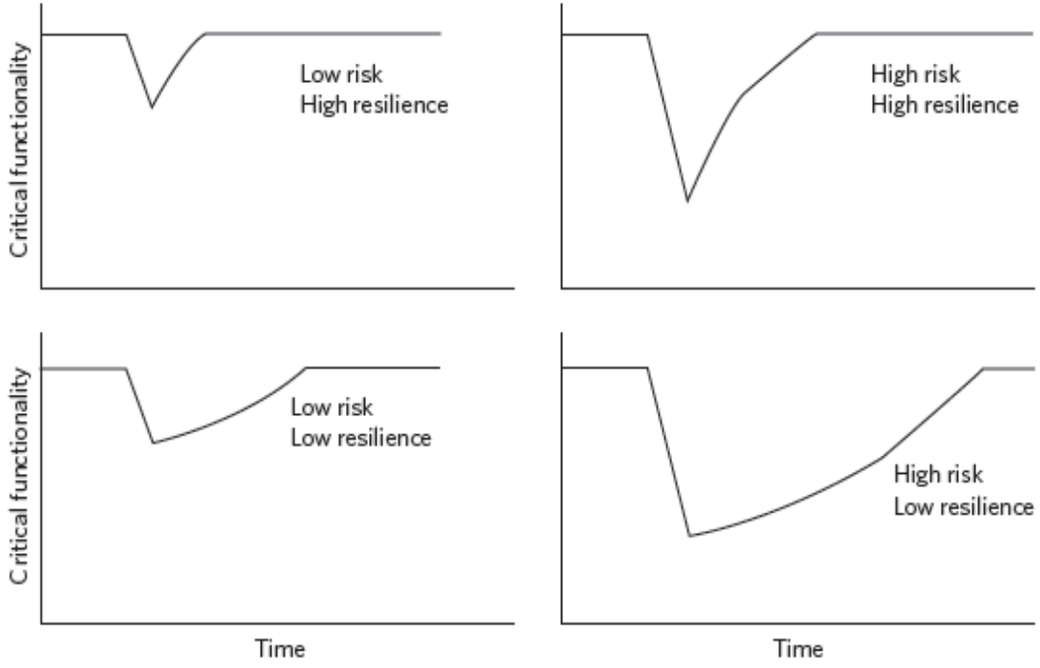
Power supply disruption in Mumbai in 2005 floods





Source: Department of Energy, Office of Electrcity Delivery and Energy Reliability

Policy implications – possible trade-offs between impacts and recovery?



Many utilities have policies to harden their infrastructure (reduce impacts).
Is this the most cost-effective approach?
What about system flexibility and recoverability?

RAPTA – tool to embed resilience thinking in project design and implementation

RAPTA is a tool to help project designers and planners build resilience, adaptation and transformation into their projects from the start, to ensure outcomes that are practicable, valuable and sustainable through uncertain futures.

* The Resilience Adaptation and Transformation Assessment Framework (2015)

RAPTA helps project developers to…

1. Determine whether a project can achieve its stated objectives
2. Increase the chances of success through a clearer understanding of the factors that control resilience. This:
    - helps untangle the complexity, helps to focus on root causes, and assesses the likelihood of a community's continued well-being despite shocks
    - supports intentional transition to desired systems
    - reduces the probability of unplanned transitions to undesired systems
    - distinguishes cases where transformational social–ecological change is needed from cases where smaller, incremental actions can suffice
3. Determine where achieving the desired state is impossible or unrealistic with existing project resources.

RAPTA is

A structured approach to understanding and assessing resilience, adaptation need and adaptive capacity

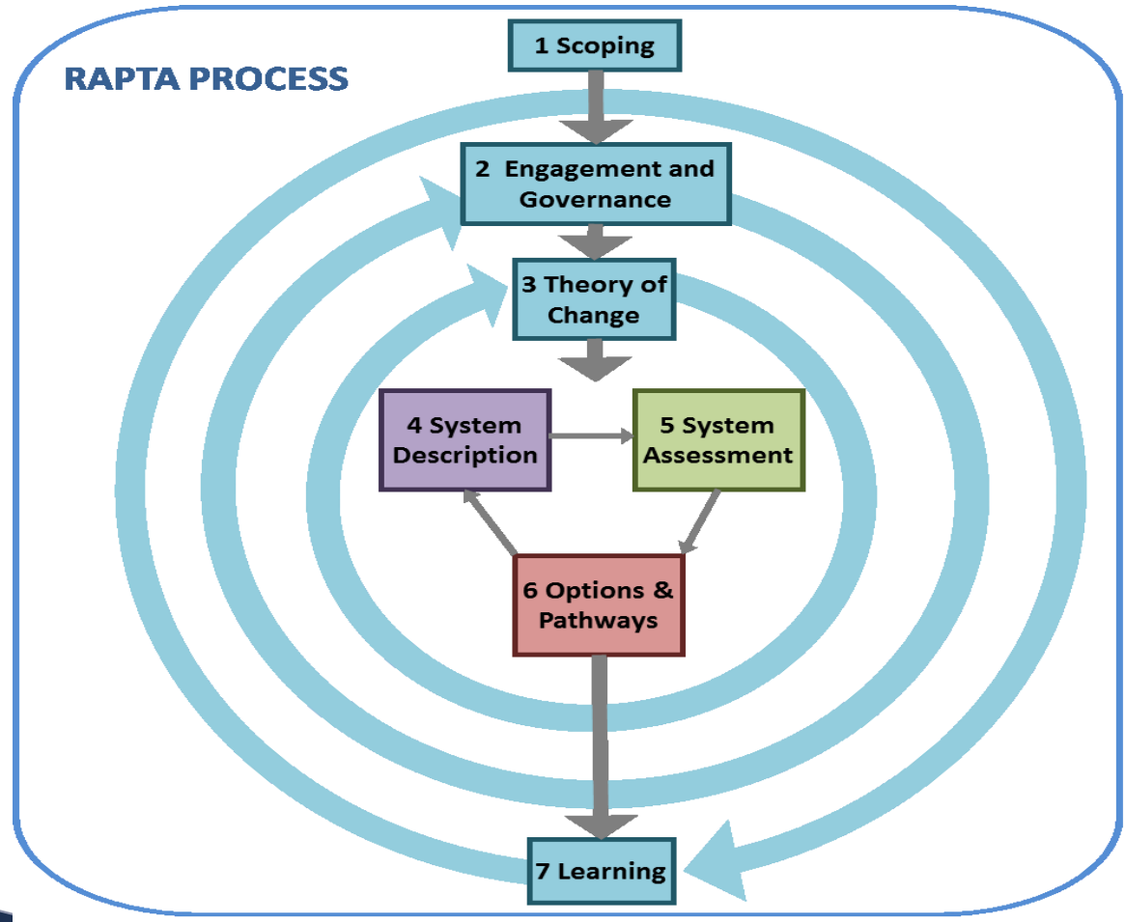
It can help to:

- focus M&A efforts on relevant indicators
- inform initiatives to build resilience of productive systems, guide users through adaptation and transformation planning processes, and
- empower local communities to participate in planning and implementation of interventions.

In summary:

a systemic approach that increases the likelihood that development initiatives will generate sustained positive impacts.

RAPTA process



Concluding thoughts – implications for research

- Measurement agenda – how can we track aspects of vulnerability that are important for response?
- Analysis and assessment – traditional resilience assumes that the current state is desirable – is this the case?
- What should be the end-point of recovery (build back better)?
- How do we think about resilience when the baseline is not fixed and we have to respond to to changing (worsening) conditions in the future?
- To what extent will autonomous adaptation happen – and will it contribute to long-term resilience?

Concluding thoughts – implications for policy

- Private responses driven by individual needs with little guidance on what is appropriate, cost effective and beneficial in the long-term – is there a possibility of mal-adaptation?
- Financing of response measures done through out-of-pocket expenses, which is a burden for poor households – does it lead to enhanced adaptive capacity and future resilience?
- Response is influenced by a variety of social and institutional factors – unless we know what they are and take them into account, adaptation policy may not be effective
- Implications for global negotiations on loss & damage