Principles and Criteria for Assessing Urban Energy Resilience

AYYOOB SHARIFI, YOSHIKI YAMAGATA

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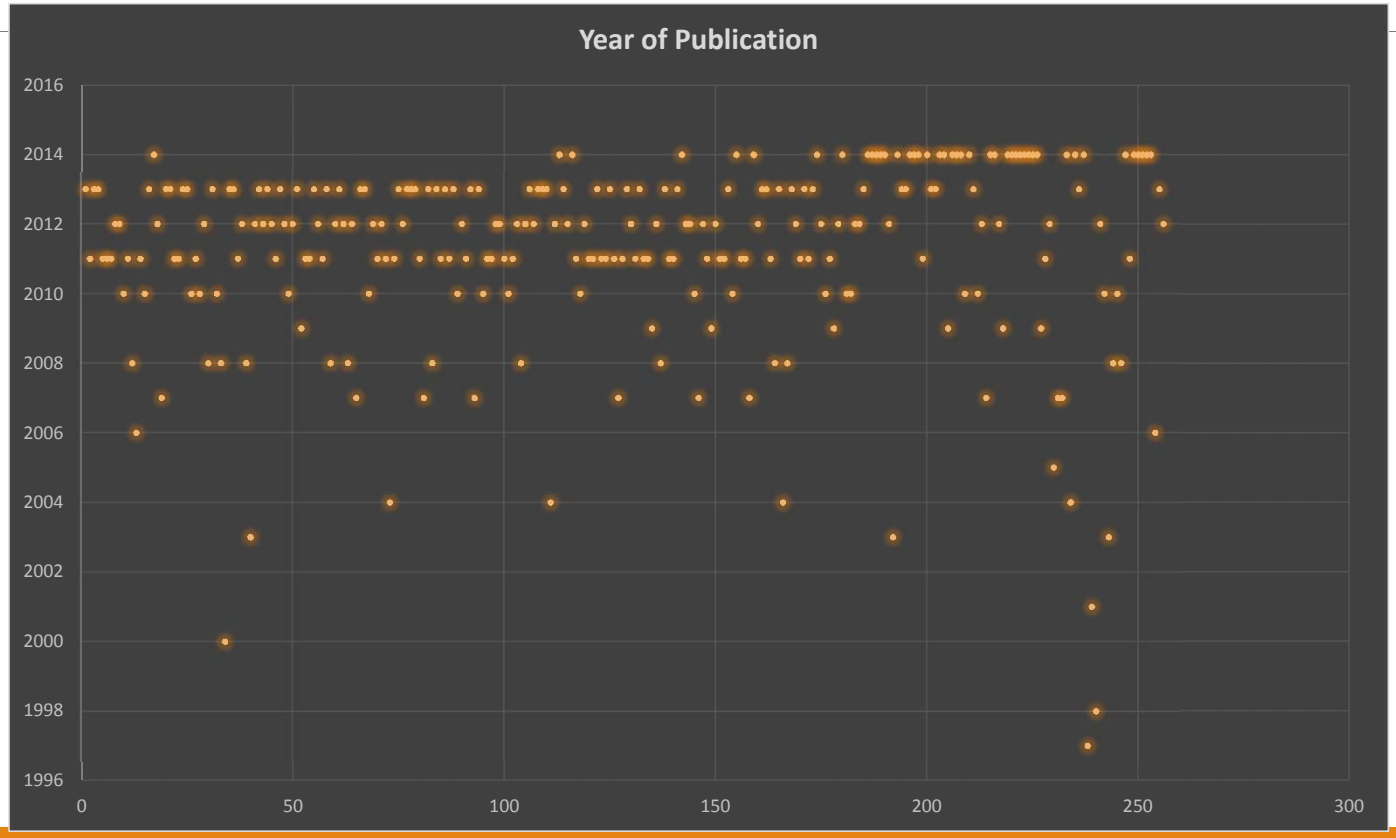
Background and Aims

- Frequency and enormity of damages caused by climate-related disasters
- A large volume of research on urban resilience
- Existing research on urban resilience is mainly discipline based
- Adaptation aspects have not received enough attention
- No appropriate metrics and indices for assessing the resilience of cities
- Such indices can play the role of decision support system and facilitate a more informed decision making process
- Here the focus in on both adaptation and mitigation issues

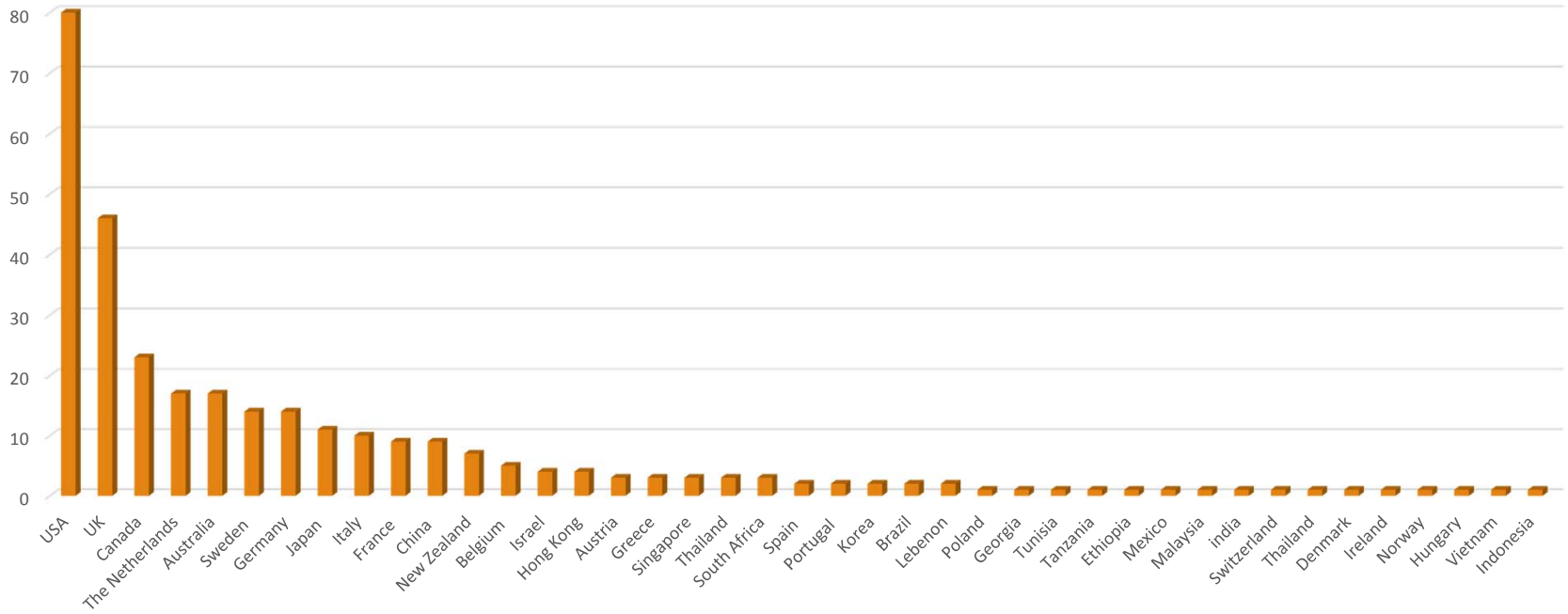
Merits

- Capture the complexity and effectively simplify the route to resiliency
- Measure resilience and track achievement of goals
- Provide guidelines for future developments that can be communicated to planners and policy makers

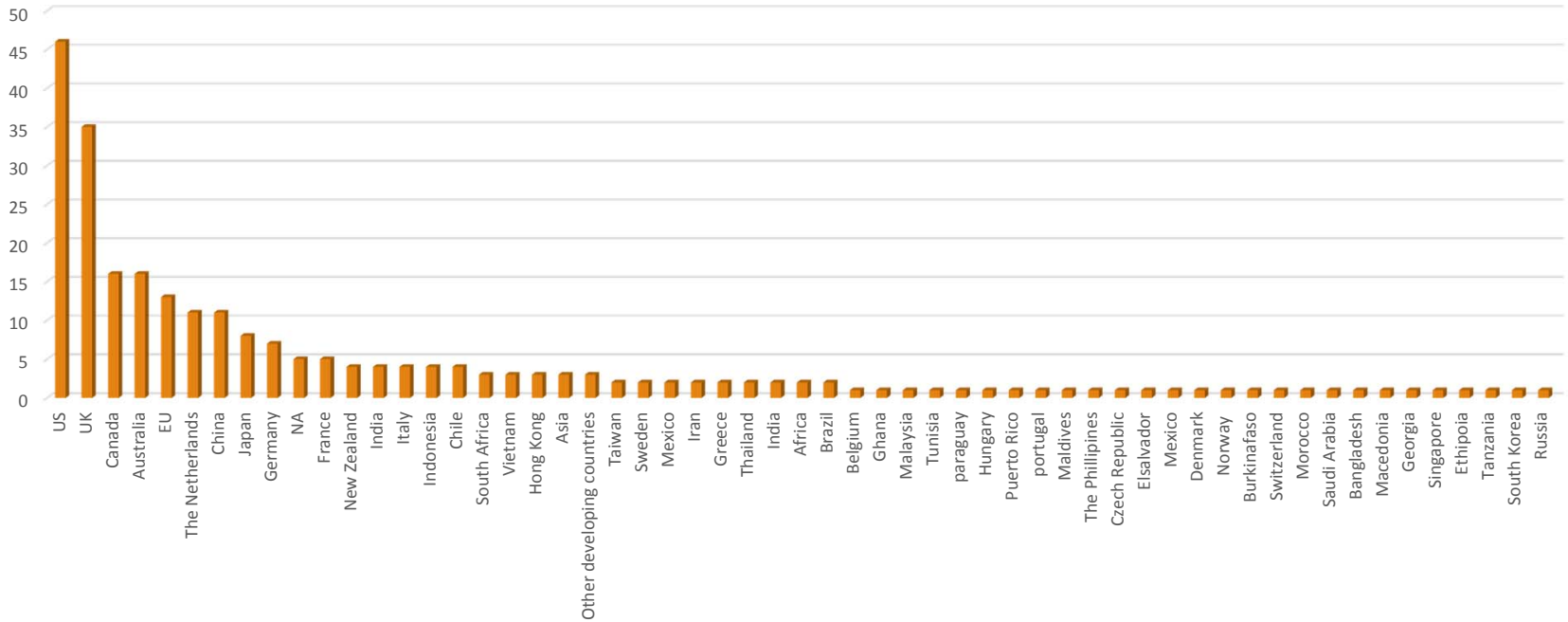
Literature Review



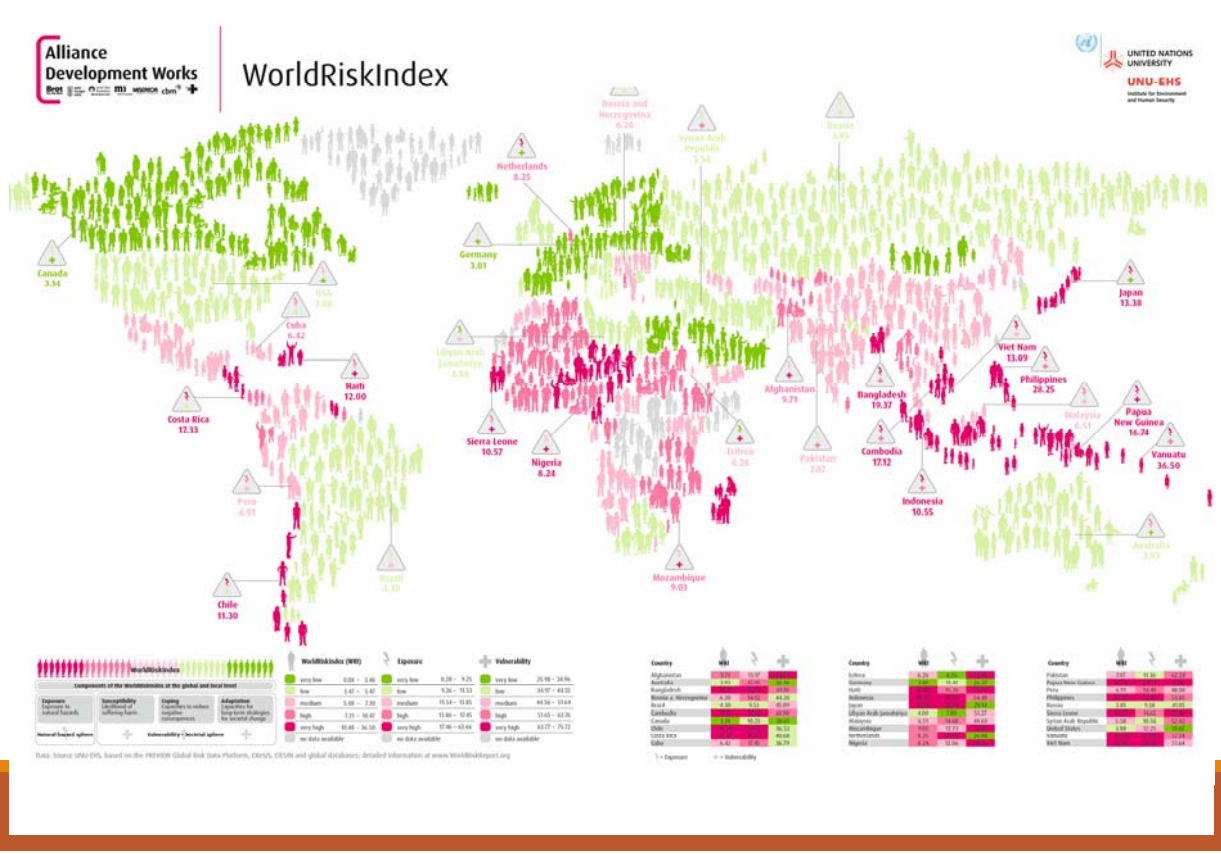
Geographical Distribution of the Authors



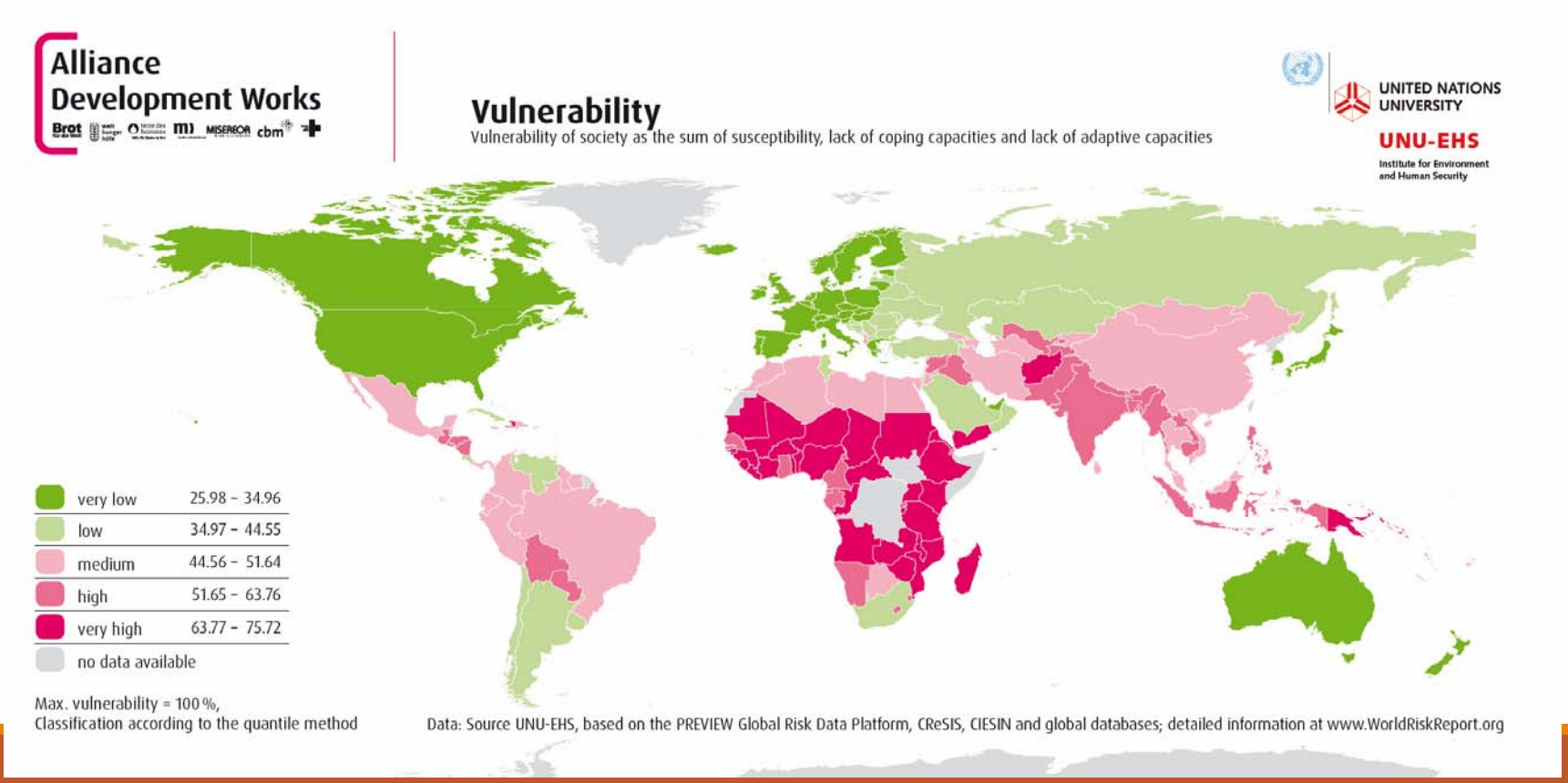
Geographical Focus



Risk Index


Alliance Development Works
WorldRiskIndex
UNITED NATIONS UNIVERSITY
UNU-EHS
Canada 3.54
Cuba 6.42
Haiti 12.00
Costa Rica 17.33
Chile 11.30
Netherlands 8.25
Germany 3.01
Sierra Leone 10.57
Nigeria 6.24
Mozambique 9.03
Afghanistan 9.71
Bangladesh 19.37
Cambodia 17.12
Indonesia 10.55
Viet Nam 13.09
Philippines 28.25
Papua New Guinea 16.74
Vanuatu 36.50
Japan 13.38

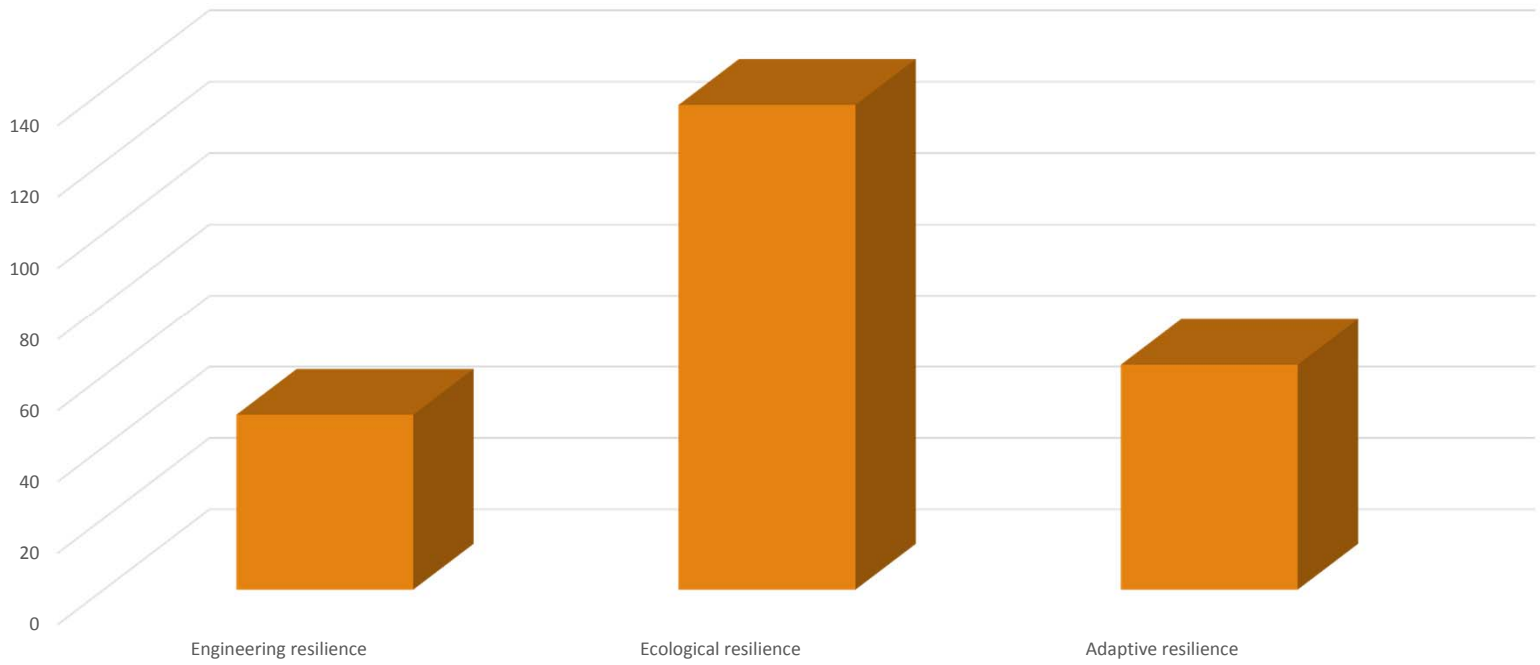
Vulnerability



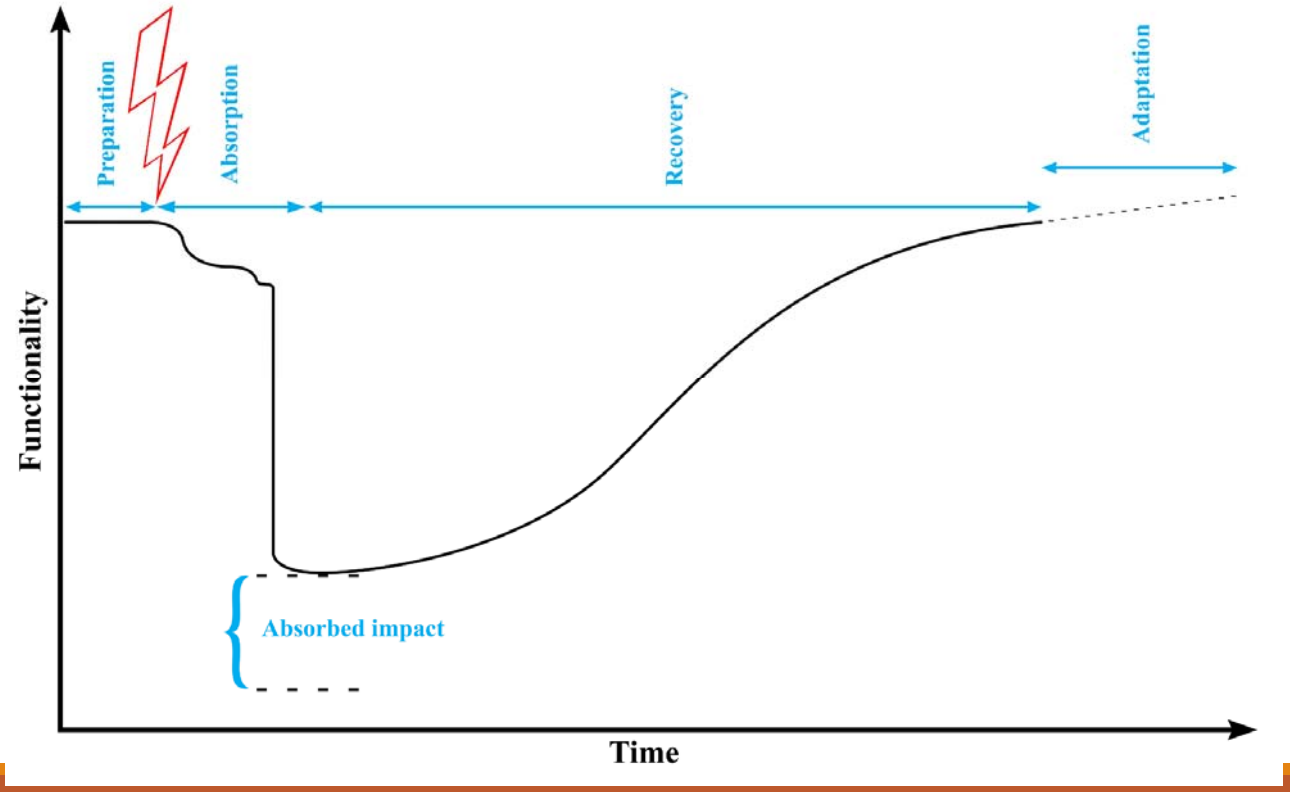
Major Approaches

- Engineering Resilience
  - Resistance to change and return to the equilibrium after receiving a shock
- Ecological Resilience
  - Persistence of a system and its ability to absorb the disturbance and sustain its structure or function. The system may return to the old or a new equilibrium(s)
- Adaptive (socio-ecological) Resilience
  - The latest approach toward resilience which suggests that complex, dynamic, and adaptive systems (e.g. cities) would not necessarily return to an equilibrium state. This approach advocates the concept of living with risk

Dominant approach



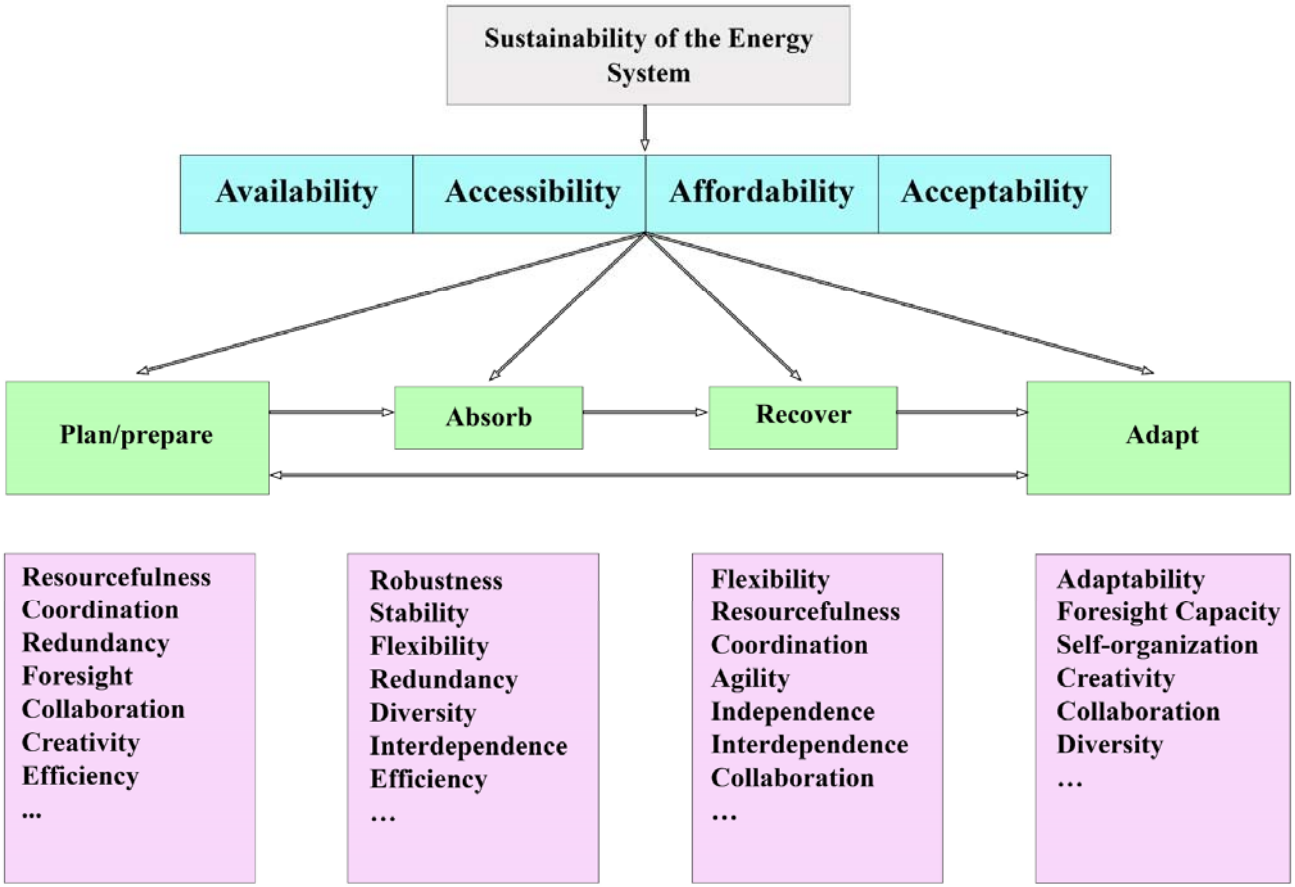
Characteristics of a resilient system



Some characteristics

Resilience
- Robustness,
- stability,
- flexibility,
- resourcefulness,
- coordination capacity,
- redundancy,
- diversity,
- foresight capacity,
- independence,
- interdependence,
- collaboration,
- agility,
- adaptability,
- self-organization,
- creativity,
- efficiency,
- equity

Conceptual framework



Tasks

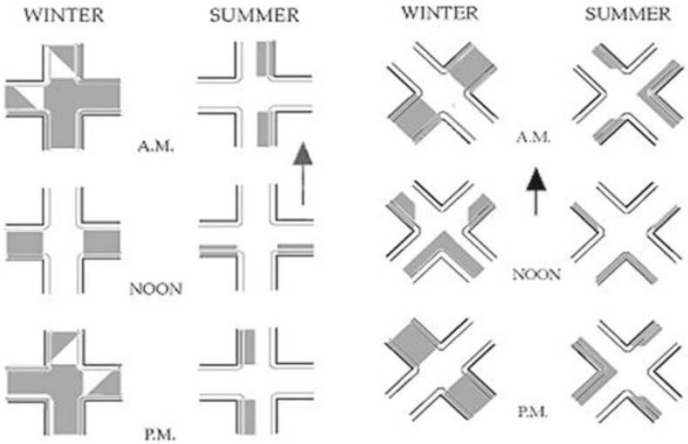
- Planning and design criteria that can be used for assessing urban energy resilience;
- The association between the components of the energy resilience framework;
- Criteria's relevance to mitigation and adaptation to climate change.

Criteria

- 196 planning and design criteria identified
  - Infrastructure
    - Supply, transmission, distribution; Back-up and storage; Green and Blue Infrastructure; buildings and neighborhoods; transportation
  - Resources
    - Energy, water-energy nexus; food-water-energy nexus

Criteria

- Land use and urban form
  - Land use; urban morphology; urban geometry; passive design
- Governance
  - Monitoring and assessment; planning and management; regulatory basis and law enforcement; pricing; supports and incentives
- Socio-demographic aspects and behavior
  - demographics, health, and equity; behavioral aspects



Relevance to the components

Urban infrastructure		Ability	Sustainability	Characteristic	Ref
Supply, transmission, distribution					
I1	Fortification and robustness (physical security)	P, Ab	A1	R	
I2	Diversification of energy supply (fuel mix, multisourcing)	P, Ab	A1,2	D	

Overall relevance

Theme		Ability				Sustainability			
		P	Ab	R	A	A1	A2	A3	A4
Total	196	184	167	61	138	192	65	99	166
%	100.0	93.8	85.2	31.1	70.4	97.9	33.1	50.5	84.6

Overall relevance

		R	S	F	Re	CC	Rd	D	FC	I	In	C	A	Ad	SO	Cr	E	Eq
Total	196	3	20	15	34	23	9	45	25	32	11	11	12	44	18	7	149	27
%	100	2	10	8	17	12	5	23	13	16	6	6	6	22	9	4	76	14

Mitigation and adaptation

- Mainly related to adaptation (literature)
- (74.49%) are related to both mitigation and adaptation
- 24.49% to adaptation only
- 1.02 to mitigation only
- Adaptation and mitigation need to go hand in hand.

	A	R	Ad	A1	A2	A3	A4	R	S	F	Re	CC	Rd	D	FC	I	In	C	A	Ad	SO	Cr	E	Eq
P	79	30	67	92	32	46	80	2	12	7	16	12	5	22	15	17	6	4	5	18	9	4	71	14
A		26	66	85	29	46	74	2	9	7	12	10	4	22	11	16	5	5	6	22	8	4	68	12
R			17	31	23	14	20	0	5	5	10	8	3	6	4	5	4	3	4	4	4	1	17	5
Ad				71	22	43	69	0	7	4	10	8	1	19	8	15	3	5	3	20	8	3	64	11
A1					83	50	33	2	11	8	17	12	5	22	14	17	6	6	6	22	9	4	76	12
A2						21	26	0	5	5	8	7	2	11	5	10	3	1	4	5	2	1	23	4
A3							49	0	5	2	10	5	0	15	4	13	1	3	3	17	5	2	45	11
A4								1	8	4	15	10	1	21	12	15	4	5	4	22	8	4	75	14
R									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S										1	2	1	0	2	1	2	1	0	0	1	1	0	5	3
F											1	1	2	1	1	0	1	1	2	1	1	0	3	0
Re												7	1	1	2	1	0	2	1	3	1	1	12	4
CC													0	1	0	0	3	1	1	1	1	0	8	3
Rd														1	1	1	0	0	1	0	1	0	1	0
D															5	13	1	0	1	1	2	1	20	2
FC																1	0	0	3	1	1	0	10	2
I																	2	0	0	1	3	1	30	0
In																		0	1	0	1	1	3	1
C																			0	2	3	0	5	1
A																				1	0	0	3	1
Ad																					2	1	21	3
SO																						0	8	2
Cr																							4	0
E																								9

	>10%		Correlation is significant

Summary

- Decisions related to one component are likely to affect other components too
- Complex, interconnected, and multi-faceted nature of energy resilience as a synergistic concept
- Importance of adopting a systemic approach
- Tailoring the tool
- Data availability and accessibility
- Cost of developing tools and conducting assessment

Next steps

- Trade offs
- Co-benefits
- Indicators
- Composite index

Thanks for your attention