Urban Morphology

Applications, Issues and Prospects for Resiliency Assessment

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Workshop on Tools and Indicators for Assessing Urban Resilience

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Urban Morphology – Analysis of Urban Form

1) Various purposes
   - Identification & measurement of formal properties
   - Typologies (i.e. building types)
   - Multiple scales & relations
   - Process focused
2) Flexible tool
   - History, geography, archeology, architecture, urban design, planning, historic preservation, economics
3) Potential for resiliency assessment
   - Adapt methods of analysis to resiliency goals
   - Scan for usable criteria
   - Identify persistent issues

Key Features and Issues

1) **Inconsistency** in focus, methods

- Fragmentation among researchers:
  - Various nations, languages
  - Various professions
  - Result: lacks even standard terminology
- Core of field – some consistency
  - Two major schools diffuse ideas globally (see Caniggia, Conzen)

Resiliency

Is one overarching framework for analysis & response desirable or possible?
Are standard methods of investigation sufficient?
Is a common vocabulary and set of measures sufficient?

2) **Purpose of Study** shapes approach

- Focus will vary accordingly, i.e.
  - Analyze historic development of city
  - Inform architectural design
  - Regulate development in historic district
- Setting also influential– differences in natural environment, urban form & culture

Resiliency

Which aspects are pertinent:

Impact – Potential hazards and vulnerabilities? Structural durability? Emergency shelter?

Recovery – Potential short-term occupation? Constraints, legal, cultural or economic?

Adaptation - Encourage or regulate changes? Pre-disaster? Post disaster?

3) **Typologies** reduce urban continuum to discrete units

- Form-based; use secondary
  - Architecture – building types
  - Geography – plan unit (area with homogenous features)
  - Planning (form-based codes) – street types
- Degree of specificity
  - Low for simplicity, flexibility, extent of applicability
    - Fusch (1994) – Identifies 6 types of piazza in all Italy
  - High for precision, control
    - San Francisco Downtown Plan – regulates 11 types of public space in downtown area

Resiliency

Which types and measures are most pertinent for:

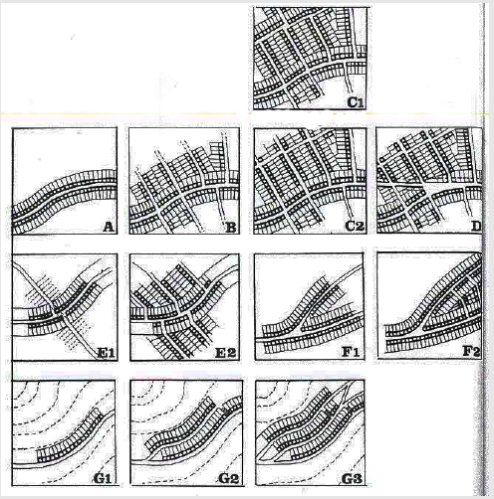
Assessment – For estimating impact damage, shelter potential, etc.

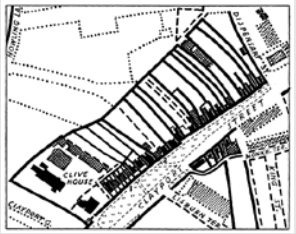
Regulation and investment – For target hardening, adaptation

Conservation during recovery – Identify sites of special cultural value, cultural sensitivities relevant to use of urban space, etc.

4) **Scale and Hierarchy** simplify and aggregate information

- Range: Building materials to region
- Intermediary scales: Applicability of each is variable
  - Existence or importance of feature described
    - i.e. Parcel is essential to Conzen, but irrelevant to modern campus-style developments
  - Urban features can be placed in more than one category
    - i.e. Urban fabric (buildings & parcels) may be part of street or part of block
- Relationship between scales: complex, variable with topic
  - Caniggia – Focus: <u>building types</u> accrete into urban fabric on <u>street</u> (connecting routes create <u>blocks)</u>
  - Conzen - Focused on rural land patterns shape <u>parcels</u>, <u>building form</u>





Resiliency

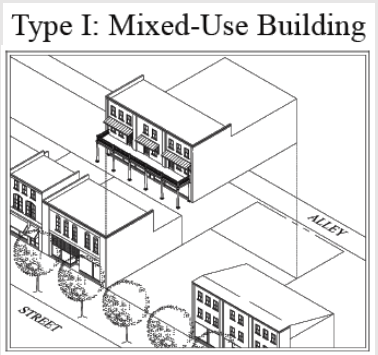
Should scale be a central organizing criteria, or is another format better? Which data can be usefully aggregated upwards or downwards?

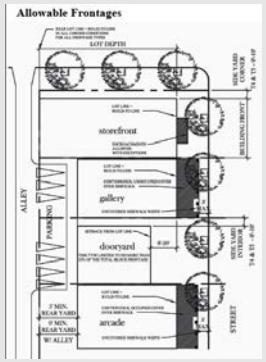
Illustration: US Form-Based Codes

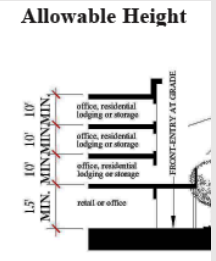
Different Typologies to Control Design Across Scales

1) Building Type

- Original approach
- Regulates building form & placement on parcel
- Maximize locational flexibility, mix of uses



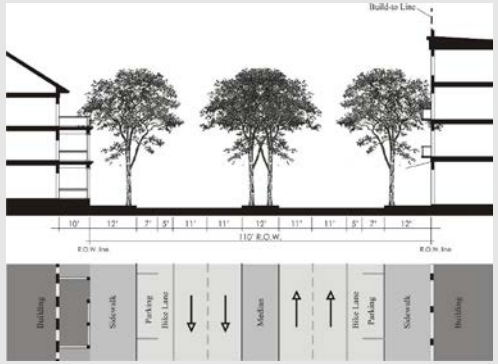




Blue Springs, MD

2) Street Type*

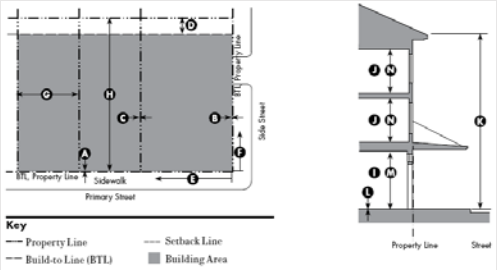
- Limited use
- Regulates roadway & building frontage as unit (public realm)



Hercules, CA

3) Transect Type (zones)

- Most widely used
- Transects organized by intensity of use or character
- Regulates parcel layout, some building form, some use
- Roadway types and other features may be keyed to transects



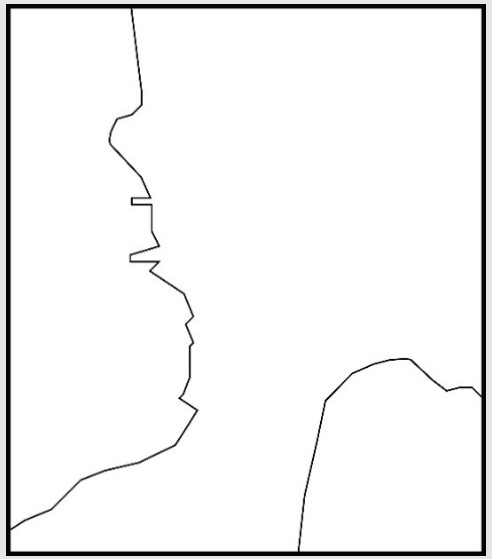
Grass Valley, CA

* Recent shift to "frontage based": Differentiates sides of street, separates roadway from building frontage

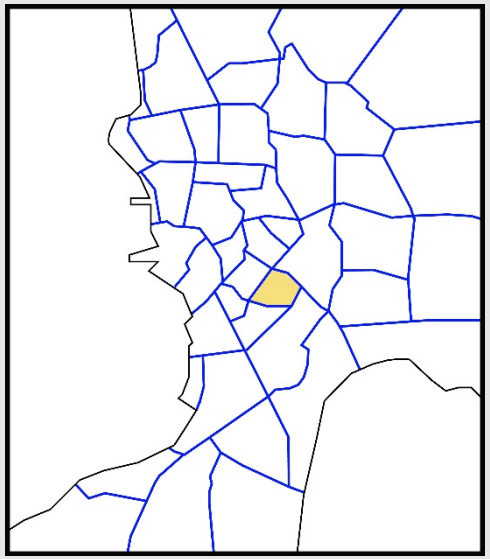
Adding Urban Morphology to Resiliency

- Existing index focused on city scale
  - Cutter, Burton & Emerich (2010) – Disaster Resilience Index – Infrastructure subset
    - **Housing Type - Percent housing units that are not mobile homes**
    - Shelter Capacity – Percent vacant rental units
    - **Medical Capacity – Number of hospital beds per 10,000 persons**
    - **Access/Evacuation Potential – Principle arterial miles per square mile**
    - Housing Age – Percent housing units nob built before 1970 and after 1994
    - **Sheltering needs – Number of hotels/motels per square mile**
- Existing research and regulation also focused on building structure
- Micro-analysis: addition of in-between scales, relations
  - Analyze consequences of spatial layout
  - Trace <u>processes</u> between scales (aggregate & disaggregate data)
    - Identify impacts of events
    - Examine effectiveness of redundancy

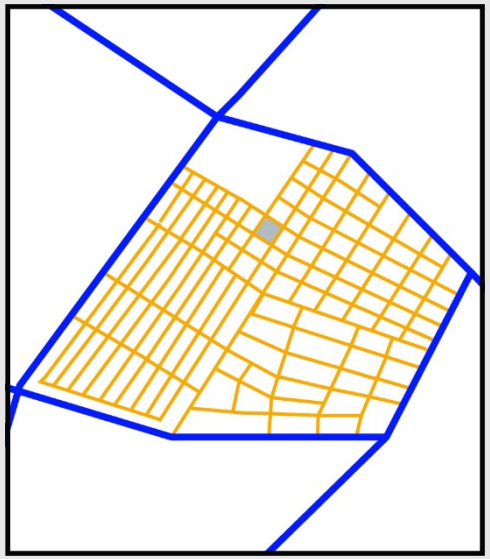
Suggested scales for resiliency analysis



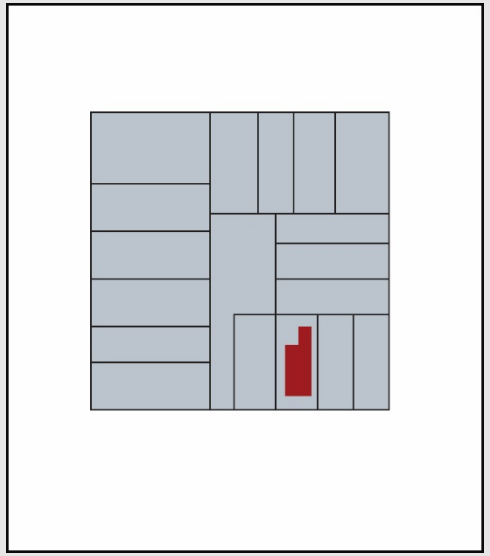
City



Districts



Blocks (Street Pattern)



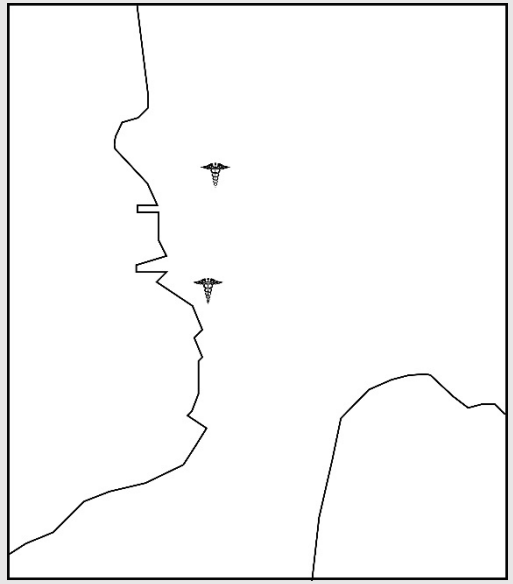
Parcels & Structures

Mass Transit
Private Auto

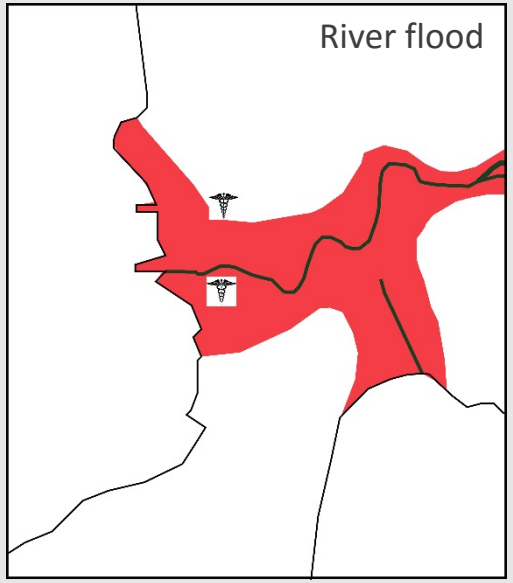
Walk
Bicycle

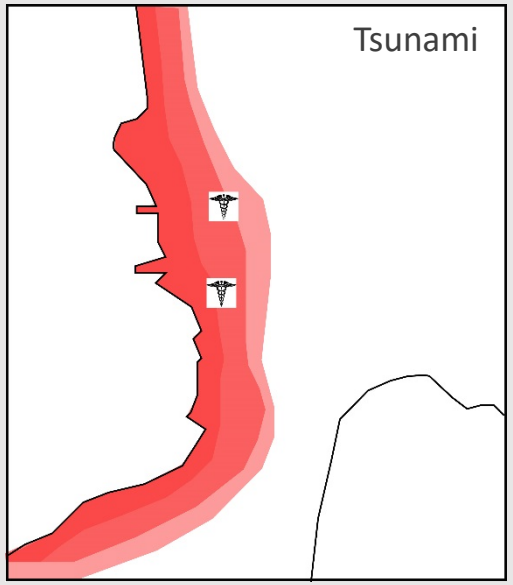
Medical Capacity

Measurement:
total beds in city

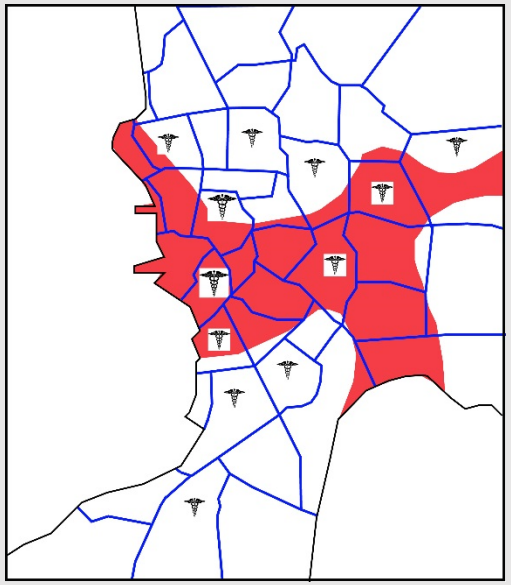


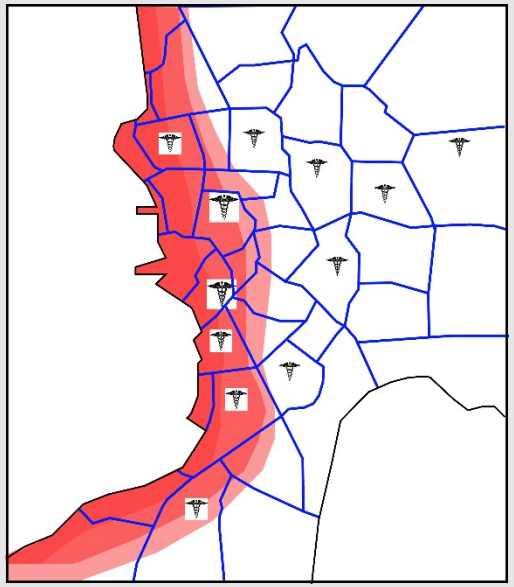
Beds concentrated in major hospitals





Hazard reduces or eliminates access





Redundancy: beds per district

Possible measures

Beds per district (size of service area?)
Beds keyed to hazard zones

Redundancy: secure routes to hospitals

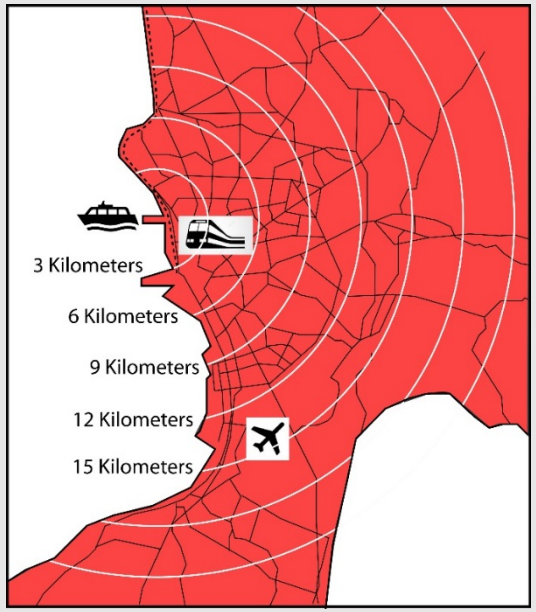
Access/Evacuation Potential

Measurement: arterial miles per square mile

Evacuation

Goal of arterial quantity may conflict w. identity, sustainability

Evacuation = lanes exiting city: Capacity in passengers/hour



- Mass transit has higher capacity
- Social justice
- Relies on feeders from districts
- Redundancy: alternative modes & routes

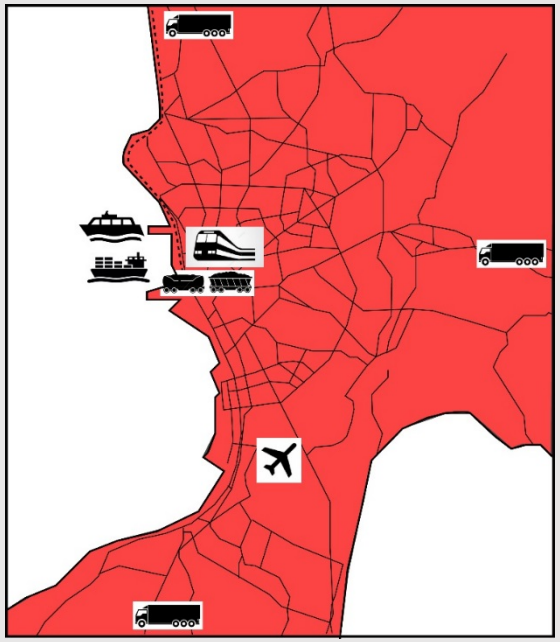
Possible measures

- Potential passengers/hour exiting city by:
Rail (by line)
Ferry
Bus
Private auto (by route)
Walking/bicycling

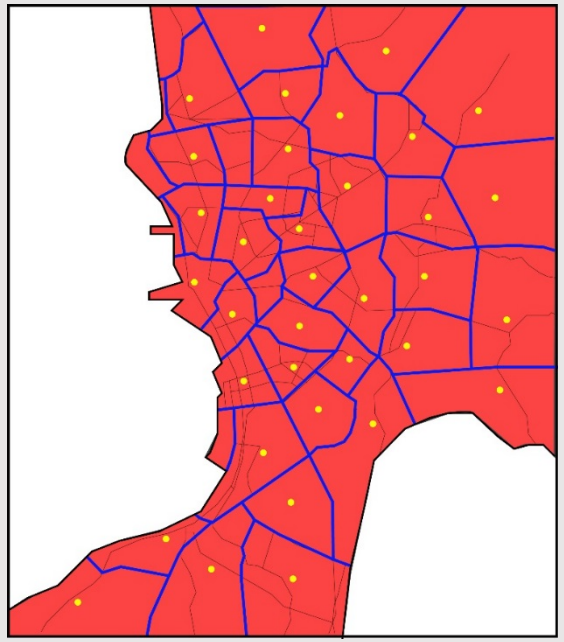
- Passengers/hour from districts to inter-city lines (emphasis on low-income districts)

- Percent of population evacuated in X hours by at least 2 routes

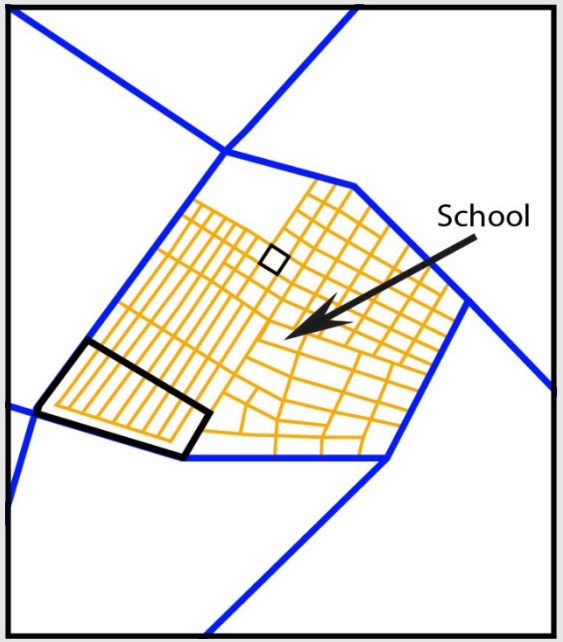
Access



- Emergency food & water, fuel, clothing, construction material;
- Redundancy through alternate modes & routes into city



- Provision of emergency supplies to remaining residents following event
- Transport to district distribution centers



- Public facility (school) as dist. center, provisional health clinic, etc.
- Street connectivity: minimizes travel distance (small blocks)
- Park as potential depot, waste disposal

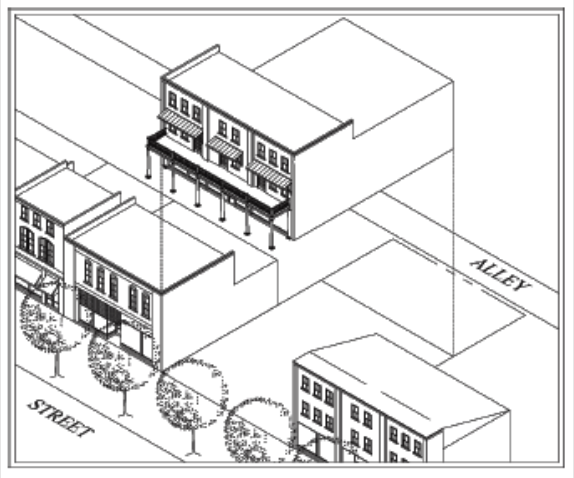
Possible measures

- *Connectivity: Maximum block perimeter or length across block (section) for districts*
  Inter-city stations to districts (transit or vehicle) assessed by travel time, potential alternative routes
- *Public building or park in 1 kilometer walk of X% of residents (districts defined?)*

Housing Type & Sheltering Needs

Measurements: % of housing that are not mobile homes and # of hotels/motels per sq. mile

- New typology of buildings based on:
  - Structure - durability under strain from different hazards (Fire, earthquake, flood, high wind, etc.)
  - Spatial capacity - relevant to needs during hazard impact and recovery
  - Ownership (public or private) and potential access during and after event



- Potential building typology for resilience
  - Structurally unsound buildings (determined by hazard type and stress level)
    - Estimate injury & loss of human life - % of population
    - Estimate damage to buildings
      - Construction materials needed
      - Salvageable materials for reconstruction by component; use as fuel; other uses
      - Debris for disposal (cubic meters)
      - Debris posing potential hazard (i.e. waterborne, airborne)
  - Structurally sound large public buildings (square meters of space per district)
  - Structurally sound small public buildings (square meters of space per district)
  - Structurally sound rentable private buildings (subtypes include hotels, large assembly spaces, etc.)
  - Structurally sound private buildings (% of units or total # of units)

- Building frontage type, roof type & relation to parcel
  - Related to climate, tradition, economic pressure, building trends
    - Central courtyard, blank wall on street, flat roof – hot, dry areas
    - Fronting street or central to parcel, gallery on street, sloped roof – hot, humid areas
- For resiliency
  - Building – parcel
    - Total permeable and impermeable surface
    - Secure outdoor space during recovery – yard enclosed by wall or internal courtyard
  - Roof type
    - Flat – storage space; habitable space in flood; green roof, garden
    - Sloped – water collection, orientation for solar panels
  - Frontage type
    - Forecourt, gallery, porch, terrace, stoop, yard
    - Potential relevance may be tied to cultural specific uses of urban space

Conclusions

- An array of measures for evaluating could contribute to better understanding and addressing urban resiliency
- Complete knowledge and control are not possible: limits on data, complexity of topic
- To what extent can academics and practitioners benefit from indicators? Are there dangers of relying on them?