Urban Morphology
Applications, Issues and Prospects for Resiliency Assessment

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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

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**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: building types accrete into urban fabric on street (connecting routes create blocks)
  • Conzen - Focused on rural land patterns shape parcels, building form

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

2) Street Type*
   • Limited use
   • Regulates roadway & building frontage as unit (public realm)

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

* 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 processes 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

Possible measures:
- Beds per district (size of service area?)
- Beds keyed to hazard zones
- Redundancy: secure routes to hospitals

Beds concentrated in major hospitals
Hazard reduces or eliminates access
Redundancy: beds per district
Access/Evacuation Potential

Measurement: arterial miles per square mile

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?