Critical Infrastructure and Regional Resilience

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Abstract - Several studies have provided a range of perspectives on the role of resilience in policies and programs designed to address natural and man-made threats. A review of those studies reveals that there is strong agreement that the concept of resilience must play a major role in assessing the extent to which various entities—critical infrastructure and key resources, systems, communities, and regions—are prepared to deal with the full range of threats they face. The literature contains various definitions of resilience. However, all these definitions generally group similar concepts. Carlson *et al.* propose a definition summarizing these concepts[1]:

> Resilience is *"the ability of an entity — e.g., asset, organization, community, region — to anticipate, resist, absorb, respond to, adapt to, and recover from a disturbance."*[2]

This definition of resilience applies regardless of the geographic scale of the study – from critical infrastructure asset level through community, regional, national, and international level of assessment.

Because critical infrastructure resilience is important both in its own right and because of its implications for community/regional resilience, it is especially important to consider its capabilities in terms of preparedness, mitigation measures, response capabilities, and recovery mechanisms. However, the resilience of critical infrastructure is not the only element to consider when considering community or regional resilience.

> Community resilience is *"a function of the resilience of the following subsystems: the community's economy, critical infrastructure (selected components), governmental and nongovernmental services (institutions), emergency services sector, and the civilian population."*[3]

Economic resilience has important implications for the ability of a community to "bounce back" from a disturbance, such as a terrorist attack. Economic variables group employment statistics, income equality, labor market conditions, and business diversification.

Infrastructure resilience in the context of community resilience is a subset of the 16 critical infrastructure sectors (Commercial Facilities, Communications, Information Technology, Energy, Healthcare and Public Health, Transportation Systems, and Water). These sectors were selected due to their criticality in the adaptation and recovery of a community once a threat has been realized.

Institutional resilience is the ability of governmental or nongovernmental units to continue to function in the event of a disturbance. This obviously has a profound impact on the community's ability to absorb, respond to, and recover from the disturbance.

Emergency services will also have a large impact on the community's ability to absorb, respond to, and recover from a disturbance, and this subsystem encompasses information and communication resilience as noted in Norris et al.[4]

Finally, civilian population resilience encompasses civil society, community capital resilience, community competence, social capital, and social resilience, which are roughly similar concepts that focus, to varying degrees, on the ability of the general public to respond to a disturbance. The public's inability to adapt, respond to, and recover from a disturbance will seriously limit the community's ability to bounce back, regardless of the resiliency of the other subsystems included here.

Considering all elements and concepts that must be integrated to address the resilience of critical infrastructure and ultimately the resilience of a region is a daunting task. As resilience assessment methodologies continue to be developed and implemented, a framework must be developed to utilize measurements of resilience at multiple levels to fully characterize a community's resilience to potential hazards (Figure 1).

[1] Carlson, L., G. Basset, W. Buehring, M. Collins, S. Folga, B. Haffenden, F. Petit, J. Phillips, D. Verner, and R. Whitfield, Resilience Theory and Applications, Argonne National Laboratory, Decision and Information Sciences Division, ANL/DIS-12-1, Argonne, Ill, USA, 2012.

[2] Ibid.

[3] Collins, M., J. Carlson, and F. Petit, Community resilience: measuring a community's ability to withstand, In: Brebbia, C.A., Kassab, A.J., and Divo, E.A.: Disaster management and Human Health Risk II – Reducing Risk, Improving Outcomes, WIT Transactions on the Built Environment, Vol. 119, Southampton, UK: WITPress, pp.111-123, 2011.

[4] Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F. & Pfefferbaum, R.L., Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness, American Journal of Community Psychology, 41(1), pp. 127–150, 2008.

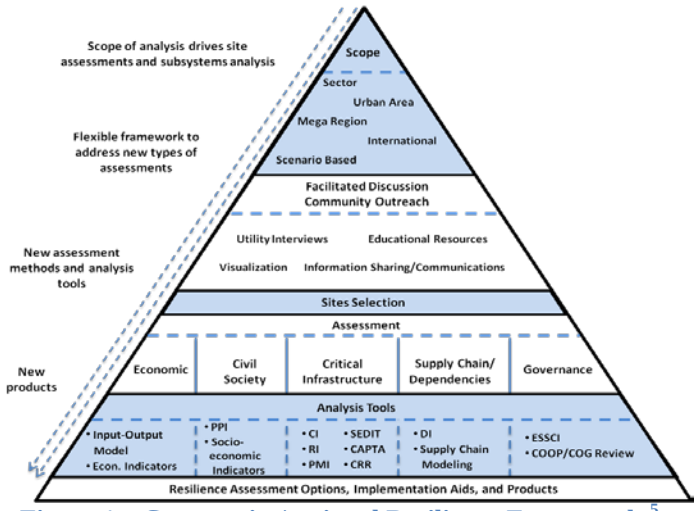

Figure 1 – Community/regional Resilience Framework.[5]

The framework must to flexible and adaptable allowing the use of different tools and methodologies. The resilience of each subsystem of the framework can be measured through various tools. Through the integration of these subsystems, a community can better understand its current resilience posture, as well as implement a systematic approach to reduce the consequences of potential threats or hazards.

The resilience of a community/region is a function of the resilience of its subsystems, to include its critical infrastructures, economy, civil society, governance (including emergency services), and supply chains/dependencies. The number and complexity of these subsystems will make the measurement of resilience more challenging as we move from individual assets/facilities to the community/regional level (where critical infrastructure resilience is only one component). Specific challenges include uncertainty about relationships (e.g., the composition of specific supply chains), data gaps, and time and budget constraints that prevent collection of all of the information needed to construct a comprehensive assessment of the resilience of a specific community or region. These challenges can be addressed, at least partially, by adopting a systems approach to the assessment of resilience.

Keywords—community resilience; critical infrastructure resilience; resilience framework

Disclaimer

[5] Carlson, L., G. Basset, W. Buehring, M. Collins, S. Folga, B. Haffenden, F. Petit, J. Phillips, D. Verner, and R. Whitfield, Resilience Theory and Applications, Argonne National Laboratory, Decision and Information Sciences Division, ANL/DIS-12-1, Argonne, Ill, USA, 2012.