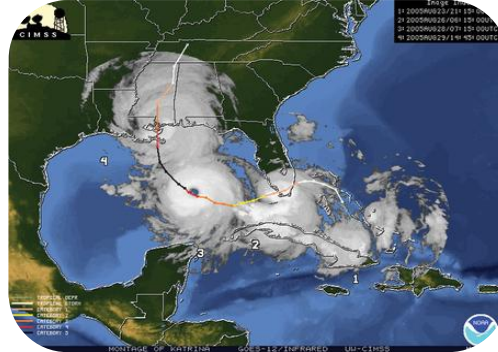
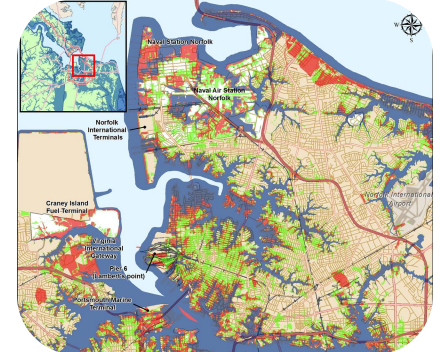


*Exceptional service in the national interest*



Track of Hurricane Katrina 2005



Projected inundation:  
Norfolk, VA flooding scenario

# Urban Resilience Analysis Framework

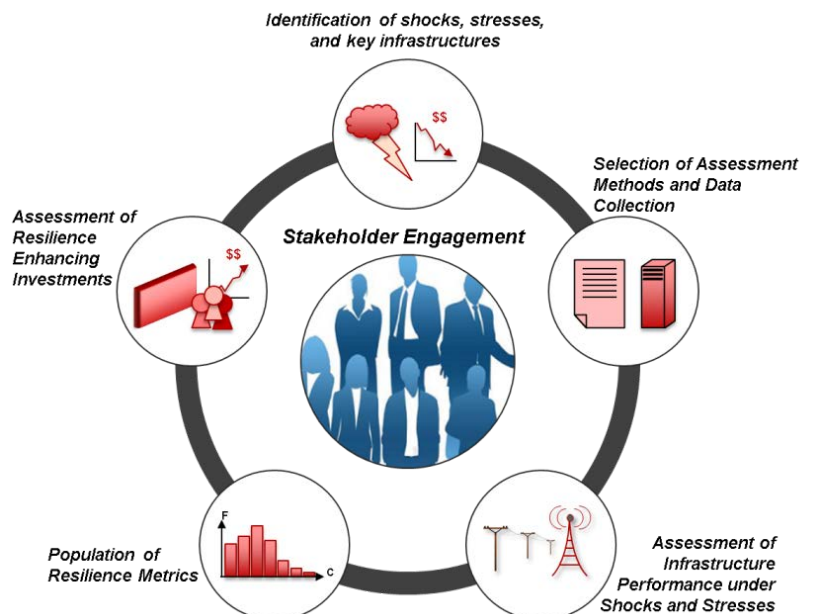
## *Sandia's Urban Resilience Analysis Process*

Sandia National Laboratories is working with urban communities to make them more resilient against a spectrum of threats and disasters. Urban communities are comprised of complex human, engineered, economic, and other systems, and planning for resilience against hurricanes, acts of terror, and other potential disasters is a significant challenge to these communities. Fortunately, Sandia has been developing computer models, data sets, and expertise for the past two decades to better understand and analyze the potential effects of disasters on critical infrastructure. Sandia applies these capabilities extensively to support the U.S. Department of Homeland Security, the U.S. Department of Energy, and other federal agencies, and now Sandia is working to leverage and extend these capabilities to support urban communities achieve their resilience goals. Sandia's five-step Urban Resilience Analysis Process\* assists urban communities to address resilience challenges.

### Stakeholder Engagement

Stakeholder engagement is critical to all process stages. Stakeholders can define the threats of concern, resilience goals, and options for enhancing resilience. They can also provide expert knowledge of the community itself. Key stakeholders typically include decision-makers, asset owners and operators, city managers, utility representatives, emergency planners, and local industry.

\* Adapted from Biringir et al. 2013. Critical Infrastructure System Security and Resilience, CRC Press.



## Shocks, Stresses, and Infrastructures

The first step in the process is specifying which critical threats the stakeholders are concerned about and want to be resilient against. These threats are comprised of shocks and stresses. Shocks are acute threats that occur abruptly, creating immediate, significant consequences. Stresses can be just as damaging, but occur more gradually over longer periods of time. Threats of concern will likely vary from one community to another, and specifying these threats establishes the scope of the analysis.

## Assessment Methods and Data Collection

Selection of appropriate resilience metrics provides an objective, quantitative means for assessing the current state of resilience and measuring how proposed measures would increase resilience. These metrics are developed in collaboration with the stakeholders to ensure that the metrics represent functionality of key urban systems. Data collection is the first step toward populating the metrics.

## Infrastructure Performance Assessment

Sandia works with local infrastructure experts to assess and measure how critical infrastructure operations are affected when shocks and stresses occur. These assessments can be performed by reviewing previous incidents, subject matter opinion, and/or computer simulation. Sandia specializes in integrated infrastructure performance assessment, so interdependencies between infrastructures can be included during this stage of the analysis. Dependency modeling can also help determine how consequences could spread beyond the urban area and to the region, nation, and even globally.

## Populating Resilience Metrics

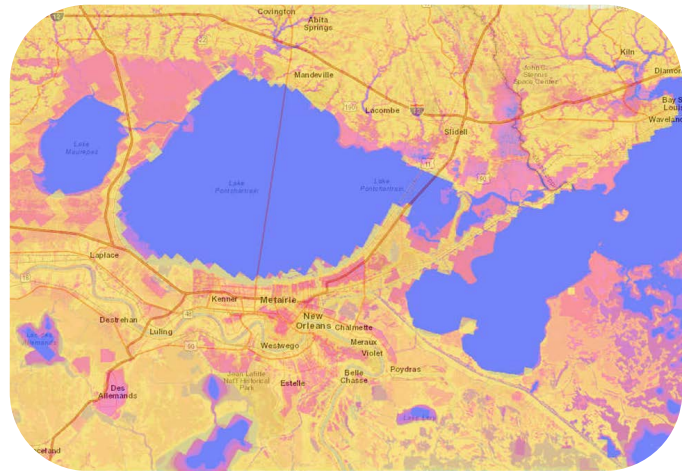
In this stage, the resilience analysts integrate the resilience metrics, collected data, and infrastructure assessments to establish a resilience baseline, i.e., how resilient is the community against the threats if no actions are taken?

## Resilience Enhancing Investments

Ultimately, the goal of the analysis process is to ensure the urban areas are sufficiently resilient to these threats. So after determining baseline levels of resilience, Sandia and the stakeholders discuss potential options and investments for improving resilience. Assessments are repeated with these options in place to measure the benefits and costs of the options relative to the baseline.

When the process is concluded, decision makers have the necessary data to make informed decisions on how to best and most cost-effectively plan for resilience.

*Projected flooding: New Orleans rainfall scenario. This analysis is being used to assist decision makers with electric grid investments to improve community resilience to storms.*



Flood calculations in collaboration with Los Alamos National Laboratory

## For More Information

Access related materials at [www.sandia.gov/cities](http://www.sandia.gov/cities) or contact:

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