

A Spatially Explicit Decision Support Framework for Parcel- and Community-Level Resilience Assessment using Bayesian Networks

Session 5: User case – how to do research with IN-CORE

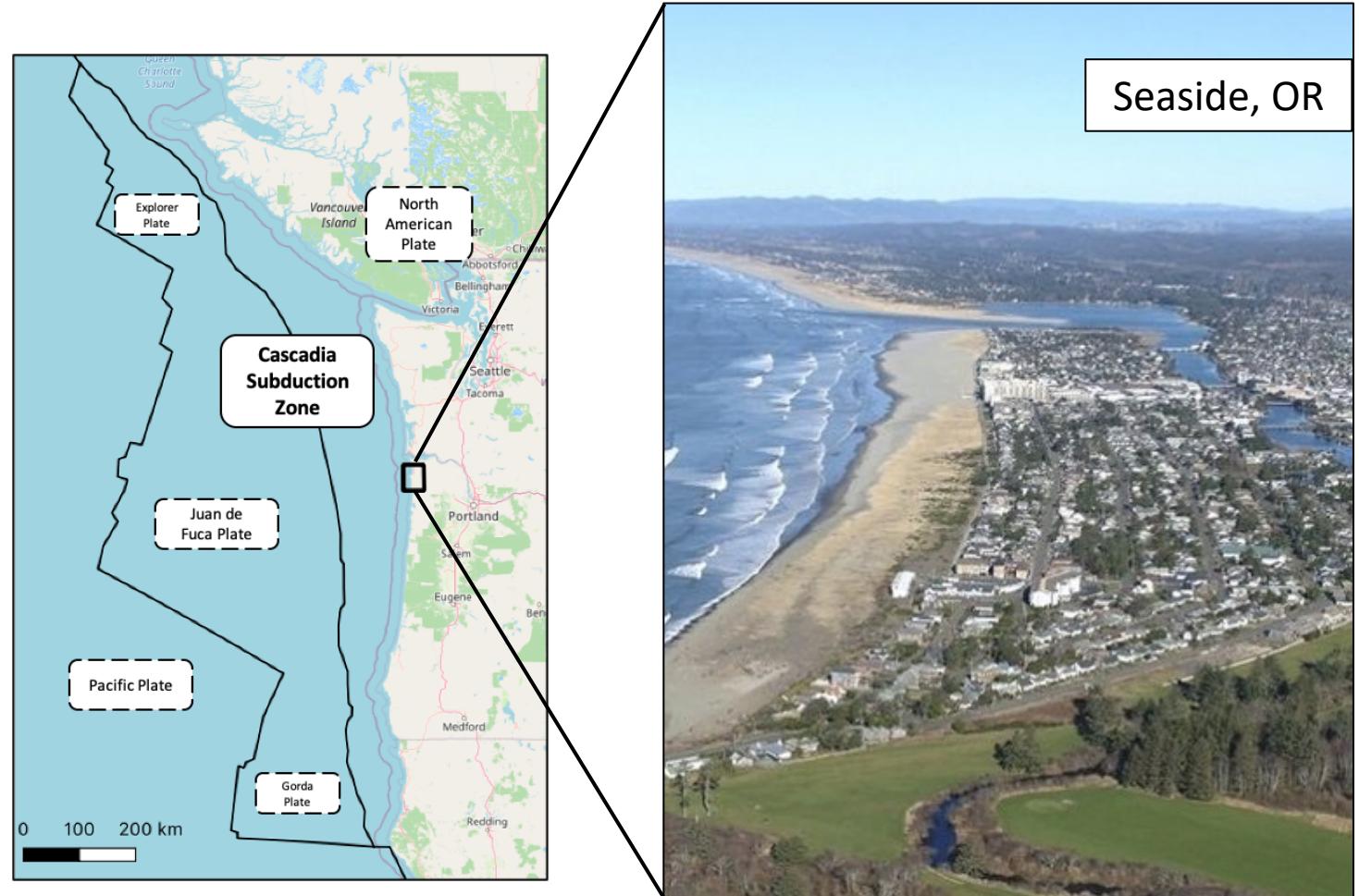
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^a Oregon State University

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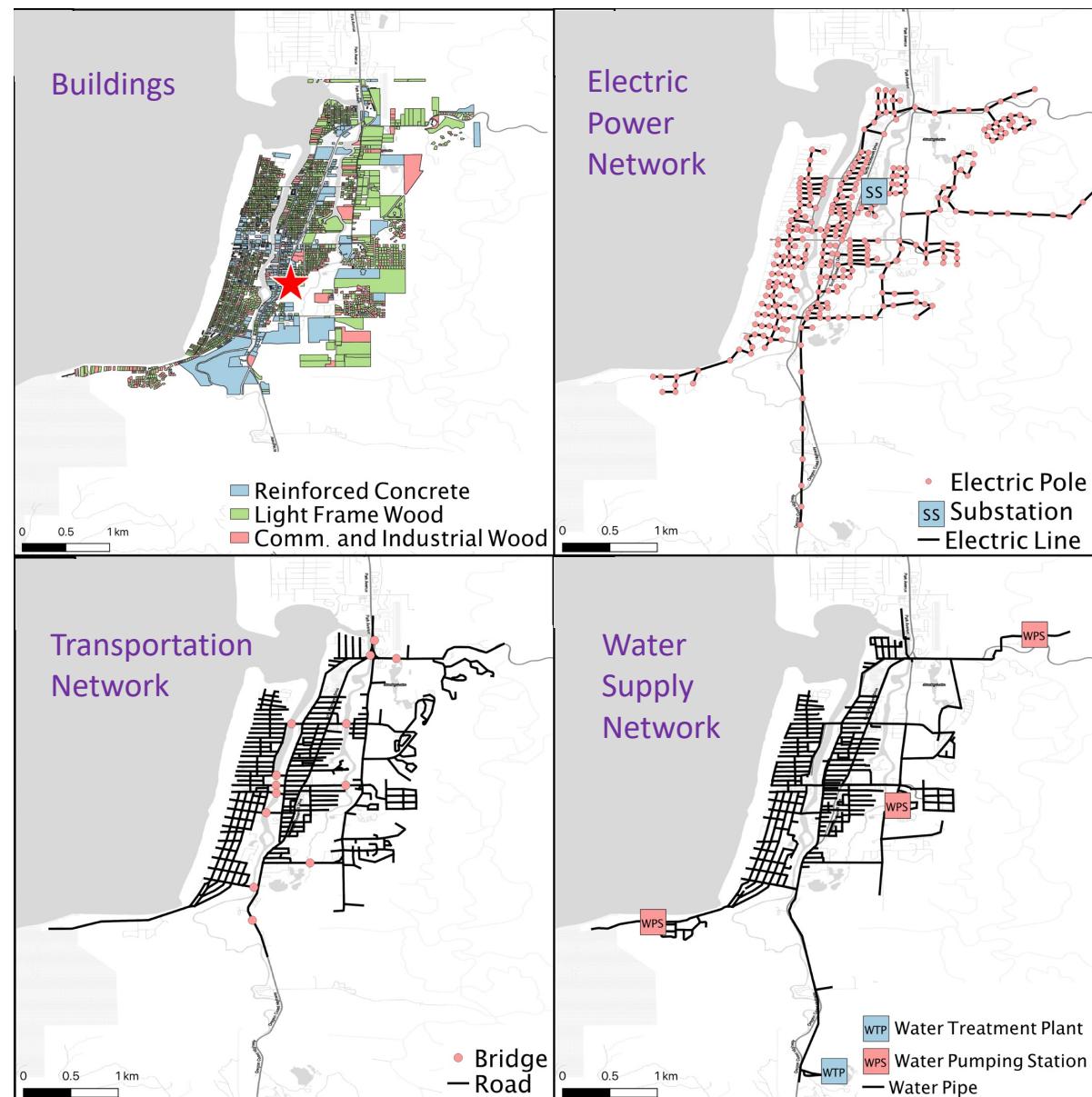
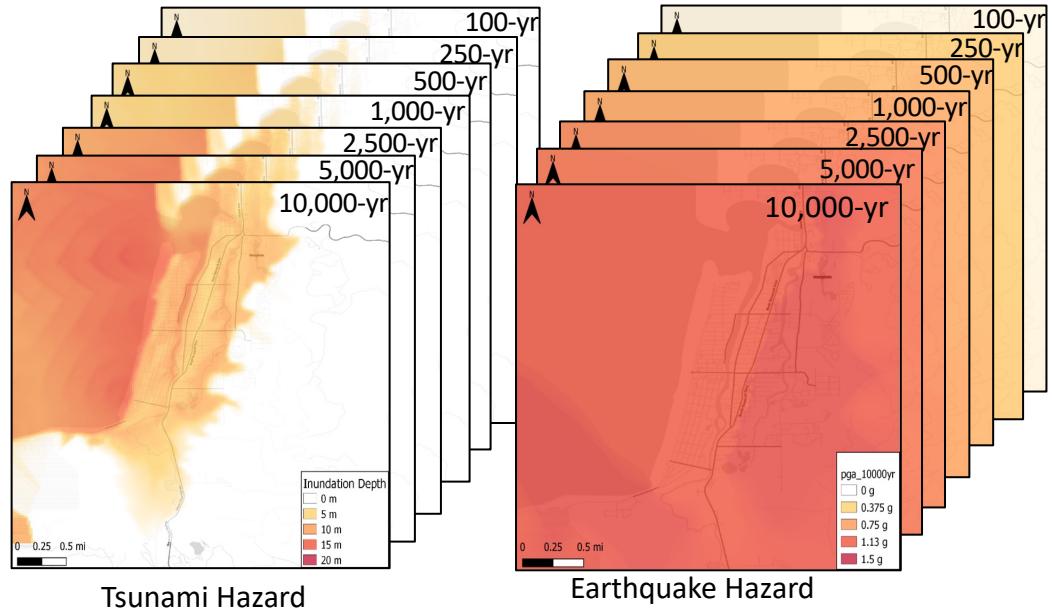
Testbed Community: Seaside, Oregon

- Located in Pacific Northwest
- Multi-hazard testbed
 - Cascadia Subduction Zone (CSZ)
 - Earthquake
 - Tsunami
- Population: 6,892 (2020 census)
- 87% developed land in inundation zone
 - Wood, 2007
- Among Oregon coastal towns: Largest number of residents with high social vulnerability index
 - Wood *et. al.*, 2008



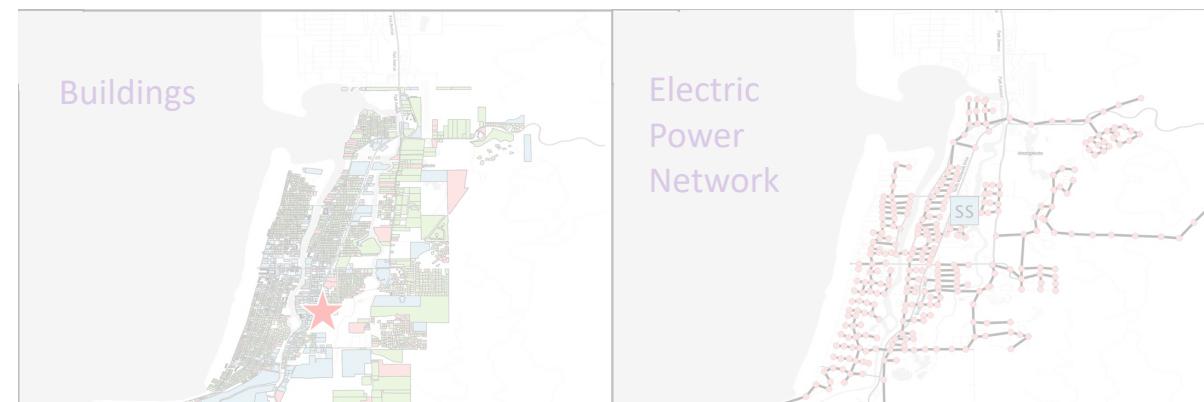
Test Bed Community: Seaside, Oregon

- Hazards from Probabilistic Seismic Tsunami Hazard Analysis (PSTHA: Park *et al.*, 2017)
 - IN-CORE Hazard Viewer
- Four infrastructure systems
 - IN-CORE Data Viewer

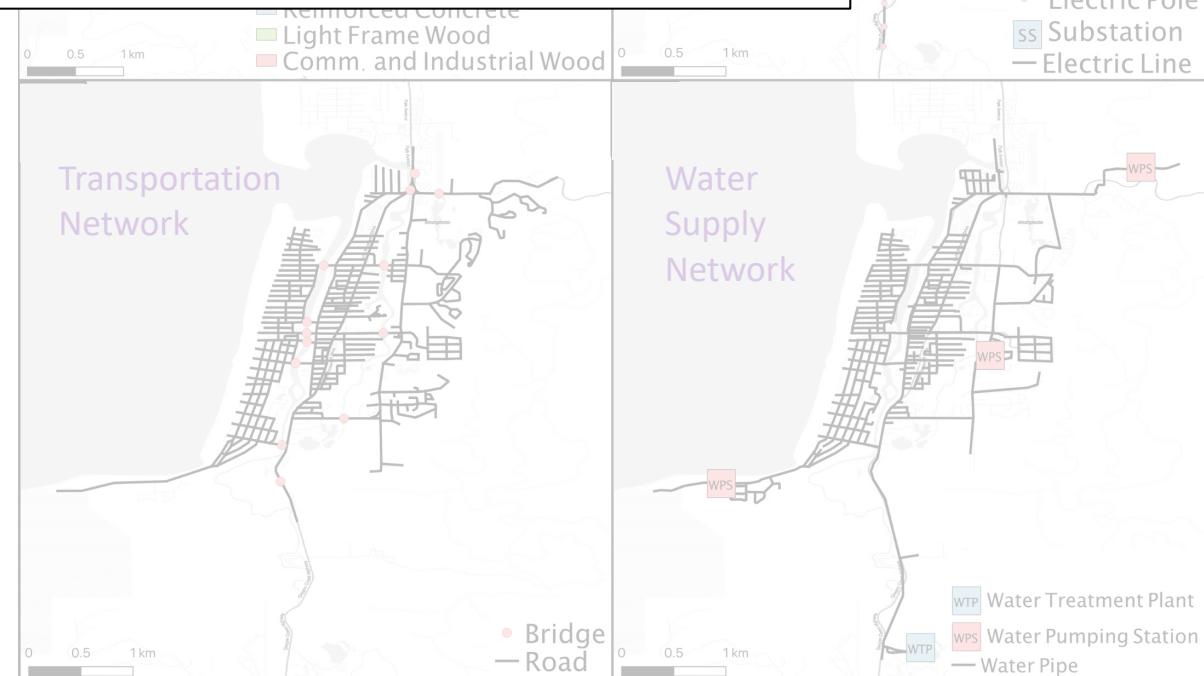
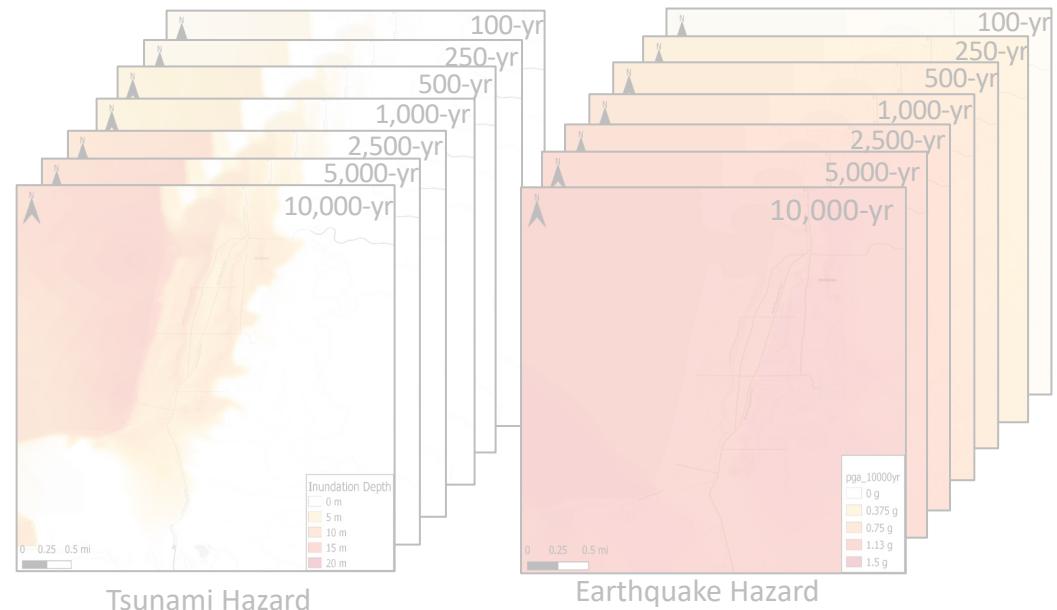


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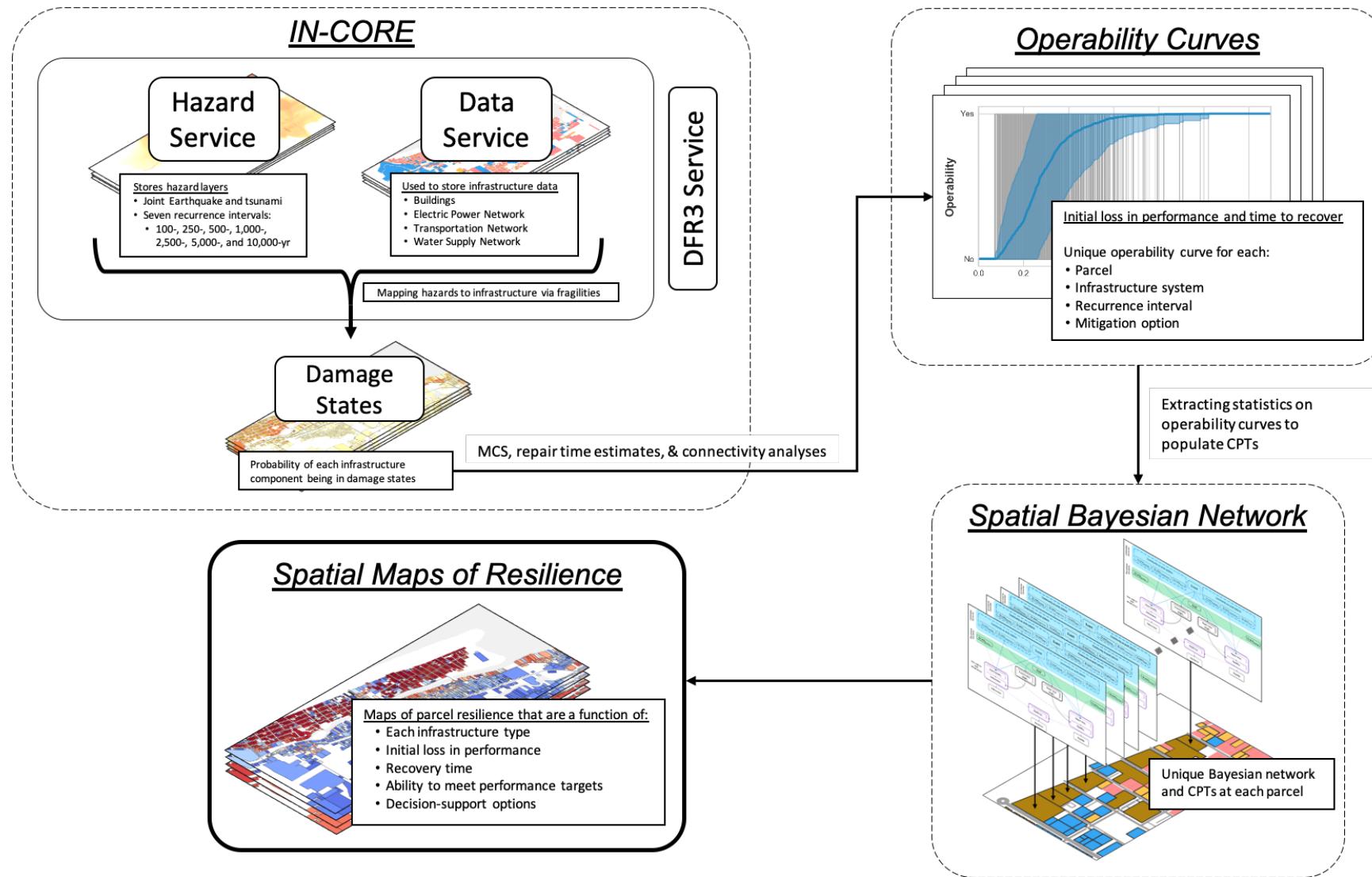
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Motivating question: How *resilient* are parcels within a community given that they rely on infrastructure systems



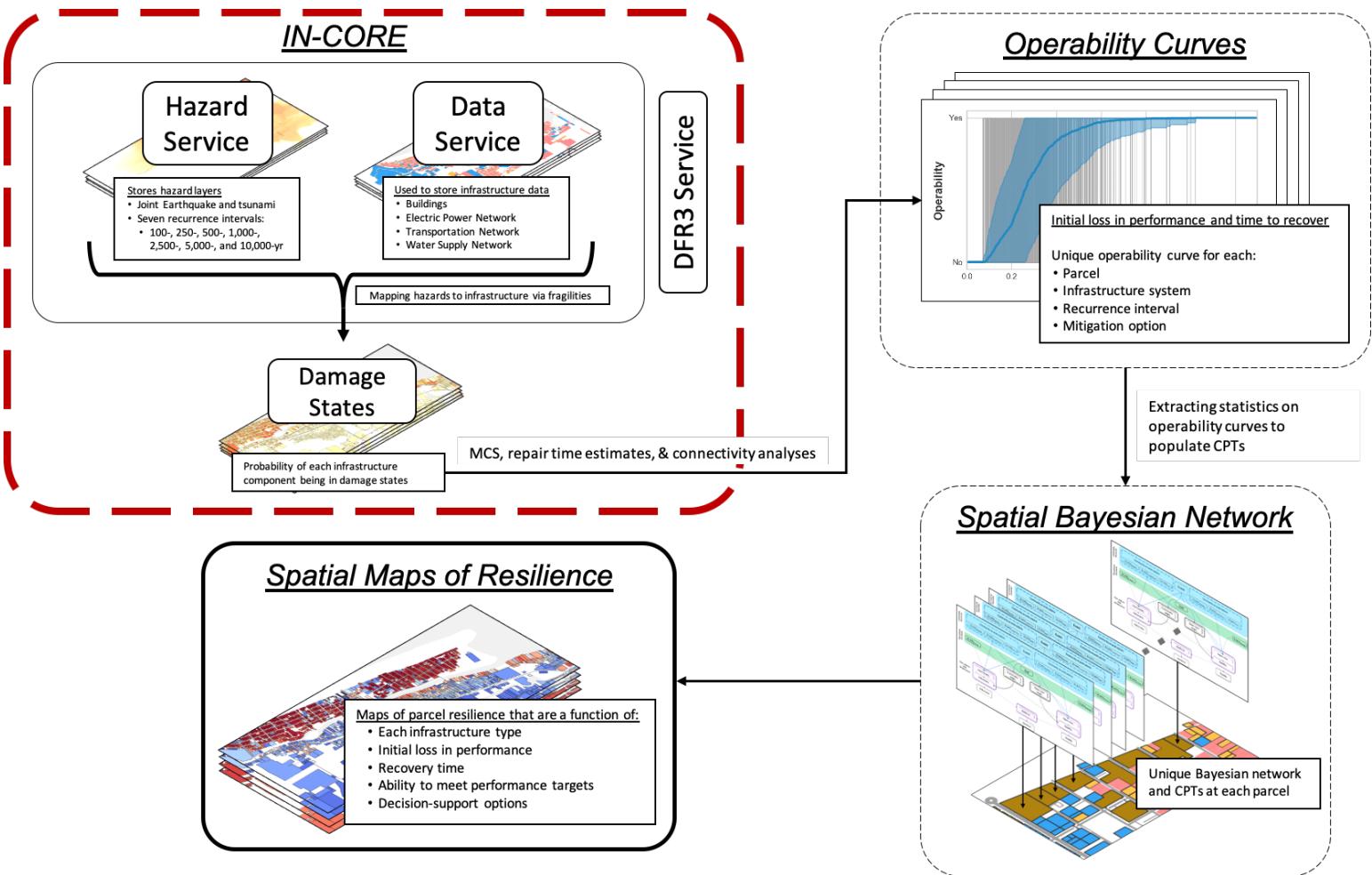
Framework



Framework

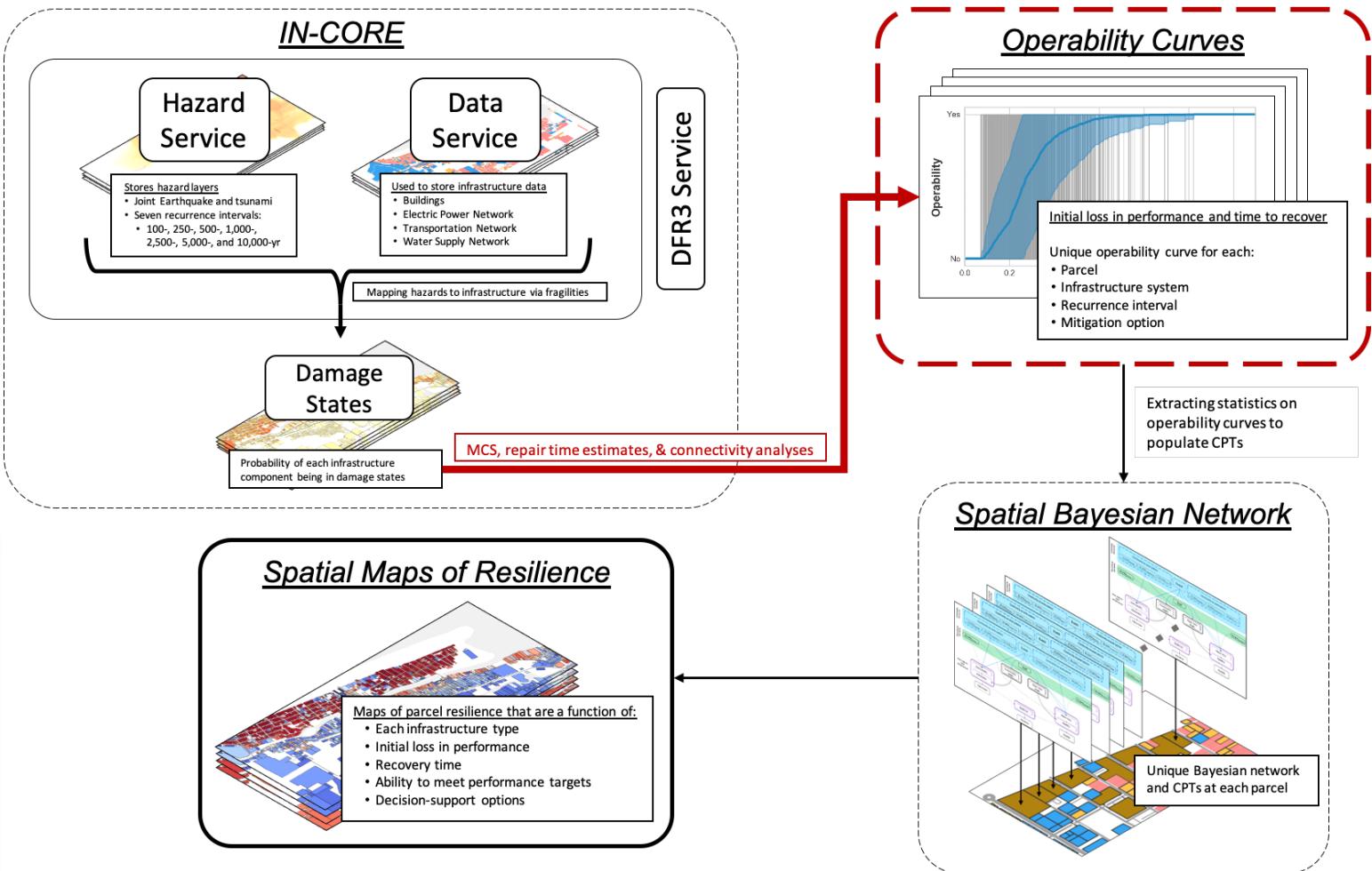
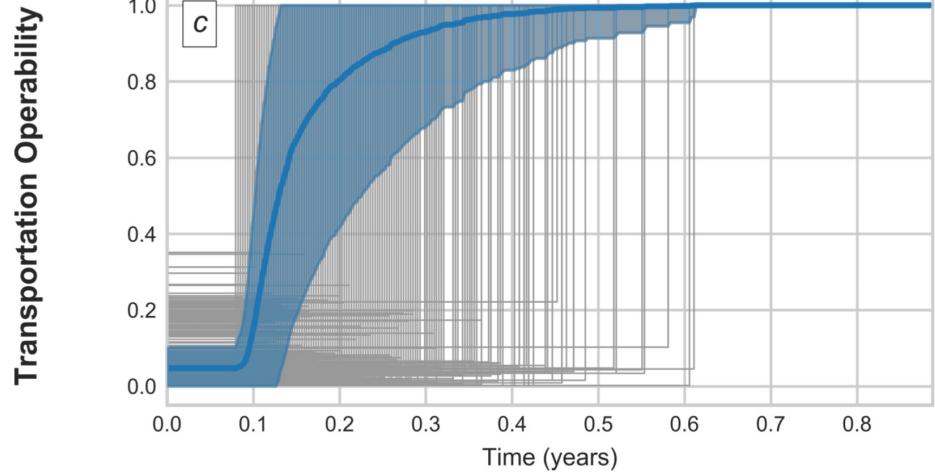
- Hazard Service stores hazard layers
- Data Service stores infrastructure
- DFR3 Service mapping hazard to infrastructure
- Using 8 damage modules from pyIncore
- <https://incore.ncsa.illinois.edu/doc/pyincore/modules.html>
- Return damage state probabilities

Infrastructure	pyIncore Module
Buildings	<i>buildingdamage</i> <i>cumulativebuildingdamage</i>
Electric	<i>epdfdamage</i>
Transportation	<i>roaddamage</i> <i>bridgedamage</i>
Water	<i>pipelinedamage</i> <i>pipelinedamagerepairrate</i> <i>waterfacilitydamage</i>



Framework

- Using output from pyIncore
- Monte-Carlo simulation
- Repair time estimates
- Connectivity analysis
- Create operability curves at each parcel

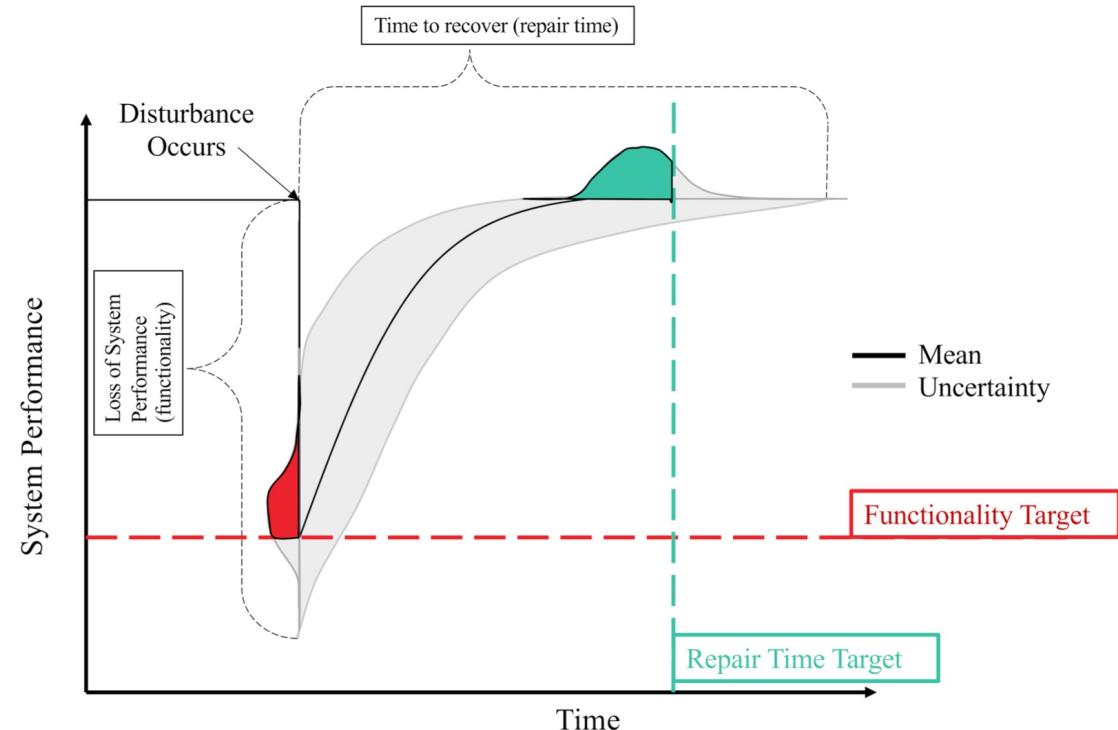
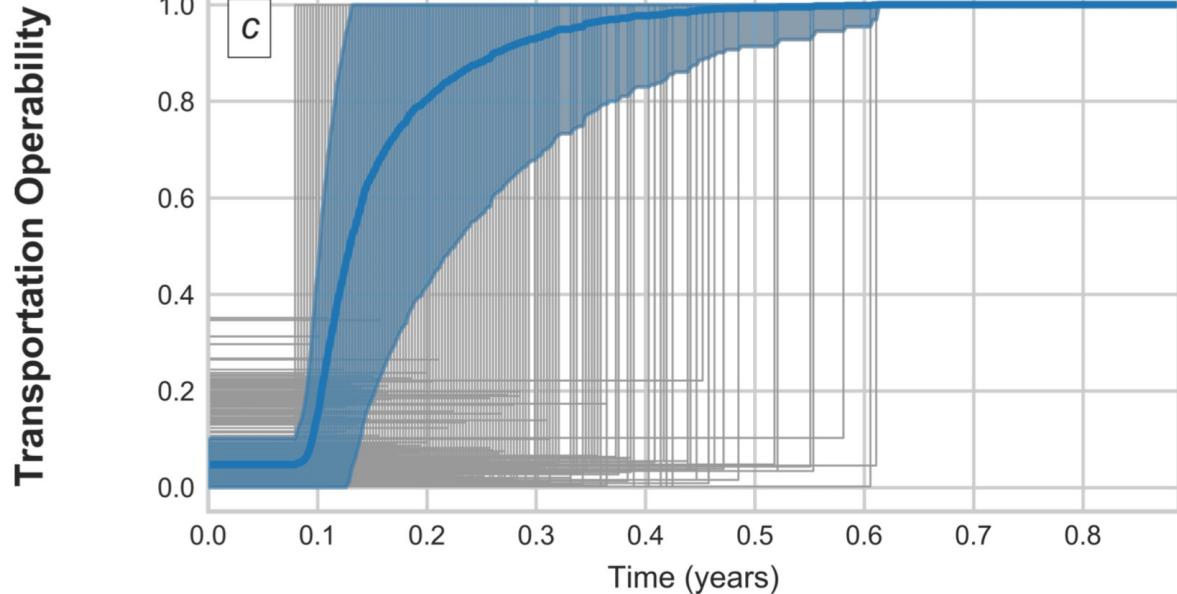


Framework

- Operability curves analogous to resilience curves
- Robustness: Probability of meeting functionality target
- Rapidity: Probability of meeting repair time target
- Resilience: Joint probability of robustness and rapidity

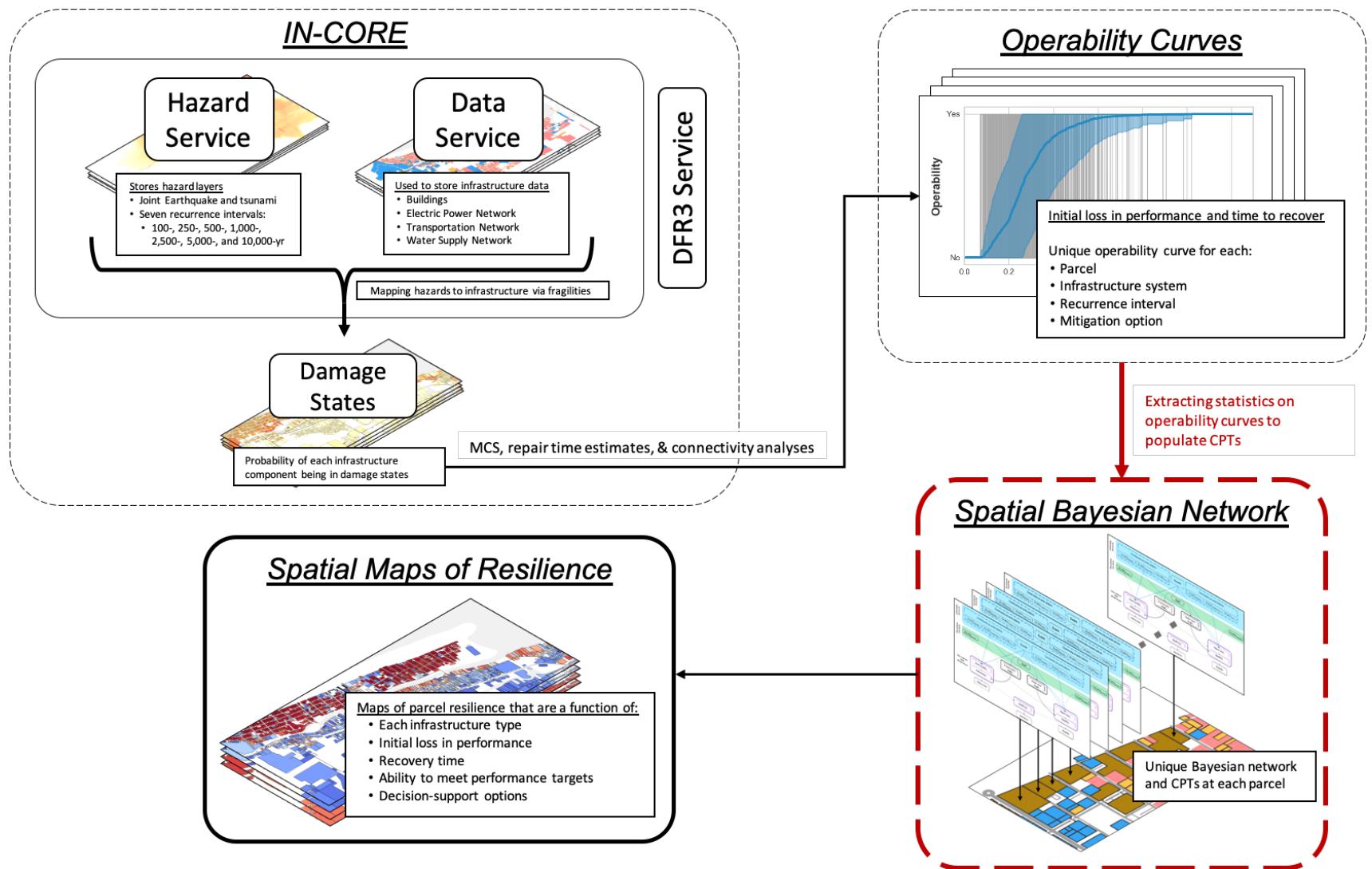
Quantifying Resilience:

- Chang and Shinozuka (2004)
- Schultz *et. al.* (2016)
- Kameshwar *et. al.* (2019)



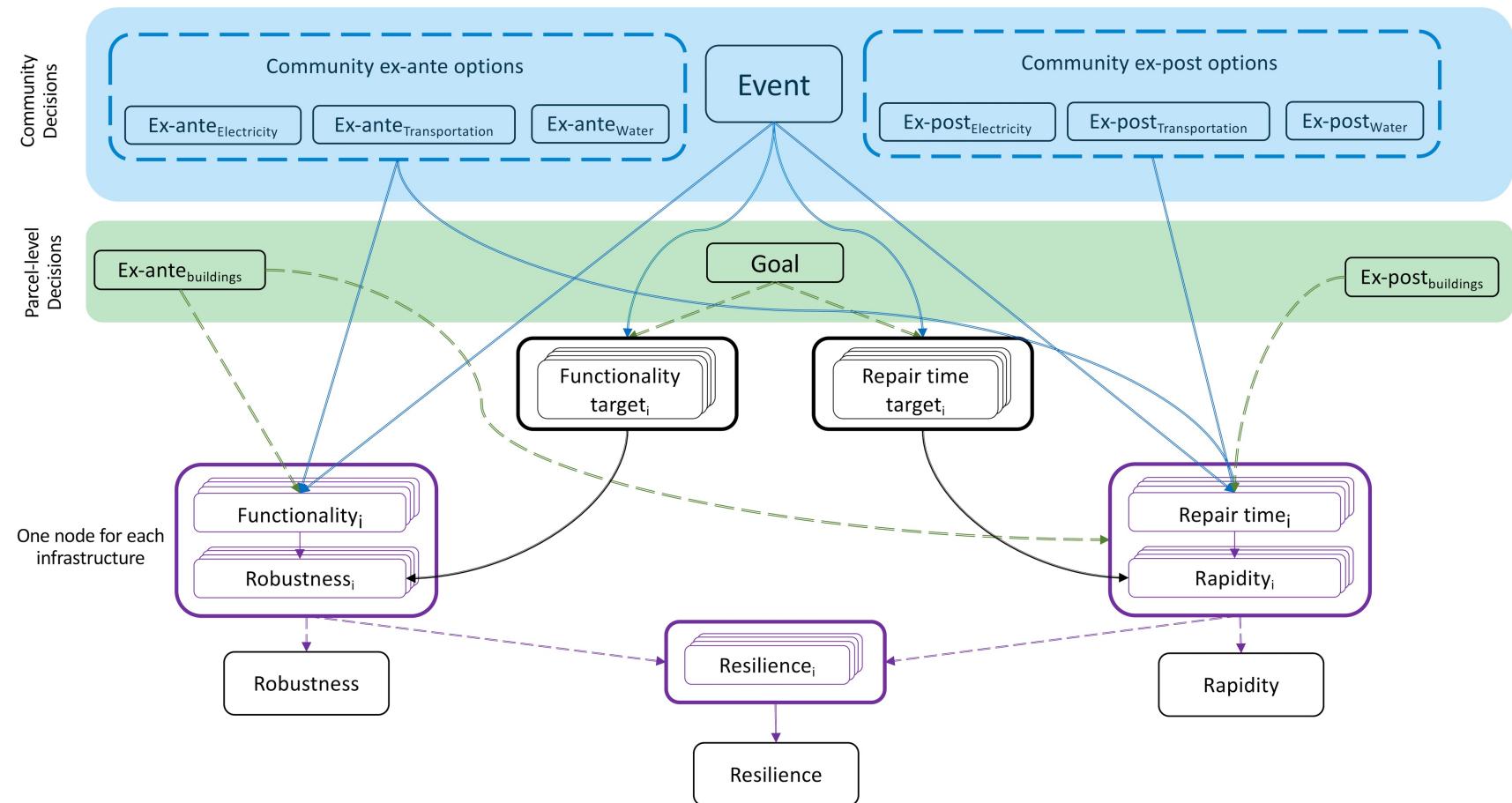
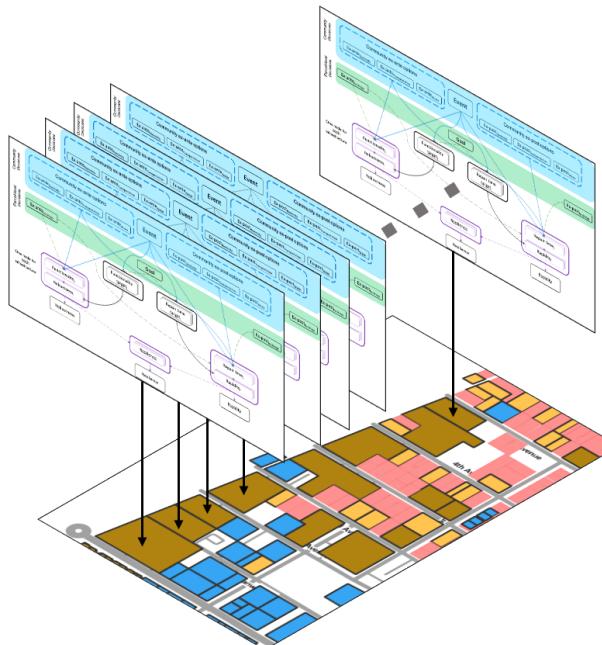
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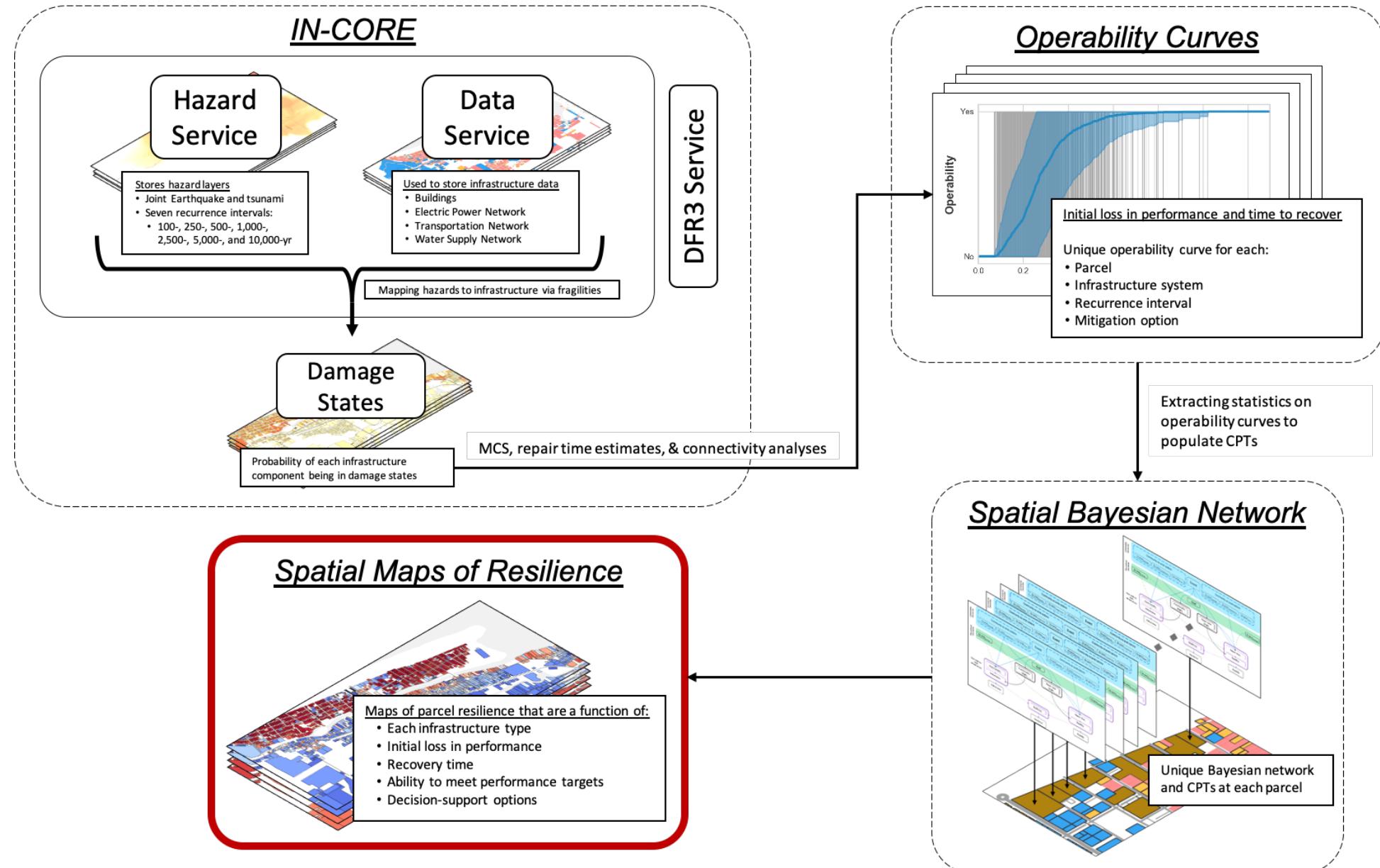
- Extract statistics from operability curves
- Populate spatial Bayesian network
- Decision nodes:
 - Community-level
 - Parcel-level
- Performance Targets
- Robustness, rapidity, and resilience
- BN applied at parcel-level



Framework

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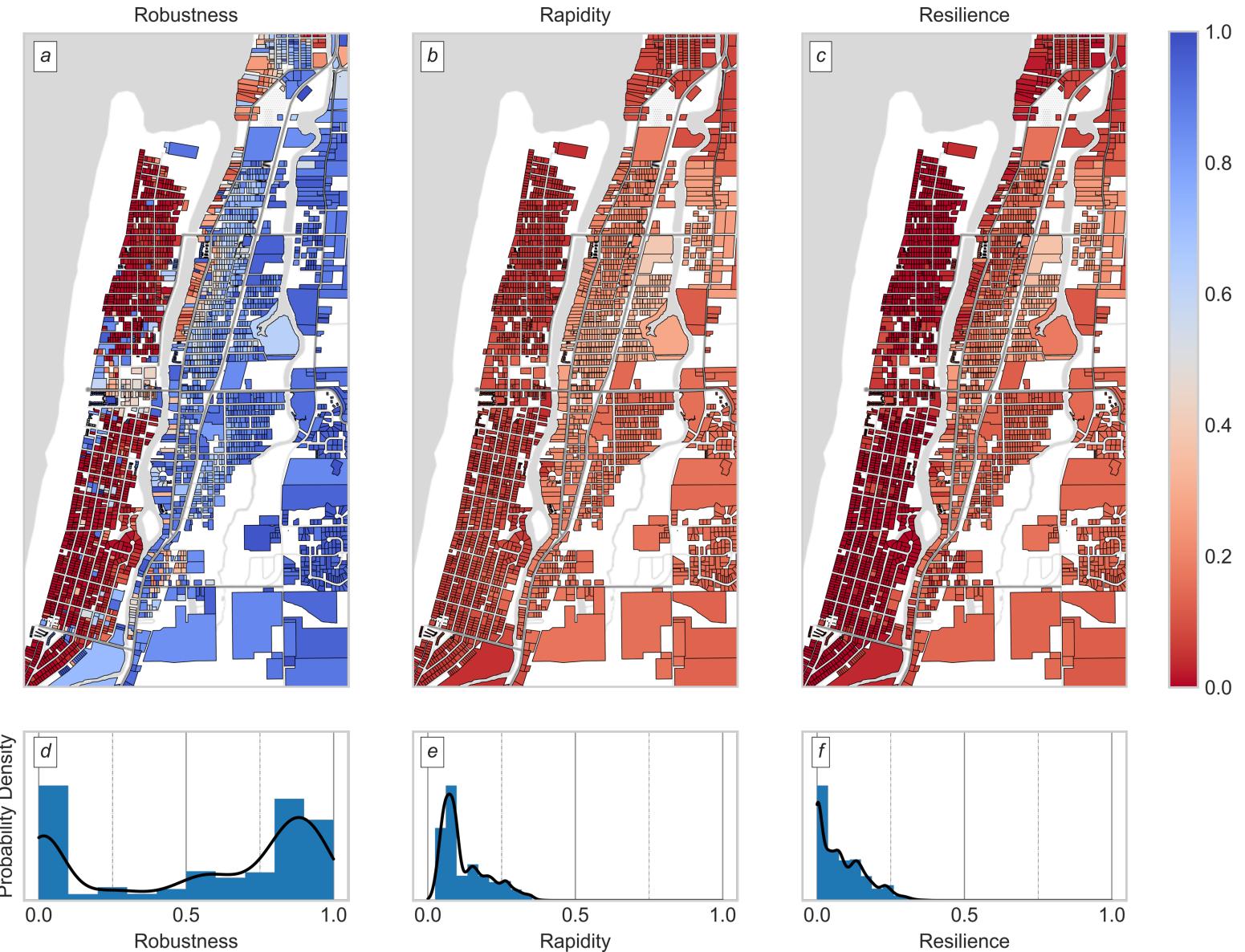




Results

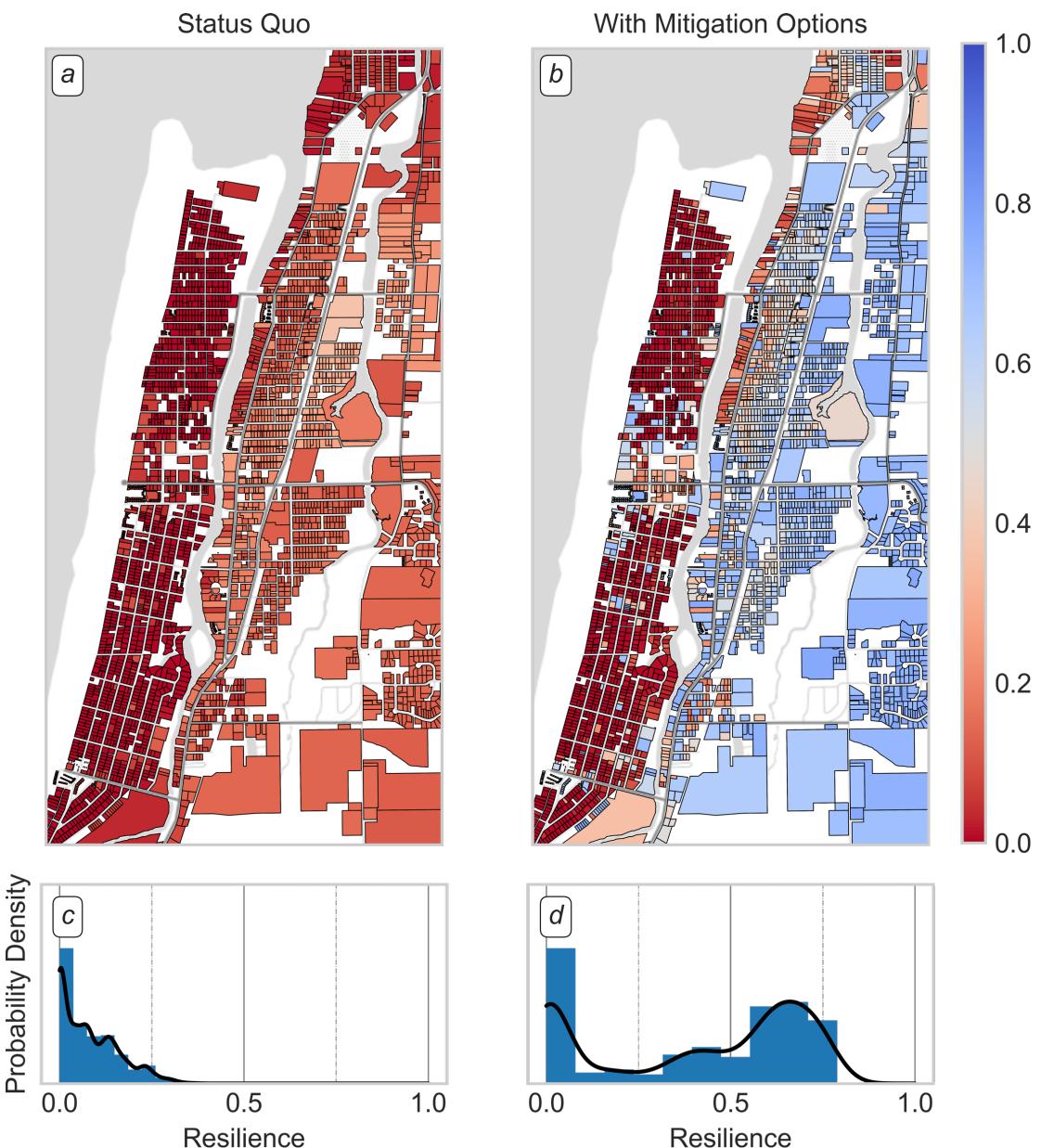
- 1,000-yr event
- Status-quo decision options
- Easy performance targets
- Robustness, rapidity, and resilience

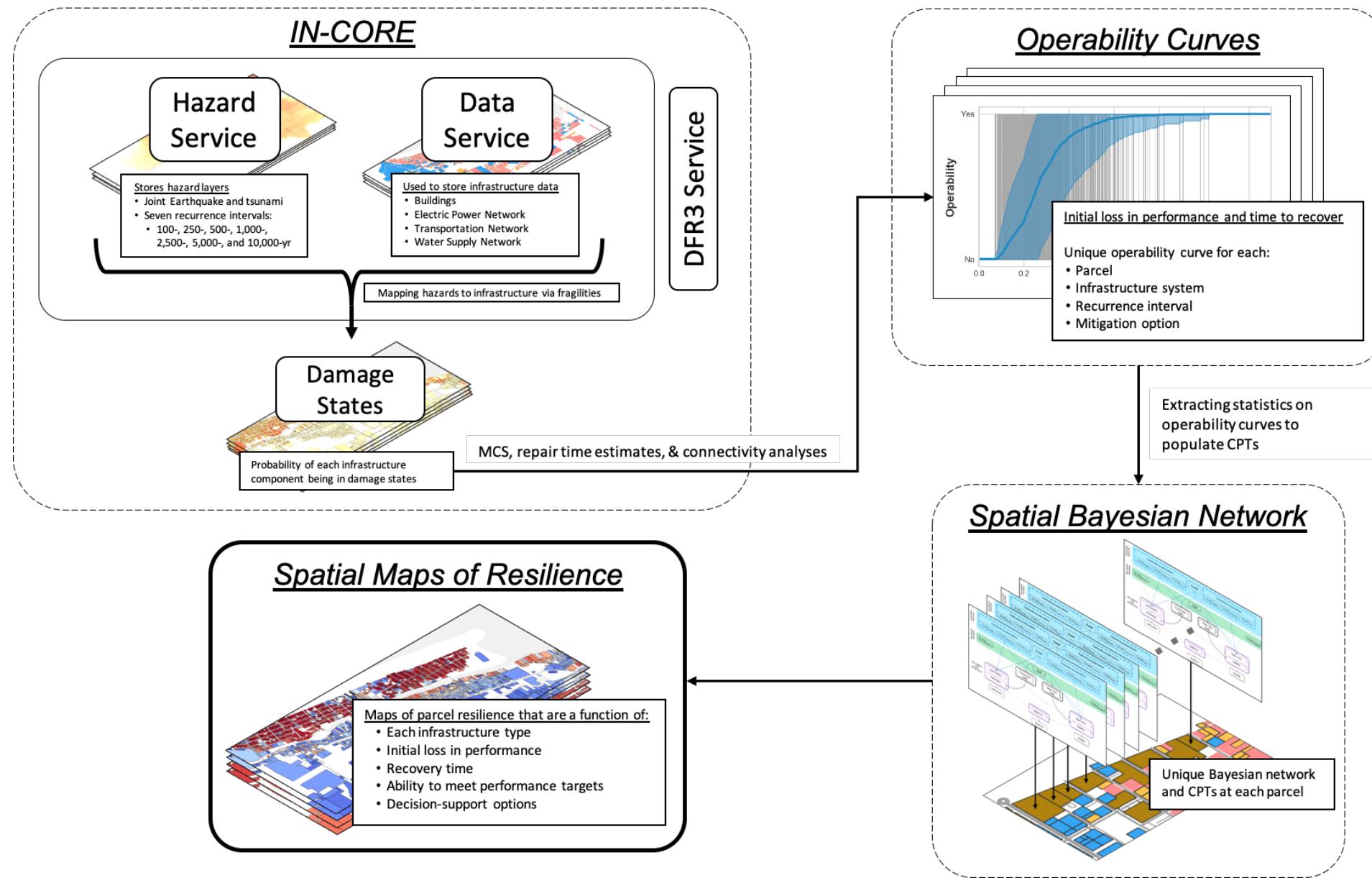
- With mitigation options:
 - Electric and water infrastructures retrofitted



Results

- 1,000-yr event
- Status-quo decision options
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- Robustness, rapidity, and resilience
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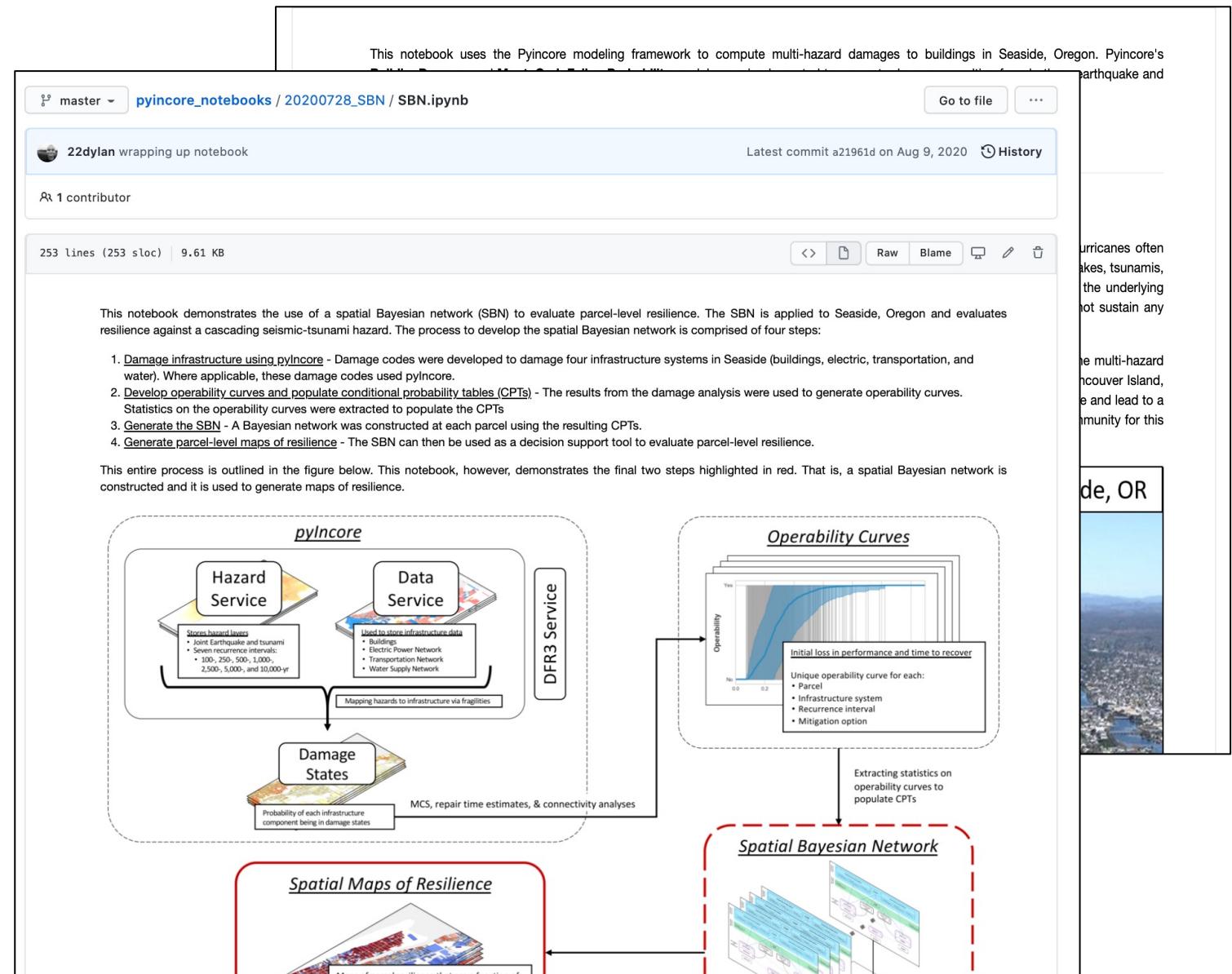


Questions and Discussion

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https://github.com/22dylan/pyincore_notebooks



Sanderson, D., Cox, D., and Naraharisetty, G. (in revision). A Spatially Explicit Decision Support Framework for Parcel- and Community-Level Resilience Assessment using Bayesian Networks. *Sustainable and Resilient Infrastructure*.