



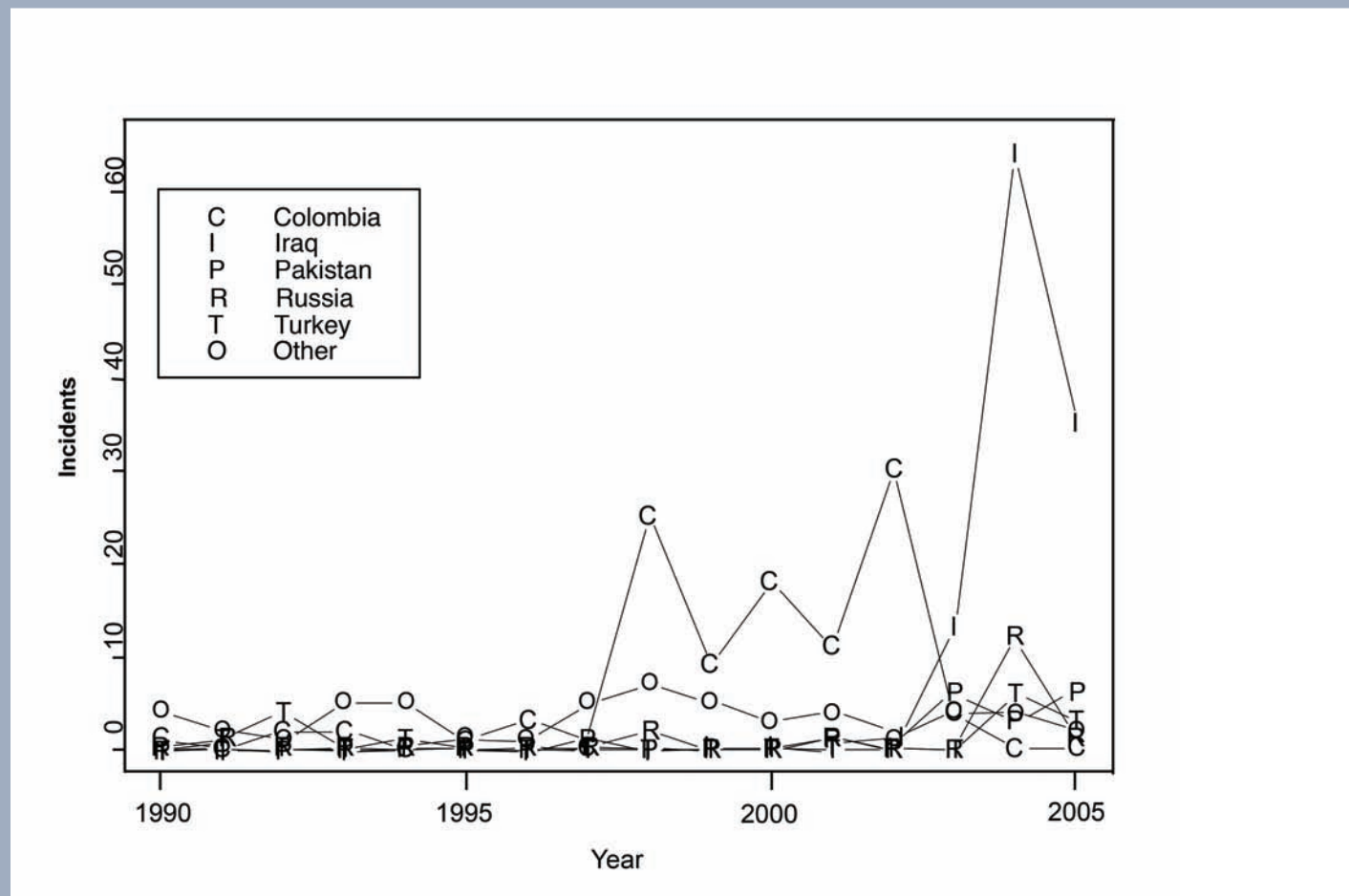
TRENDS AND PATTERNS IN OIL & GAS INDUSTRY VULNERABILITIES

New York University - Wagner Graduate School of Public Service, Institute for Civil Infrastructure Systems (ICIS) (www.nyu.edu/icis)

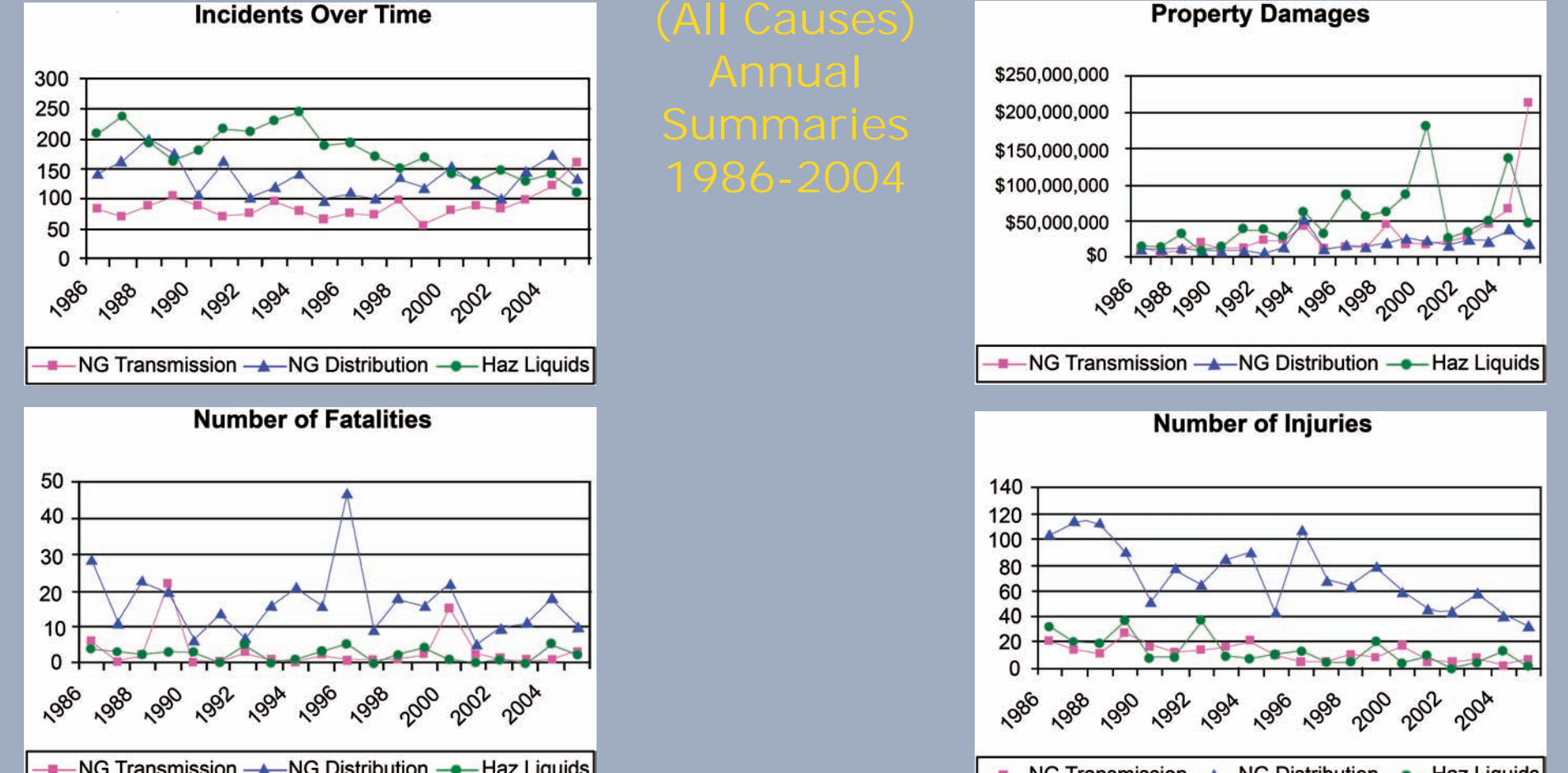
INTRODUCTION

- Oil and gas facilities face threats from terrorist attacks and natural hazards
- Incident trends and patterns and their causes (including process control systems) provide estimates of vulnerability
- Measures of spatial concentration and interdependencies between oil and gas and other infrastructure provide a means to quantify vulnerability

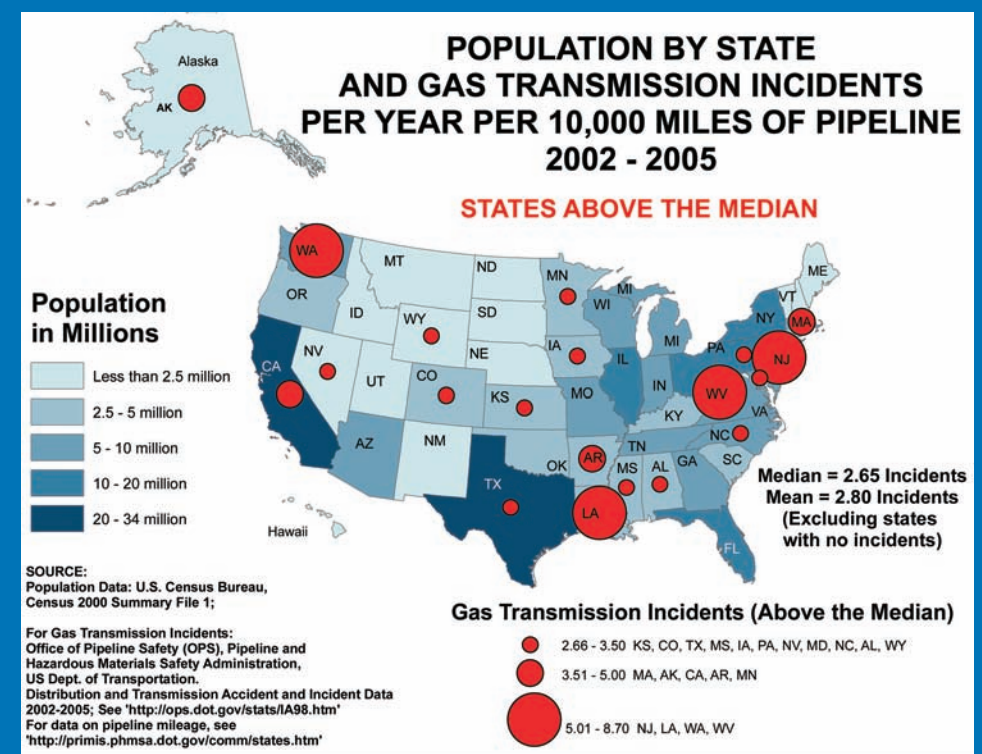
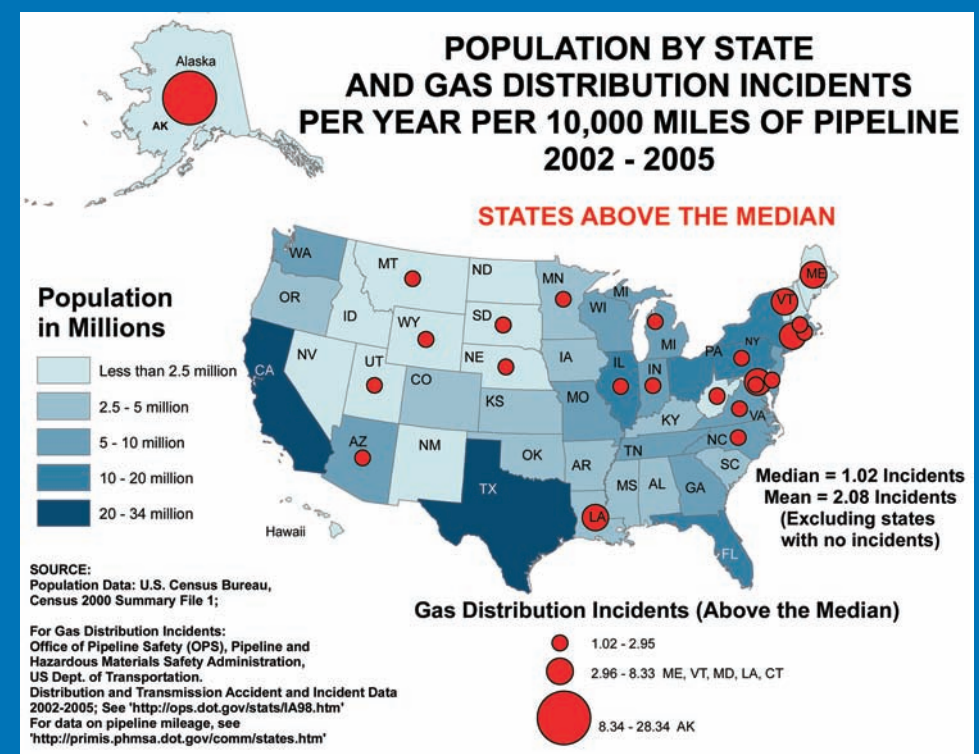
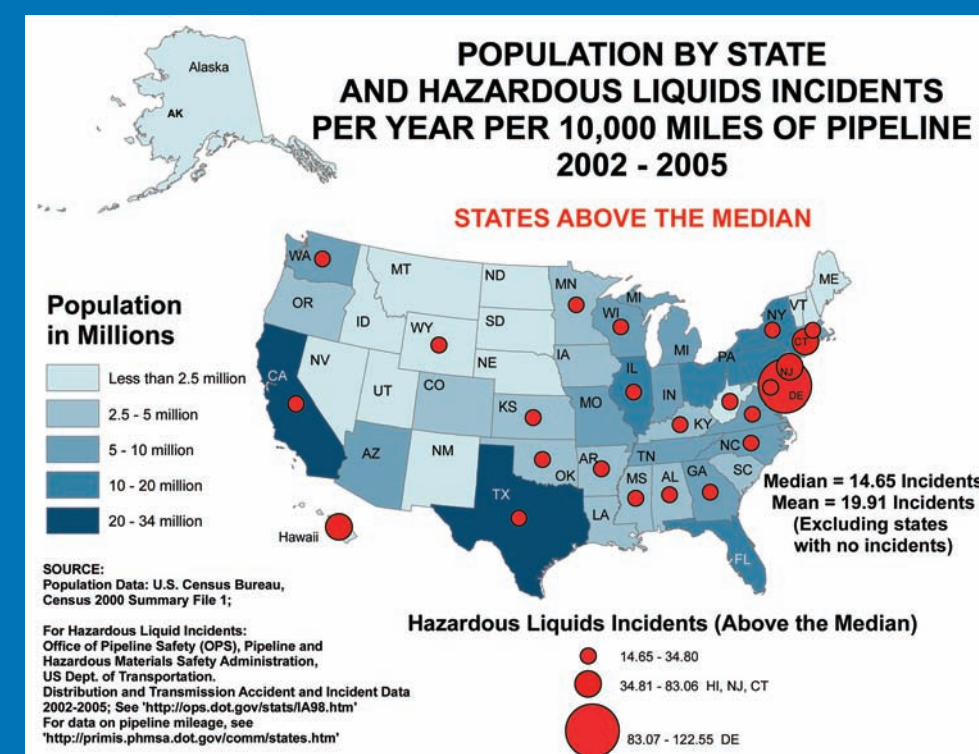
Terrorism: Trends in International Oil & Gas Terrorist Attacks



U.S. Non-Terrorism Outages: Initial Descriptive Statistics for Incidents (All Causes)



Location of Oil & Gas Non-Terrorist Outages



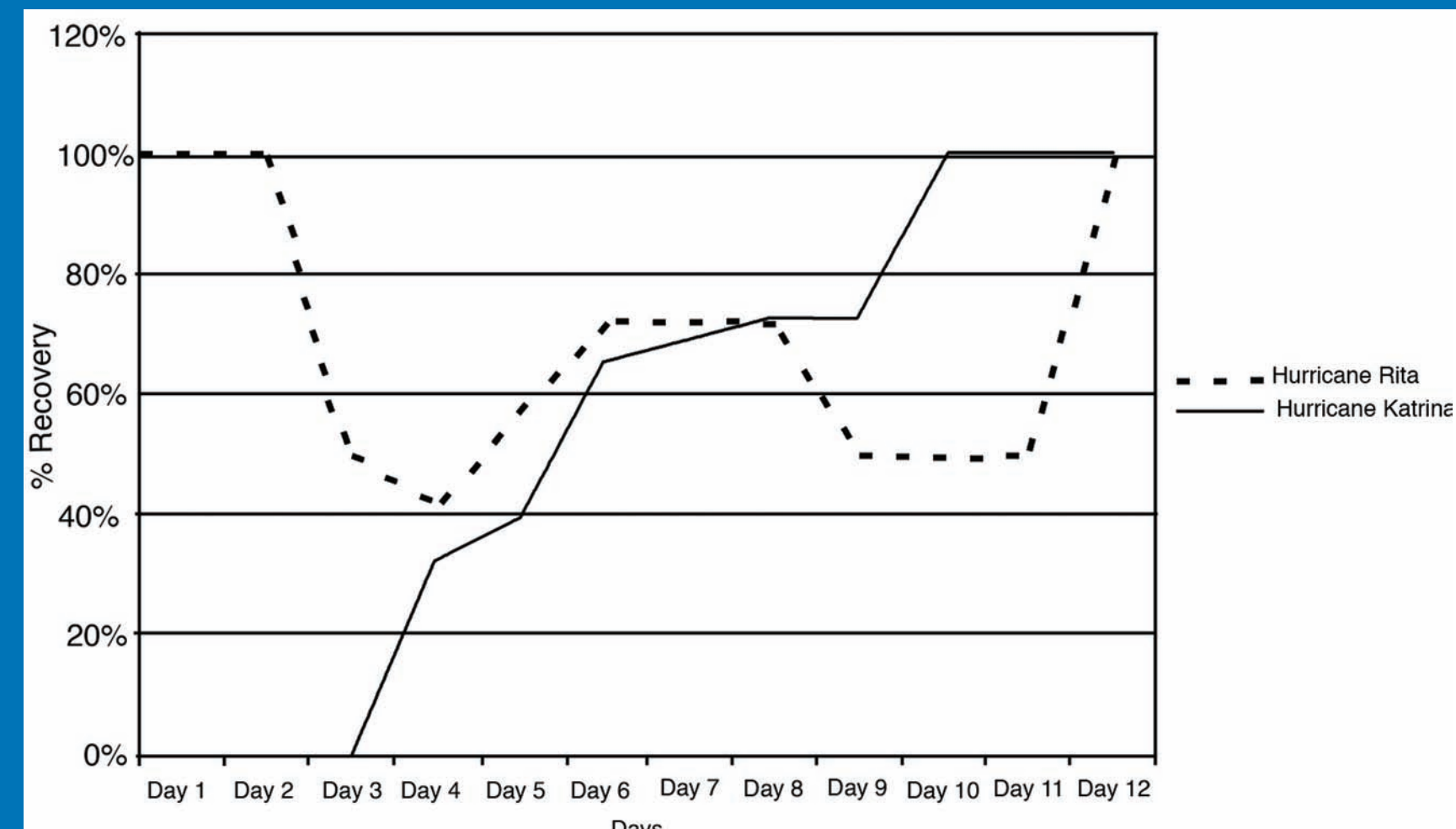
INTERDEPENDENCIES AND CASCADING EFFECTS ON OIL & GAS

Interdependency Consequences: SCADA/IT Disruptions of Oil & Gas

Year	Facility / Location	Industry	Description	Consequences
1999	Olympic Pipeline, Washington	Oil and Gas	SCADA failure contributed to a pipeline incident.	SCADA system became unresponsive and prevented operation of pumps to alleviate pressure build-up. Gasoline leaked and caught fire, and 1.5 miles of shoreline were damaged and three people were killed.
2004	Gulf of Mexico	Oil and Gas	Sasser worm disrupted several oil platforms	Oil platforms were disrupted for two days.

Source: NYU-Wagner/ICIS for the Institute for Information Infrastructure Protection (I3P) at Dartmouth College, SCADA Project.

Energy Infrastructure Impacts and Restoration - Colonial Pipeline, Gulf Coast Hurricanes 2005



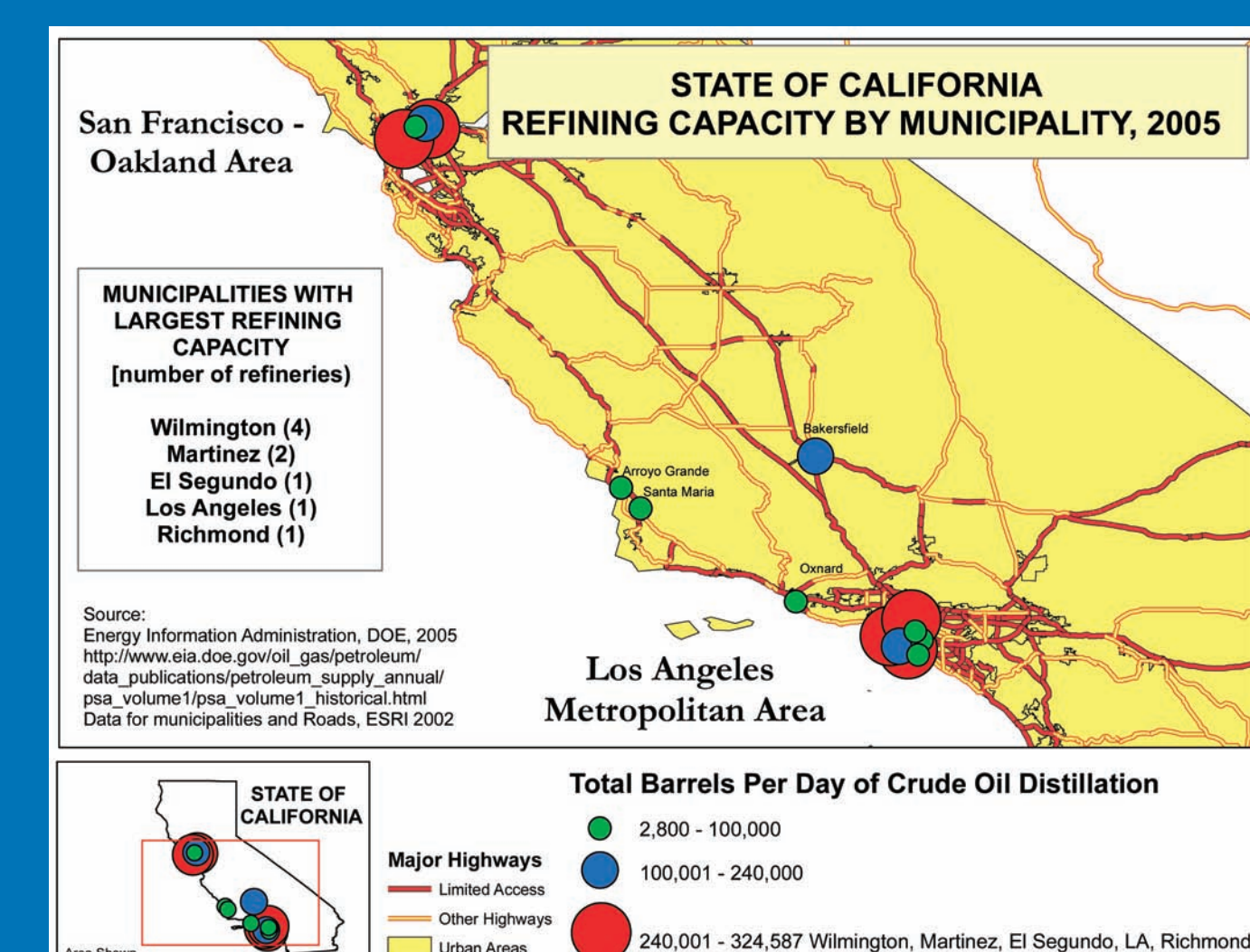
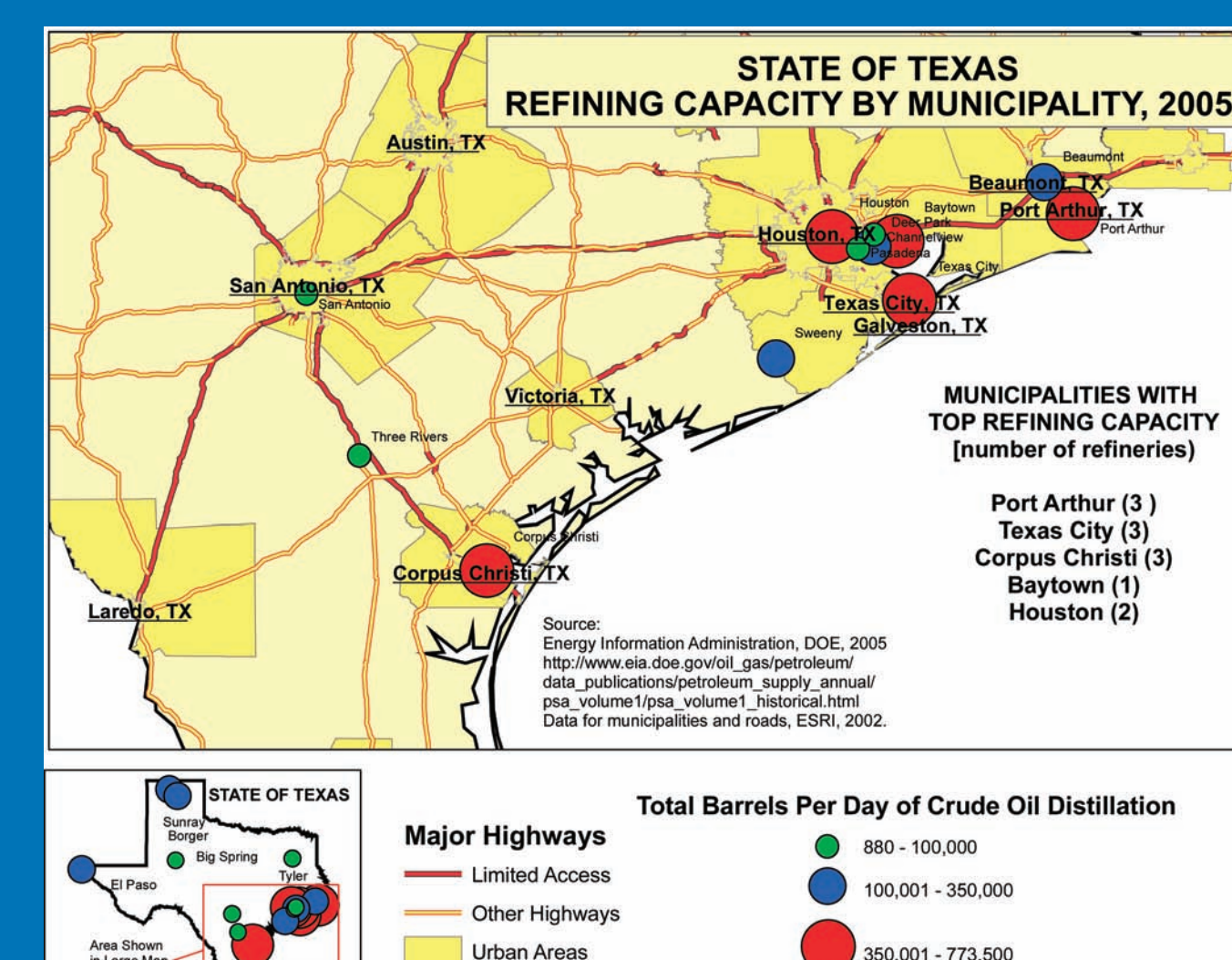
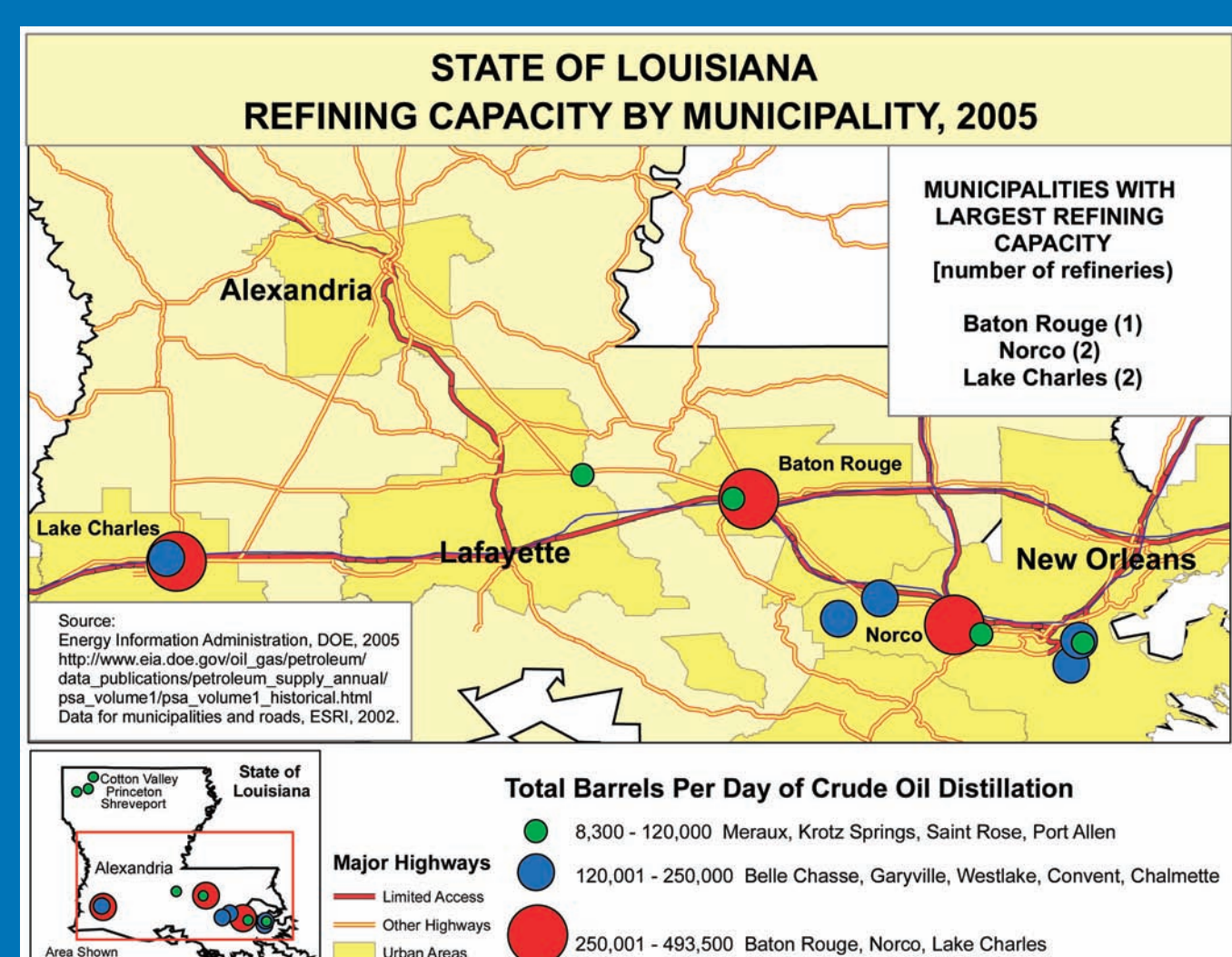
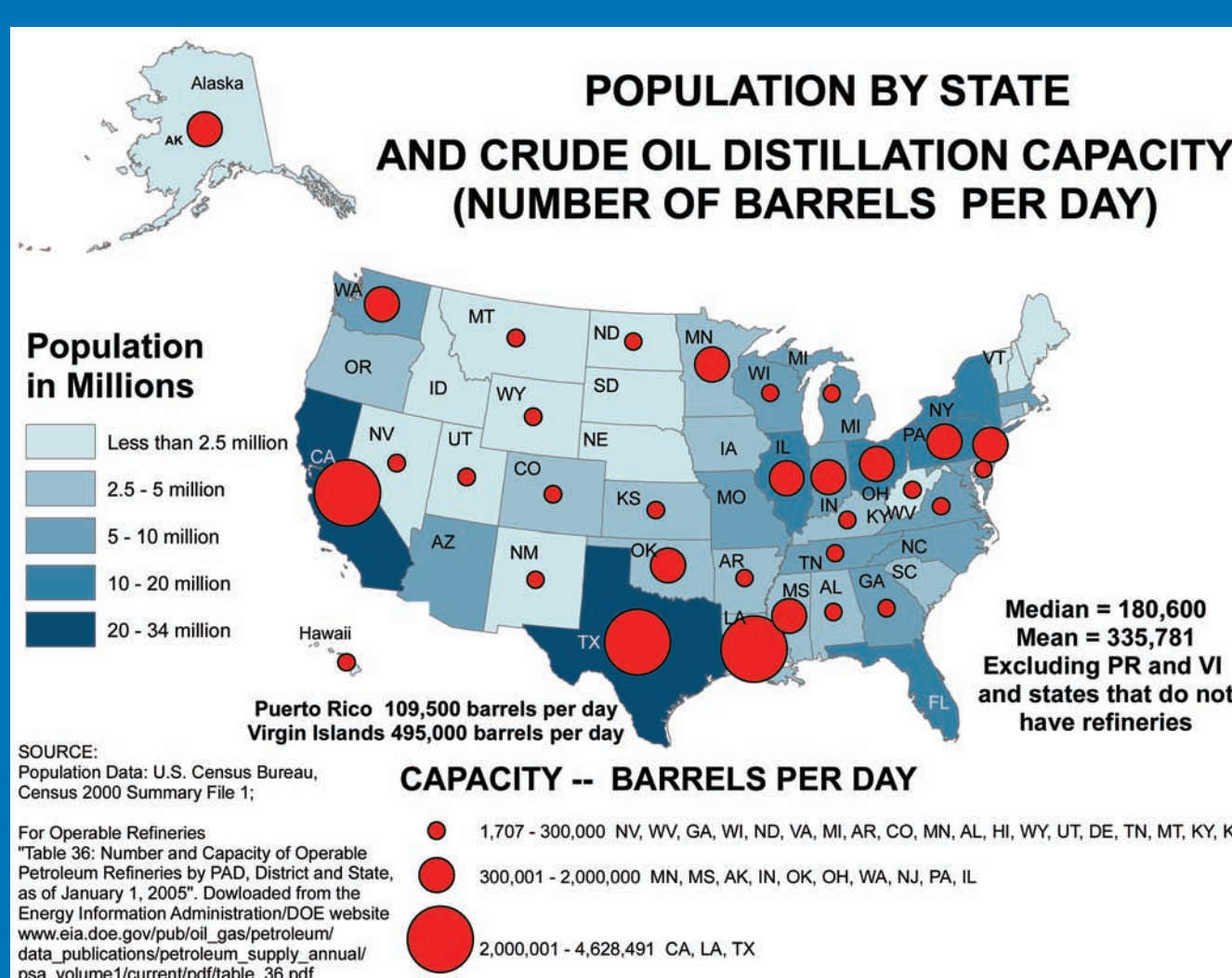
Source: Graphed by NYU-Wagner from Office of Electricity Delivery and Energy Reliability (OE) (2005) Hurricane Situation Repts 9/22 - 10/6, U.S. DOE <http://www.electricity.doe.gov/program/electric_oa4.cfm?section=divisions&level2=home>

Application of Duration Ratio: Oil Refinery Recovery after Hurricane Katrina

Refinery	Site	State	Restoration of refinery (days)/ Power Restoration (days)
Calcasieu	Lake Charles	LA	1.07
Chalmette Refining LLC (Exxon Mobil)	Chalmette	LA	1.58
Citgo	Lake Charles	LA	3.20
Exxon Mobil	Beaumont	TX	2.29
Motiva (Shell)	Port Arthur	TX	2.47
Total	Port Arthur	TX	2.47

Source: NYU-Wagner/ICIS for the Institute for Information Infrastructure Protection (I3P) at Dartmouth College, SCADA Project.

SPATIAL CONCENTRATION OF OIL & GAS PRODUCTION (POTENTIAL VULNERABILITIES)



CONCLUSIONS

- Effects of terrorism and natural hazards on oil and gas contribute to deaths, injuries and property damage
- Distribution systems are more commonly attacked than production systems suggesting ways to deploy risk management strategies, including those managed by process control systems

Acknowledgment and Disclaimer
 This research was supported by the United States Department of Homeland Security through the Institute for Information Infrastructure Protection (I3P) at Dartmouth College under grant number 2003-TX-TX-0003. However, any opinions, findings, and conclusions or recommendations in this document are those of the authors and do not necessarily reflect views of the United States Department of Homeland Security.