Compliance and Risk Management in the Fourth Revolution

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Motivation

Top Amazon China Sellers

Here are the top 500 sellers on the Amazon.cn marketplace.

July

#	M'place	Store name	Feedback				
			Total	12 mo	3 mo	1 mo	Pos %
1 —		新华文轩网络书店 (四川文轩在线电子…	123,947	47,638	7,515	1,615	89
2 —		博库网官方旗舰店 (博库网络有限公司)	41,824	16,994	2,023	499	86
3		北发图书网旗舰店 (北京北发电子商务…	5,769	5,437	1,554	431	89
4 ▲		中关村图书大厦专营店 (北京中关村图…	7,248	4,729	1,514	142	92
5 ▲		上海外文书店 (上海外文图书有限公司)	9,785	4,037	725	207	99
6 ▲		王府井书店 (北京市新华书店王府井书店)	3,218	2,930	1,087	126	91
7		北京图书大厦旗舰店 (北京图书大厦网…	2,907	2,907	1,314	339	92

Supply chain reliability, security, trust, …

Motivation (cont.)

Risk, Safety, and Security *Programs*

What is scope of the program

Where are the resources

How is monitoring and evaluation

Sources: Teng, Thekdi, and **Lambert** 2012a, 2012b

IEEE Systems, Man, & Cybernetics Society

Motivation (cont.)

An influence of *scenarios* to *priorities*.

Lambert et al. (2017, 2016, 2014, 2013, 2012, 2011, 2010, 2009)

The effect of uncertainty on objectives.

ISO 31000 (2009)

What can be done in what time frames, what are the tradeoffs, and what are the impacts of current decisions on future options

Haimes (1991)

What can go wrong, what are the likelihoods, what are the consequences

Kaplan and Garrick (1981)

Measure of the probability and severity of adverse effects.

Lowrance, *Of Acceptable Risk* (1976)

Motivation (cont.)

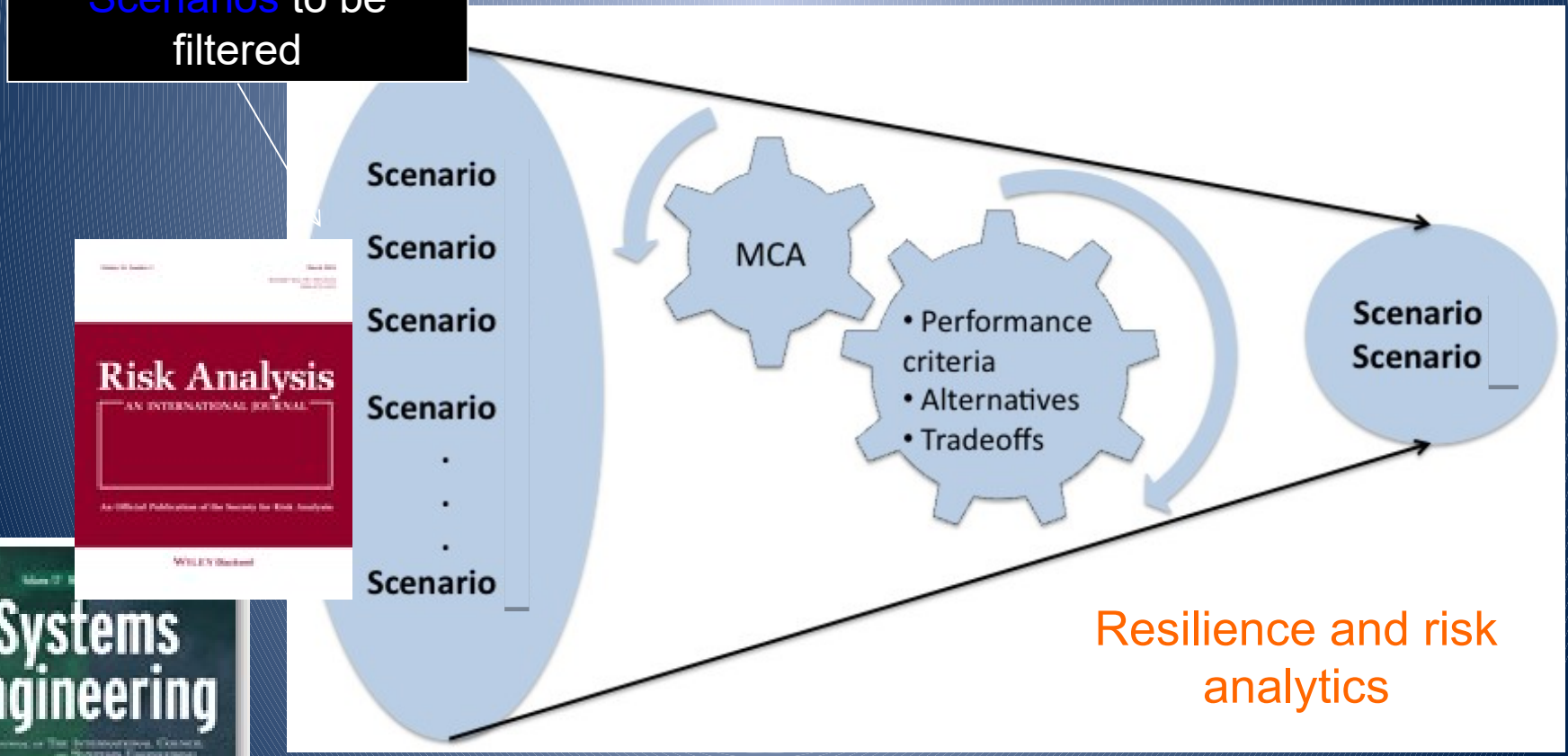
- **Regulatory**
  - New guidelines or increasingly stringent national or international trade policies.
- **Technological**
  - Immediate, unforeseen shifts in the directions of energy technologies (such as nuclear technologies, coal technologies, or promising renewable energy technologies).
- **Cyber**
  - Known and unknown conditions of data/information and control systems
- **Geopolitical**
  - Shifts in the geopolitical power relating to fossil fuels and natural gas that influence availability and costs of these energies.
- **Behavioral**
  - Changes in societal viewpoints or lack of acceptance of energy legislation.
- **Climate and others**
  - Disruption of infrastructure services, commercial energy grid failures, destruction of energy systems, and deterioration of energy and other infrastructure systems.

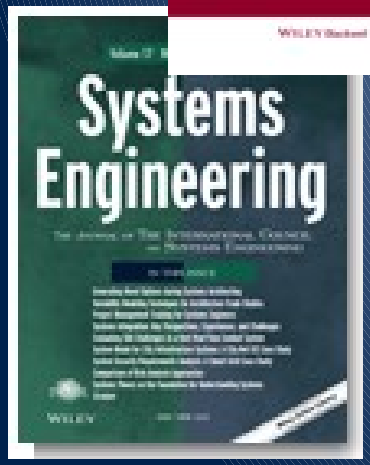
Sources:

Thorisson, Lambert et al. 2017;

Nakićenović, N. (2000). Energy Scenarios. Chapter 9 in United Nations Development Programme. United Nations Department of Economic and Social Affairs. World Energy Council. World Energy Assessment. New York 2000

Motivation (cont.)
Influences of Scenarios to Priorities

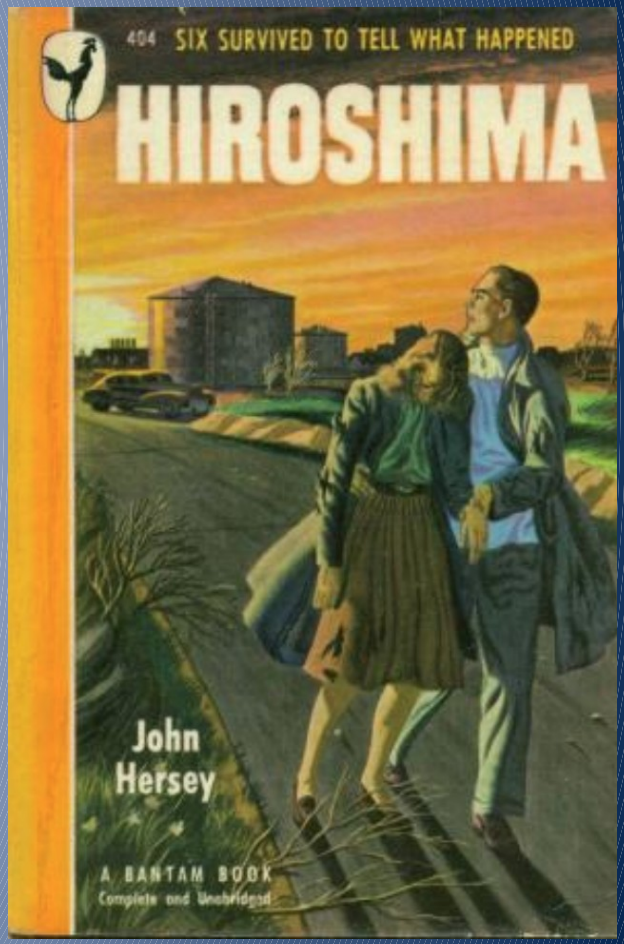




Sources: Thorisson, Lambert, et al. 2017; Karvetski and Lambert 2012

Motivation (cont.)

…presence of justice and the absence of fear…



Ursula Martius Franklin (1921–2016)
Inducted to the SRA Pantheon of Risk Analysis (2017)

http://www.sra.org/pantheon-risk-analysis

Motivation (cont.)

"Fear of radiation and radioactive contamination has the potential to produce **complicated behavioral responses** and pose additional **challenges to a coordinated response**."

-Dodgen et al.

"**Dirty Bomb** attacks among the fifteen *National Planning Scenarios* that have the greatest risk of mass fatalities, injuries, property loss and **major social disruption**."

-US Department of Homeland Security

Motivation (cont.)

"An understanding of **behavioral aspects** of both disaster management personnel and the **civilians impacted by catastrophes** is essential to improving response performance"

-Gheytanchi et al.

"…Radiological disasters cause **significant fear and disruption** among the population compared to other emergencies."

-Perry and Lindell

Goal

Discover implications of **population behaviors** for **resilience** to radiological emergencies, addressing a dirty bomb in the National Capital Region disuprting the **priorities of agencies** in sheltering and evacuation.

Objectives

- Model implications of population behaviors
  - **Evacuation on road network**
  - **Emergency response initiatives**
- Extend the *Survey of Population B*
- Conduct interviews with practitioners
- Characterize initiatives for agencies
- Identify additional stakeholders, interests, requirements, etc.

Background

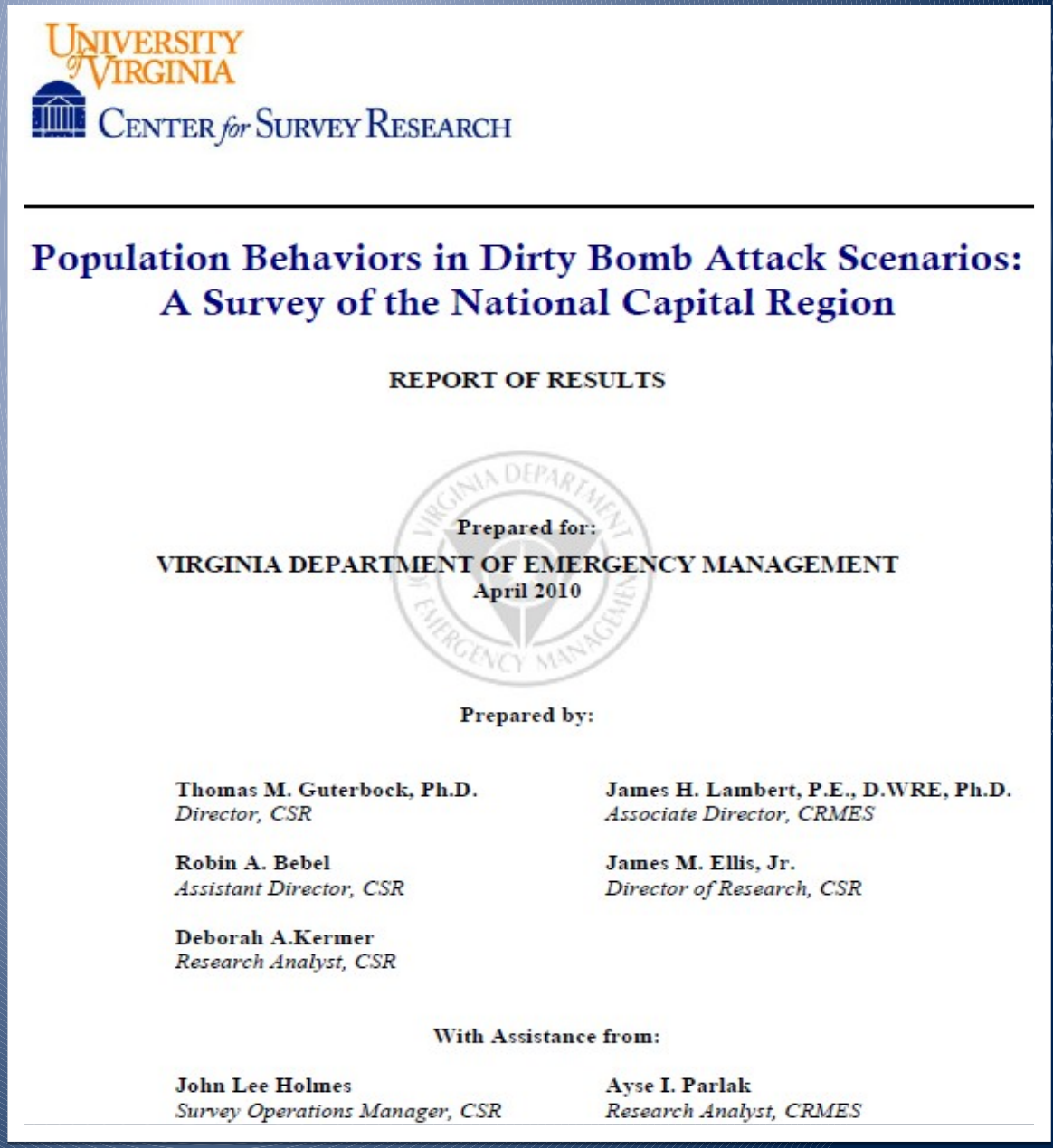
Scenario 1a: One dirty bomb in Tyson's Corner, VA
Scenario 1b: One dirty bomb in College Park, MD
Scenario 2: Multiple dirty bombs across the region

Background (cont.)

Dirty bomb event at several hazard levels

- Minimum
- Moderate
- Maximum

- **Behaviors and needs of affected population** in the aftermath of a regional radiological disaster



University of Virginia
Center for Survey Research

Population Behaviors in Dirty Bomb Attack Scenarios: A Survey of the National Capital Region

REPORT OF RESULTS

Prepared for:

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

April 2010

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Background (cont.)

"The survey data are beneficial to planners and government officials in the National Capital Region as well as surrounding states as we look at potentially **providing shelter, transportation and public information to people in need**"

"Results from the survey will help **refine emergency response, traffic movement and evacuation plans.**"

-Virginia Department of Emergency Management (2016)

Background (cont.)

- Emergency management and **preparedness**
  - Rao, Perry and Lindell, Tierney et al., Mileti
- **Radiological emergencies** and uncertainties of population behaviors
  - Wein et al, DHS, Carter et al., Dombroski et al., Dombroski and Fischbeck, Dombroski
- Uncertain **behaviors** of the population
  - Kang et al., Lindell and Prater, Tanaka, Southworth

Background (cont.)

Uncertain population behaviors of interest to agencies

Agency types

Behaviors

Behaviors	Resource Management	Public Preparedness	Mass Care	Modeling and Simulation	Transportation
Trust in people, local /state /federal government				•	
Emergency preparedness	•		•	•	
Shelter-evacuate behaviors under different conditions	•	•	•	•	•
Evacuation detail (vehicles, destination)	•	•	•	•	•
Expected services	•	•	•	•	
Consulted Sources of information channels & people		•	•	•	
Confidence in utilities and services	•	•	•	•	

TECHNICAL APPROACH
Part 1. Compliance in Evacuation

Technical Approach: Evacuation

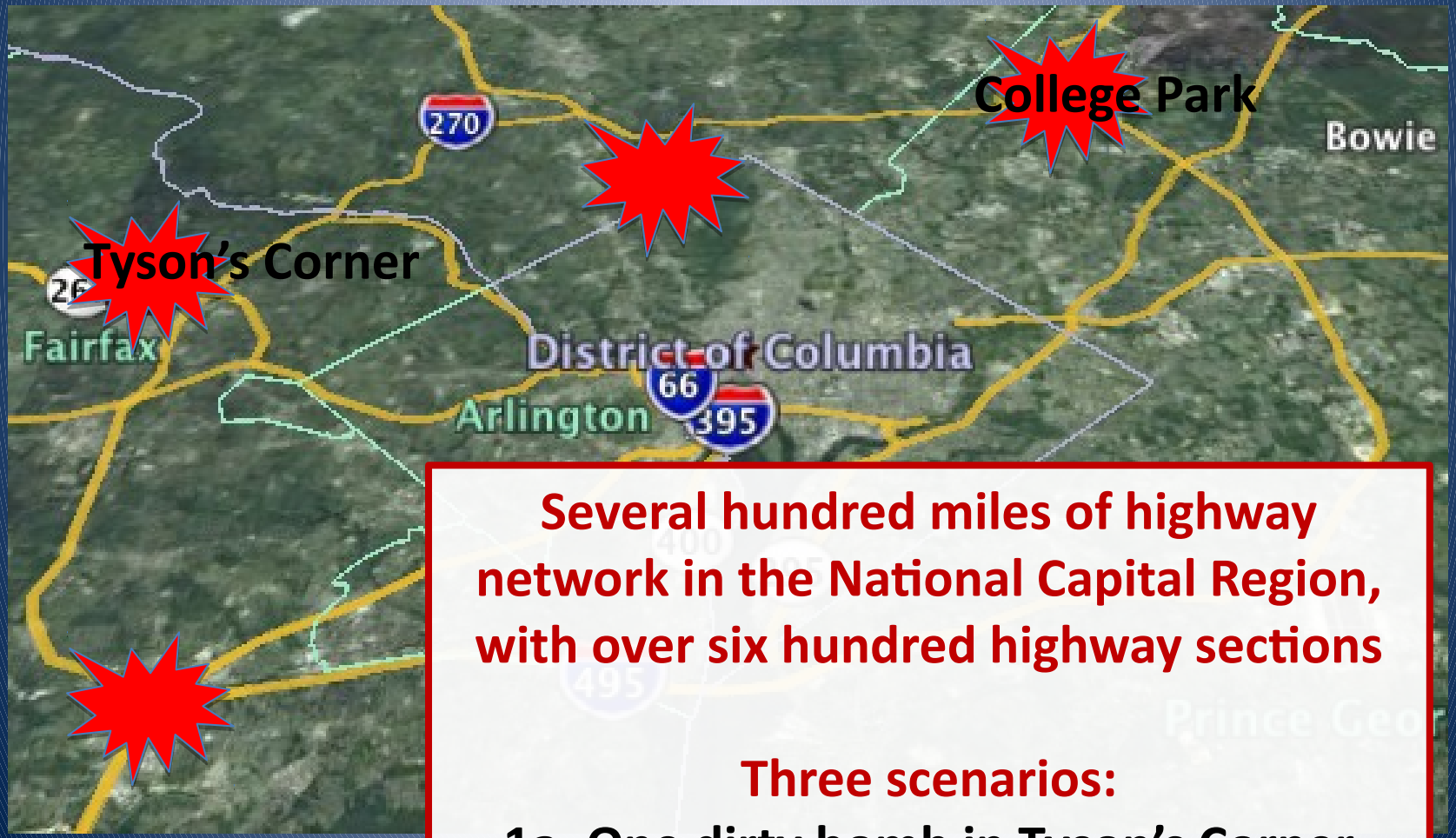
Behavioral Survey Data

Transportation Planning Board Travel Forecast Data

Travel demand model

Identification of **critical locations** in the **transportation system**

Technical Approach: Evacuation (cont.)



Several hundred miles of highway network in the National Capital Region, with over six hundred highway sections

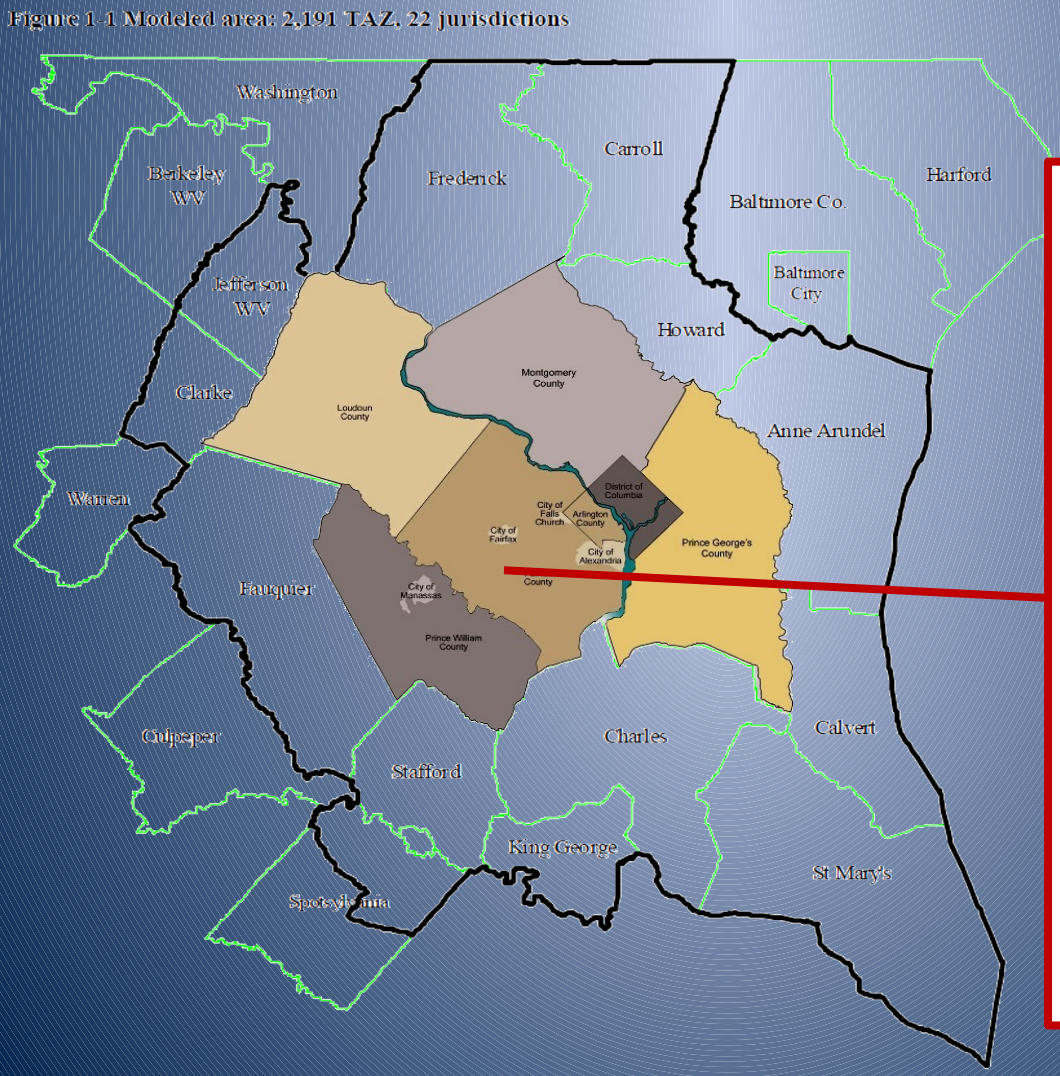
Three scenarios:

1a. One dirty bomb in Tyson's Corner

1b. One dirty bomb in College Park

2. Multiple dirty bombs in the region

Technical Approach: Evacuation (cont.)



Eight jurisdictions and **six million** in population

- District of Columbia
- Arlington
- Alexandria
- Fairfax
- Prince George's
- Montgomery
- Prince William
- Loudoun

Technical Approach: Evacuation (cont.)

Scenario 1A Tyson's Corner

	District of Columbia	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Montgomery	Prince George's	Other	TOTAL
	,593	9,949	4,624	16,015	6,973	9,184	29,521	43,257	29,265	**262,382**
	,419	20,839	4,425	12,099	6,916	7				
Alexandria	1,013	2,496	9,616	7,674	3,0					
Farifax&City& Falls Church	1,297	2,927	2,026	59,485	33,					
Loudoun	118	93	23	7,588	36					
Mana										
Prince										
Montg										
Prince G										

Scenario 2 Multiple dirty bombs

	District of Columbia	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Montgomery	Prince George's	Other	TOTAL
	2,363	1,470	1,061	2,64	5,666	5,836	11,384	10,328	58,604	129,354
	1,650	5,379	1,776	4,26					916	0,469
	415	886	2,448	2,30	2,715	2,881	639	364	9,223	1,931
Farifax&City& Falls Church	1,834	3,778	3,344	33,3		21,350	2,506	2,862	64,533	153,913
Loudoun	366	616	600	2,8	11,706	5,128	540	569	16,579	8,961
Manassas& Prince William	486	815	818	2,3						0,239
Montgomery	6,610	558	433	1,350	3,146	3,098	17,177	49,067	62,015	143,453
Prince George's	6,918	479	499	1,143	3,280	3,287	39,502	18,841	67,428	141,377
TOTAL										729,697

Scenario 1B College Park

	District of Columbia	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Montgomery	Prince George's	Other	TOTAL
District of	106,661	10,446	5,121	17,009	4,247					
	5,424	21,549	5,134	13,518	5,922					
	1,013	2,793	9,913	8,268	2,429					
	2,367	9,727	7,749	137,055	32,784					
Loudoun	121	624	553	8,648	35,877					
Manassas& Prince William	153	1,013	1,026	5,182	8,177	48,244	433	29	16,945	**81,202**
Montgomery	13,949	1,028	401	3,239	1,605	1,365	212,495	8,843	48,582	**291,507**
Prince George's	6,499	249	284	809	1,070	1,081	41,412	38,747	37,569	**127,719**
TOTAL										**1,197,081**

Evacuation origins and intended destinations for passengers

Over one million individuals

Technical Approach: Evacuation (cont.)

Scenario 1A Tyson's Corner

	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Montgomery	Prince George's	Other	TOTAL
District of Columbia	57,753	5,347	2,485	8,607	2,924				
Arlington	3,453	13,255	2,814	7,695	4,895				
Alexandria	718	1,765	6,800	5,427	2,241				
Farifax&City& Falls Church									
Loudoun									
Manassas& Prince William									

Scenario 1B College Park

	District of Columbia	Arlington	Alexandria						
	57,753	5,625	2,763	9,					
	3,453	13,728	3,288	8,					
	718	1,986	7,021	5,					
Farifax&City& Falls Church	1,762	7,077	5,563	10					
Loudoun	97	495	438	6,					
Manassas& Prince William	95	610	621	3,783	4,939	37,478	264	24	10,846	**58,660**
Montgomery	10,307	761	295	2,401	1,174	995	157,149	6,567	35,542	**215,192**
Prince George's	5,225	202	228	641	907	915	34,867	29,649	31,328	**103,962**
TOTAL										**836,088**

Scenario 2 Multiple dirty bombs

	Arlington	Alexandria	Fairfax	Loudoun					
Columbia	15,557	740	520	1,319	2,642				
Arlington	1,097	3,501	1,209	2,872	4,767				
Alexandria	303	642	1,747	1,699	2,041				
Farifax&City& Falls Church	1,454	2,976	2,644	25,721	16,241	17,014	2,266	1,993	51,650	**121,960**
Loudoun	305	513	501	2,344	9,605	4,270	474	451	13,819	**32,283**
Manassas& Prince William	422	707	710	1,977	5,671	12,813	634	634	19,474	**43,042**
Montgomery	5,138	433	341	1,041	2,491	2,456	37,220	13,537	49,057	**111,714**
Prince George's	5,747	405	421	951	2,818	2,823	15,966	31,776	57,554	**118,460**
TOTAL										**541,060**

Evacuation origins and intended destinations for vehicles

Over 800,000 vehicles

Technical Approach: Evacuation (cont.)

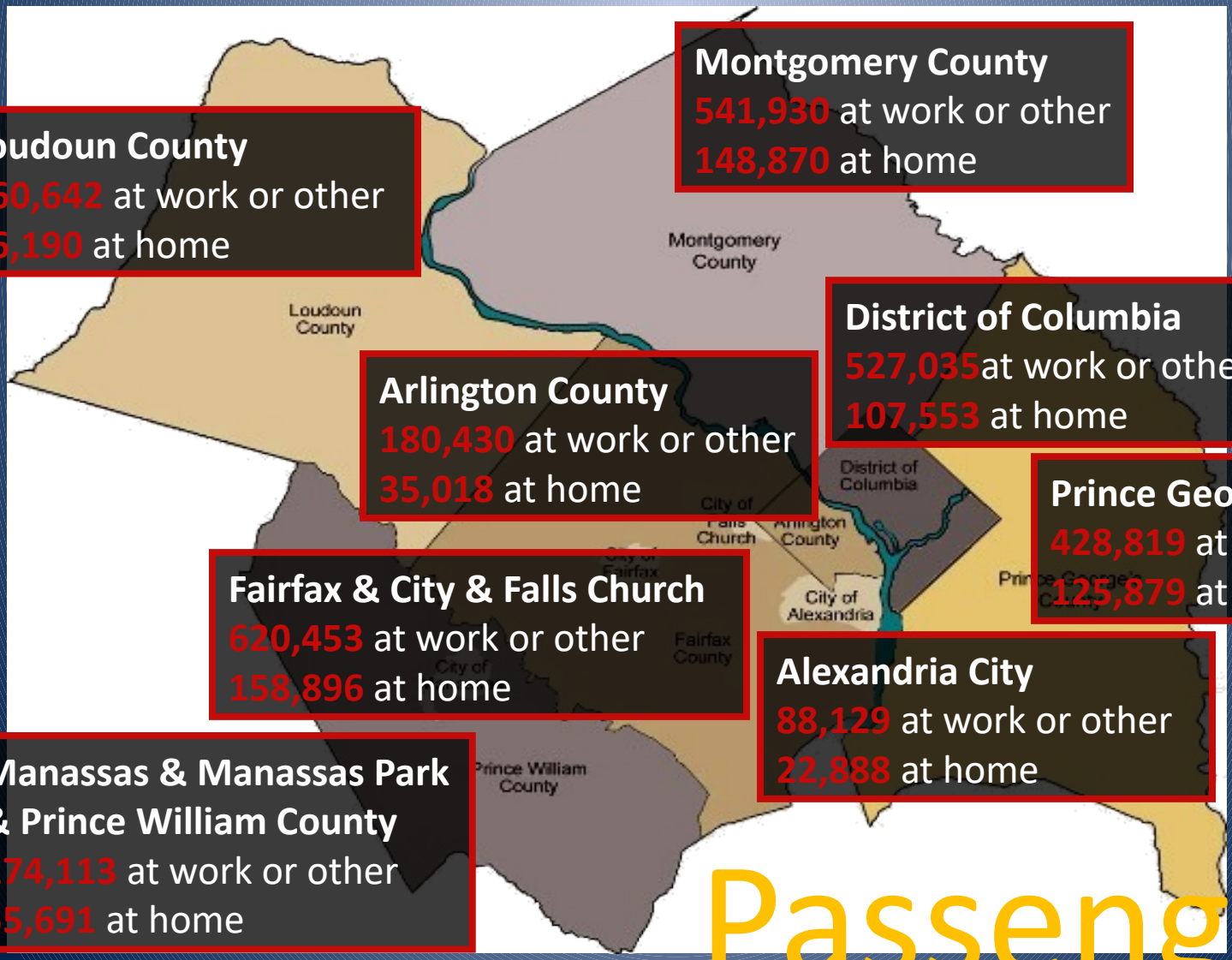
19 destinations (8 inside-NCR, 11 Other)

8 Inside- NCR origins

Vehicles

	District of Columbia	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Montgomery	Prince George's	Other	TOTAL
Di… of Co… a	57,753	5,347	2,485	8,607	2,924	4,112	15,154	22,536	13,257	**132,174**
Ar… n	3,453	13,255	2,814	7,695	4,895	5,375	1,295	1,481	7,338	**47,601**
Ale… ia	718	1,765	6,800	5,427	2,241	2,777	243	1,130	3,486	**24,587**
Farif… ty& Fall… ch	1,020	2,242	1,551	45,560	27,859	29,775	1,705	1,139	36,562	**147,123**
Lo… n	97	76	19	6,154	29,855	5,548	219	112	7,910	**49,990**
Ma… s& Prince William	95	25	37	2,615	6,107	38,646	144	144	10,846	**58,660**
Montgomery	10,307	652	187	2,183	1,391	1,213	141,458	22,258	35,542	**215,192**
Prince George's	10,569	275	355	1,264	1,145	1,171	24,755	104,328	41,629	**185,490**
TOTAL										**860,816**

Technical Approach: Evacuation (cont.)



Montgomery County
541,930 at work or other
148,870 at home

Loudoun County
160,642 at work or other
36,190 at home

District of Columbia
527,035at work or other
107,553 at home

Arlington County
180,430 at work or other
35,018 at home

Prince George's County
428,819 at work or other
125,879 at home

Fairfax & City & Falls Church
620,453 at work or other
158,896 at home

Alexandria City
88,129 at work or other
22,888 at home

Manassas & Manassas Park & Prince William County
174,113 at work or other
55,691 at home

Passengers

Technical Approach: Evacuation (cont.)

Adapted an existing model to allocate demand across the localities and highways

$$P_i' = (P_{(+18)_i} - \sum_{j=1}^{n} HBW_{ij}^{adj})(\text{at home}\%) + \sum_{j=1}^{n} HBW_{ji}^{adj} + \sum_{j=1}^{n} HBO_{ji}$$

$$+ \sum_{j=1}^{n} HBS_{ji} + P_{(-18)_i}$$

Population of county i at 2 pm =
(Number of people 18+ arriving for work in county i by 2 pm)
+ (Number of people 18+ arriving for another activity in county i at 2 pm)
+ (Number of people 18+ staying at home in county i at 2 pm)
+ (Number of people under age 18 population of county i)

Technical Approach: Evacuation (cont.)

- **Modeled 3 types of evacuation behaviors**
  1. *From work or other places to home*
  2. *Evacuation from work or other places*
  3. *Evacuation from home*

From behavioral survey*

Trips from jurisdiction *i* to jurisdiction *j*
= People at home in jurisdiction *i* * percentage leaving immediately from home * percentage evacuating to jurisdiction *j*
+ People at work or other building in jurisdiction *i* * percentage evacuating from work or other building * percentage evacuating to jurisdiction *j*
+ People at work or other building in jurisdiction *i* and live in jurisdiction *j* * percentage going home from work or other building

*Guterbock, Lambert, et al.

Technical Approach: Evacuation (cont.)

- Over 90% of the evacuees intend to use their own, their family's, or someone else's vehicle
  - Home based work auto driver trips
  - Home based shopping and other auto driver trips
  - Persons per household
  - Vehicles per household
  - Average auto occupancy rates
  - Public transportation use percentages

Adapting travel demand models to the several dirty-bomb scenarios

Scenario	Total evacuees	Total evacuating vehicles
1A (Tyson's Corner, VA)	1,205,088	860,816
1B (College Park, MD)	1,197,081	836,088
2 (Multiple bombs in NCR)	729,696	541,060

Source: Guterbock and Lambert et al.

Technical Approach: Evacuation (cont.)

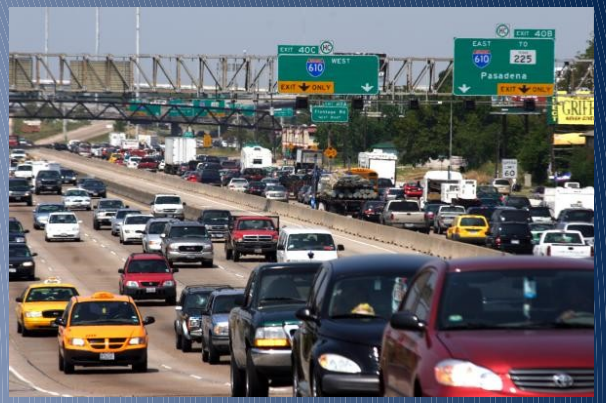
Scenario	Total trips occurring on the network around 2 pm	Trips moving between points within the NCR	Trips leaving the NCR
0	1,085,278	718,771	26,217
1A	1,946,094	1,423,017	182,787
1B	1,921,366	1,412,455	168,622
2	1,626,338	1,017,910	268,139

Scenario 1A (Tyson's Corner) produces highest total demand and highest demand in the National Capital Region

Scenario 1A (Tyson's Corner) and Scenario 1B (College Park, MD) have similar patterns in terms of total demand and distribution of demand

Although Scenario 2 (Multiple dirty bombs in NCR) generates lowest total demand and lowest inside-NCR demand, it generates highest outside-NCR demand

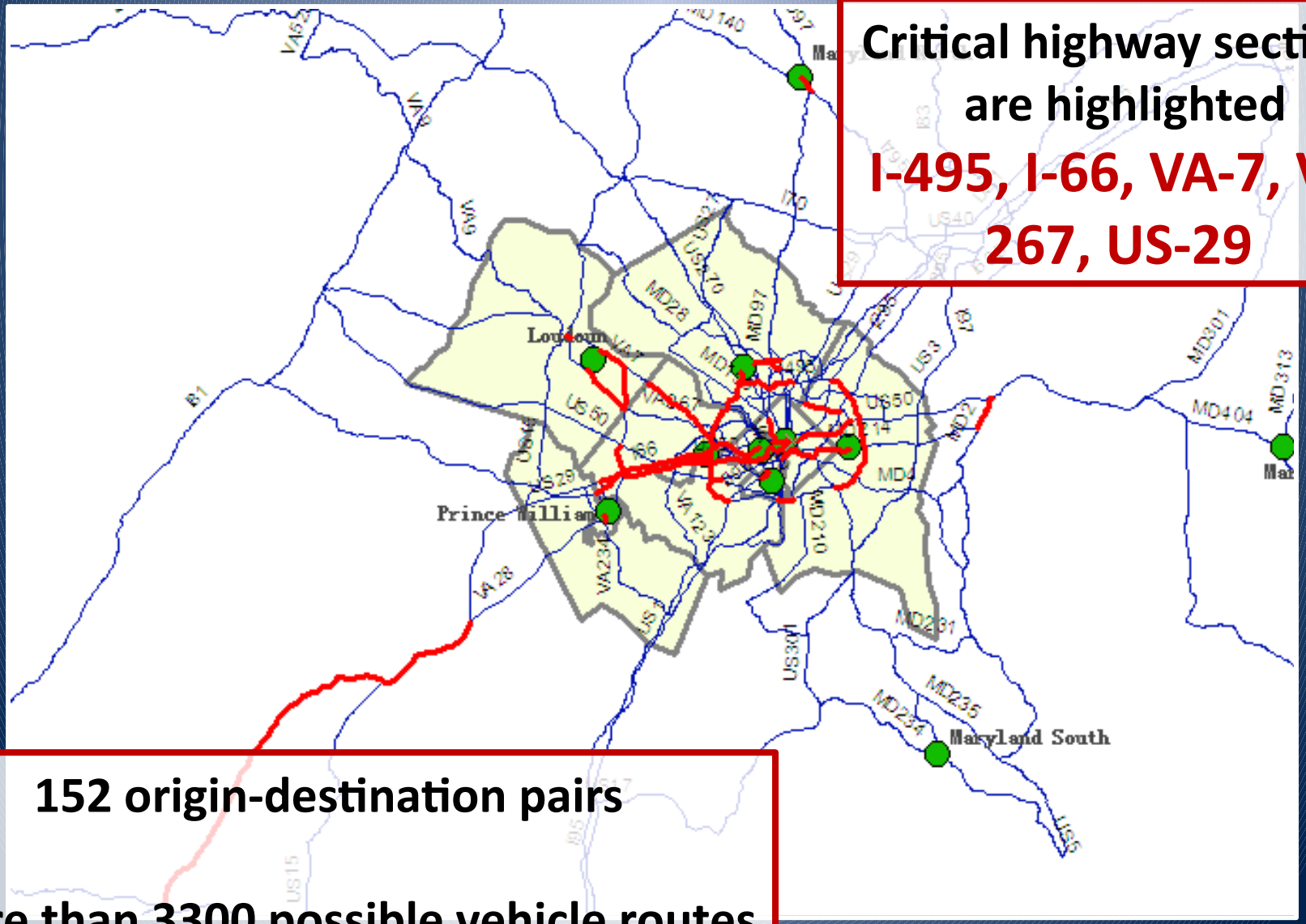
Technical Approach: Evacuation (cont.)



For each scenario, criticalities of highway sections assessed with three attributes:

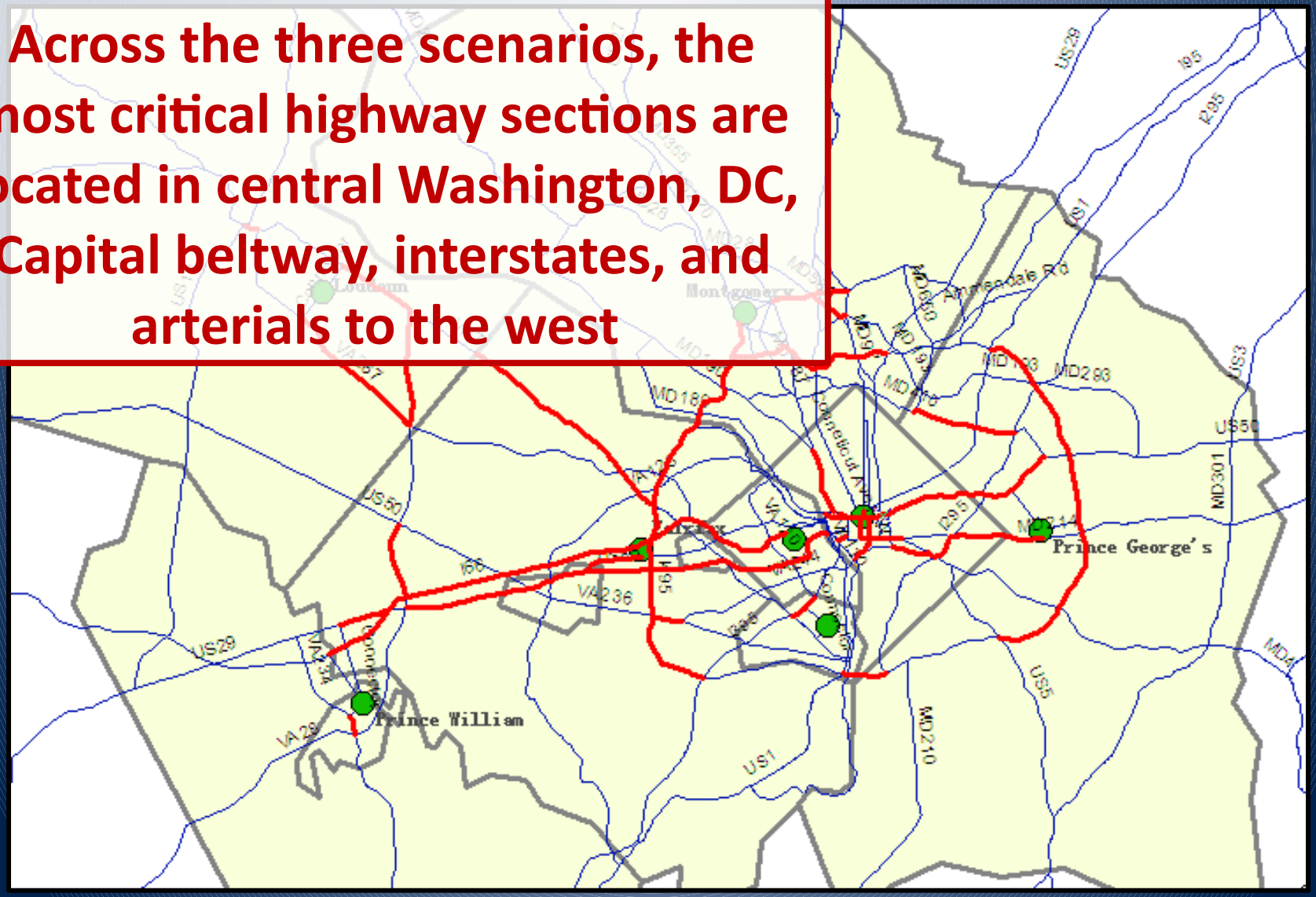
	1	2	3	4	5
Volume	10500<	7500-10500	4500-7500	1500-4500	<1500
Speed	<10mph	10mph-20mph	20mph-35mph	35mph-50mph	50mph <
V/C ratio	1<	0.8-0.9	0.7-0.8	0.6-0.7	<0.7

Technical Approach: Evacuation (cont.)

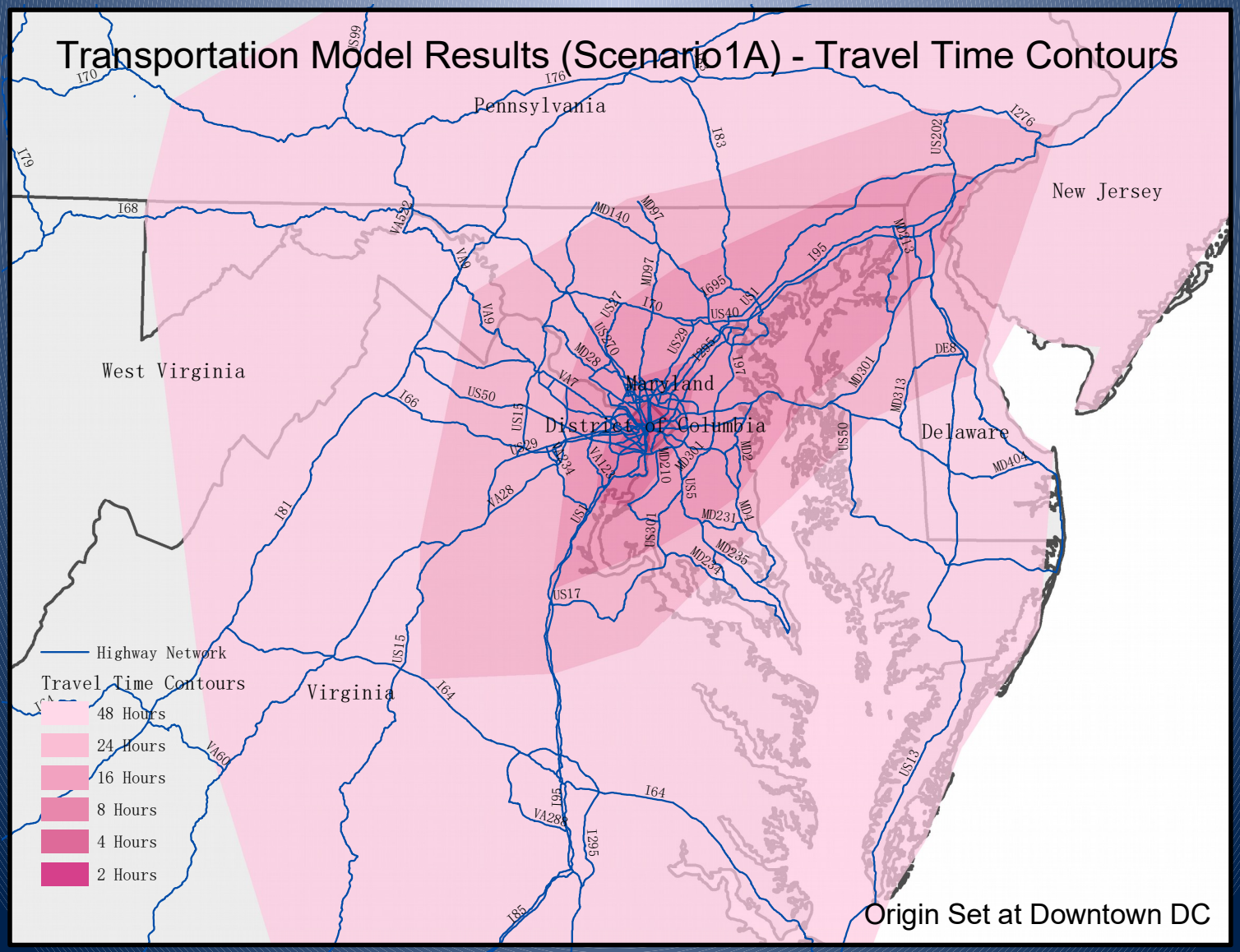


Technical Approach: Evacuation (cont.)

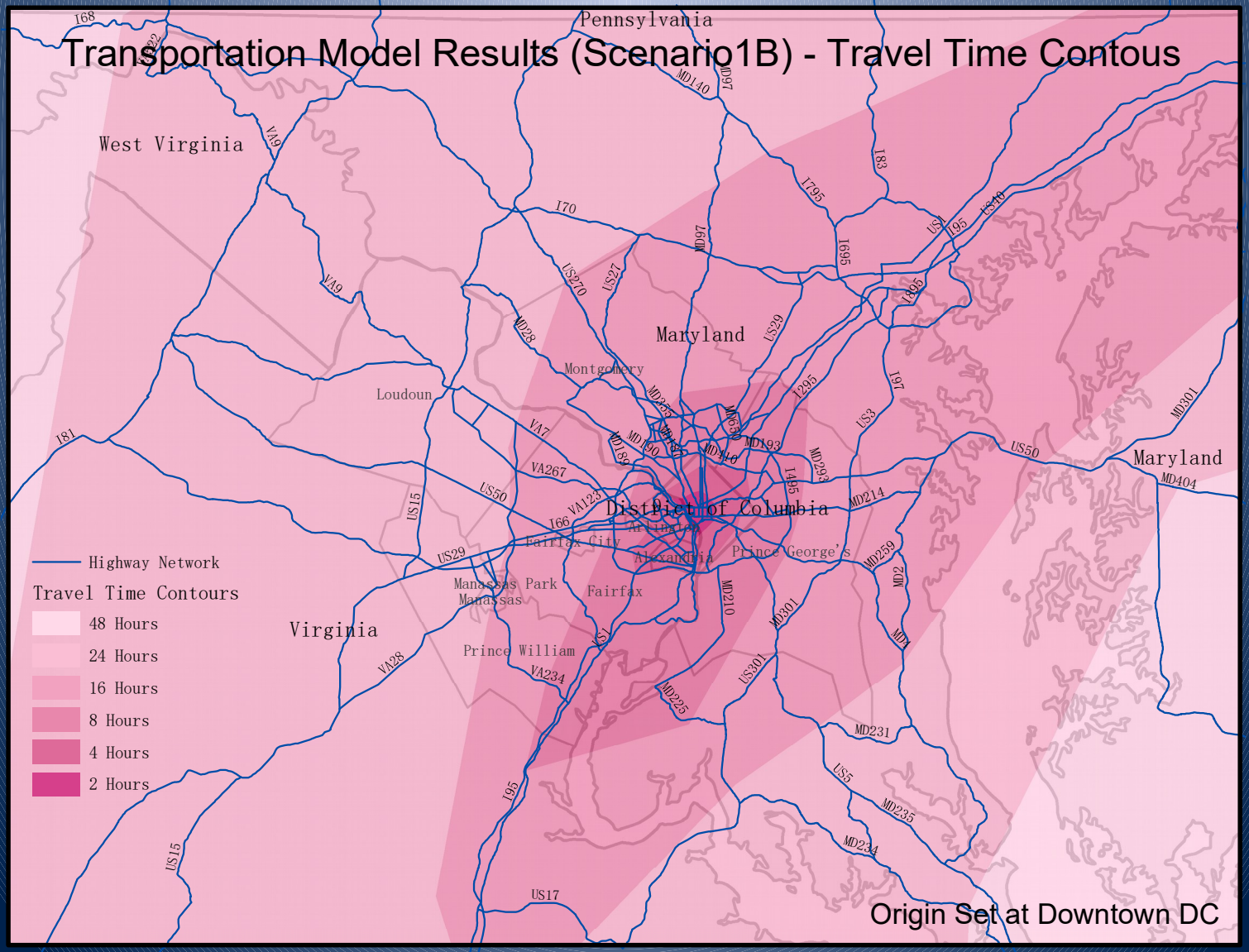
Across the three scenarios, the most critical highway sections are located in central Washington, DC, Capital beltway, interstates, and arterials to the west



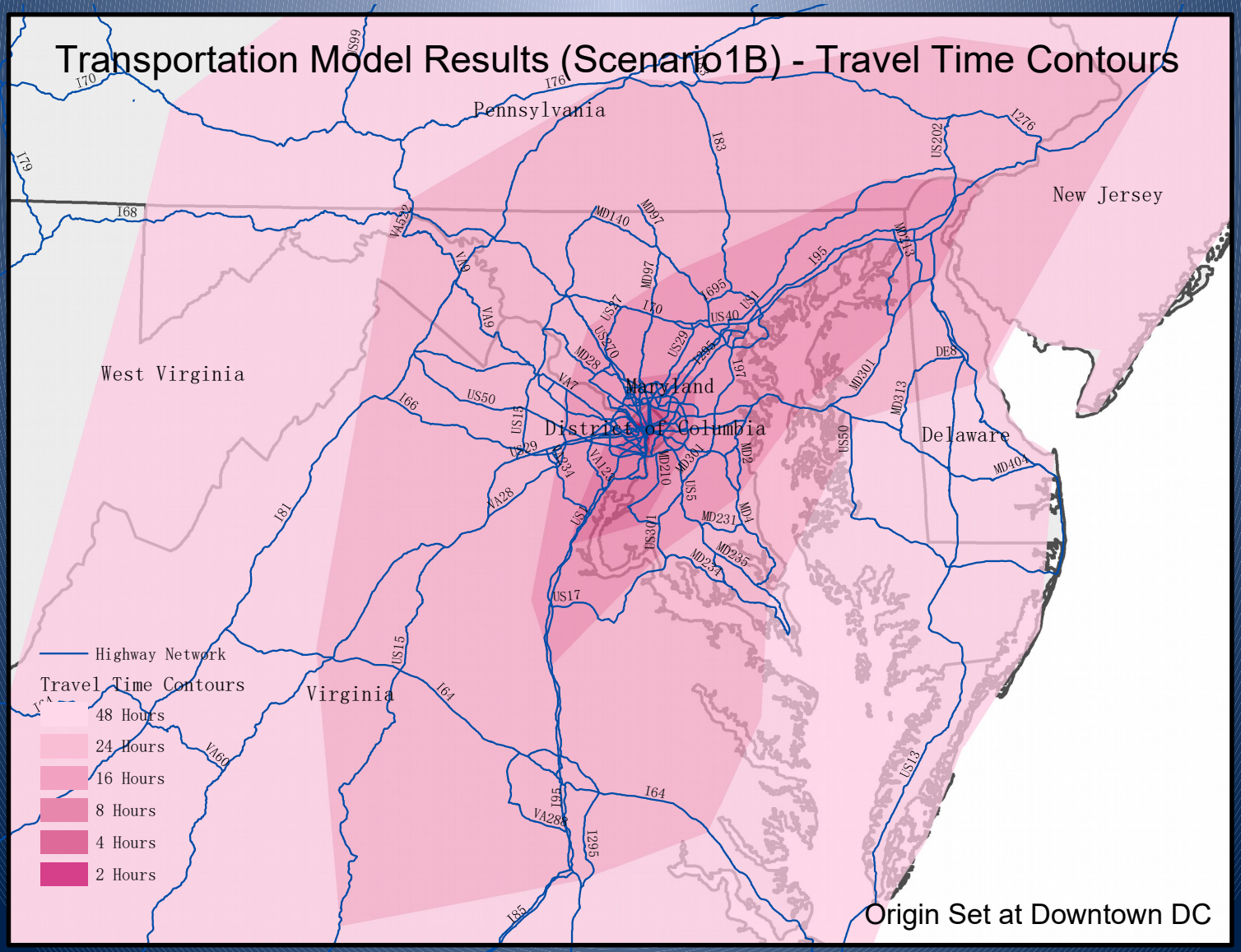
Evacuation Times from Downtown



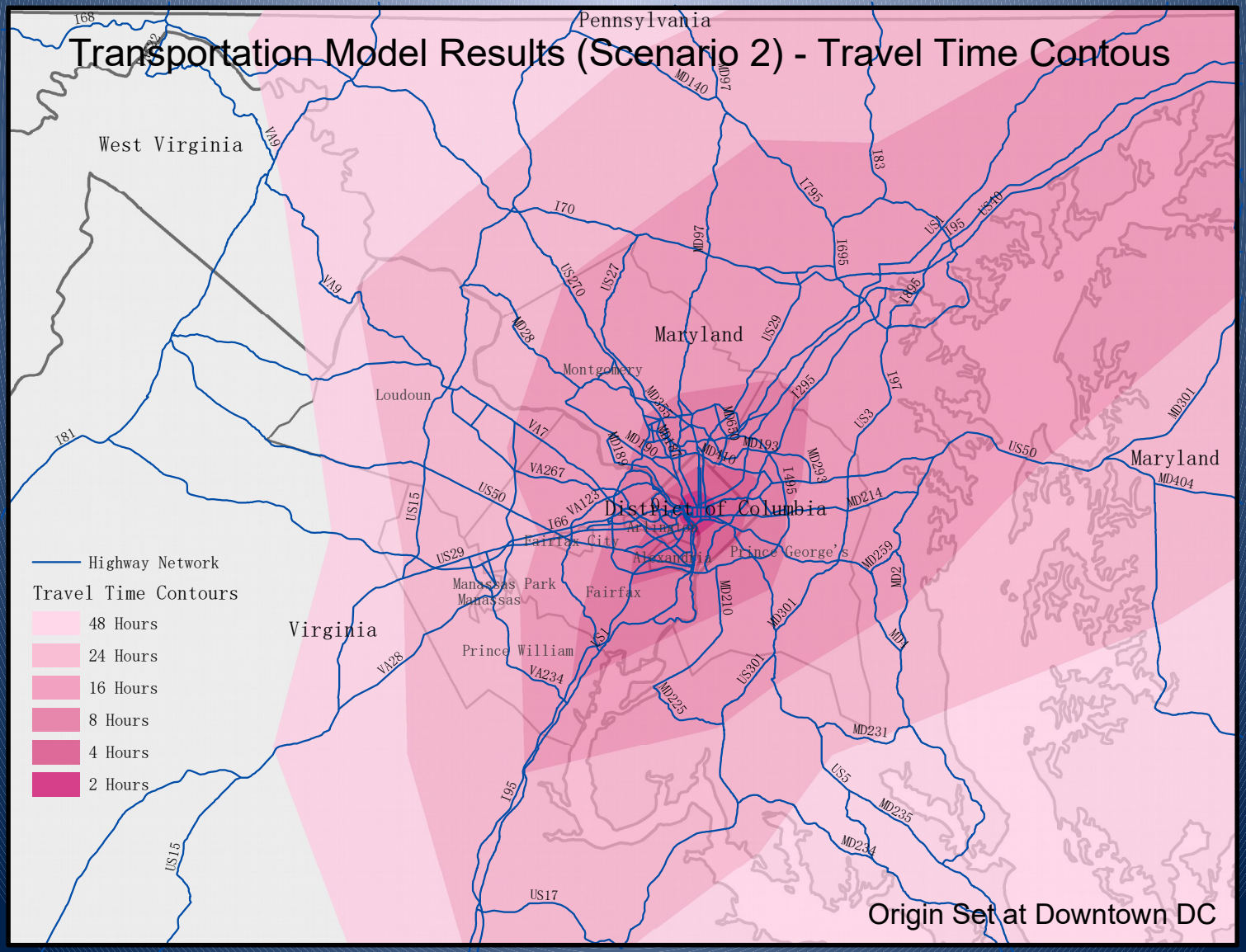
Evacuation Times (cont.)



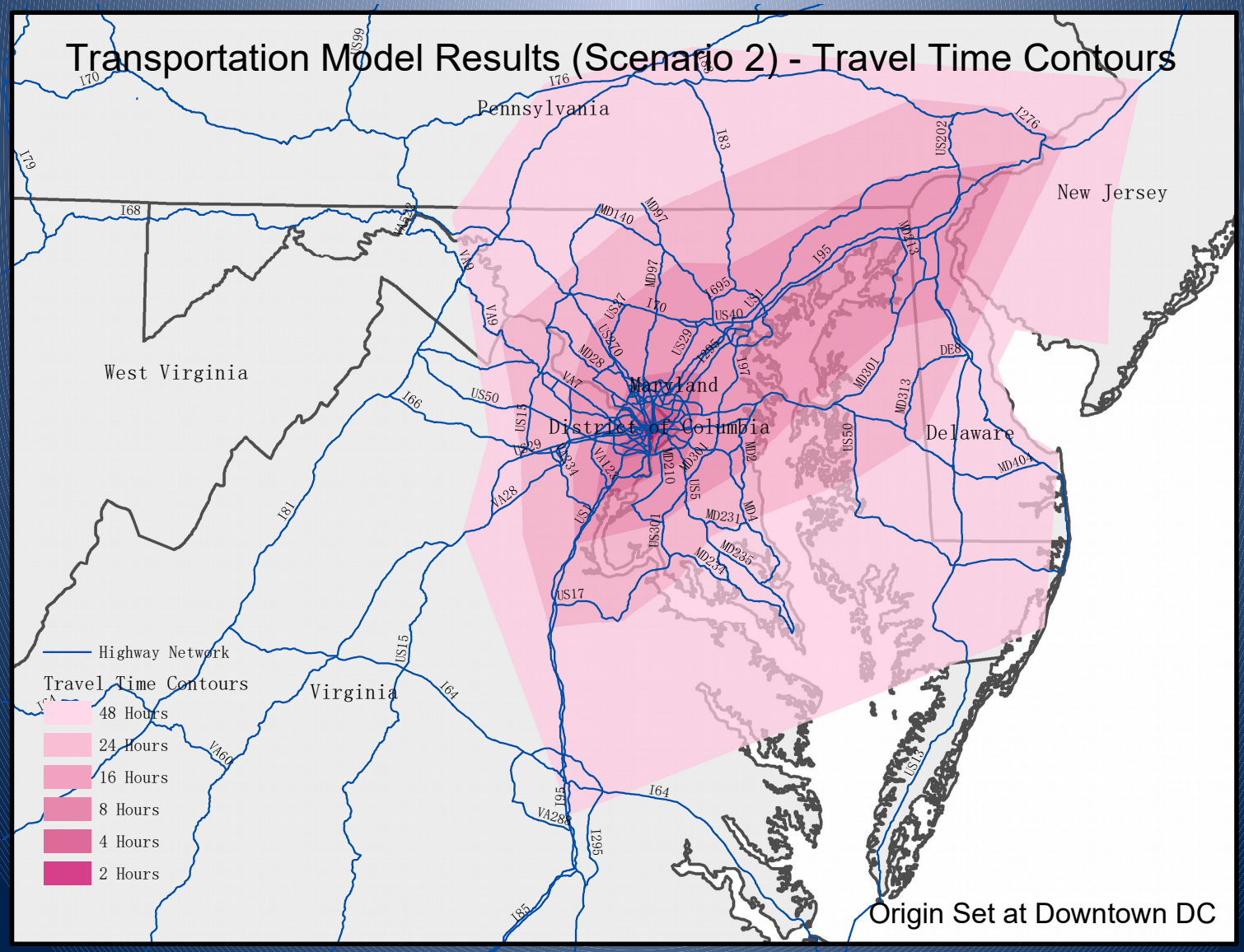
Evacuation Times (cont.)



Evacuation Times (cont.)



Evacuation Times (cont.)



Sample of Results

- **Uncertain behaviors matter** at least as much as the bomb locations
- Individual **choices of drivers** are influential to the performance of the highways
  - Traveler information, detours, and contraflows could be critical for mitigating breakdowns
- For each of the three scenarios (1a, 1b, and 2):
  - Several hundred thousand evacuees on the highways
  - Highways fail to perform at multiple critical highway sections, in terms of volume, speed, and volume-to-capacity ratio

TECHNICAL APPROACH

Part 2. Compliance in Emergency Response

Technical Approach: Emergency Response

S_{01}	**A majority of affected population will lack preparedness and tend to become "walking wounded"**	This scenario assumes that the majority of affected population will lack basic preparedness such as emergency kits including essential medical supplies, food or water. There is large number of people on the streets with minor to medium level injuries.
S_{02}	**A majority of affected population will have limited access and trust in information sources**	This scenario assumes that due to various factors (either because of physical factors such as power outages and behavioral factors such as having no access do to being on the streets.), access to information channels is limited. The affe information broadcasted via The affected population has functionality of public transp services, etc. Power and ene
S_{03}	**A majority of affected population will lack confidence in transportation, energy, communication or other infrastructure**	
S_{04}	**A majority of affected population will have unpredictable compliance with shelter in place directions**	After a radiological attack, r effective to shelter in place not in the hot zone ie. the in bomb. Affected population place due to many reasons a family member.
S_{05}	**Private sector workers will be willing to have unprecedented role in emergency response**	One of the major concerns is about private sector and critical workers. Since most of the critical infrastructure and key resources are operated by private sector, the worker's behaviors have a huge impact on the society. This scenario assumes that workers will not leave their workplaces and the services they provide will be uninterrupted.

Focus is on five behavioral assumptions

Technical Approach: Emergency Response(cont.)

30 initiatives of agencies

1. Improve mobility options for **disabled and special needs populations**
2. Provide **education and training** for citizen emergency preparedness
3. Increase availability of real time public **information and advisories**
4. Improve interoperability of **emergency communications** among first responders
5. Increase stockpiles and availability of **essential medical supplies**
6. Increasing the **shelter availability**
7. Improve planning that facilitates **shelter-in -place**
8. Increasing number of **first aid location**s along transportation routes
9. Increase capabilities for **radiological decontamination** at shelters or along transportation routes
10. Increase availability of public information on the **real time conditions of critical infrastructures**

Parlak, A., J.H. Lambert, T. Guterbock, and J. Clements 2012. Population behavioral scenarios influencing radiological disaster preparedness and planning. *Accident Analysis and Prevention.* 48: 353– 362.

Technical Approach: Emergency Response (cont.)

Ranking criteria adapted from:

- **National Preparedness Guidelines (2007)**
- **National Incident management System (2008)**
- **National Response Framework (2008)**

Criteria used for ranking among agency initiatives

Technical Approach: Emergency Response (cont.)

Assessing agency initiatives on the criteria

Initiatives

Criteria	Improve mobility options for disabled and special needs populations	Increase emergency public transportation options and capacities	Provide education and training for citizen emergency preparedness	Increase availability of real time public information and advisories	Improve interoperability of emergency communi… among fi…
C.01 Public Health and Safety is addressed by this initiative.	Somewhat Agree	Somewhat Agree	Somewhat Agree		
C.02 Estimated Cost is addressed by this initiative.	Somewhat Agree		Agree	Somewhat Agree	Agree
C.03 Information Sharing and Collaboration is addressed by this initiative.			Strongly Agree	Strongly Agree	Strongly A
C.04 Planning and Public Preparedness is addressed by				Somewhat	

Assessments

Criteria

Technical Approach: Emergency Response (cont.)

Importance of the criteria are updated (cont.)

Performance criteria	Behavioral assumptions: *A majority of affected population will lack preparedness and tend to become "walking wounded"*	*A majority of affected population will have limited access and trust in information sources*	*A majority of affected population will lack confidence in transportation, energy, communication or other infrastructure*
C.01 Public Health and Safety	Increases	-	-
C.02 Estimated Cost	Decreases	-	-
C.03 Information Sharing and Collaboration	Increases	Increases	Increases
C.04 Planning and Public Preparedness	Increases	-	-
C.05 Environmental Considerations	-	-	-

Technical Approach: Emergency Response (cont.)

High ranked and robust

Agency initiatives

planning for shelter-in-place
education and training for
citizens
radiologic
capabilities
emergend
among firs
mobility o
needs popu
stockpiles
supplies
first aid lo
real time public information and
advisories
emergency public
transportation
increasing the shelter
availability
number of volunte

Rank Order
1
2
3
4
5
6
7
8
9
10
11

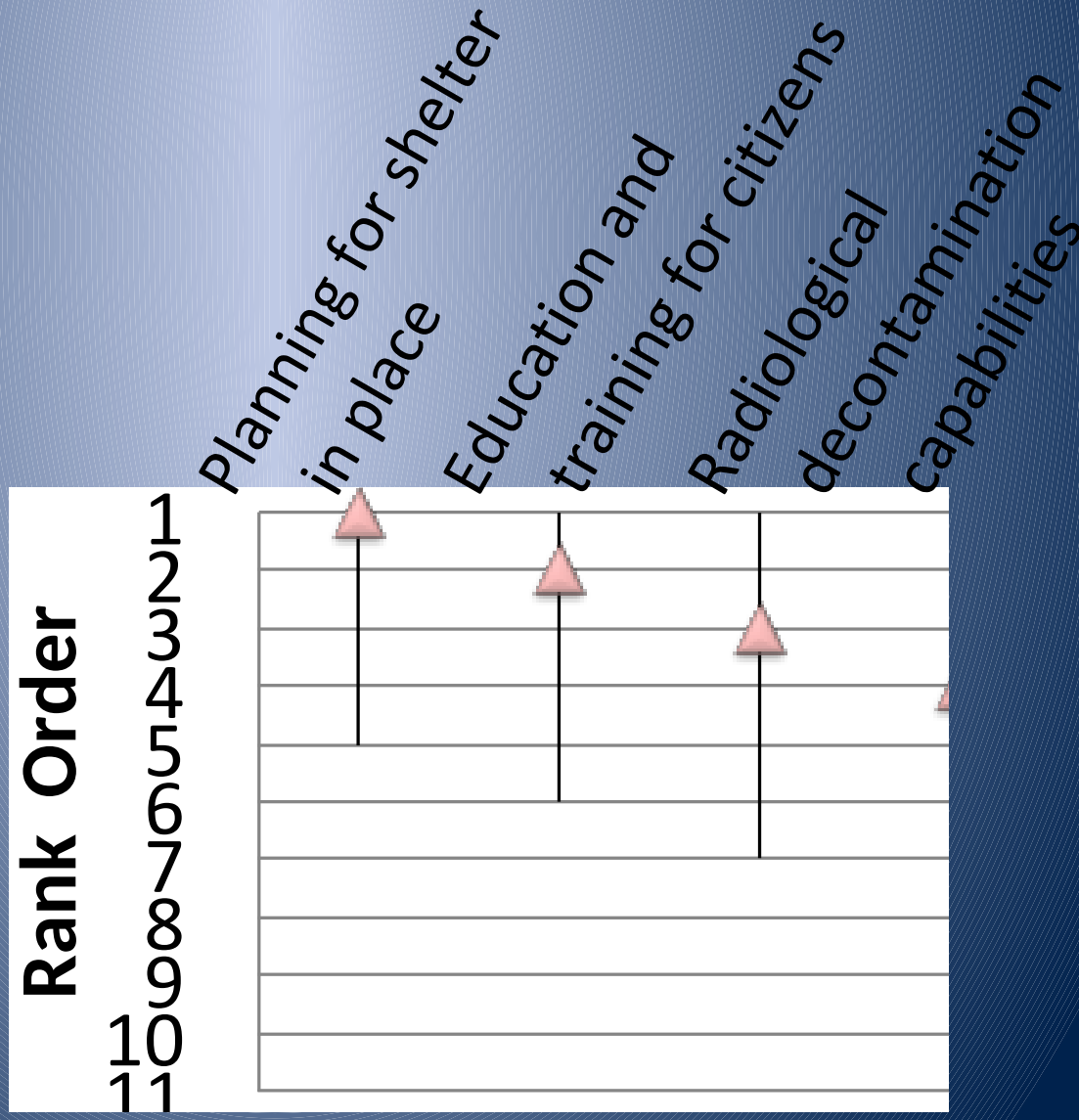
Triangles indicate baseline ranking of the initiatives.

Influence of behavioral scenarios on the priorities of initiatives

Source: Parlak, Lambert, et al. 2012

Technical Approach: Emergency Response (cont.)

Top three initiatives and the influences of uncertain behaviors on the rankings.

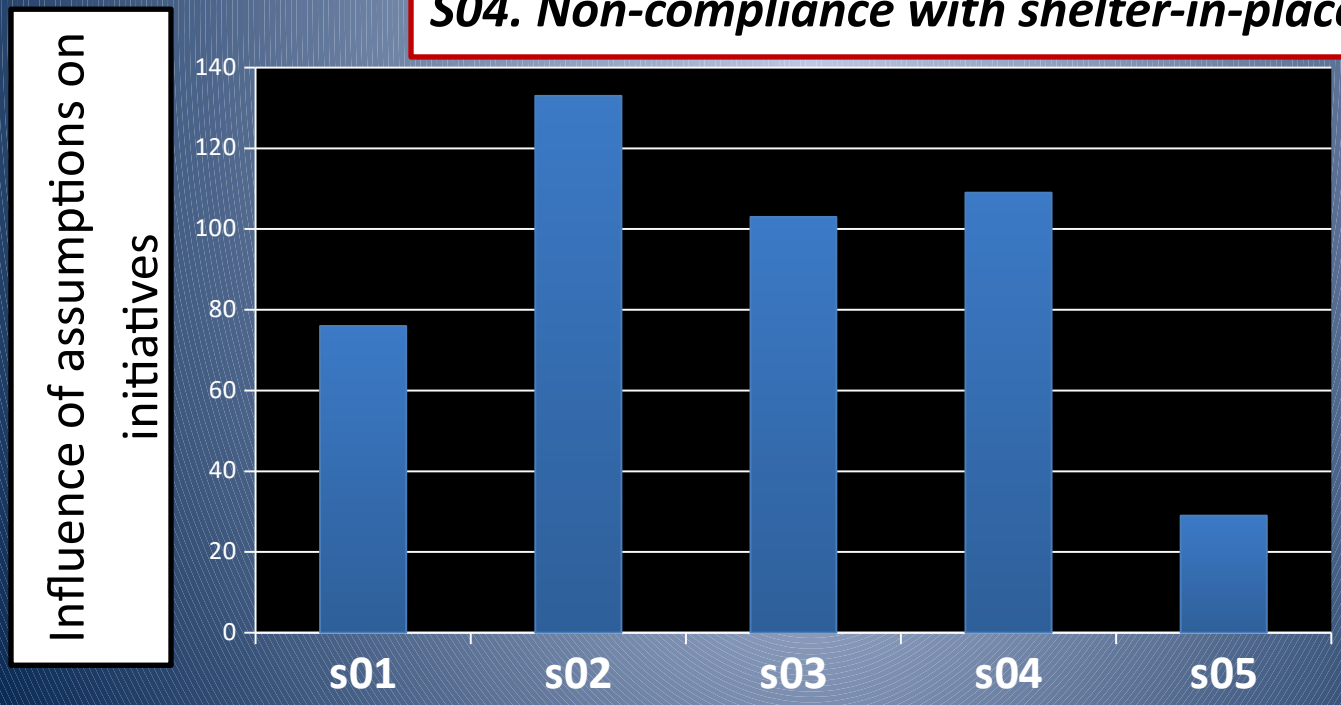


Technical Approach: Emergency Response (cont.)

Most influential assumptions are:

S02. ***Access and trust in information sources***

S04. Non-compliance with shelter-in-place orders



Least influential assumption is:

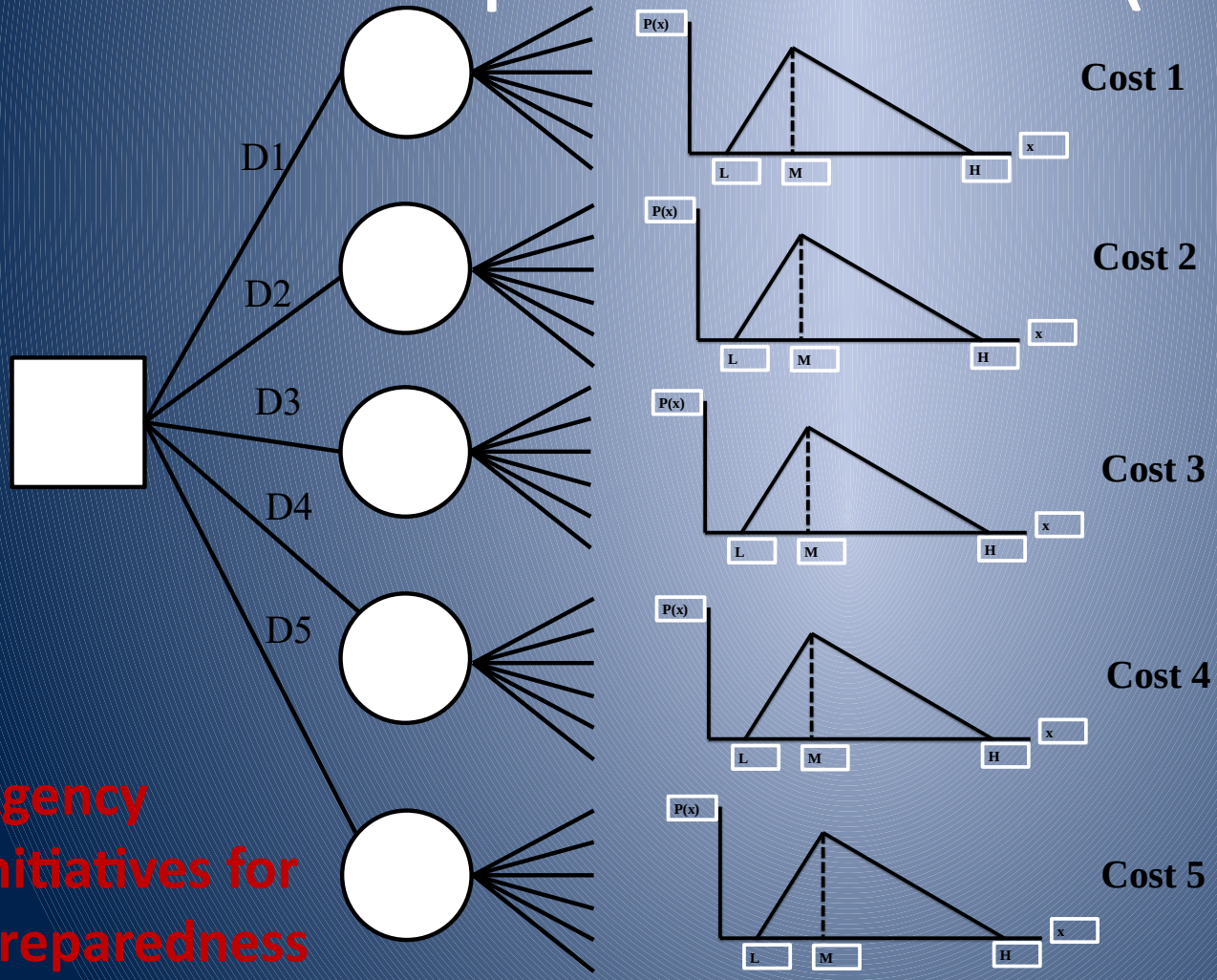
S05. ***Workplace behaviors of critical workers***

Technical Approach: Emergency Response (cont.)

Other key results

	Provide **education and training** for citizen emergency preparedness
Highest ranked initiatives	Improve planning that facilitates **shelter-in-place**
	Increase capabilities for **radiological decontamination** at shelters or along transportation routes
Lowest ranked initiative	Increasing **number of volunteers** to help in case of emergency
Greatest increase in rank relative to no-scenario	Increase availability of **real time public information** and advisories
Greatest decrease in rank relative to no-scenario	Improve interoperability of **emergency communications** among first responders

Sample of Results (cont.)



Agency initiatives for preparedness

Uncertain behaviors

Behavioral scenarios critical to community resilience, with impacts to:

- Schedule
- Cost
- Performance

Lessons Learned

Scenario 1a: One bomb in Tyson's Corner, VA
Scenario 1b: One bomb in College Park, MD
Scenario 2: Multiple bombs across the region

Shelter in place

Lambert, J.H., A.I. Parlak, Q. Zhou, J.S. Miller, M.D. Fontaine, T.M. Guterbock, J.L. Clements, and S.A. Thekdi 2013. Understanding and managing disaster evacuation on a transportation network. *Accident Analysis and Prevention*. 50(1): 645-659.

Lessons Learned (cont.)

- **Implications of uncertain population behaviors:**
  - Evacuation and sheltering
  - Stockpiling and mobilization of essential supplies
  - Planning for traffic and transportation
  - Public awareness
  - Communication and information sharing capabilities
  - Recruitment of staff
  - Health and medical care
  - Hazardous material preparedness
- Each behavioral assumption had impacts in **early, intermediate, and long time horizons** of response

Lessons Learned (cont.)

Characterized the **needs of the emergency planners** in interviews with stakeholders

Found the implications of the origins and intended destinations of residents

Predicted the critical sections of highway across the region

Lessons Learned (cont.)

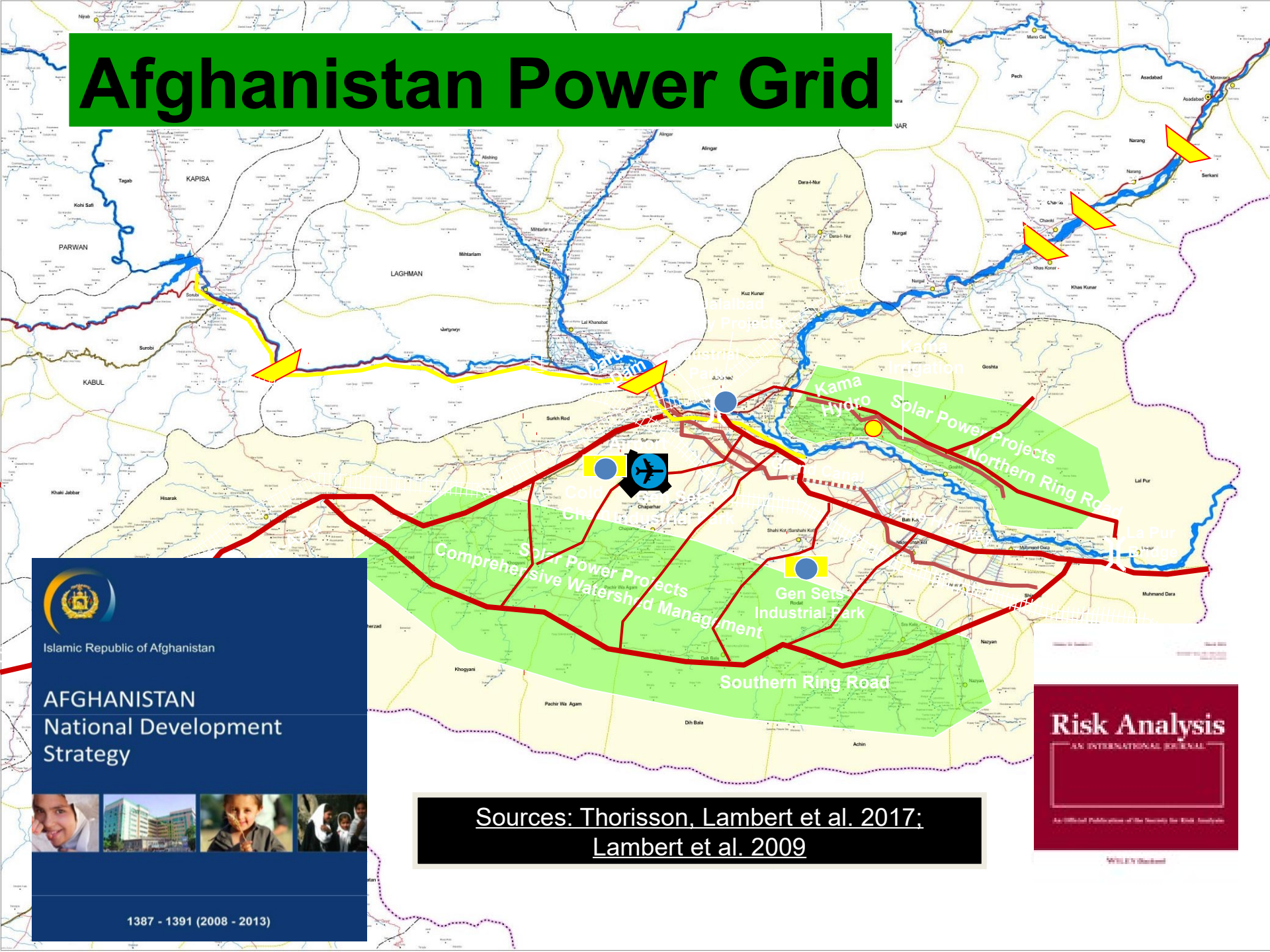
Assembled agency initiatives, behavioral assumptions and criteria for strategic priority-setting

Identified the **most influential behaviors for ranking of agency initiatives**

Developed **recommendations for risk assessment** and management for preparedness of agencies

Further Examples of Compliance and Disruption of Priorities

Afghanistan Power Grid



Sources: Thorisson, Lambert et al. 2017; Lambert et al. 2009

Radiological & Power Blackout at Olympic Games

Corpo de Bombeiros Militar do Estado do Rio de Janeiro (CBMERJ)

Departamento Nacional de Infra-Estrutura de Transporte (DNIT)

Departamento Geral de Defesa Civil (DGDEC)

Operador Nacional do Sistema Elétrico (ONS)

Exército Brasileiro (EB)

Secretaria de Estado de Ambiente (SEA)

Comissão Nacional de Energia Nuclear (CNEN)

Polícia Civil do Estado do Rio de Janeiro (PCERJ)

Departamento de Transportes Rodoviários (DETRO)

Coordenação Regional de Defesa Civil (REDEC)

Marinha do Brasil (MB)

Força Aérea Brasileira (FAB)

Source: Parlak, Lambert, et al. 2012

Enterprise Risk of Mobile Broadband for Public Safety

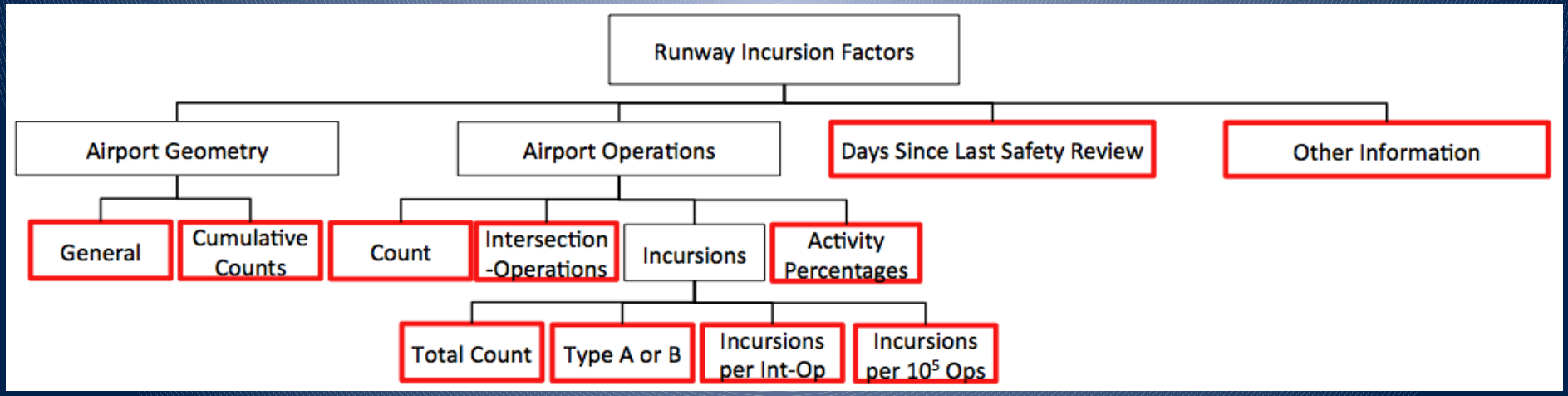
FirstNet™

at&t

S_s	Scenario	Description
S_0	Baseline scenario	--
S_1	Funding decreases	Government funding reduced
S_2	Change of vendor	Contract with current vendor ends or change in contract
S_3	Environmental event disrupts service	Natural disaster or accident
S_4	Low enrollment	Agencies across the state choose not to enroll
S_5	Change in government policy …	Changes to bill creating FirstNet or state level laws restrict rollout, etc.

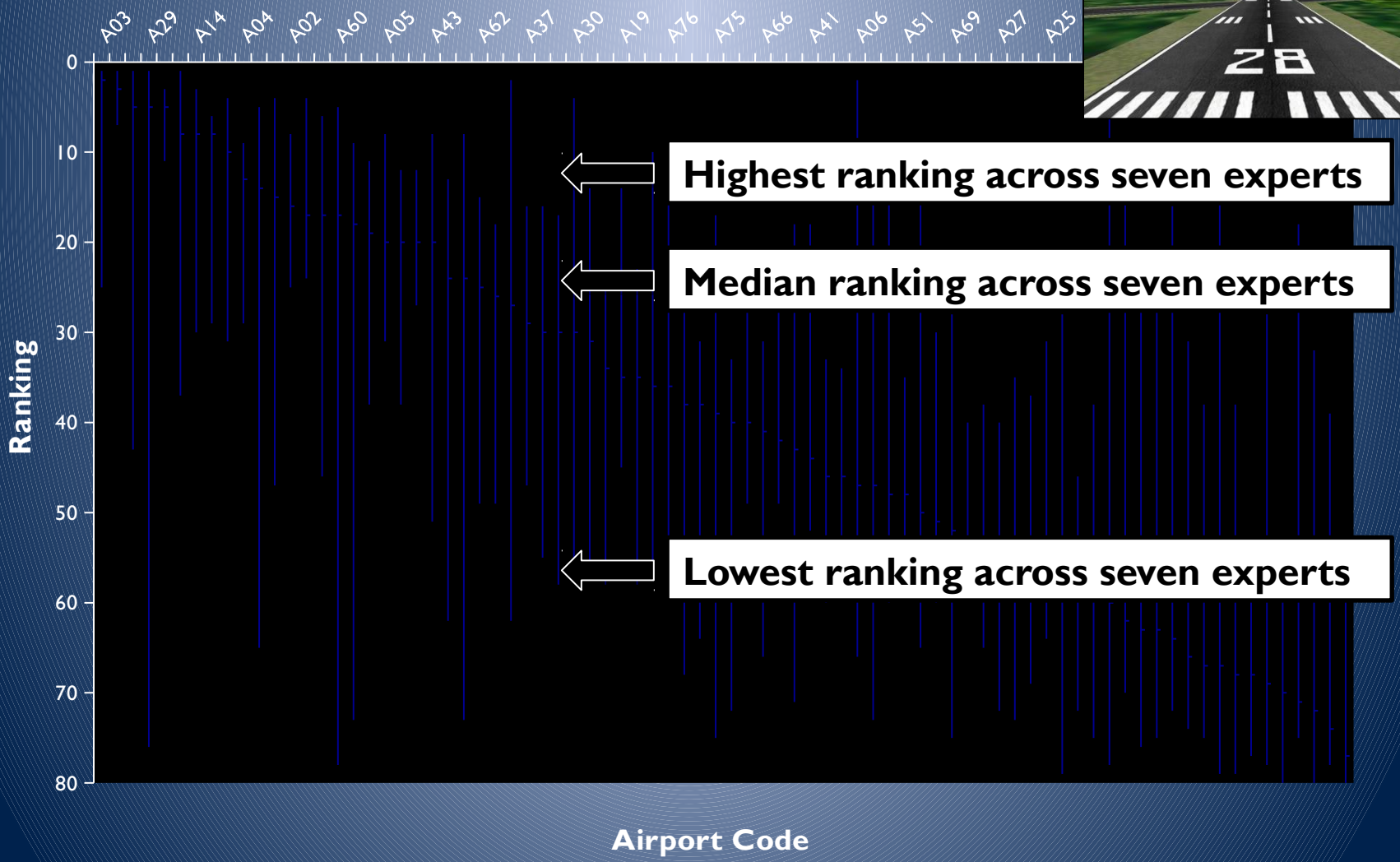
Risk of Runway Incursions

- Scenarios that influence rankings of airports
  - *Pilot* scenario
  - *Owner* scenario
  - *Regulator* scenario



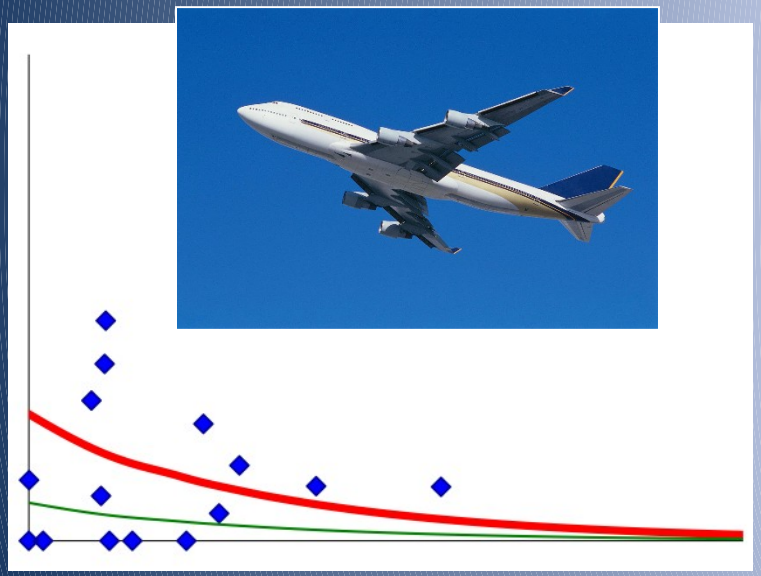
Source: Rogerson and Lambert 2012

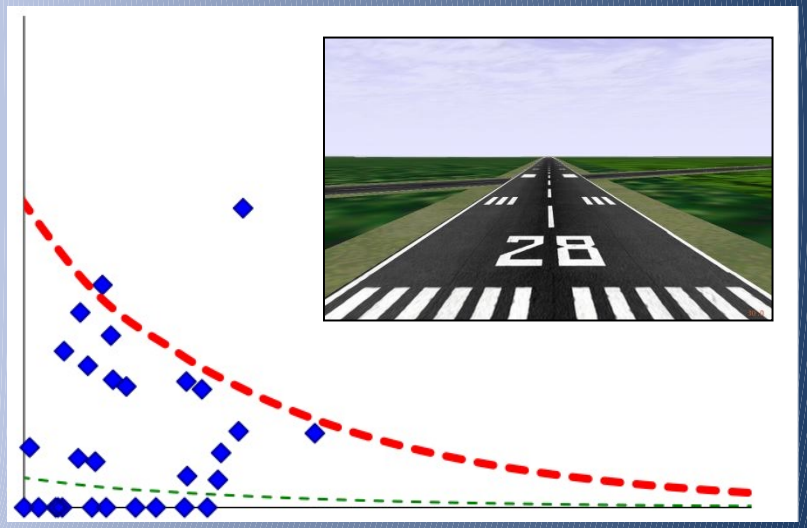
Runway Incursions (cont.)

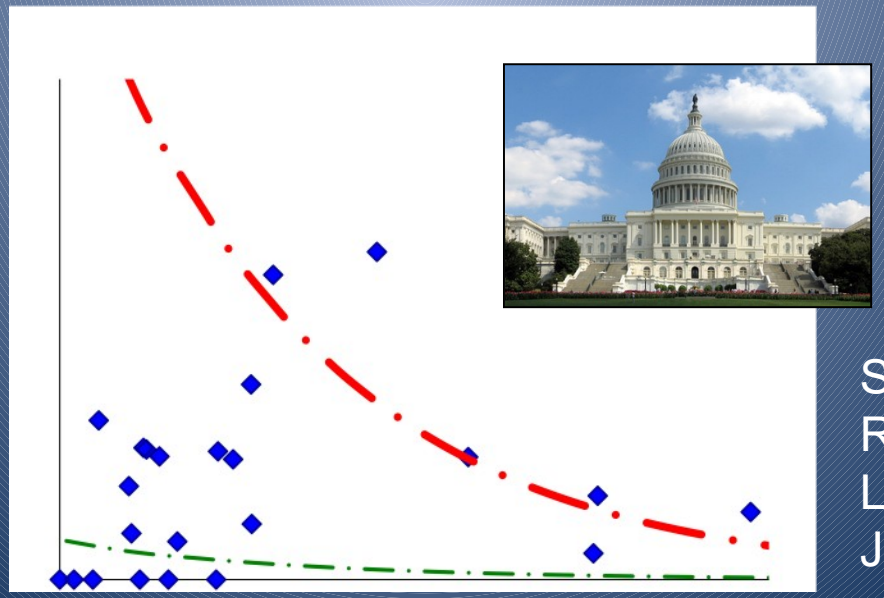


Source: Rogerson and Lambert 2012

Runway Incursions (cont.)



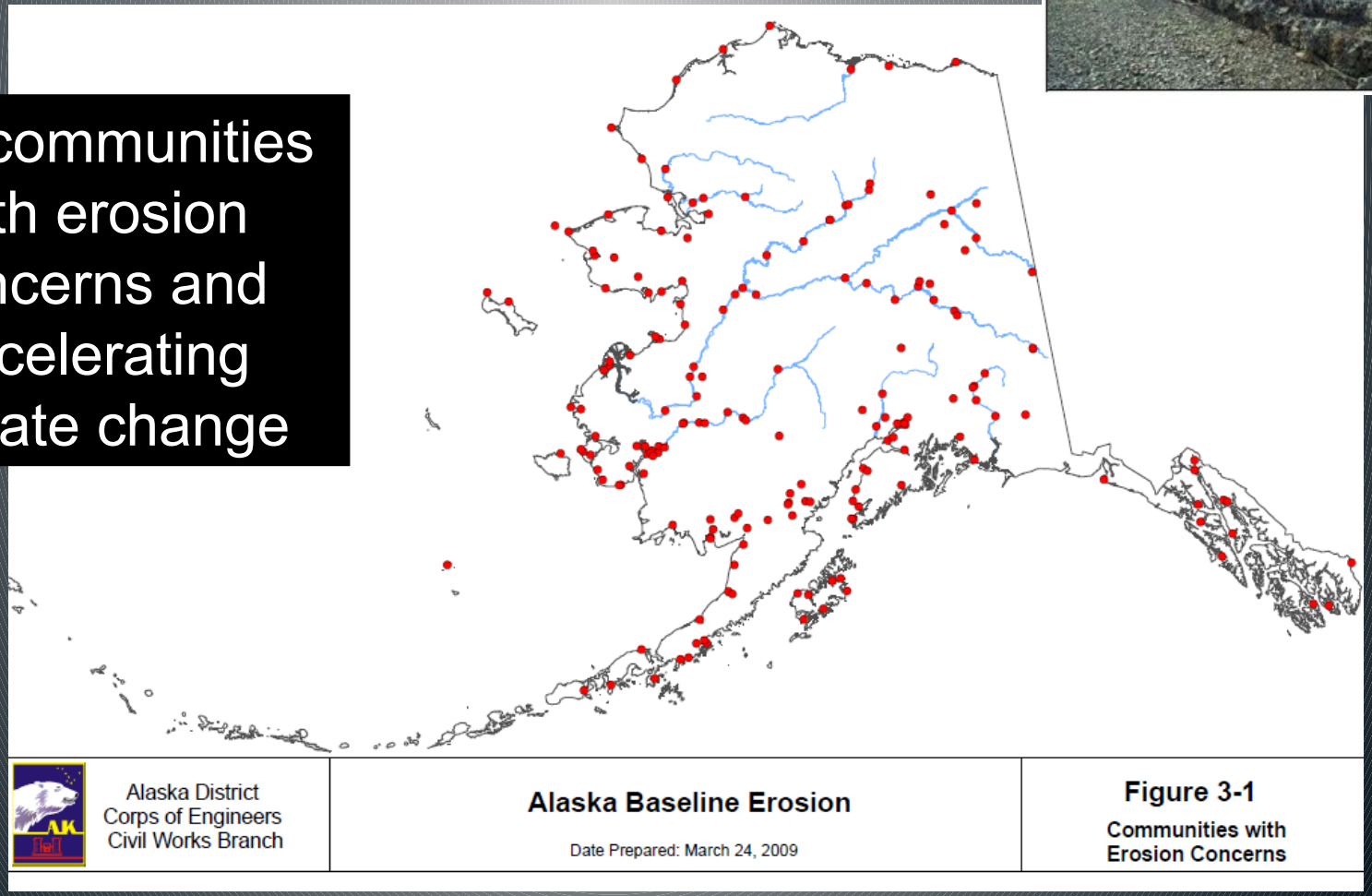




Source: Rogerson, Lambert, and Johns 2013

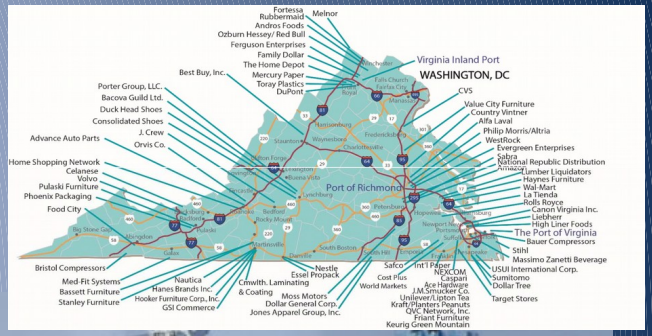
Alaska USA Coastal Erosion

200 communities with erosion concerns and accelerating climate change



Source: Karvetski, C.W., J.H. **Lambert**, et al. 2011. Climate change scenarios: risk and impact analysis for Alaska coastal infrastructure. *Int. J. Risk Assessment and Management*, 15(2/3): 258–274.

Disruptions of Port Operations



THE PORT OF VIRGINIA

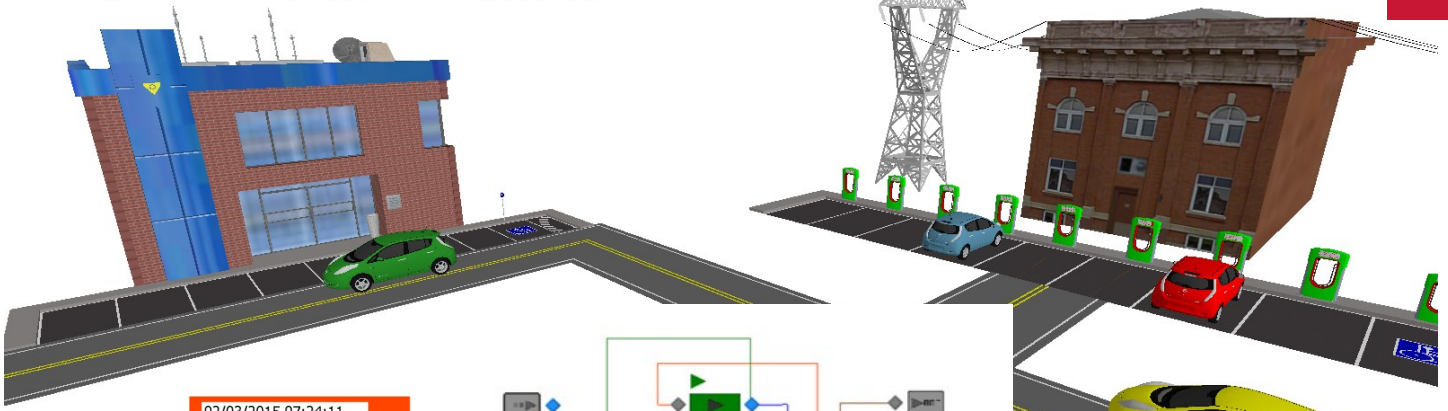
Source: Almutairi, Lambert, et al. 2017

VEHICLE

FERMATA ENERGY

NISSAN

2



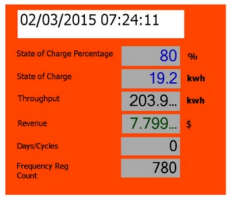


FIGURE 3
EXAMPLE OF SIMIO SIMULATION OUTPUT

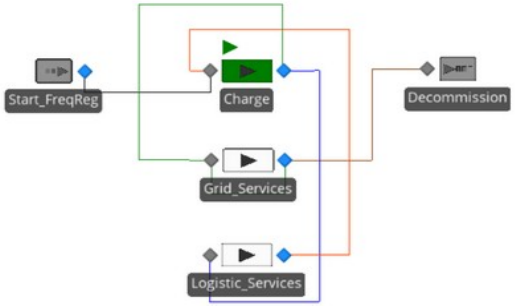
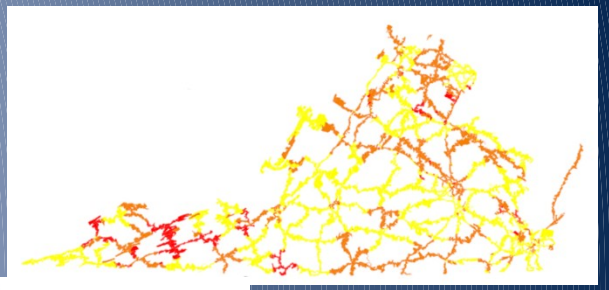


FIGURE 2
SIMIO MODEL OF INTEGRATED GRID AND LOGISTICS SERVICES

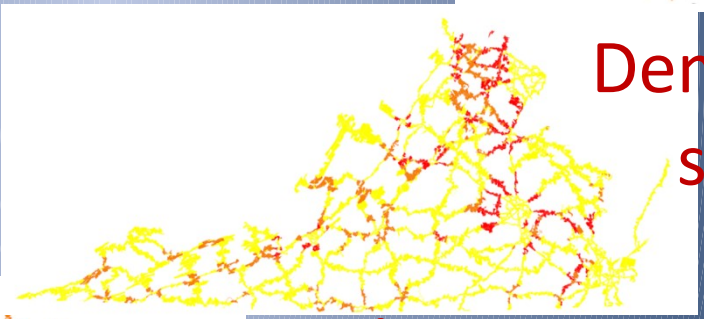
GRID

Risks of Economic Development on Highway Arterials

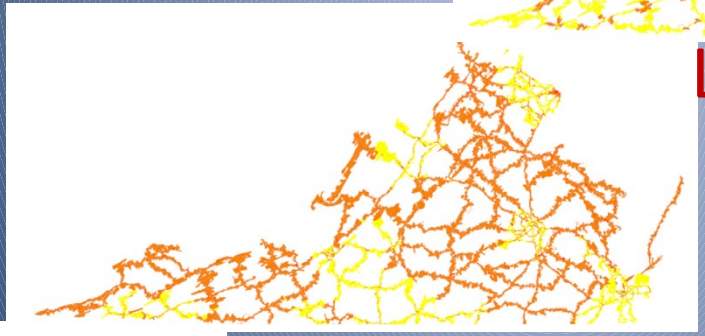
Transportation systems vulnerable to development



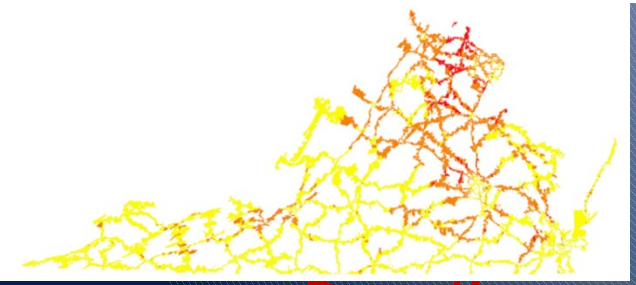
Demographic scenario



Land-Use scenario



Markets scenario

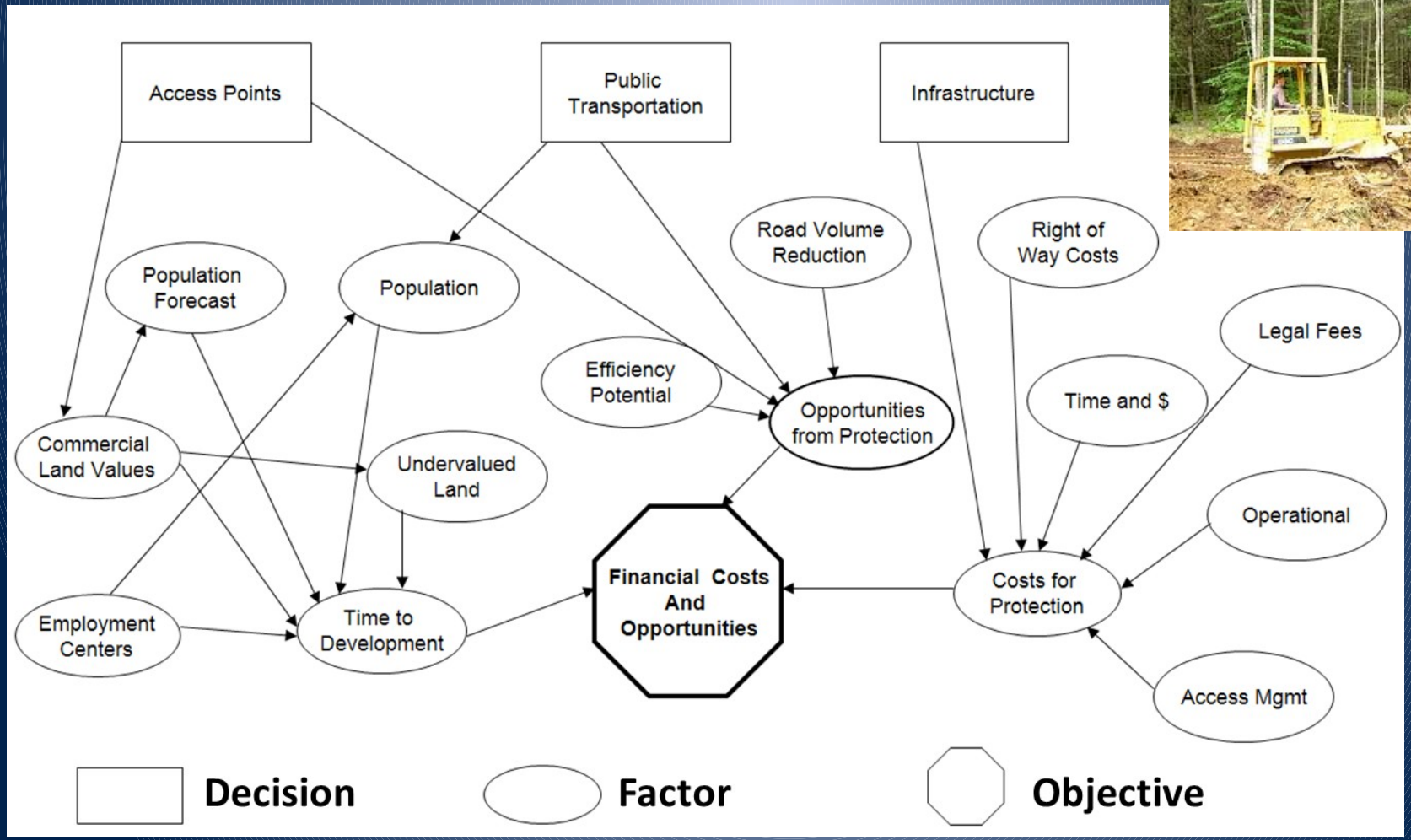


Baseline scenario

VDOT Virginia Department of Transportation

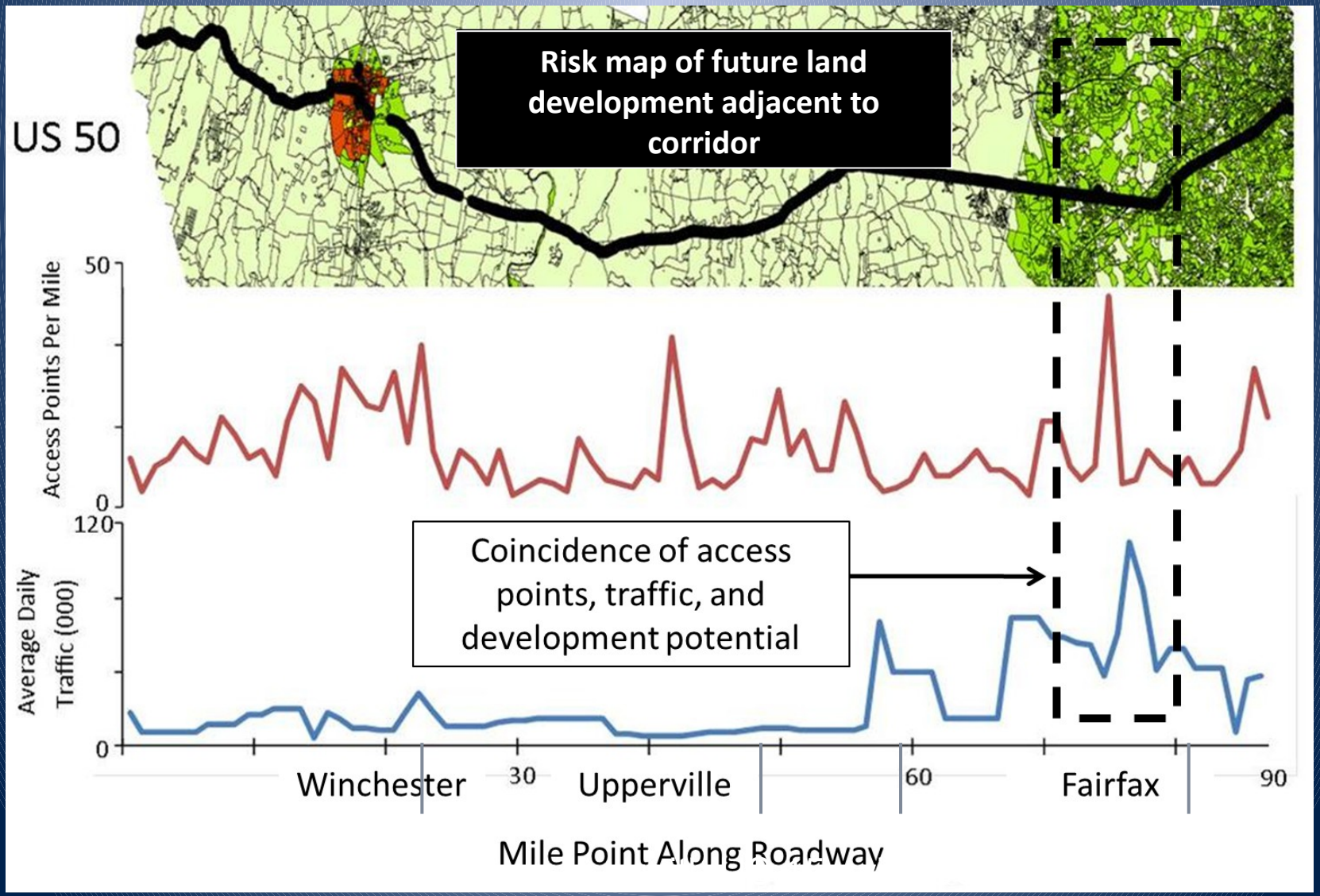
Source: Thekdi and Lambert 2012

Economic Development (cont.)

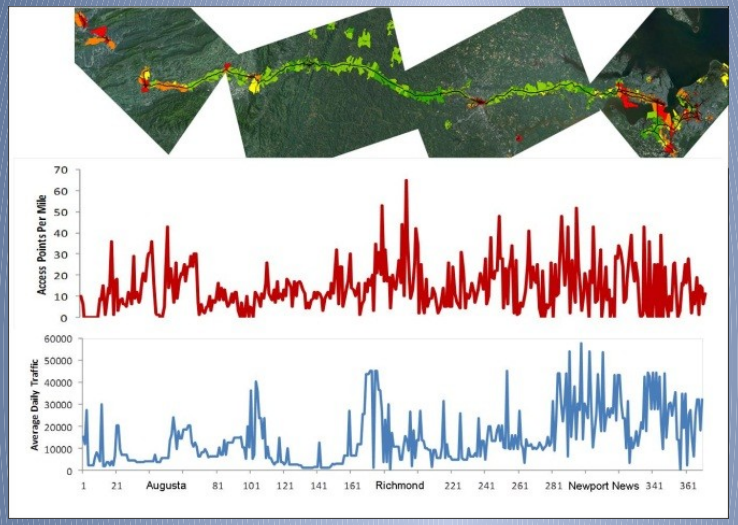


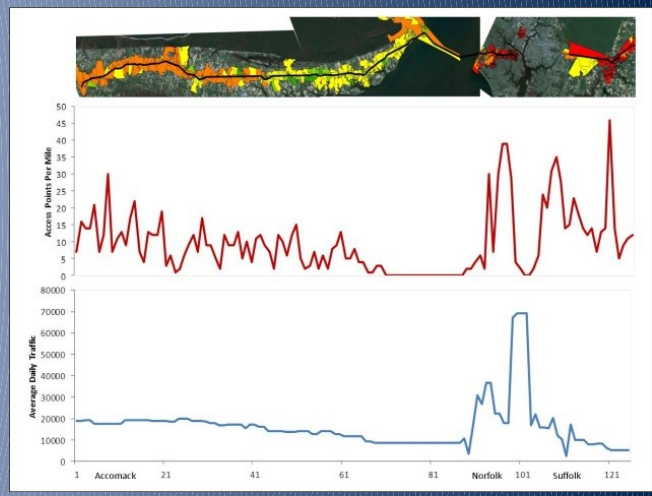
Source: Thekdi and Lambert 2012

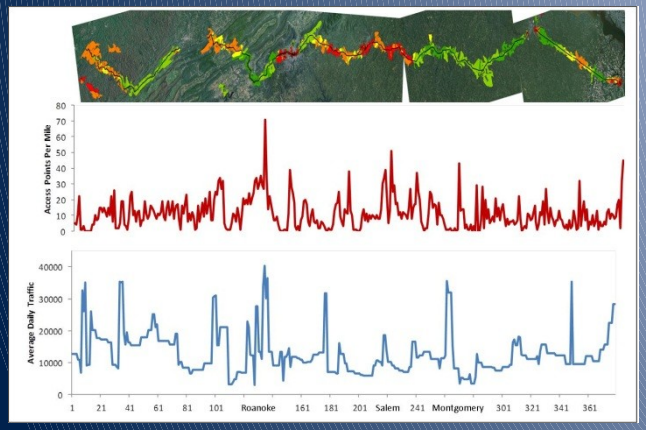
Economic Development (cont.)

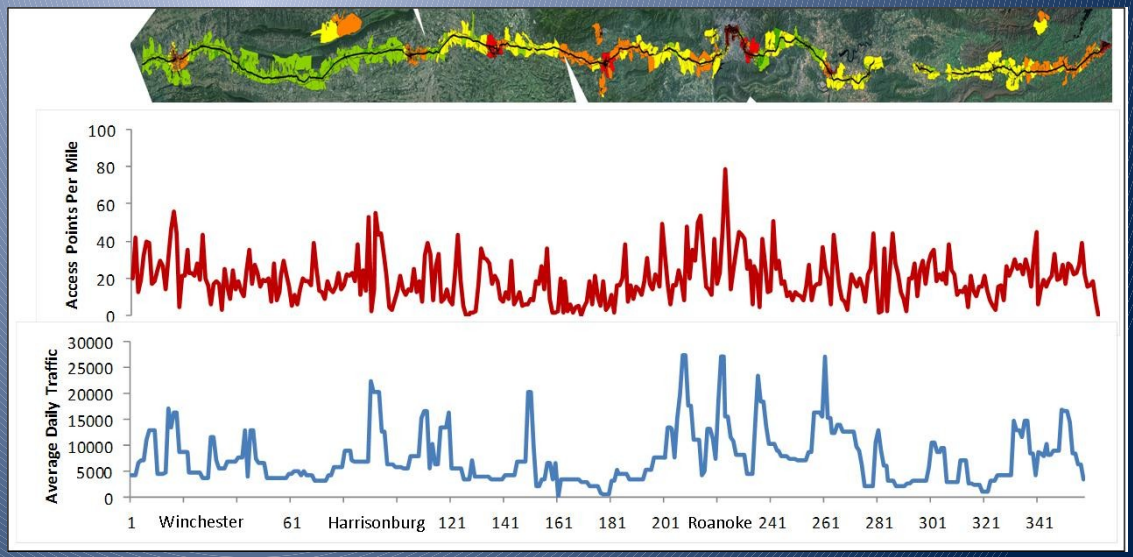


Economic Development (cont.)

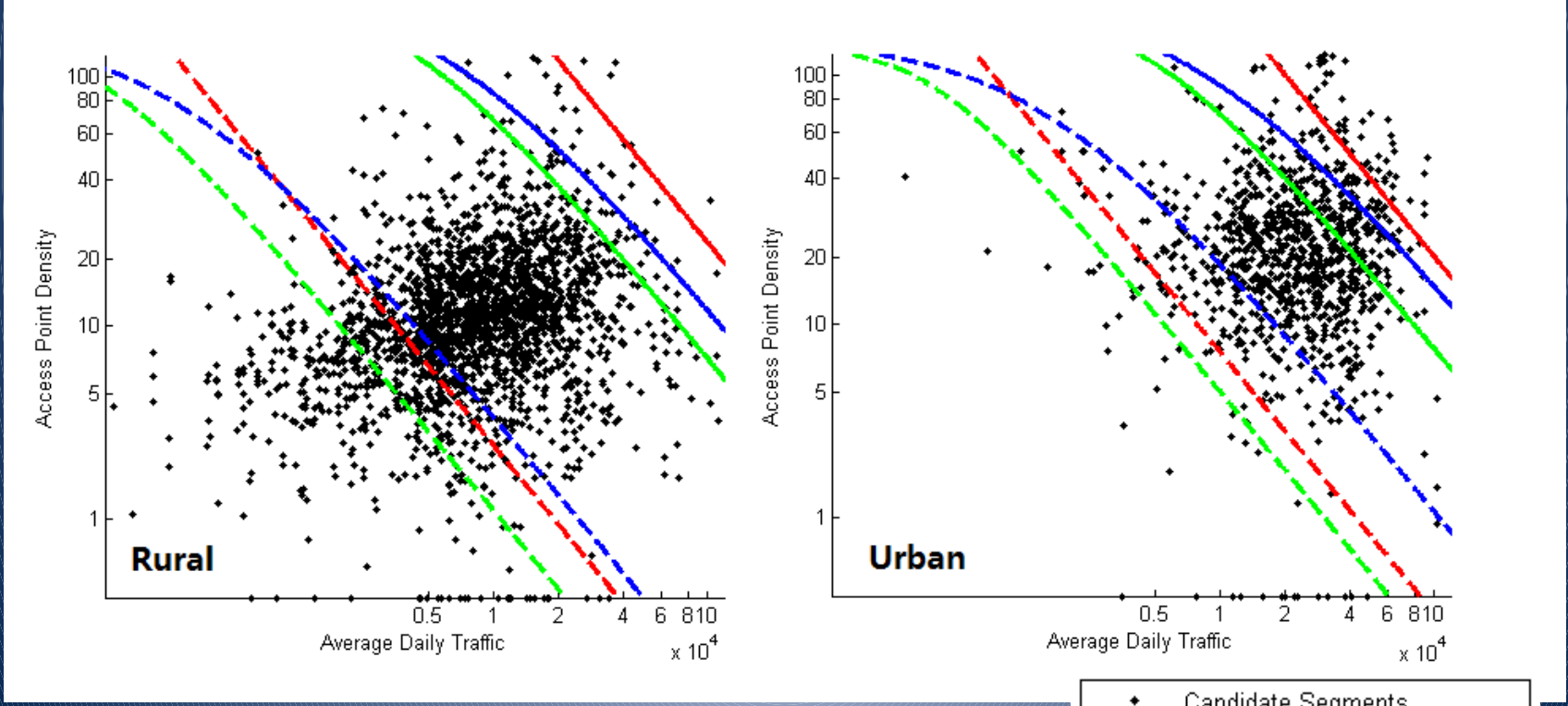








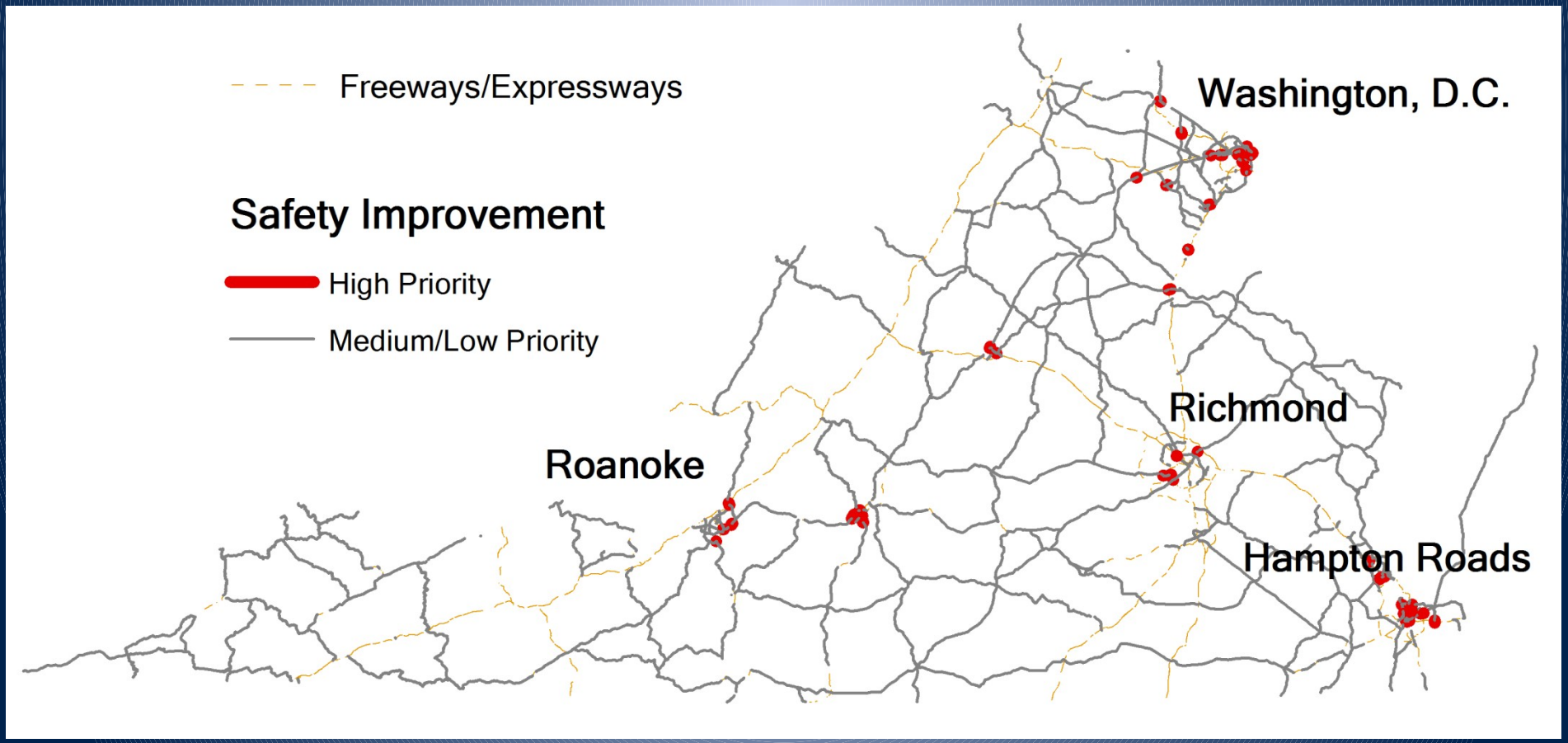
Economic Development (cont.)



Segments above the upper contour are addressed first, segments between upper and lower contours next, and segments below the lower contour last.

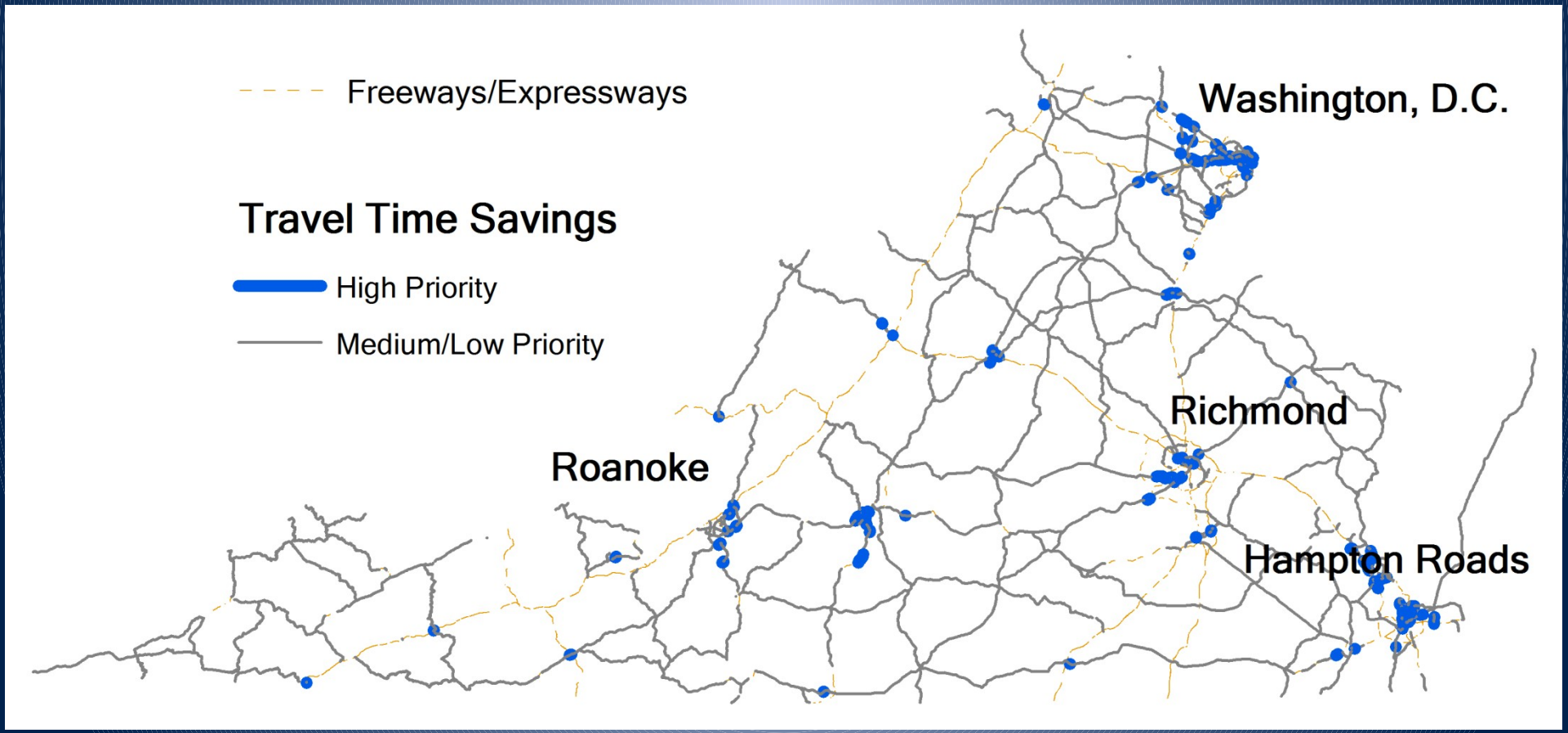
Source: Xu and Lambert 2013

Economic Development (cont.)



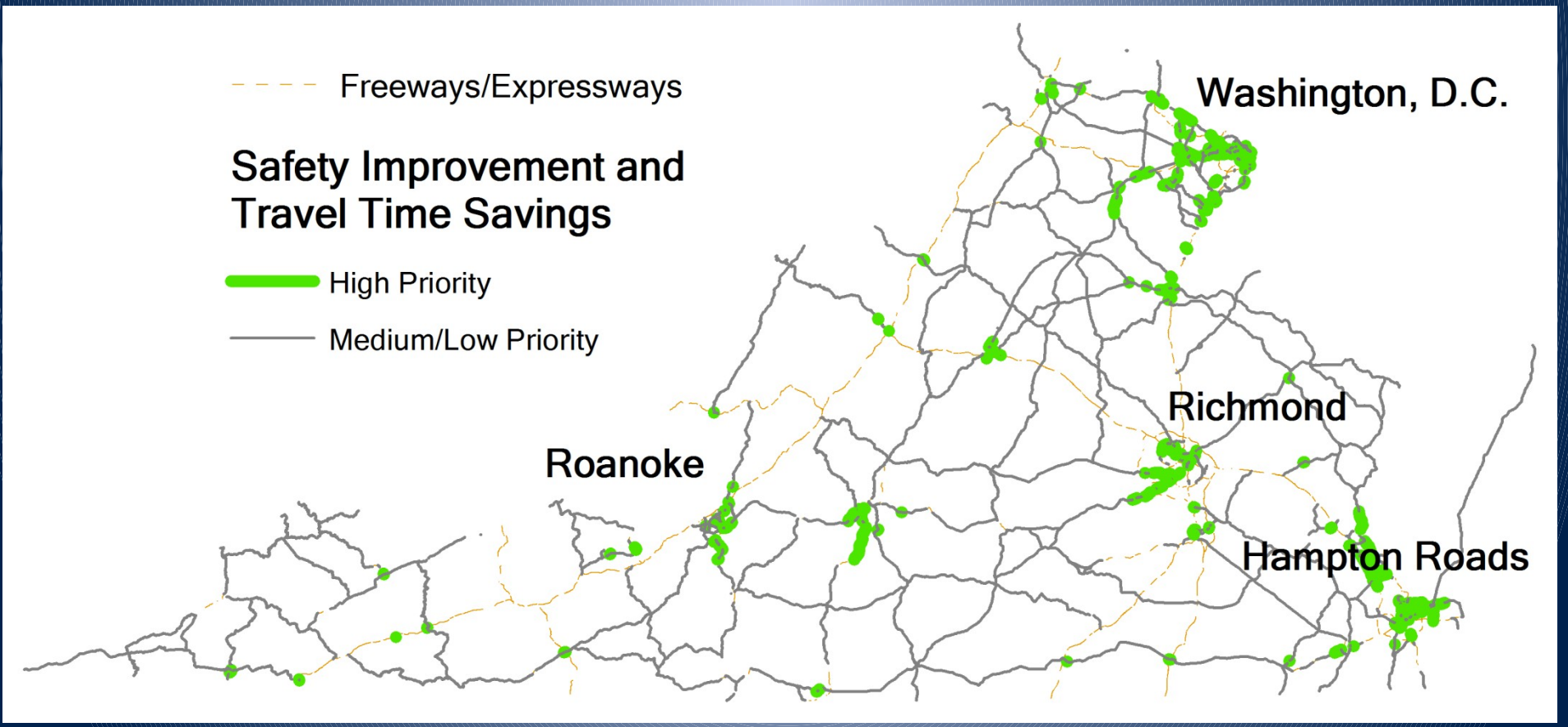
Source: Xu and Lambert 2013

Economic Development (cont.)



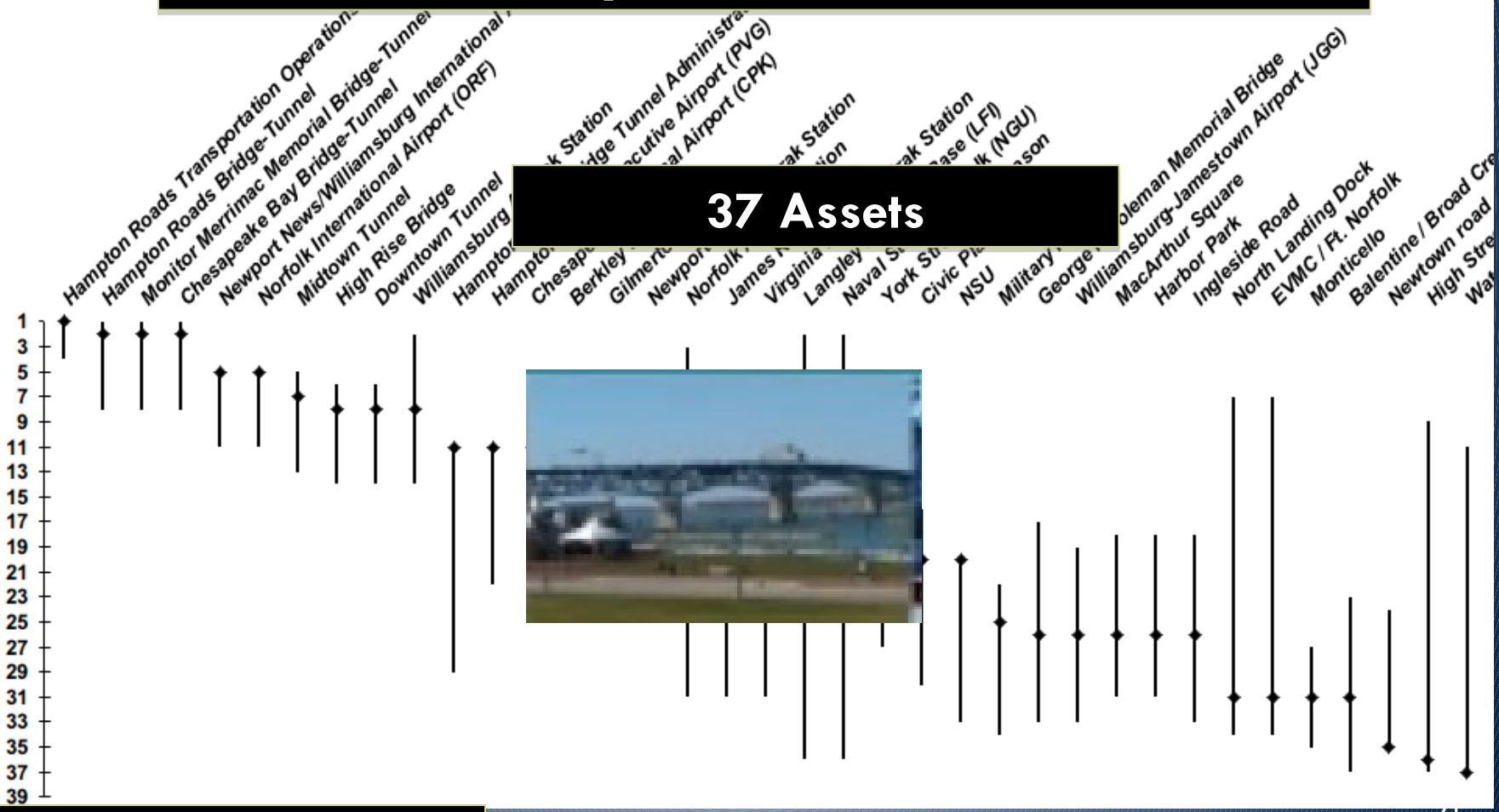
Source: Xu and Lambert 2013

Economic Development (cont.)



Source: Xu and Lambert 2013

Transportation Assets

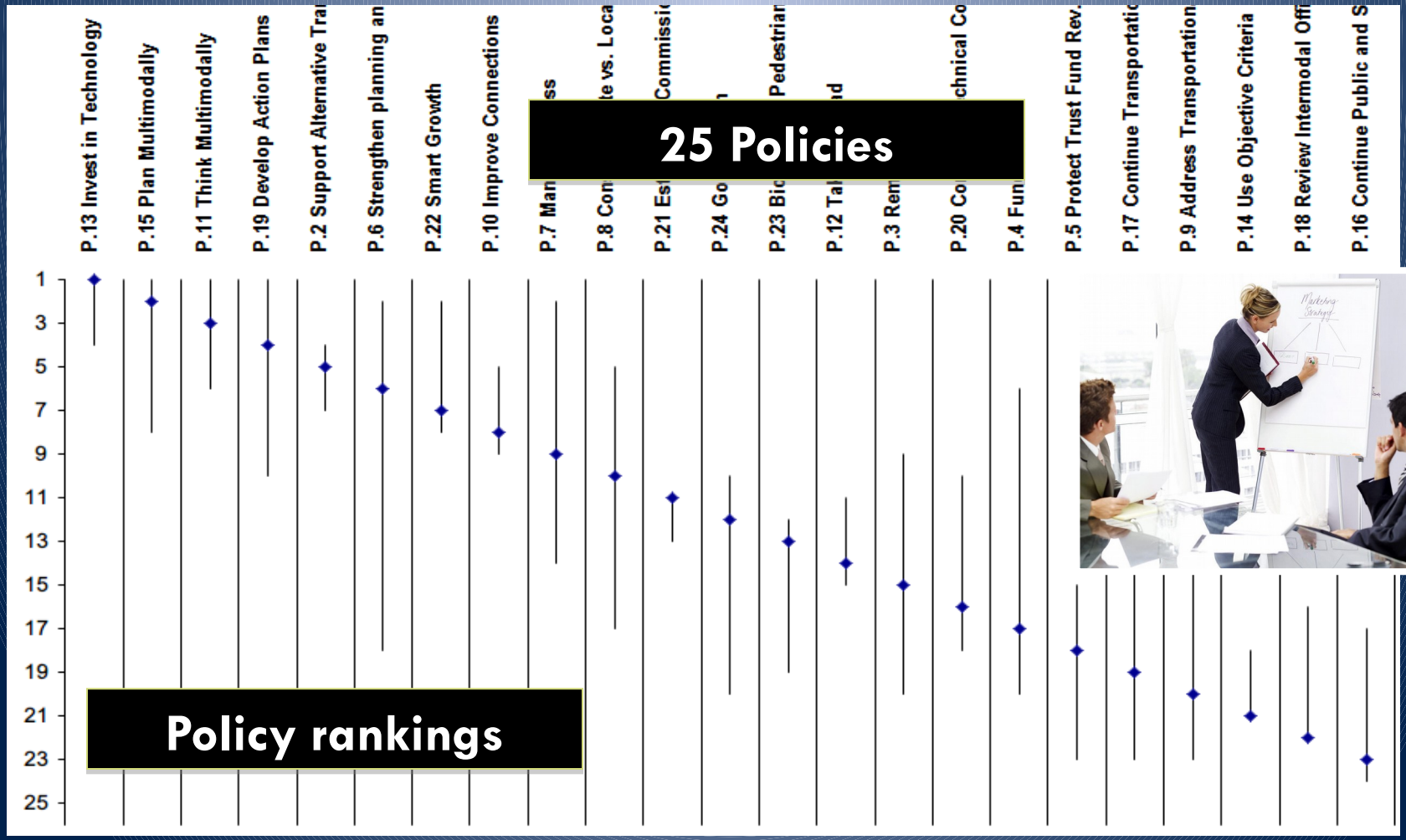


37 Assets

Asset rankings

Source: Lambert et al. 2013

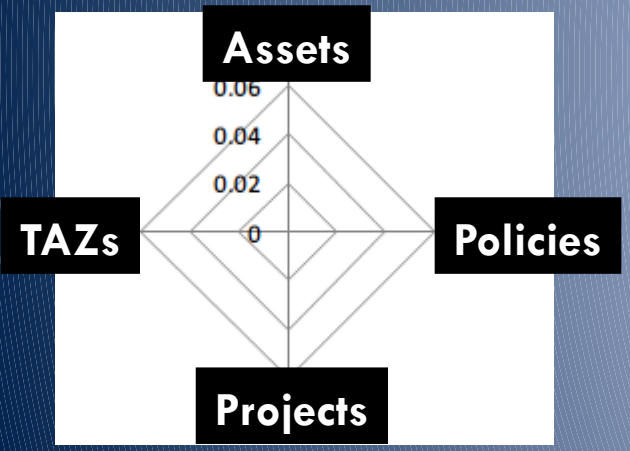
Transportation Policies



Source: Lambert et al. 2013

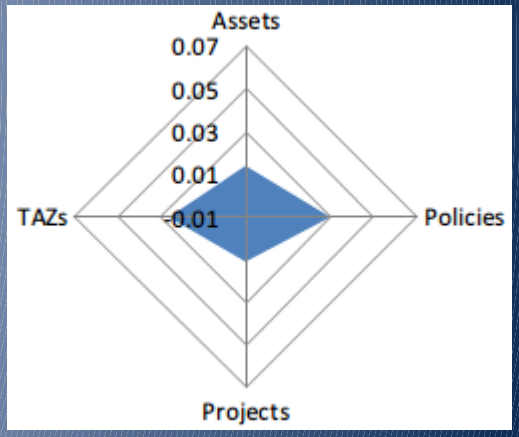
Influences of Climate + Other Conditions

S0. Base Scenario

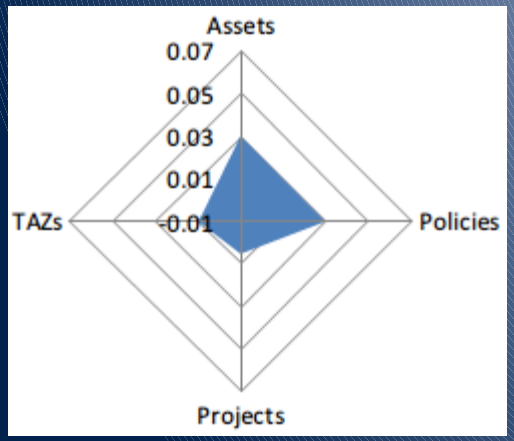


S1. Climate Change

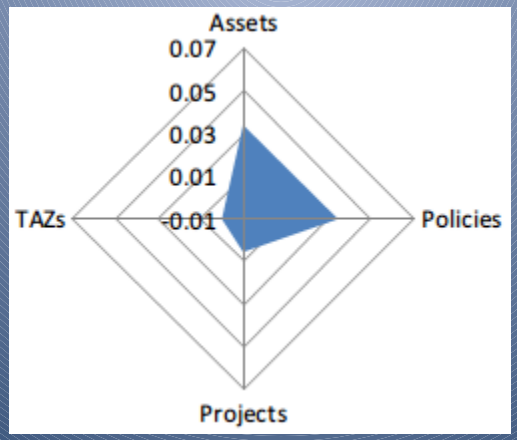
S2. Climate + Economy



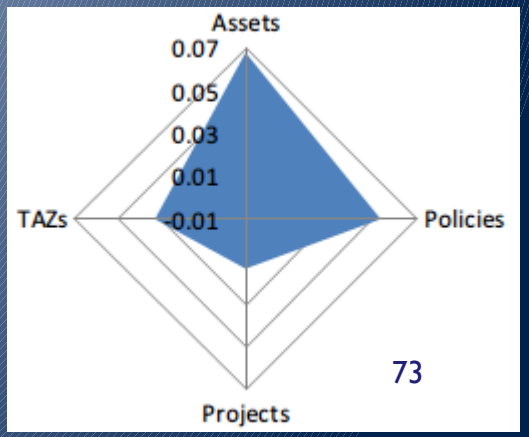
S3. Climate + Wear / Tear



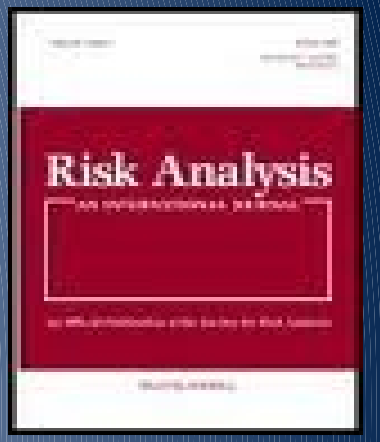
S4. Climate + Ecology



S5. Climate + Traffic Demand



Source: Lambert et al. 2013



THEORY

- Belton and Stewart(2002)
- Mendelow (1981)
- Freeman (1984)
- Goodwin and Wright (2001)
- van der Heijden(1996)
- Karvetski et al. (2009)
- Hamilton, 2014 Dissertation
- Connelly, 2016 Dissertation
- ★ **Almutairi** Dissertation
- **Almutairi** et al. (2017c) ★
- **Almutairi** et al. (2017a) ★
- Montibeller and Franco (2010)
- You et al. (2014)
- Cairns et al. (2016)
- Montibeller et al. (2006)
- Rosso et al. (2014)
- Connelly et al. (2015)
- **Almutairi** et al. (2017b)★
- Thorisson et al. (2017a)★

ICSEng 2017

SRA EUROPE

SRA

METHODOLOGY

APPLICATION

Research Directions

system resilience in **multiple time frames**

Hamilton and Lambert (2016)

Hamilton Dissertation

Iteration and evolution

scenario-based **preferences & risk analysis**

Karvetski et al. (2009)

Schroeder and Lambert (2011)

Karvetski et al. (2011a and b)

You et al. (2013)

Parlak et al. (2012)

Karvetski and Lambert (2012)

Hamilton et al. (2013a and b)

Adjust weights based on baseline scenario

Mise-en-scene

scenario-based preferences

Montibeller et al. (2006)

Ram et al (2009)

Ram and Montibeller 2012

Stewart (2013)

Separate additive model for each scenario

Robustness based on regret

Preference aggregation across scenarios

scenario analysis and multicriteria

Goodwin and Wright (2001)

Belton and Stewart (2002)

Evaluate alternative-scenario pairs

multicriteria analysis

Corner et al (2001)

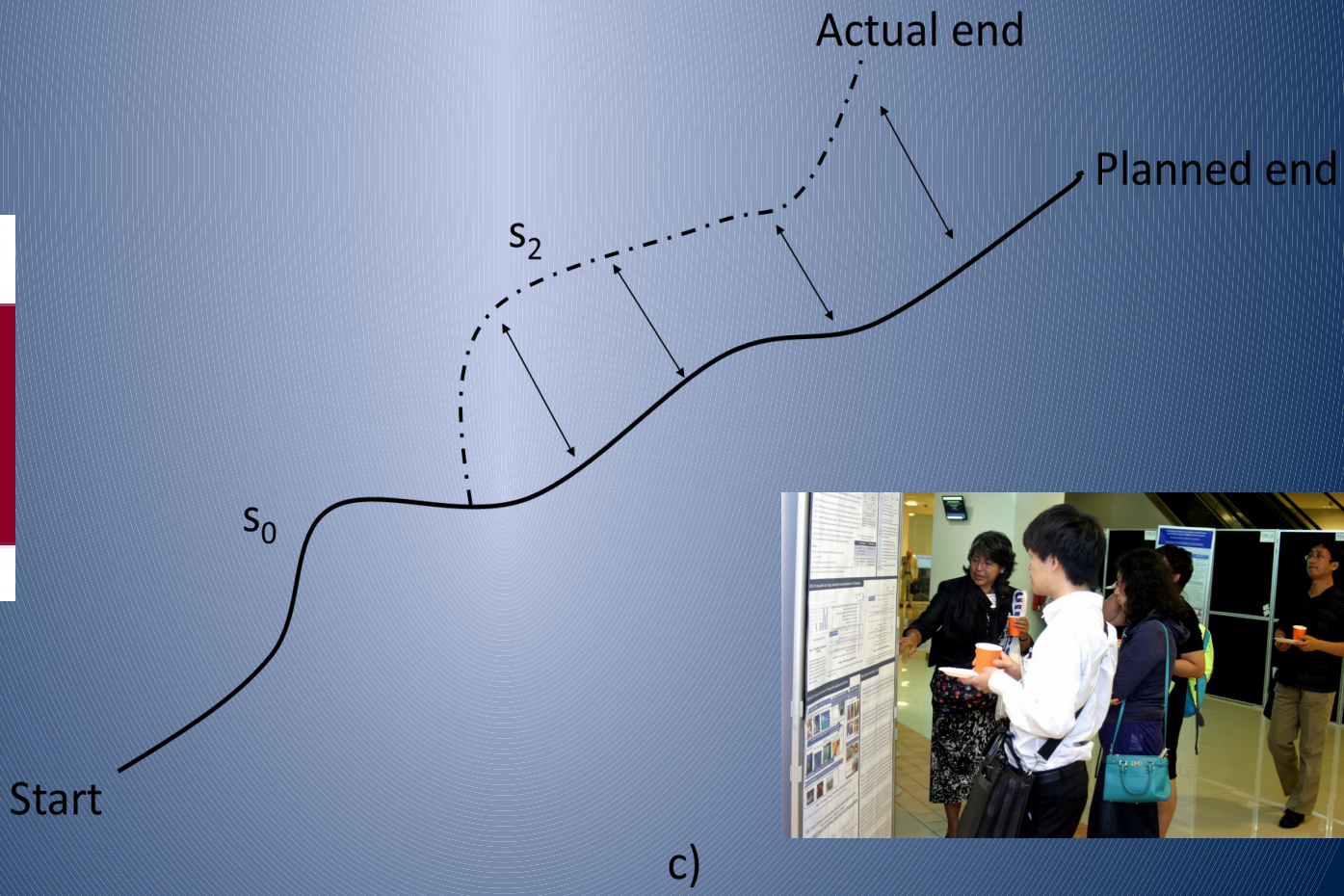
Montibeller and France (2010)

Dynamic mcda

Transitional object


“N’ira pas loin celui qui sait d’avance où il veut aller.”
Grand Challenges, Smart Cities, Human and Sociotechnical Systems, Engineering Systems and Environment, Compliance, etc.

Directions (cont.)



Source: Thorisson, Lambert, et al. 2017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INSTITUTE OF
INDUSTRIAL
& SYSTEMS
ENGINEERS

Applied Risk Management

Decision Analysis and Risk

Dose Response

Ecological Risk Assessment

Economics and Benefits Analysis

Emerging Nanoscale Materials

Engineering and Infrastructure

Exposure Assessment

Foundational Issues in Risk Analysis

Microbial Risk Analysis

Occupational Health and Safety

Resilience

Risk and Development

Risk Communication

Risk Policy and Law

Security and Defense

SRA

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Co-Chair: **Mary Gulumian**, South Africa
Program Chair: **Igor Linkov**, USA
Finance Chair: **Patricia Nance**, USA
Local Organizing Chair: **Sasa Jovanović**, Germany

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DEVELOPMENT AND RESILIENCE

Cape Town International Convention Centre
Cape Town, South Africa
May 6-8, 2019

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Compliance and Risk Management in the Fourth Revolution

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