
Quantifying and Visualizing Risk in the Garment Manufacturing Supply Chain

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May 19, 2016

Agenda

1. Previous Research
2. Introduction
3. Methodology
4. Results
5. Conclusion
6. Further Research

Previous Research

Xia and Liu (2014)

Application of Supply Chain Risk Management through Visualization and Value-at-Risk Quantification

“Create SCRM framework using supply chain visualization software and Value-at-Risk from catastrophe modeling software.”

Buscher and Poyato Ayuso (2015)

Factors Influencing Tier 2 Supply Chain Risk Data Collection

“Factors vary throughout different players in the networks. Internally, supply chain transparency must be indoctrinated in the culture of the executing company.”

Introduction

Motivation:

A method to quantify supply chain risks is needed to focus risk mitigation efforts.

Objectives:

Combine different categories of risks to present a picture of vulnerability throughout a supply chain.

Build an effective risk mitigation tool by quantifying and visualizing the values-at-risk across the supply chain.

Methodology

Network Structure

Visualization

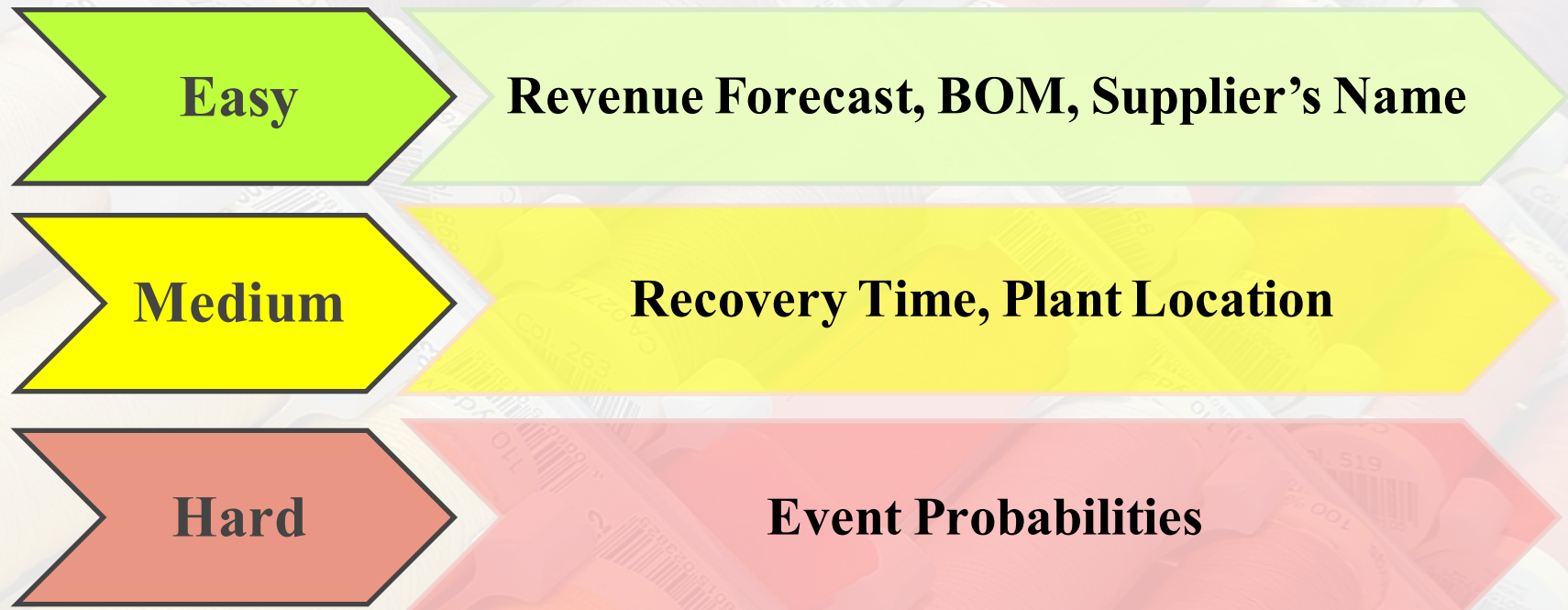
Value-at-Risk

Risk
Exposure
Index

**Probability
of Loss**

Visualization

Data Input:

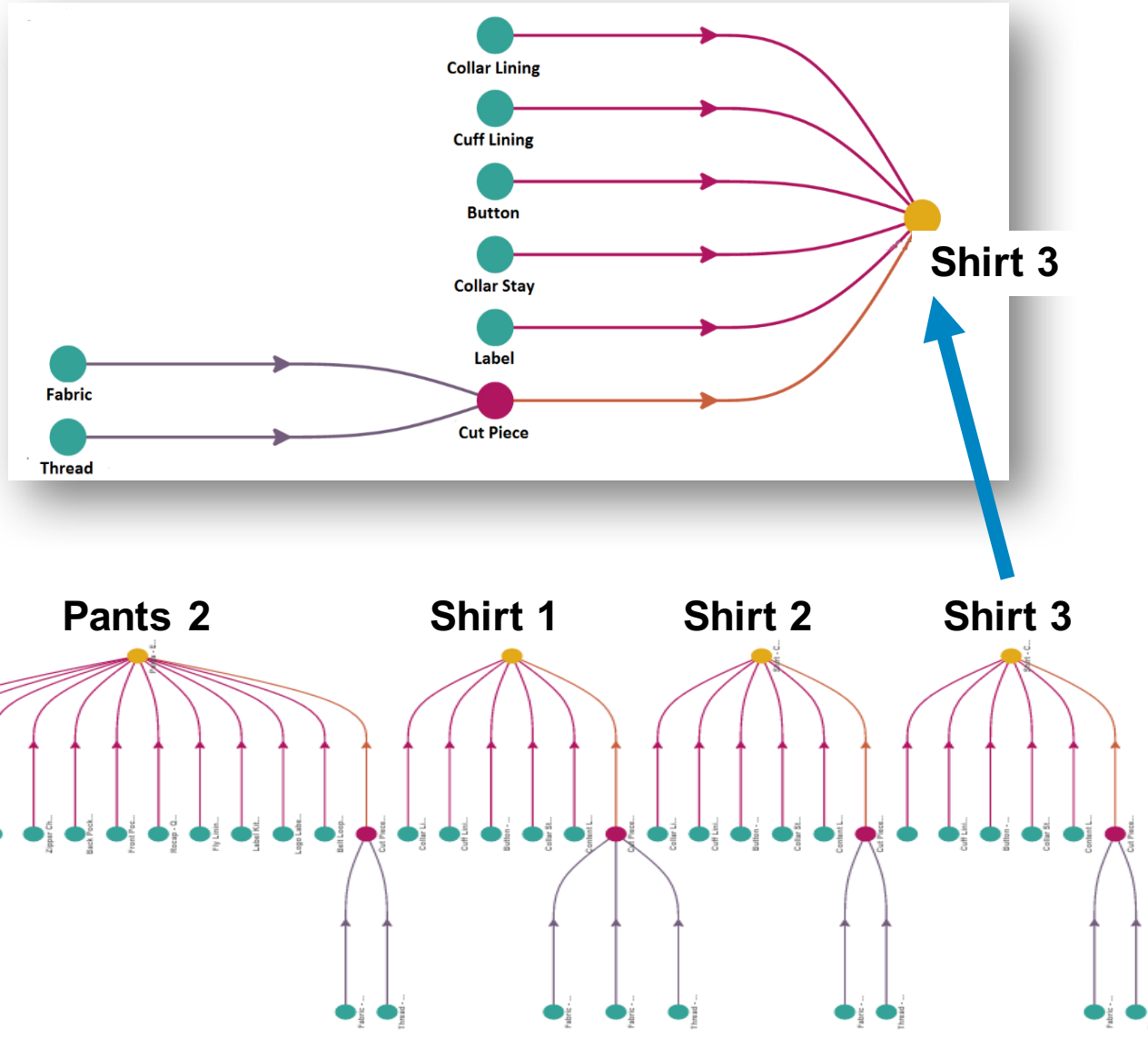


Tool: SourceMap

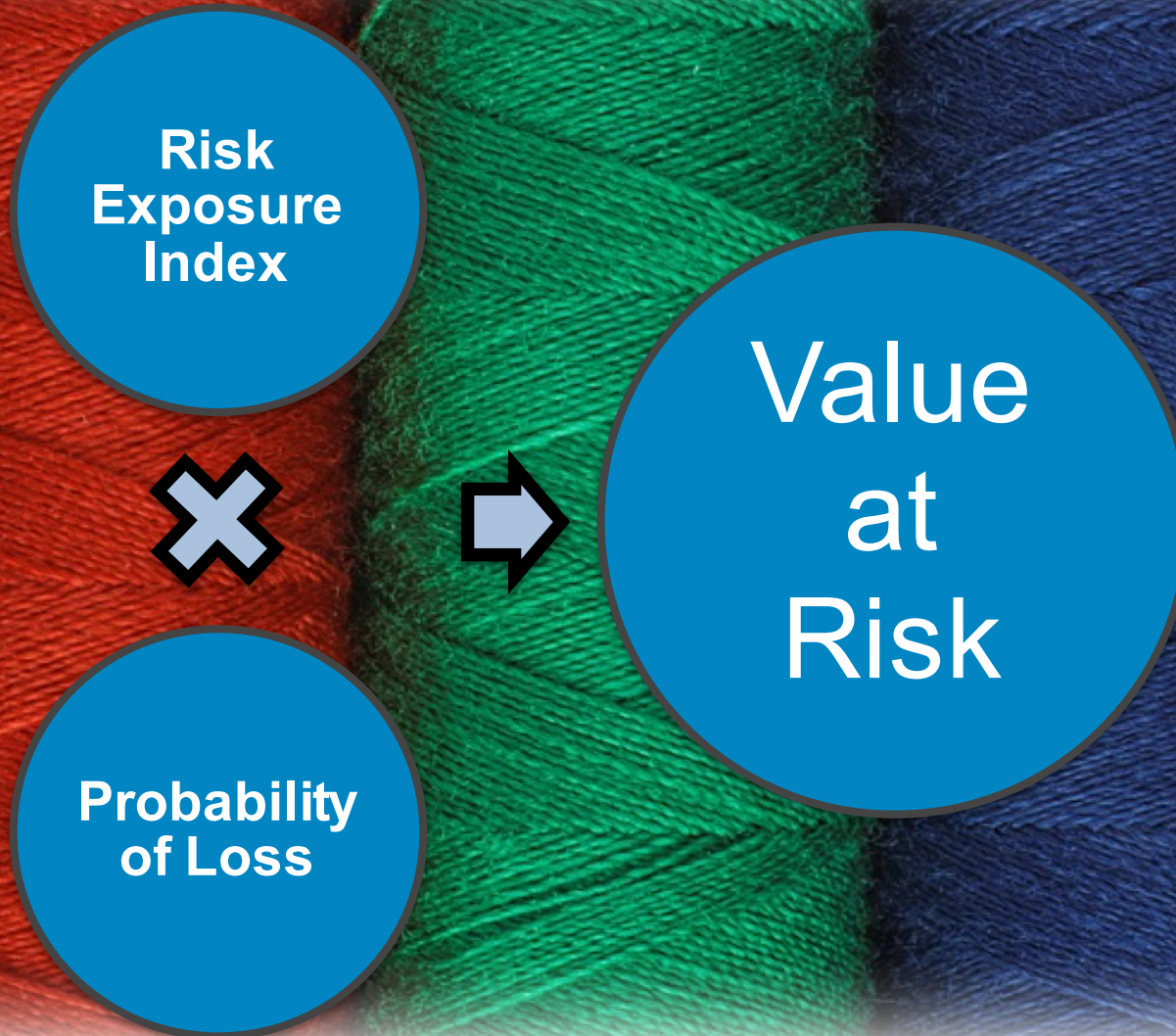
Key: Supply Chain Visibility and Transparency

Output: A map of the supply chain overlaid with relative value-at-risk.

Visualization



Value-at-Risk



Risk Exposure Index

Amount of revenue lost during inventory blackout days.

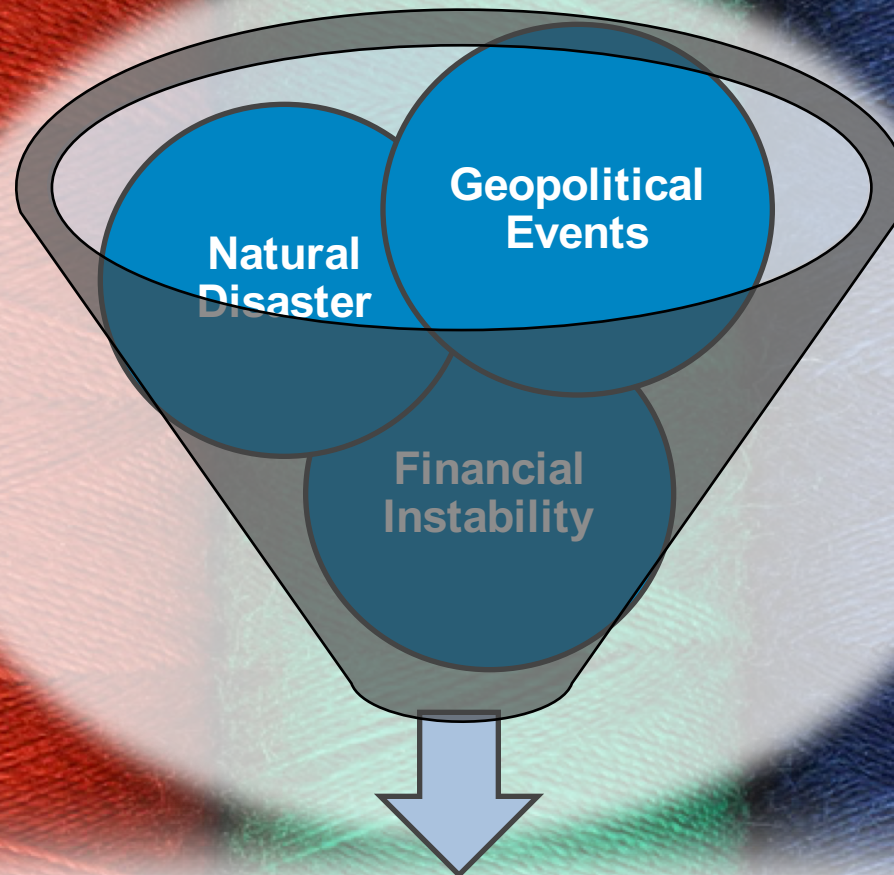


Source: ESD265 Lecture Supply Chain Risks

$$\text{REI} = \text{Forecast Revenue} * (\text{Inventory Days} - \text{Recovery Days})$$

Probability of Loss

*Value-at-Risk = Risk Exposure Index * **Probability of Loss***



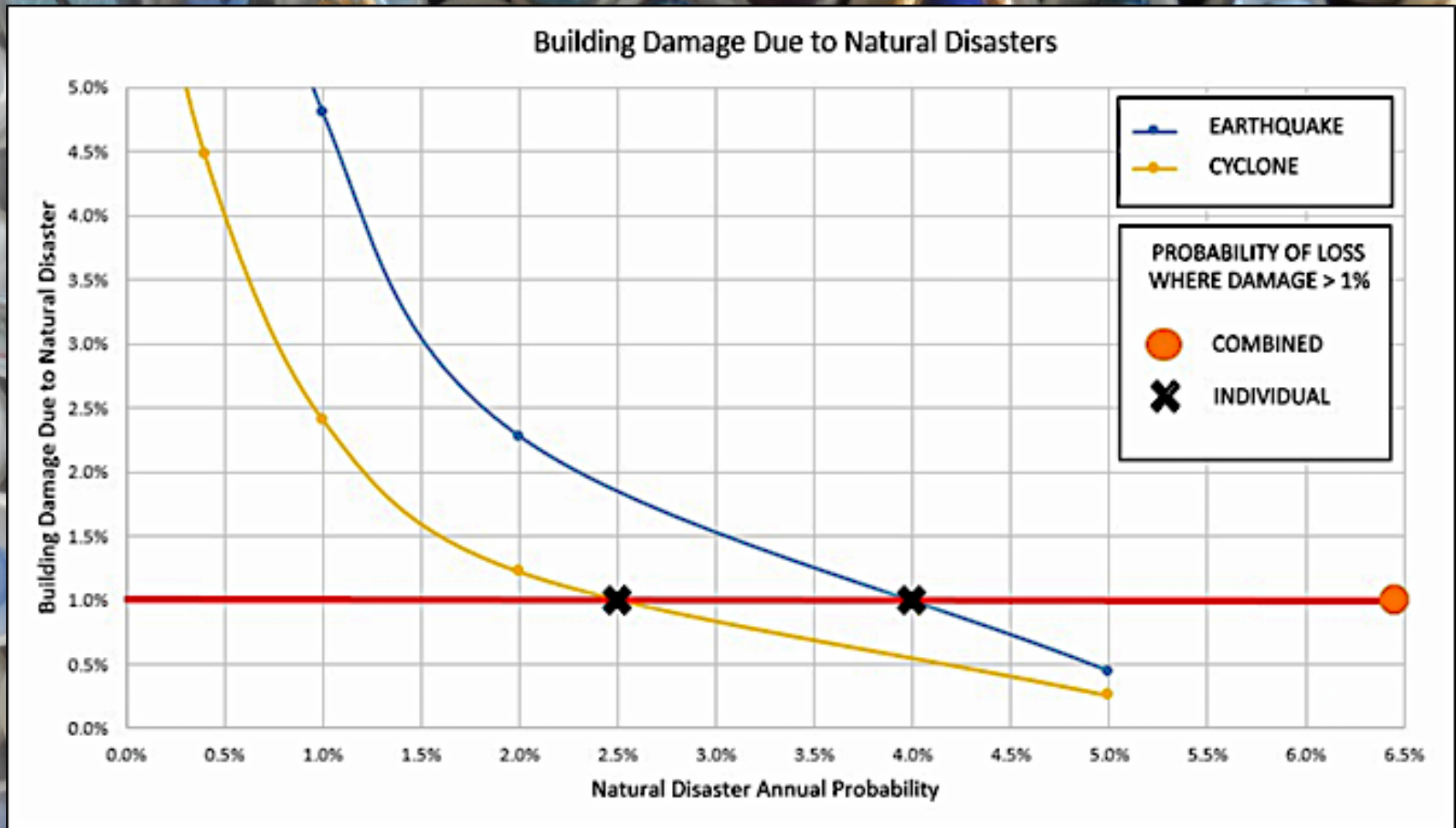
Probability of Loss

Natural Disasters

Source: AIR Worldwide

Annual Probability		Building Damage					
		5.0%	2.0%	1.0%	0.4%	0.2%	0.1%
Location	Natural Disaster	20 yr	50 yr	100 yr	250 yr	500 yr	1000 yr
1	Tropical Cyclone	0.1%	0.1%	0.2%	0.3%	0.4%	0.5%
2	Earthquake	0.5%	2.2%	4.7%	9.0%	15.1%	16.8%
2	Tropical Cyclone	0.4%	1.3%	2.8%	4.9%	8.5%	12.4%
3	Earthquake	0.4%	2.3%	4.8%	8.2%	12.3%	16.5%

Natural Disasters



Financial Instability – US Public Companies

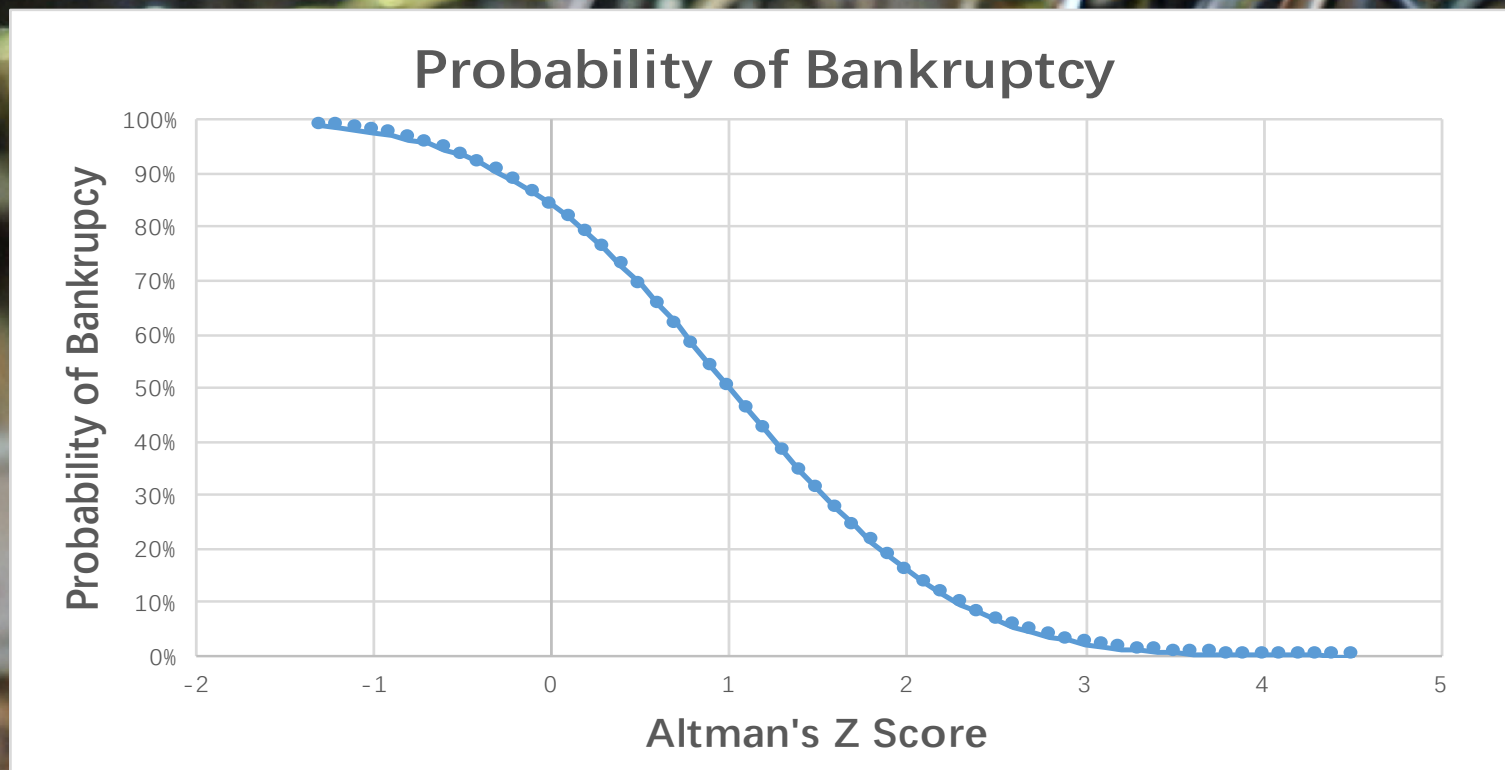
Altman Z-Score =

$$\begin{aligned} & .012 * (\text{Working Capital} / \text{Total Assets}) \\ & + .014 * (\text{Retained Earnings} / \text{Total Assets}) \\ & + .033 * (\text{EBIT} / \text{Total Assets}) \\ & + .006 * (\text{Market Value Equity} / \text{Value of Total Debt}) \\ & + .999 * (\text{Sales} / \text{Total Assets}) \end{aligned}$$

Altman Z-Score	Zone of Discrimination
$Z > 2.99$	Safe
$1.81 < Z < 2.99$	Grey
$Z < 1.81$	Bankrupt

Financial Instability – US Public Companies

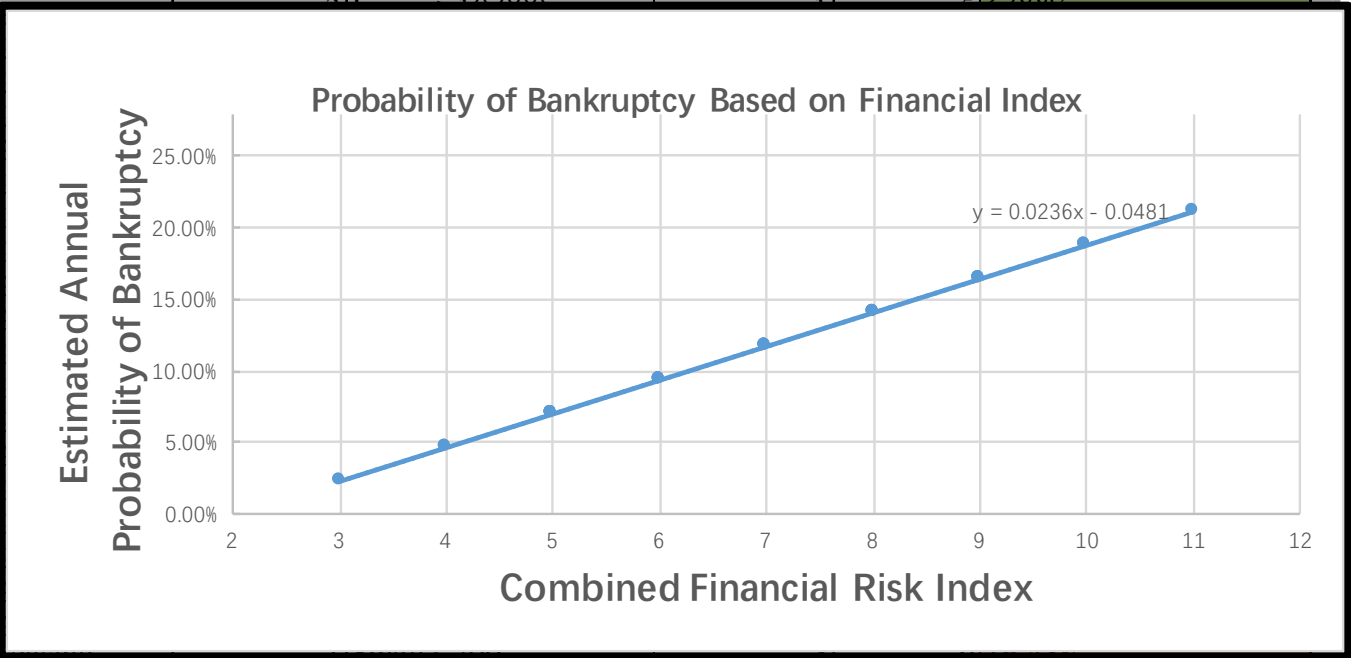
Convert Altman Z-Score to Probability of Loss
Normal Density Distribution Function



Financial Instability - Foreign Private Companies

Estimated Annual Probability of Bankruptcy

Risk Propensity	Risk Propensity Index	Spending Rate	Spending Rate Index	Company Size	Company Size Index	Sum of Index	Estimated Annual Probability of Bankruptcy
Low Risk	1	Increasing	1	Large >10,000	1	3	2.27%
Low Risk	1	Increasing	1	Medium 200-10,000	2	4	4.63%
Low Risk	1	Stable	2	Large >10,000	1	4	4.63%
Low Risk	1	Decreasing	3	Medium 200-10,000	1	5	6.99%
Low Risk	1	Increasing	2	Medium 200-10,000	2	5	6.99%
Moderate Risk	3	Increasing	1	Medium 200-10,000	1	5	6.99%
Low Risk	1	Stable	3	Medium 200-10,000	1	5	6.99%
Low Risk	1	Decreasing	2	Medium 200-10,000	2	5	6.99%
Moderate Risk	3	Increasing	1	Medium 200-10,000	1	5	6.99%
Low Risk	1	Stable	3	Medium 200-10,000	1	5	6.99%
Moderate Risk	3	Stable	2	Medium 200-10,000	1	6	9.35%
Low Risk	1	Decreasing	3	Medium 200-10,000	1	6	9.35%
Moderate Risk	3	Decreasing	2	Medium 200-10,000	1	6	9.35%
High Risk	5	Increasing	1	Medium 200-10,000	1	6	9.35%
Moderate Risk	3	Increasing	2	Medium 200-10,000	1	6	9.35%
Moderate Risk	3	Stable	3	Medium 200-10,000	1	7	11.71%
Moderate Risk	3	Decreasing	2	Medium 200-10,000	2	7	11.71%
High Risk	5	Increasing	1	Small <200	2	7	11.71%
High Risk	5	Stable	2	Small <200	2	7	11.71%
Moderate Risk	3	Stable	3	Small <200	1	7	11.71%
High Risk	5	Decreasing	2	Small <200	2	7	11.71%
Moderate Risk	3	Decreasing	3	Small <200	1	7	11.71%
High Risk	5	Increasing	1	Small <200	3	9	16.43%
High Risk	5	Stable	2	Medium 200-10,000	2	9	16.43%
High Risk	5	Decreasing	3	Medium 200-10,000	2	10	18.79%
High Risk	5	Stable	2	Small <200	3	10	18.79%
High Risk	5	Decreasing	3	Small <200	3	11	21.15%



Geopolitical Risks

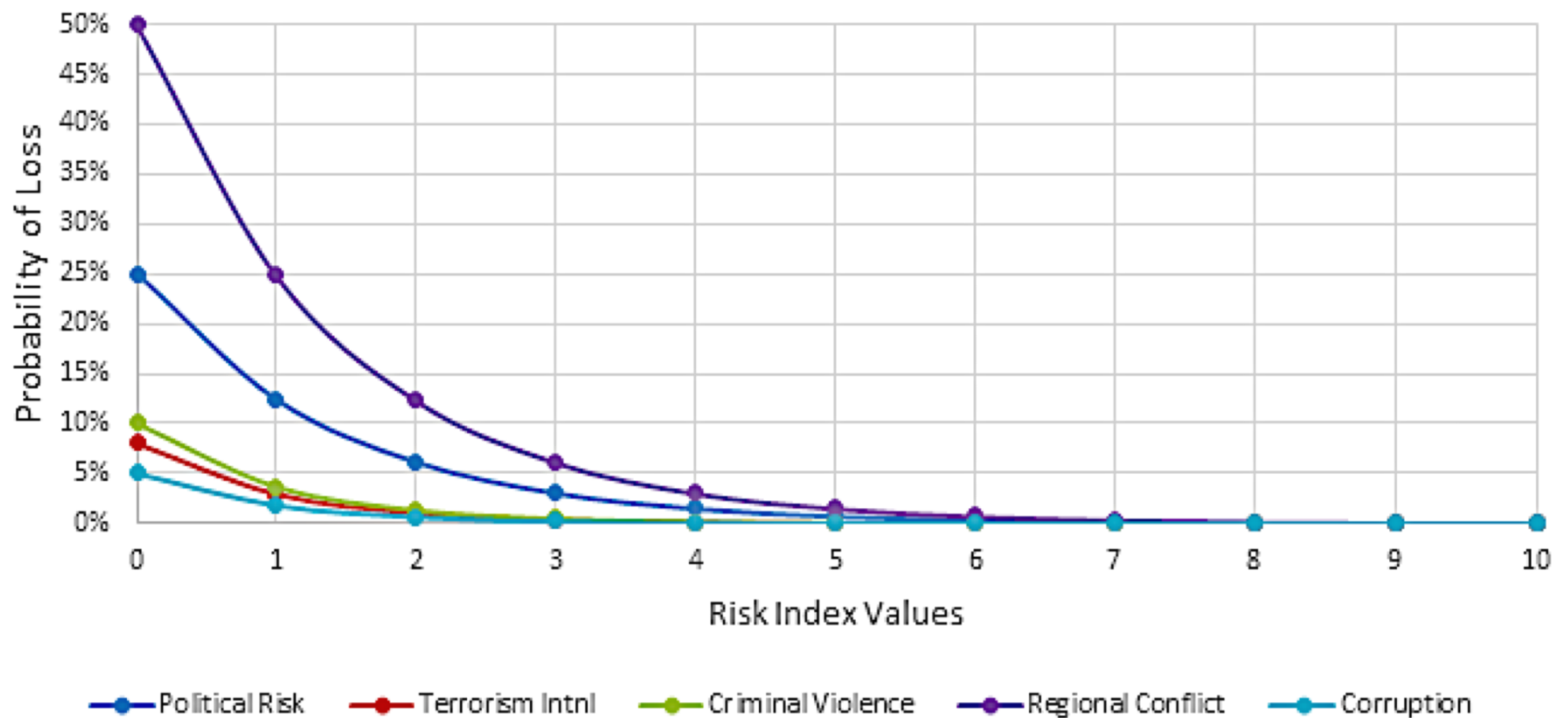
Source: Verisk Maplecroft

Location	Political Risk	Terrorism Intl	Criminal Violence	Regional Conflict	Corruption
1	8.36	9.11	8.97	10.00	8.76
2	6.77	9.68	3.46	10.00	4.05
3	6.77	9.68	3.46	10.00	4.05
4	6.77	9.68	3.46	10.00	4.05
5	7.20	10.00	1.90	10.00	4.46
6	5.40	10.00	2.90	10.00	2.16
7	5.73	10.00	0.28	10.00	2.10
8	5.73	10.00	0.28	10.00	2.10
9	7.08	9.76	0.99	10.00	2.84
10	7.08	9.76	0.99	10.00	2.84

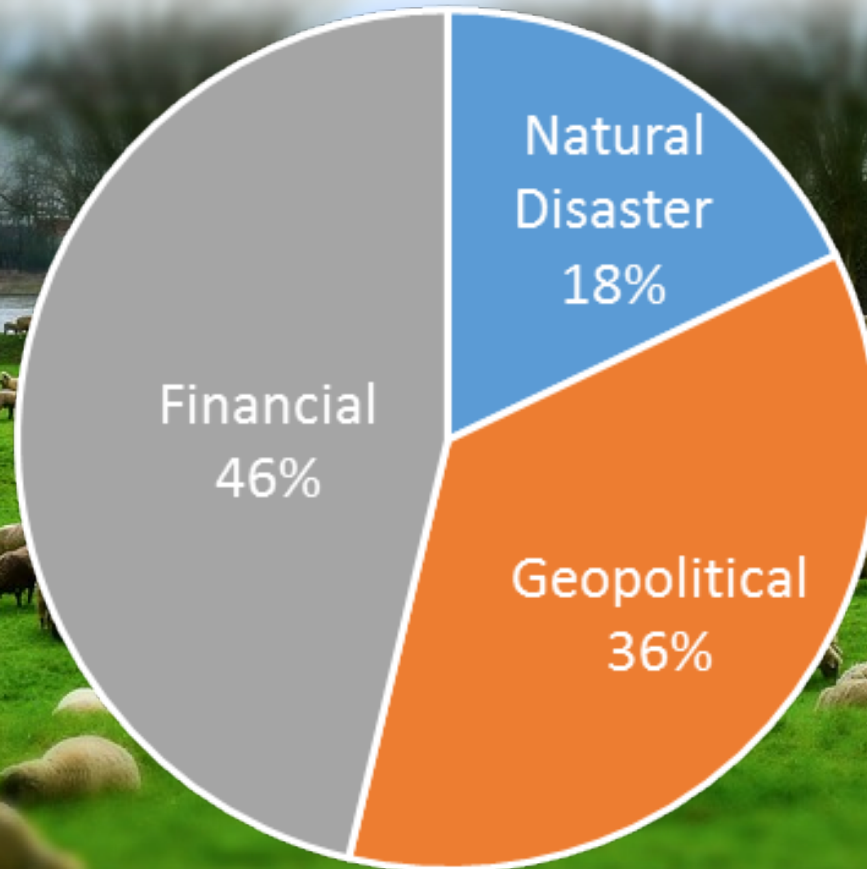
0	10
Bad	Good

Geopolitical Risks

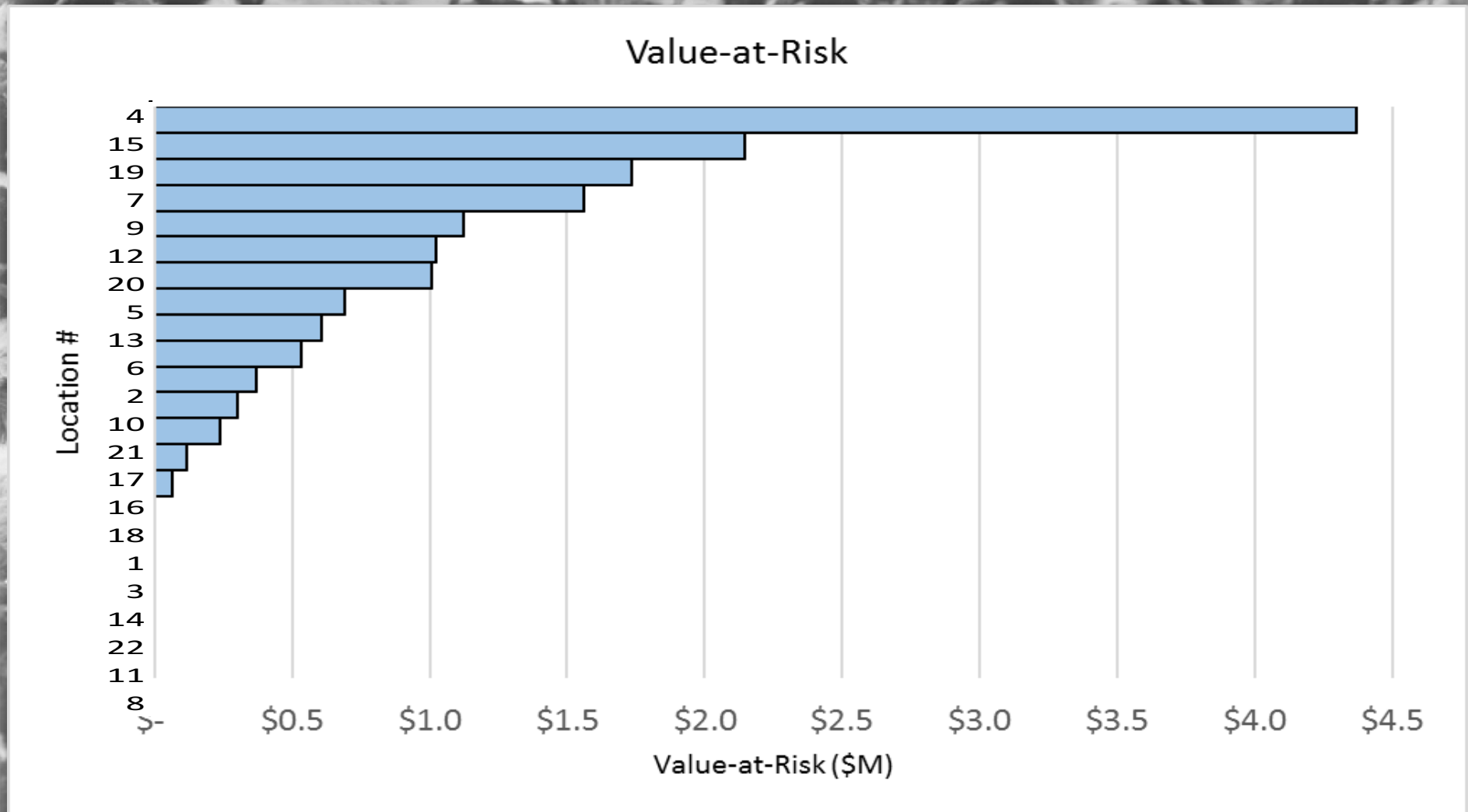
Probability of Disruption from Political Risks



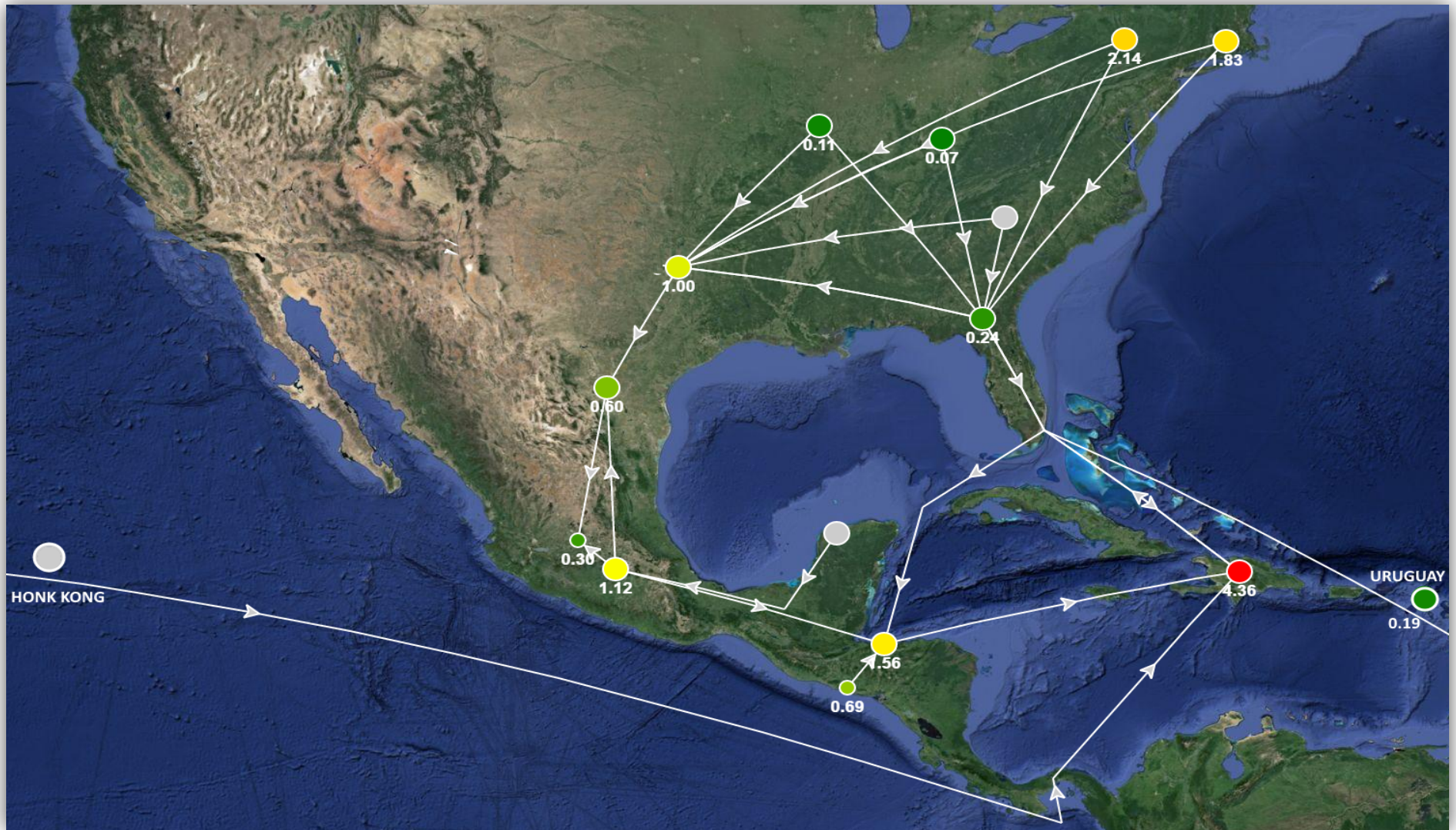
Results: Probability of Loss



Results: Value-at-Risk



Results: Visualization



From SourceMap, shows Value-at-Risk (\$M).

Conclusion

Risk mitigation should address different sources of risks.

Different categories of risks can be combined to present a comprehensive picture of risk throughout a supply chain network.

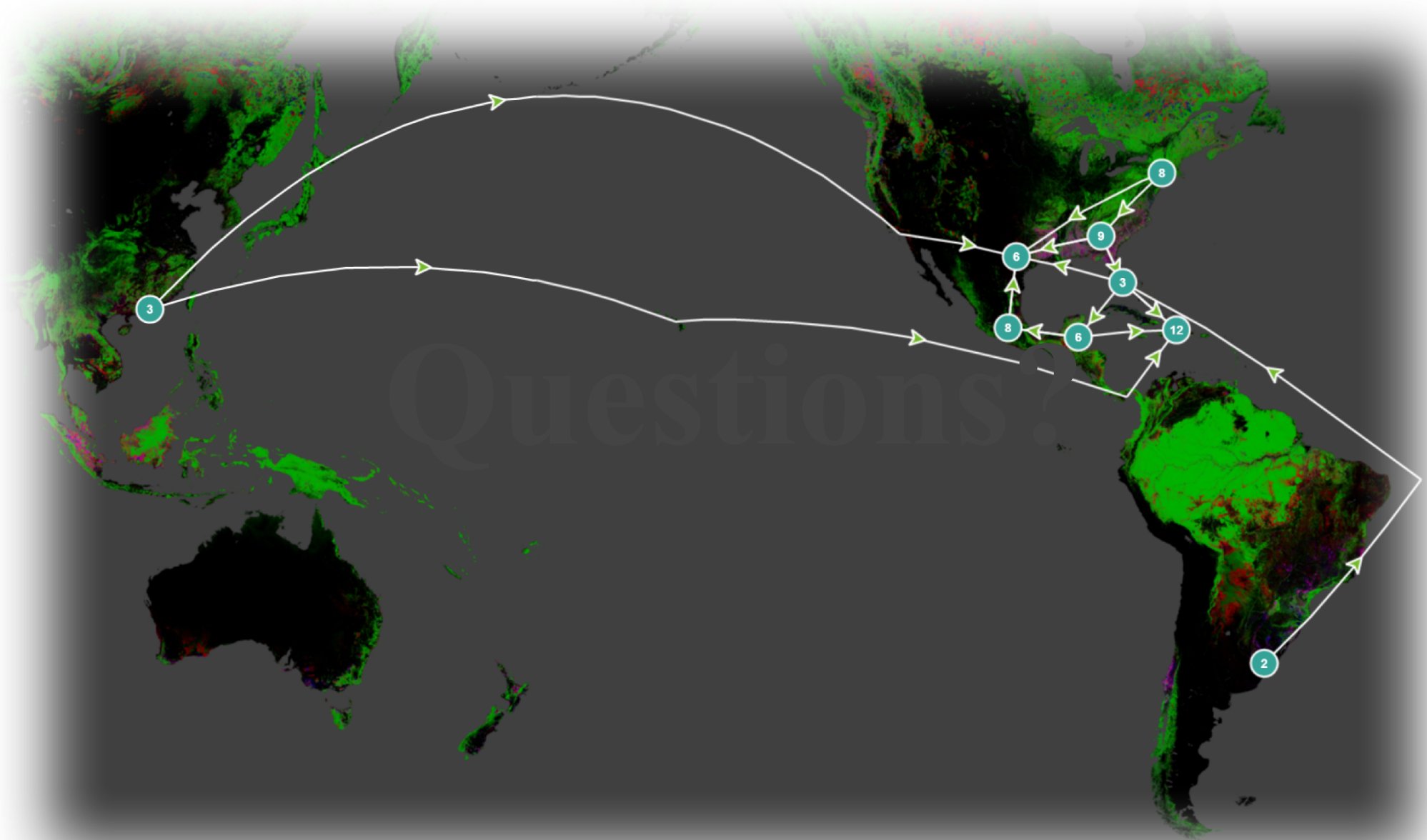
This will allow companies to allocate resources to focus on locations with the most risk.

Further Research

Common-Sense Approach



Research-Based Approach



Questions