

Simulating Disaster Mutual Assistance

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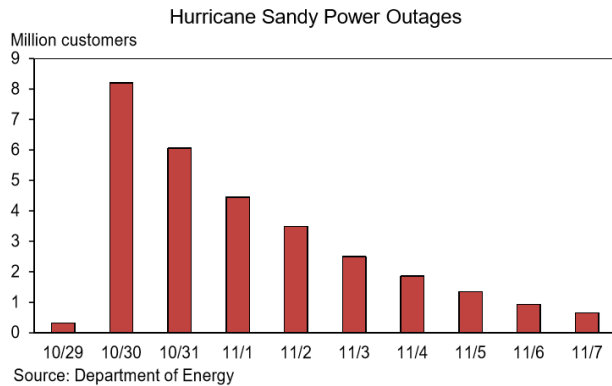
Acknowledgment



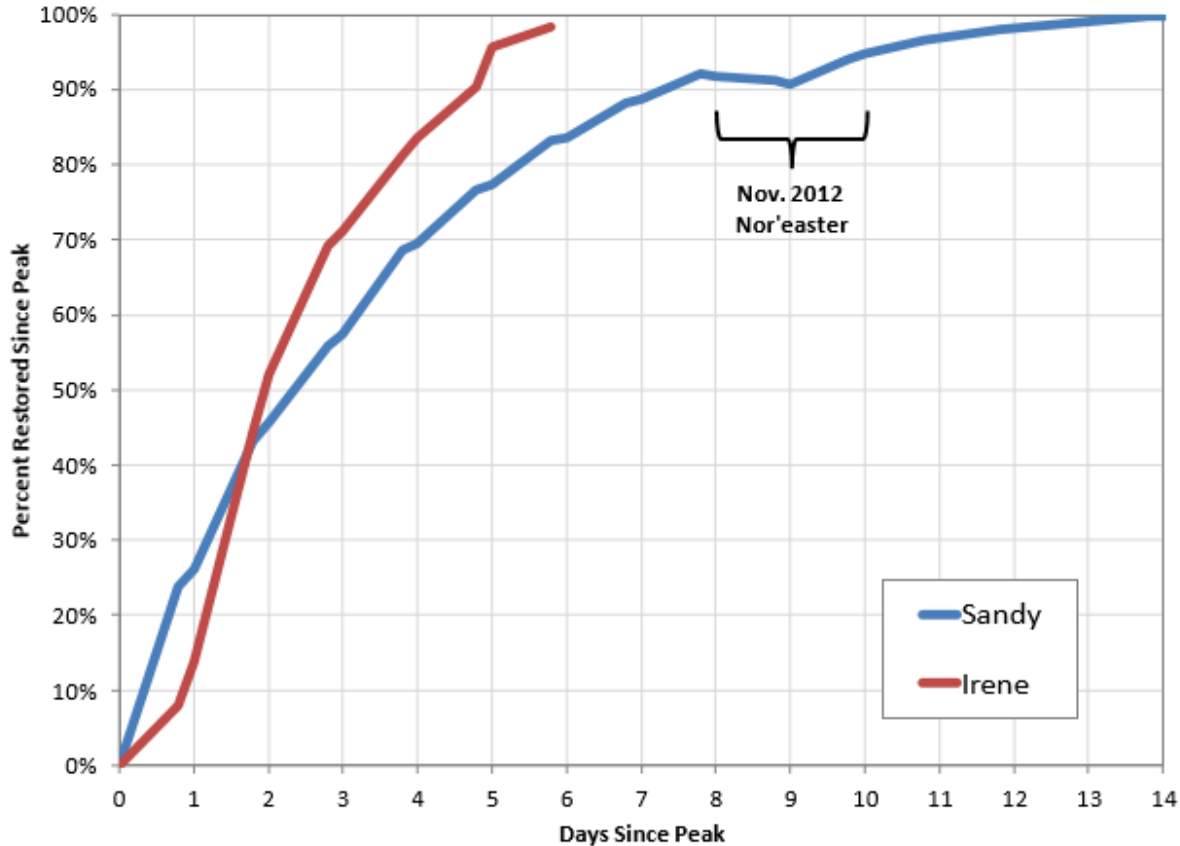
Anonymous Utility Experts
participated in the Survey

Utility Companies Goals: Reducing the Power Outage Restoration Period

Figure 5. Comparison of Power Outage Restoration Percentages by Storm



2012 Estimated
Billion \$ – Cost of
power outages in
2012



Source: OE/ISER Emergency Situation Reports

Solution: Mutual Assistance

REGIONAL MUTUAL ASSISTANCE GROUP



Great Lakes Mutual Assistance Group



Midwest Mutual Assistance Group



North Atlantic Mutual Assistance Group



Southeastern Electric Exchange

December 2013 Ice Storm

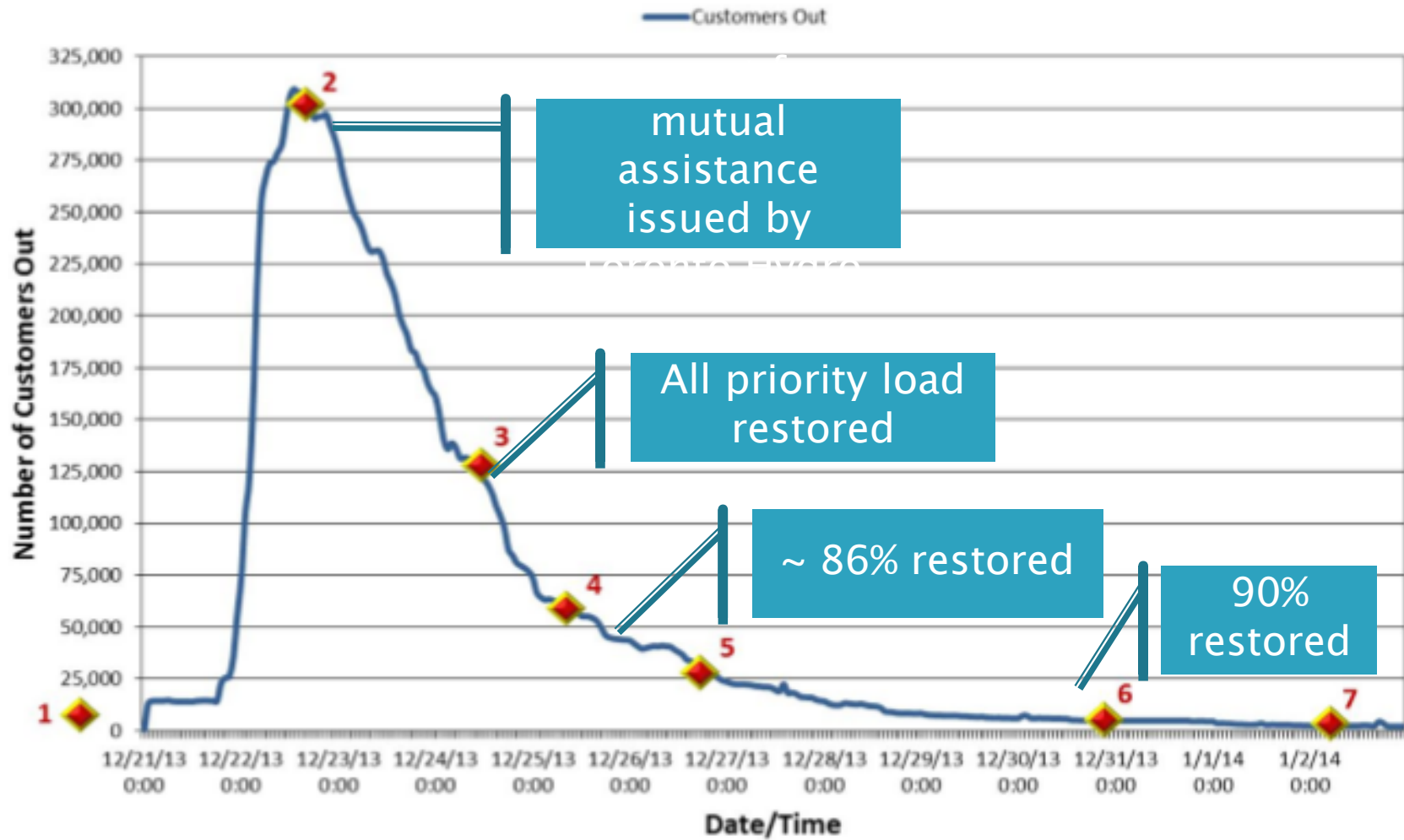


- ▶ **Toronto Hydro:**
 - 1,250 own personnel,
 - 400 Mutual aid and contractors.
- ▶ **Crews completed restoration of all customers by January 2, 2014.**

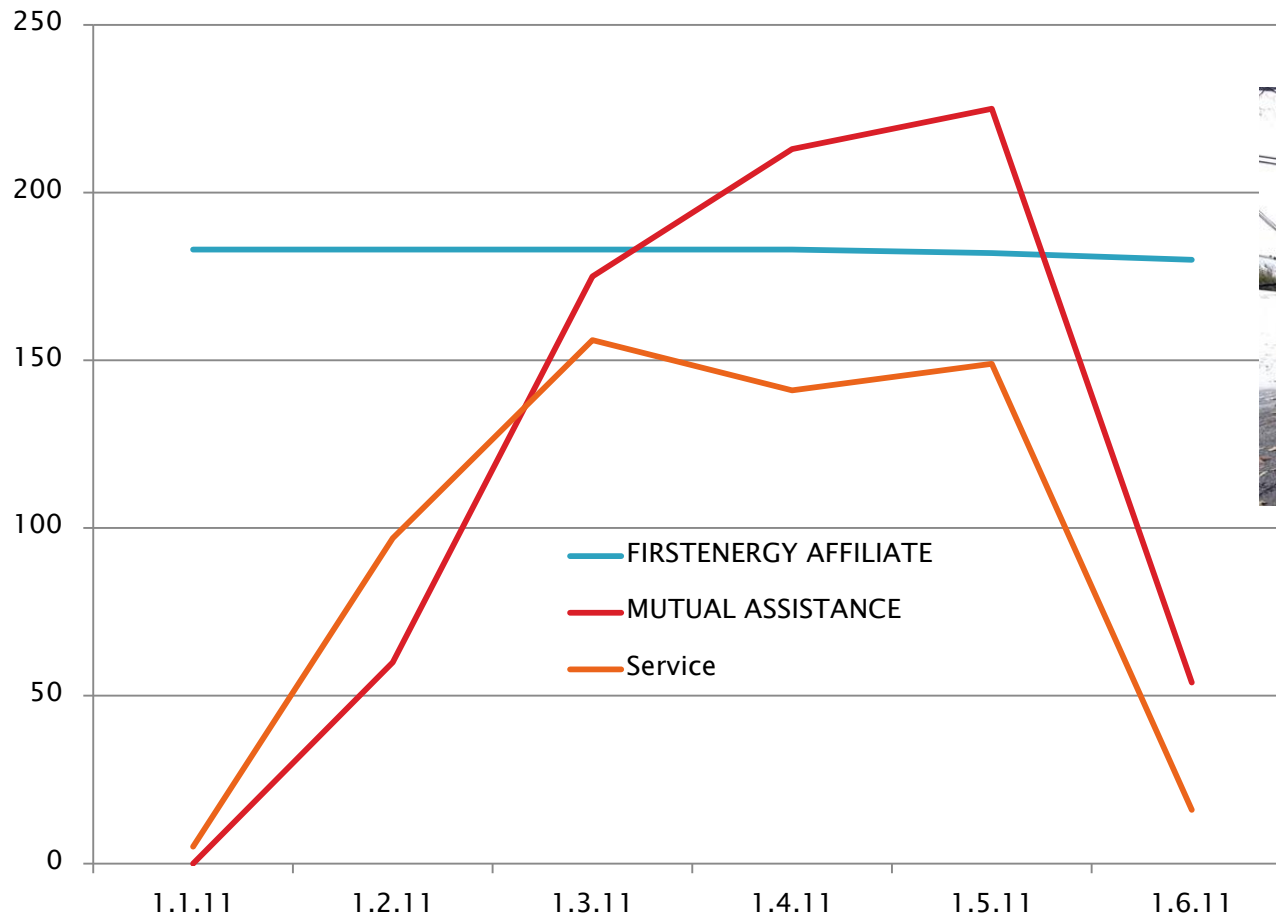
Figure 1: 2013 Ice Storm Restoration Timeline with Key Milestones



Toronto Hydro 2013 Ice Storm Restoration Timeline

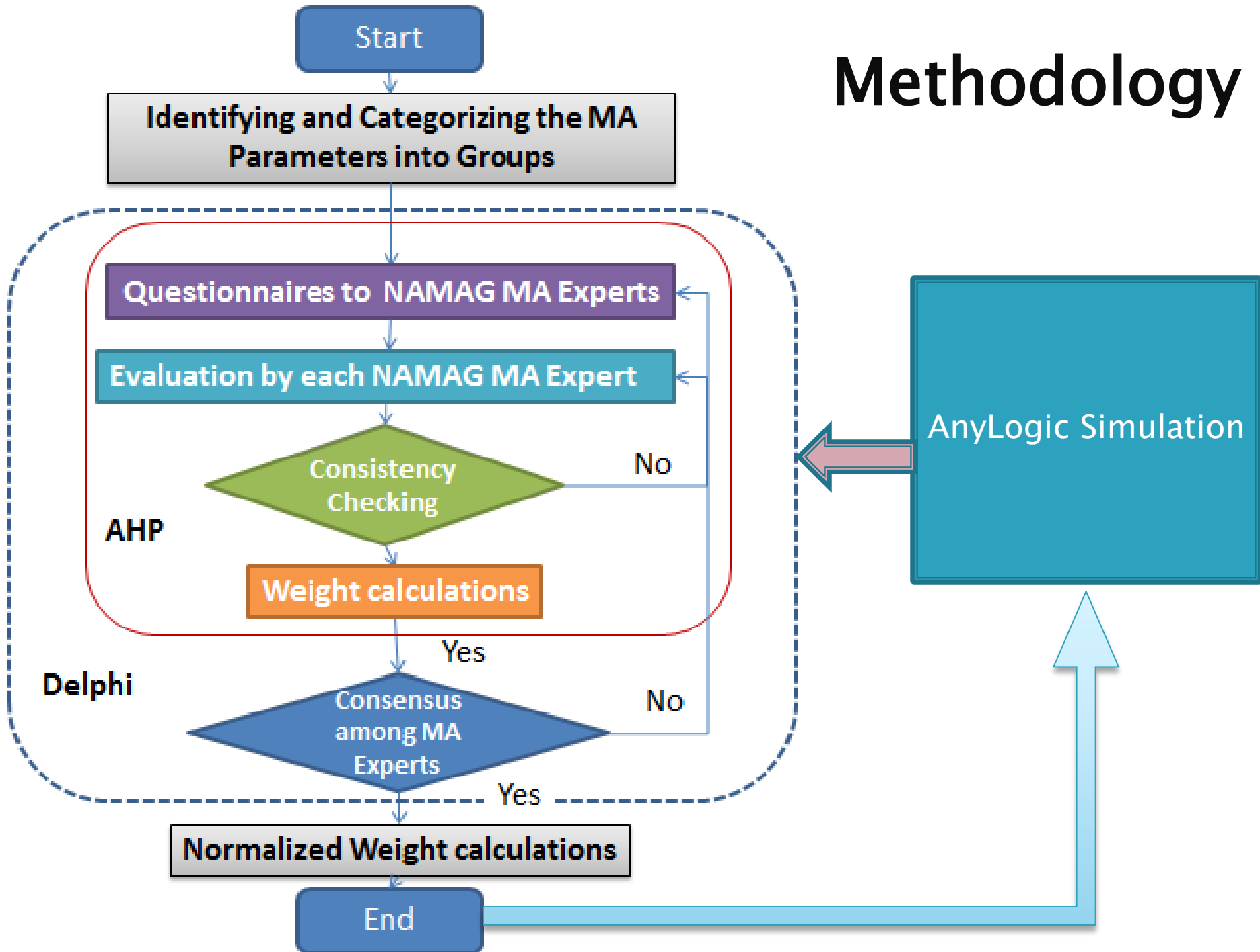


Mutual Aid During October 2011 Snow storm in New Jersey (JCP&L).

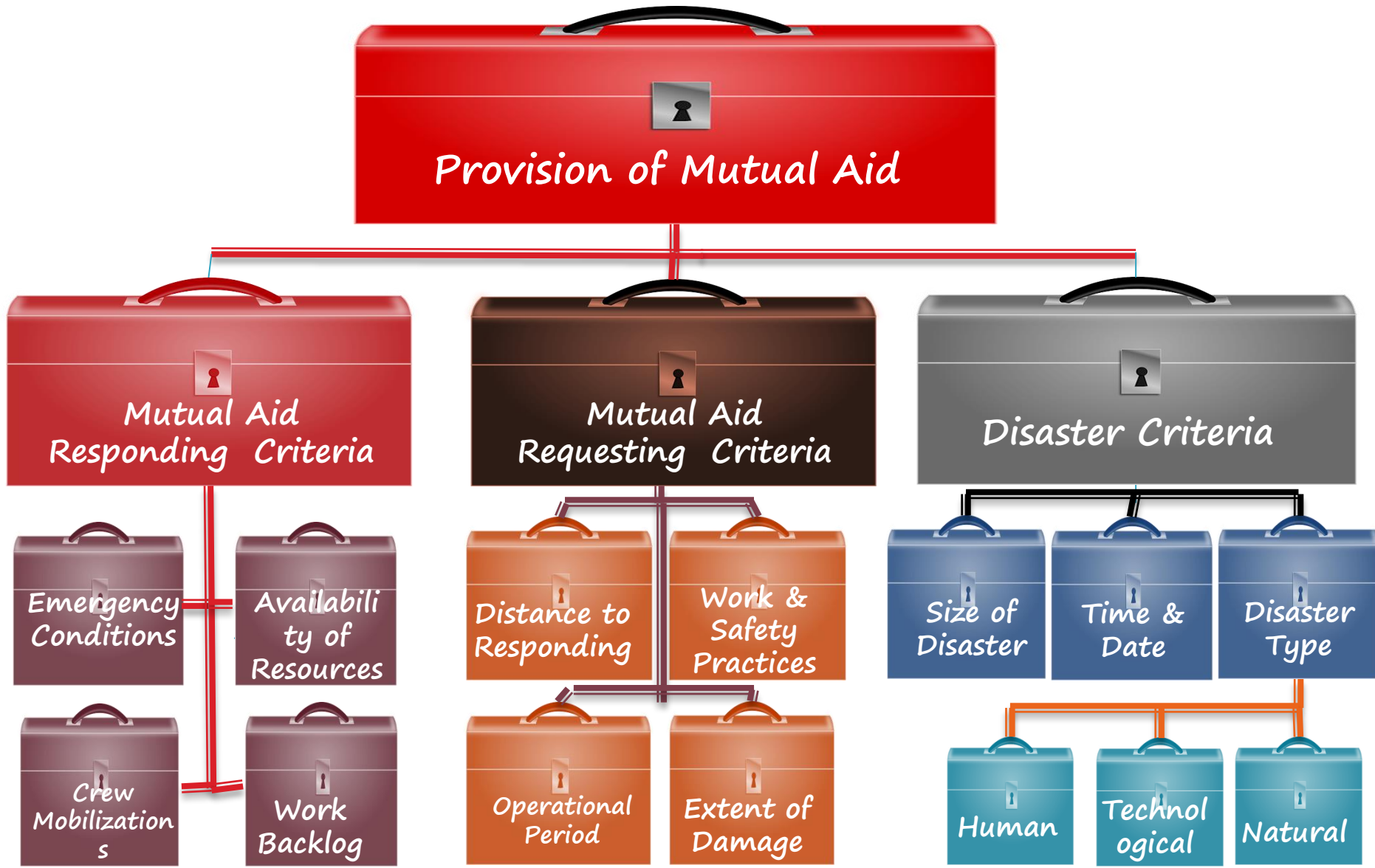


- 6 to 12 inches of snow
- About one million customers

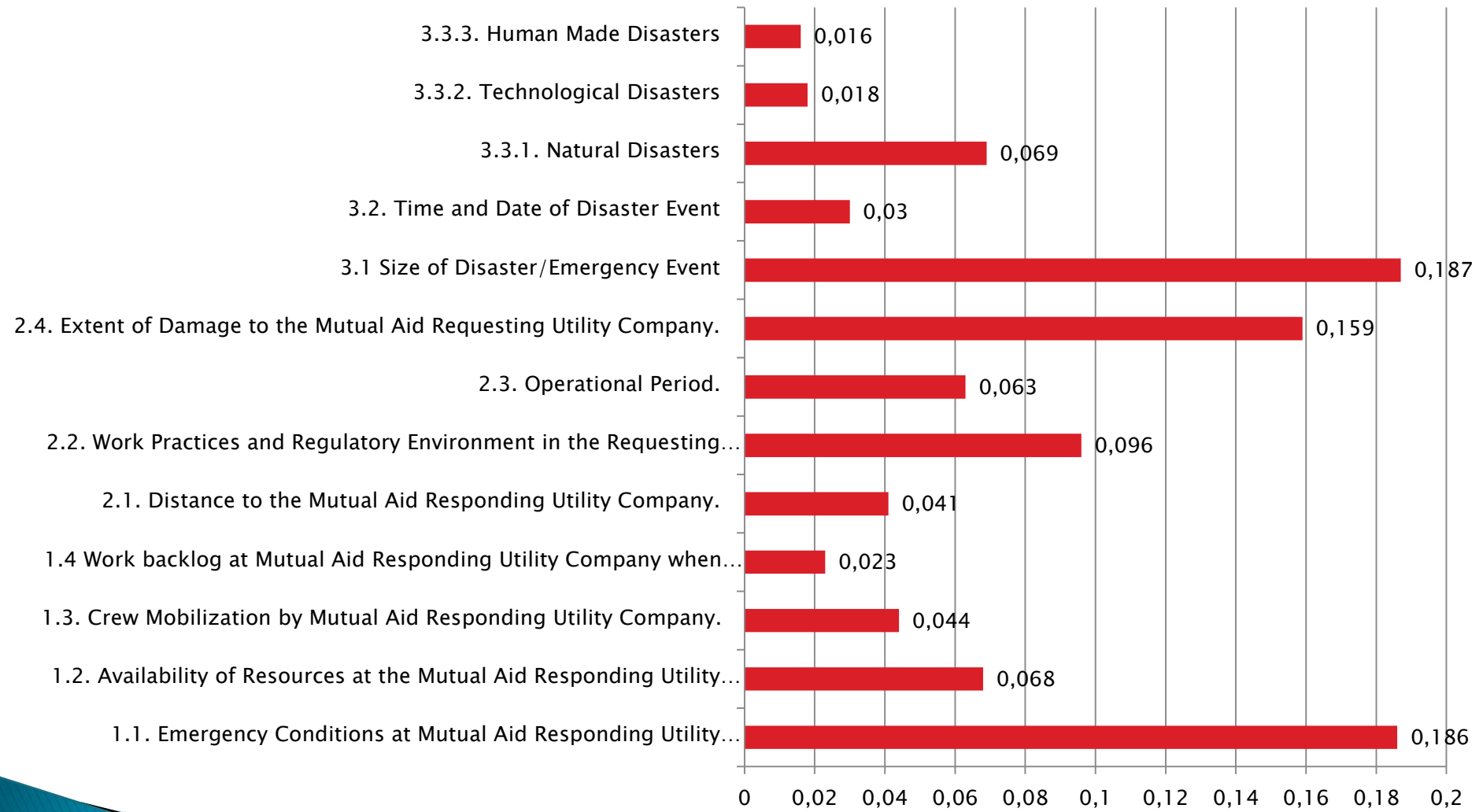
Methodology



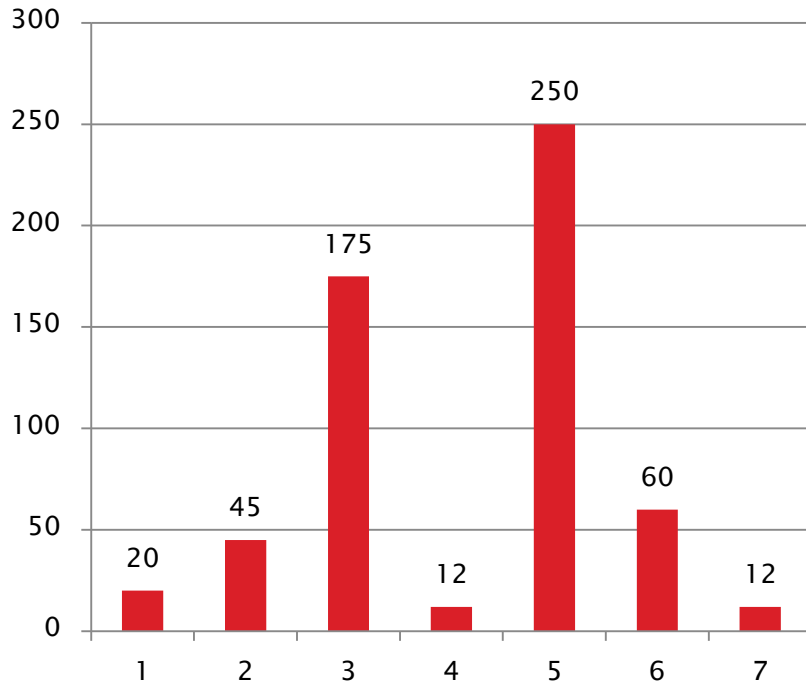
Mutual Aid Decision Criteria



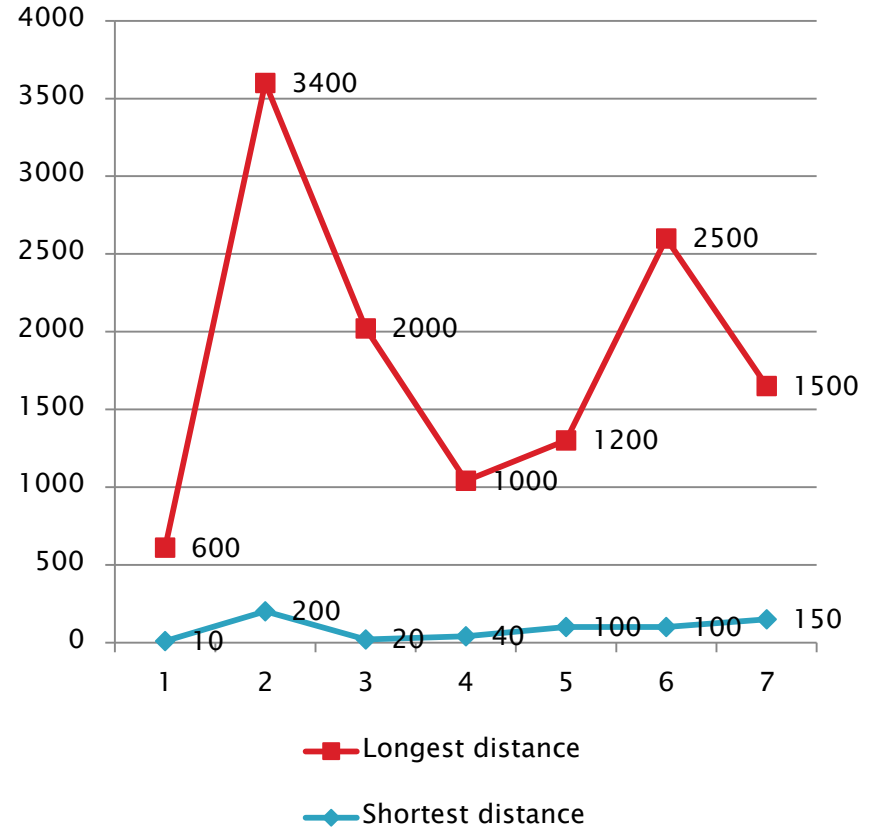
Criteria Weights Derived from AHP



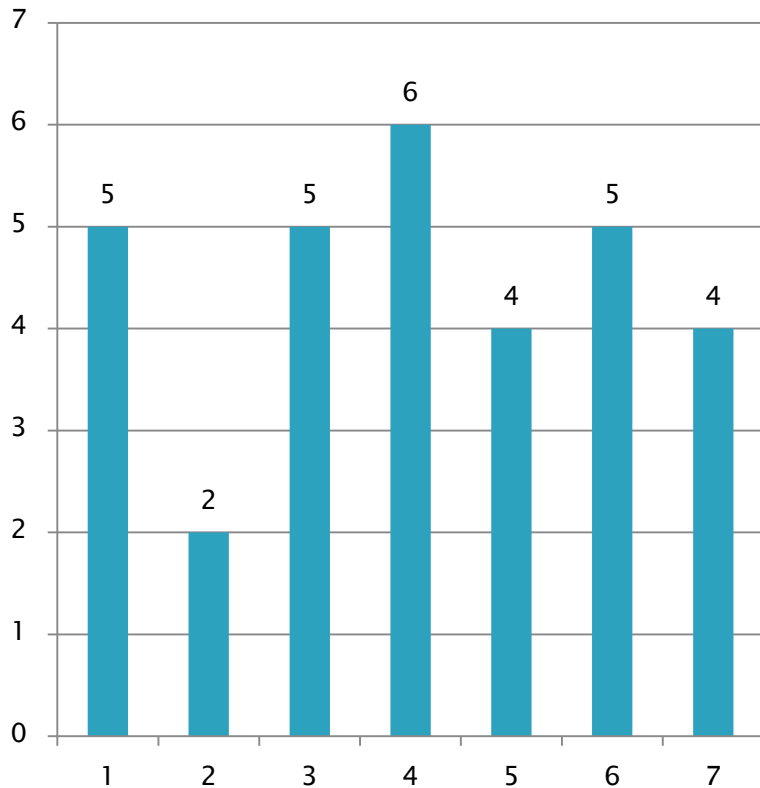
Average/ approximate number of mutual aid FTEs



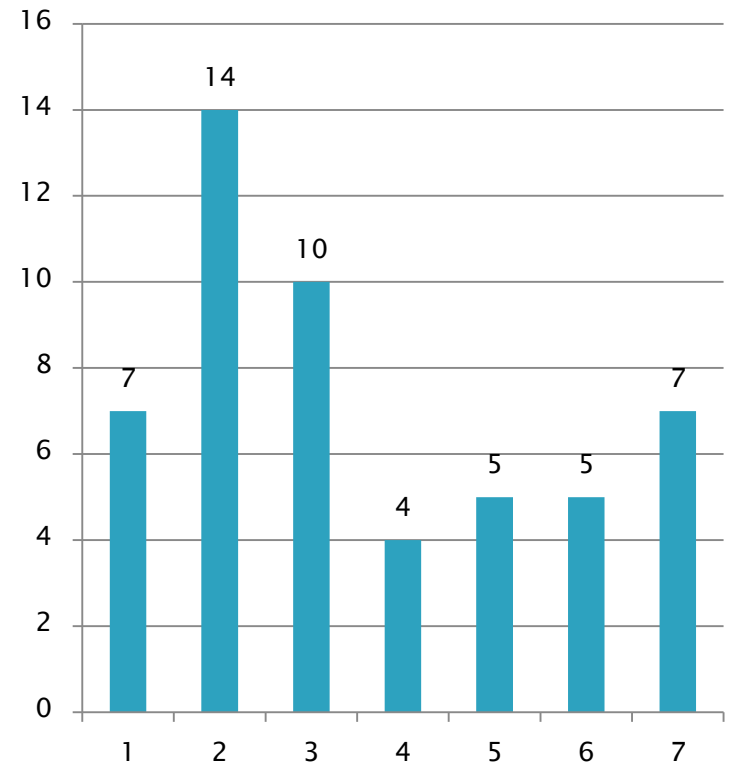
Shortest and longest distance traveled to provide MA



Average number of personnel in a crew

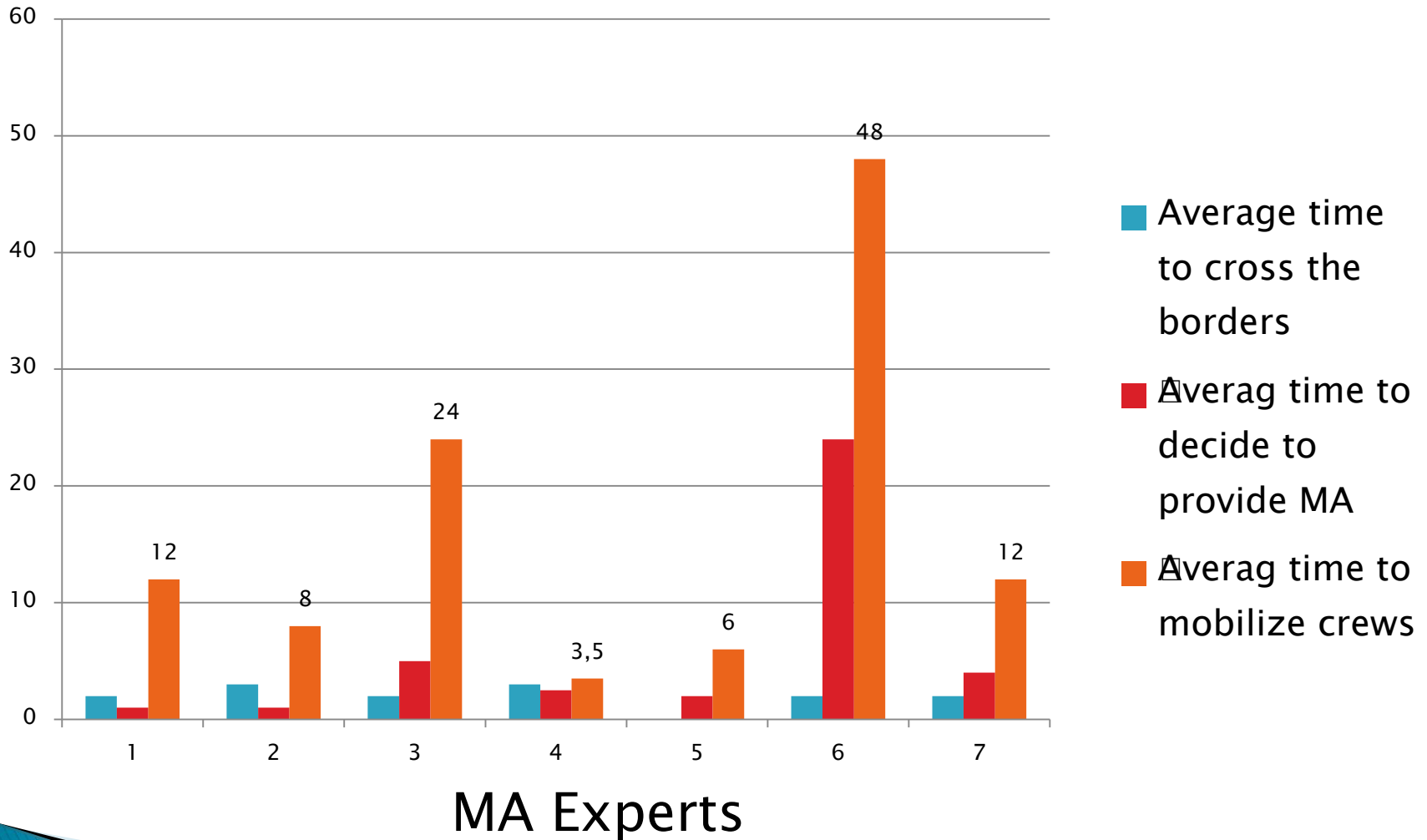


Average operational period (number of days)



MA Experts

Time to decide, mobilize and cross the borders



Mutual Aid Scenario Simulation

▶ Goal:

- Simulate various MA scenarios

▶ Inputs:

- MA provision parameter values
- Crew Information
- Disaster Impacted area information
- Travel Time Information

▶ Outputs:

- Potential number of Crews and FTEs
- Cost Estimation
- Optimization

TorontoHydro : Simulation - AnyLogic University [EDUCATIONAL USE ONLY]



Mutual Aid Simulation

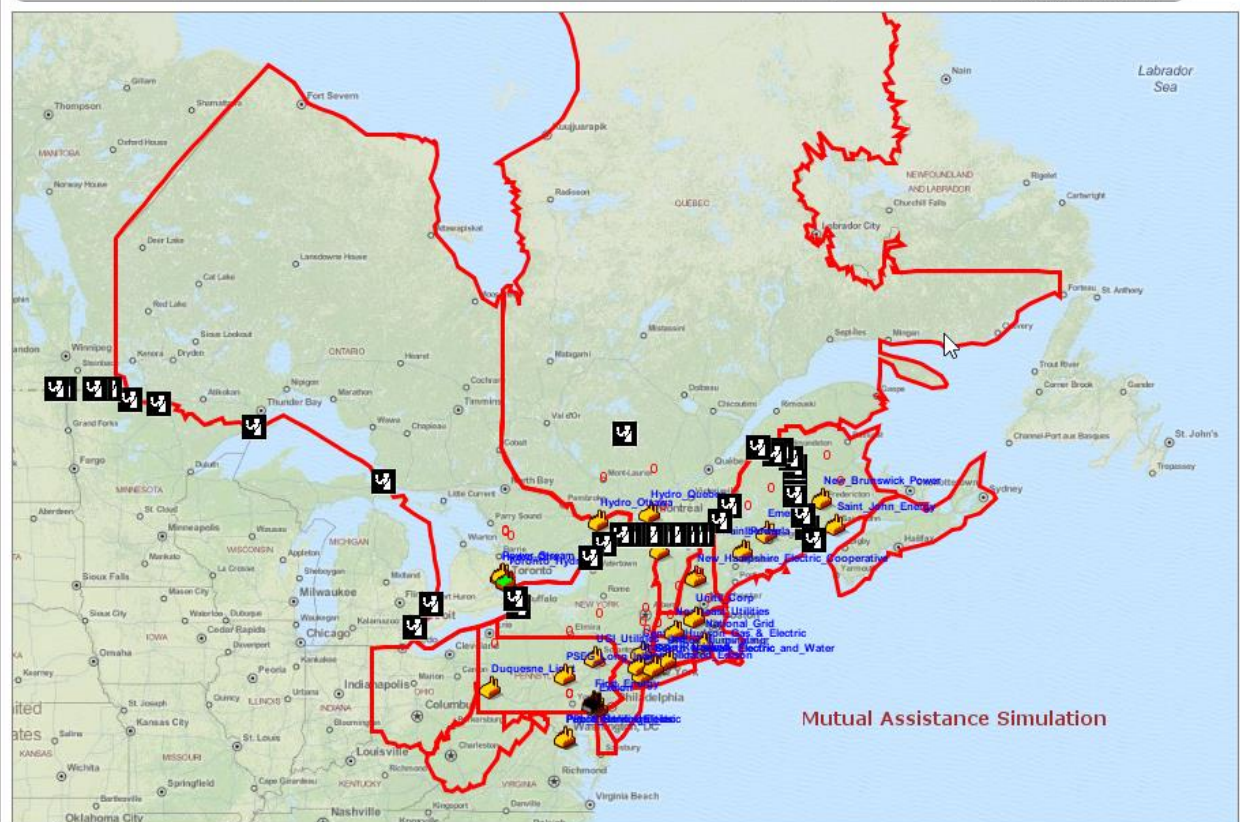


Ali Asgary
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Management

Setting Mutual Assistance Requesting/Responding Companies

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Navigation Toolbar: x1, root:Main, Zoom to selected loc... X: -54.43173734964102 Y: 52.61838473392897


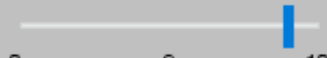
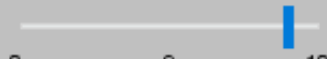


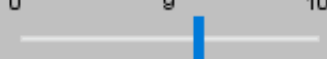
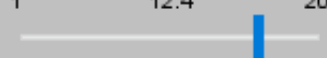
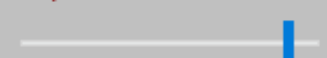


Companies	Parameters	Weights	Outputs	Simulation Setup
Mutual Aid Requesting Company:		Mutual Aid Responding Company:		
<input type="radio"/> Central_Hudson_Gas_&_Electric	<input type="radio"/> Central_Hudson_Gas_&_Electric	<input type="radio"/> Central_Hudson_Gas_&_Electric	<input type="radio"/> Central_Hudson_Gas_&_Electric	<input type="radio"/> Central_Hudson_Gas_&_Electric
<input type="radio"/> Consolidated_Edison	<input type="radio"/> Consolidated_Edison	<input type="radio"/> Consolidated_Edison	<input type="radio"/> Consolidated_Edison	<input type="radio"/> Consolidated_Edison
<input type="radio"/> Duquesne_Light	<input type="radio"/> Duquesne_Light	<input type="radio"/> Duquesne_Light	<input type="radio"/> Duquesne_Light	<input type="radio"/> Duquesne_Light
<input type="radio"/> Emera	<input type="radio"/> Emera	<input type="radio"/> Emera	<input type="radio"/> Emera	<input type="radio"/> Emera
<input type="radio"/> Exelon	<input type="radio"/> Exelon	<input type="radio"/> Exelon	<input type="radio"/> Exelon	<input type="radio"/> Exelon
<input checked="" type="radio"/> First_Energy	<input type="radio"/> First_Energy	<input type="radio"/> First_Energy	<input type="radio"/> First_Energy	<input type="radio"/> First_Energy
<input type="radio"/> Green_Mountain_Power	<input type="radio"/> Green_Mountain_Power	<input type="radio"/> Green_Mountain_Power	<input type="radio"/> Green_Mountain_Power	<input type="radio"/> Green_Mountain_Power
<input type="radio"/> Hydro-One	<input type="radio"/> Hydro-One	<input type="radio"/> Hydro-One	<input type="radio"/> Hydro-One	<input type="radio"/> Hydro-One
<input type="radio"/> Hydro_Quebec	<input type="radio"/> Hydro_Quebec	<input type="radio"/> Hydro_Quebec	<input type="radio"/> Hydro_Quebec	<input type="radio"/> Hydro_Quebec
<input type="radio"/> Iberdrola	<input type="radio"/> Iberdrola	<input type="radio"/> Iberdrola	<input type="radio"/> Iberdrola	<input type="radio"/> Iberdrola
<input type="radio"/> National_Grid	<input type="radio"/> National_Grid	<input type="radio"/> National_Grid	<input type="radio"/> National_Grid	<input type="radio"/> National_Grid
<input type="radio"/> New_Brunswick_Power	<input type="radio"/> New_Brunswick_Power	<input type="radio"/> New_Brunswick_Power	<input type="radio"/> New_Brunswick_Power	<input type="radio"/> New_Brunswick_Power
<input type="radio"/> New_Hampshire_Electric_Cooperative	<input type="radio"/> New_Hampshire_Electric_Cooperative	<input type="radio"/> New_Hampshire_Electric_Cooperative	<input type="radio"/> New_Hampshire_Electric_Cooperative	<input type="radio"/> New_Hampshire_Electric_Cooperative
<input type="radio"/> Northeast_Utilities	<input type="radio"/> Northeast_Utilities	<input type="radio"/> Northeast_Utilities	<input type="radio"/> Northeast_Utilities	<input type="radio"/> Northeast_Utilities
<input type="radio"/> Pepco_Holdings_Inc	<input type="radio"/> Pepco_Holdings_Inc	<input type="radio"/> Pepco_Holdings_Inc	<input type="radio"/> Pepco_Holdings_Inc	<input type="radio"/> Pepco_Holdings_Inc
<input type="radio"/> PPL_Electric_Utilities	<input type="radio"/> PPL_Electric_Utilities	<input type="radio"/> PPL_Electric_Utilities	<input type="radio"/> PPL_Electric_Utilities	<input type="radio"/> PPL_Electric_Utilities
<input type="radio"/> Public_Service_Electric	<input type="radio"/> Public_Service_Electric	<input type="radio"/> Public_Service_Electric	<input type="radio"/> Public_Service_Electric	<input type="radio"/> Public_Service_Electric
<input type="radio"/> South_Nonwalk_Electric	<input type="radio"/> South_Nonwalk_Electric	<input type="radio"/> South_Nonwalk_Electric	<input type="radio"/> South_Nonwalk_Electric	<input type="radio"/> South_Nonwalk_Electric
<input type="radio"/> Uniti_Corp	<input type="radio"/> Uniti_Corp	<input type="radio"/> Uniti_Corp	<input type="radio"/> Uniti_Corp	<input type="radio"/> Uniti_Corp
<input type="radio"/> UGI_Utilities_Inc	<input type="radio"/> UGI_Utilities_Inc	<input type="radio"/> UGI_Utilities_Inc	<input type="radio"/> UGI_Utilities_Inc	<input type="radio"/> UGI_Utilities_Inc
<input type="radio"/> United_Illuminating	<input type="radio"/> United_Illuminating	<input type="radio"/> United_Illuminating	<input type="radio"/> United_Illuminating	<input type="radio"/> United_Illuminating
<input type="radio"/> Toronto_Hydro	<input checked="" type="radio"/> Toronto_Hydro	<input type="radio"/> Toronto_Hydro	<input type="radio"/> Toronto_Hydro	<input type="radio"/> Toronto_Hydro
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<input type="radio"/> Saint_John_Energy	<input type="radio"/> Saint_John_Energy	<input type="radio"/> Saint_John_Energy	<input type="radio"/> Saint_John_Energy	<input type="radio"/> Saint_John_Energy

Run: 0 Paused | Time: 0.17 | Simulation: Stop time not set | Date: Jul 19, 2015 12:10:00 AM

Memory: 0.03M of 455M

Setting Mutual Assistance Provision Parameters

Companies	Parameters	Weights	Outputs	Simulation Setup	
MUTUAL AID RESPONDER'S FACTORS (VALUES)					
Possibility of being impacted by the same disaster or similar event:			0	1	10
Availability of Resources Requested:			0	9	10
Crew Mobilization Possibility:			0	9	10
Work Backlog:			0	2	10
MUTUAL AID REQUESTING'S FACTORS (VALUES)					
Distance to Impacted Areas:				501.842	
Similarity in Work Practices and Safety Regulatory Environment:			0	9	10
Operational Period (days):			1	12.4	20
Extent of damage to the utility company (power outage):			0	8	10
DISASTER/EMERGENCY FACTORS (VALUES)					
Disaster Size (Magnitude):			0	9	10
Date of Request:		<input type="radio"/> Long Holiday <input type="radio"/> Long Weekends <input type="radio"/> Weekends <input checked="" type="radio"/> Week Days			
Hour of Request:		<input type="radio"/> Night hours <input type="radio"/> Evening hours <input type="radio"/> Afternoon hours <input checked="" type="radio"/> Morning hours			
Type of Disaster:		<input checked="" type="radio"/> Natural <input type="radio"/> Technological <input type="radio"/> Human			

Set Mutual Assistance Parameters' Weights

Companies Parameters **Weights** Outputs Simulation Setup

MUTUAL AID RESPONDER'S FACTORS (WEIGHTS) change default

Possibility of being impacted by the same disaster or similar event: 0 0.19 1

Availability of Resources Requested: 0 0.07 1

Possibility of Crew Mobilization: 0 0.04 1

Work Baklog Problem: 0 0.02 1

MUTUAL AID REQUESTING'S FACTORS (WEIGHTS)

Distance to Impacted Areas: 0 0.04 1

Work Practices and Safety Regulatory Environment: 0 0.1 1

Operational Period (days): 0 0.06 1

Extent of damage (outage): 0 0.16 1

DISASTER/EMERGENCY FACTORS (WEIGHTS)

Disaster Size (Magnitude): 0 0.19 1

Date & Time: 0 0.03 1

Type of Disaster: Natural 0 0.07 1

Type of Disaster: Technological 0 0.02 1

Type of Disaster: Human 0 0.02 1

Utility Companies State-Chart

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utility_companies[0]

Environment: is set
 latitude: N41°31'50.3"
 longitude: W73°51'00.6"
 station: D
 heading: 0° N
 speed: 10.0 m/k
 moving: no
 connections:
 crew_collection (0)
 deployable (10)
 decisionTime 0
 mobilizationTime 0

score
 utilityLon -73.917
 utilityLat 41.531
 utility_name Central_Hudson_Gas_&_Electric
 States
 crew_size 30
 CrewMobilized 10
 country USA
 customer_size 300,000

statechart

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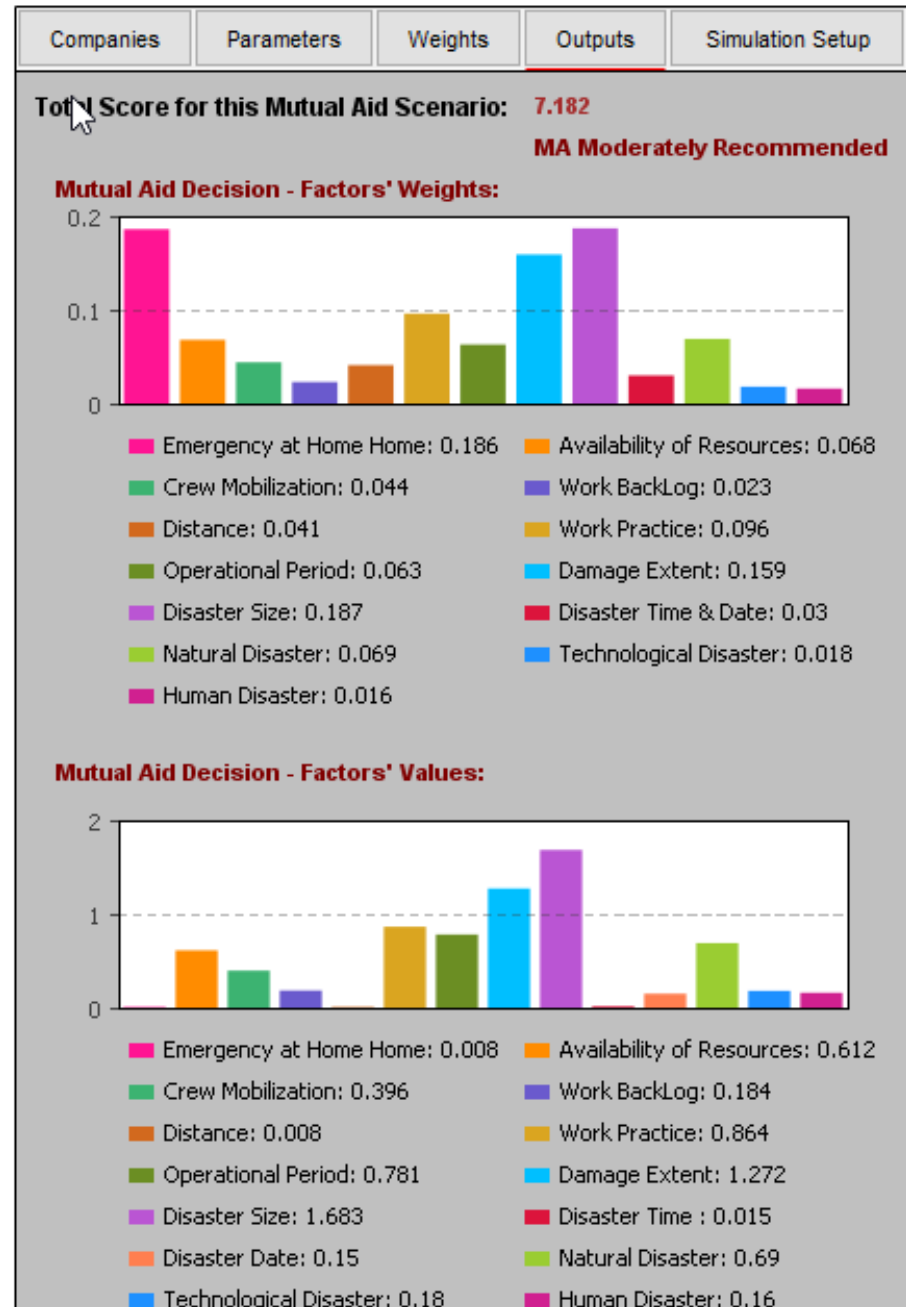
stateDiagram-v2
    [*] --> Normal
    Normal --> MARequestReceived
    MARequestReceived --> Assessment
    Assessment --> Able_Respond
    Able_Respond --> MARequestProcessed
    MARequestProcessed --> MADispatch
    Assessment --> Not_Able_Respond
    Not_Able_Respond --> Assessment
        
```

Mutual Assistance Decision Variables, Weights, and Criteria

<ul style="list-style-type: none"> SEmergencyHome 1.594 SAvailabilityResource 0.549 SCrewMobilization 0.171 SWorkBackLog 0.169 SDistance 0 SWorkPractice 0.031 SOperationalPeriod 0.661 SDamageExtent 1.431 SDisasterSize 1.87 SDate 0.15 STime 0.015 STypeDisaster 0 STypeDisasterNatural 0.69 STypeDisasterTechnological 0.18 STypeDisasterHuman 0.16 dd 4.296 sdistance 73.382 FDistance 0 TotalScore 7.672 Distance 73.381.842 	<ul style="list-style-type: none"> WEmergencyHome 0.186 WAvailabilityResource 0.069 WCrewMobilization 0.044 WWorkBackLog 0.023 WWorkPractice 0.096 WOperationalPeriod 0.063 WDamageExtent 0.159 WDisasterSize 0.187 WTimeDate 0.03 WNaturalDisaster 0.069 WTechnologicalDisaster 0.018 WDistance 0.041 	<ul style="list-style-type: none"> FEmergencyHome 8.571 FAvailabilityResource 8.071 FCrewMobilization 3.887 FWorkBackLog 2.652 FWorkPractice 0.324 FOperationalPeriod 10.5 FDamageExtent 9 FDisasterSize 10 FDate 10 FTime 1 FTypeDisaster 10 FHumanDisaster 0.016
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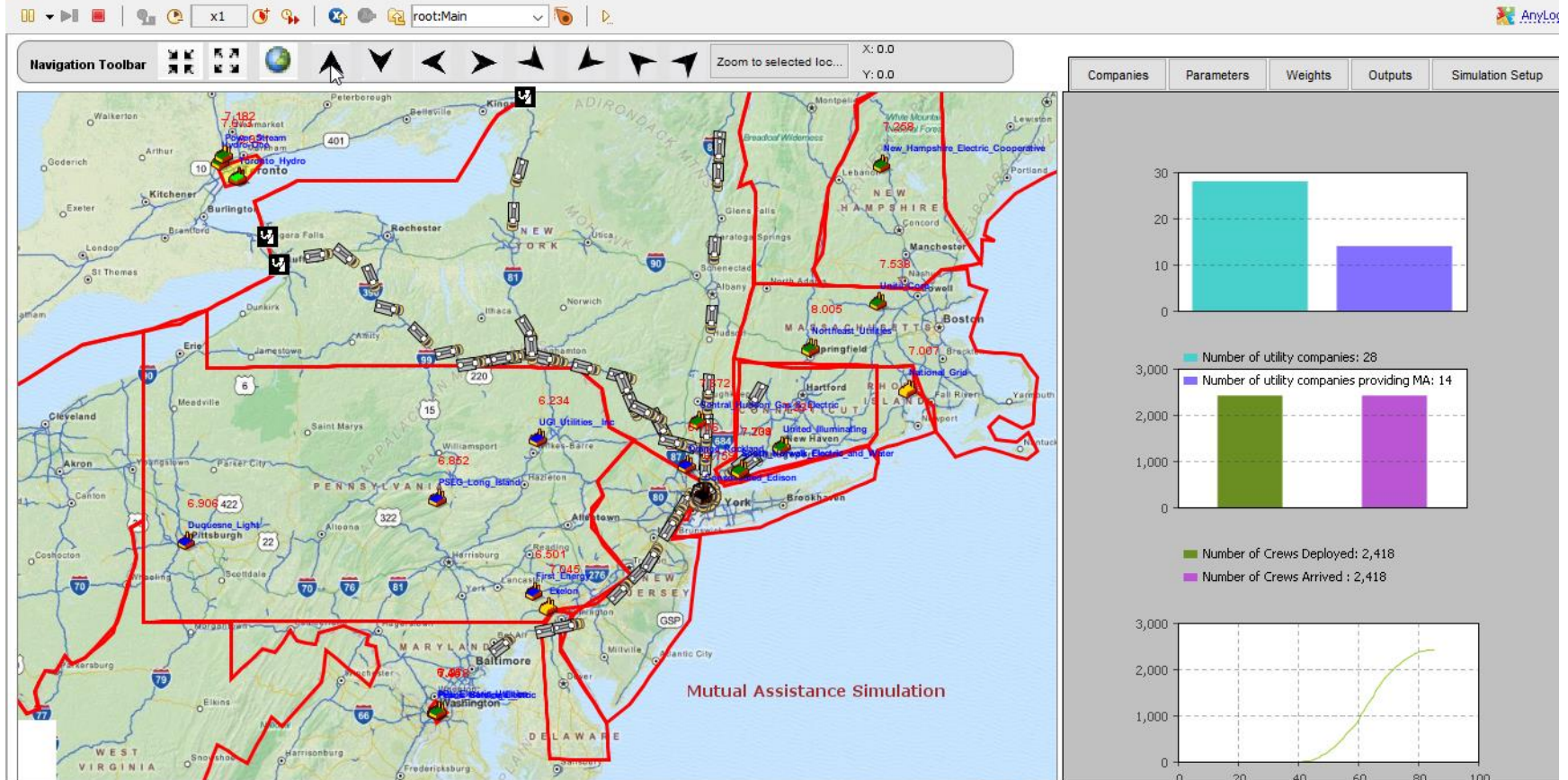
Variable	Value
Emergency at Home Home	0
Availability of Resources	0.549
Crew Mobilization	0.171
Distance	0
Operational Period	0.661
Disaster Size	1.87
Disaster Date	0.15
Technological Disaster	0.18
Human Disaster	0.16
Work BackLog	0.169
Work Practice	0.031
Damage Extent	1.431
Disaster Time	0.015
Natural Disaster	0.69

Mutual Assistance Results



Mutual Assistance Deployment

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Future Works

1. Testing the simulation in some of the future mutual assistance cases
2. Adding multi-responder multi-requesting Scenarios

