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Resiliency Planning

Climate Change Considerations

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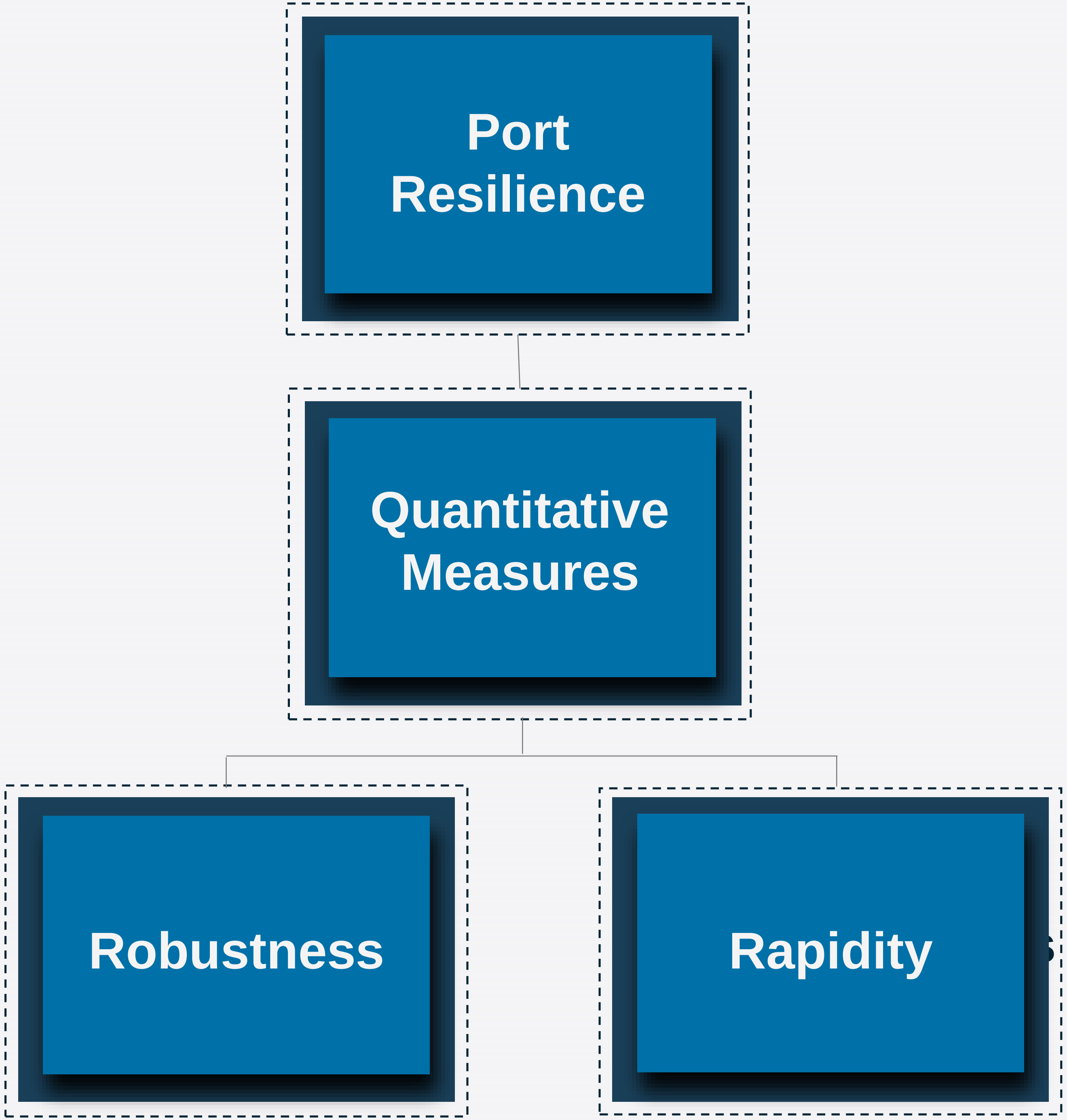
What is Resilience?

Resilience is the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

Port Resilience



What is Robustness?

Robustness is the ability to retain system function immediately following a storm

(eg. Strength of elements or redundancies)

What is Rapidity?

Rapidity is the ability to quickly recover full function following a storm (eg. emergency repairs)

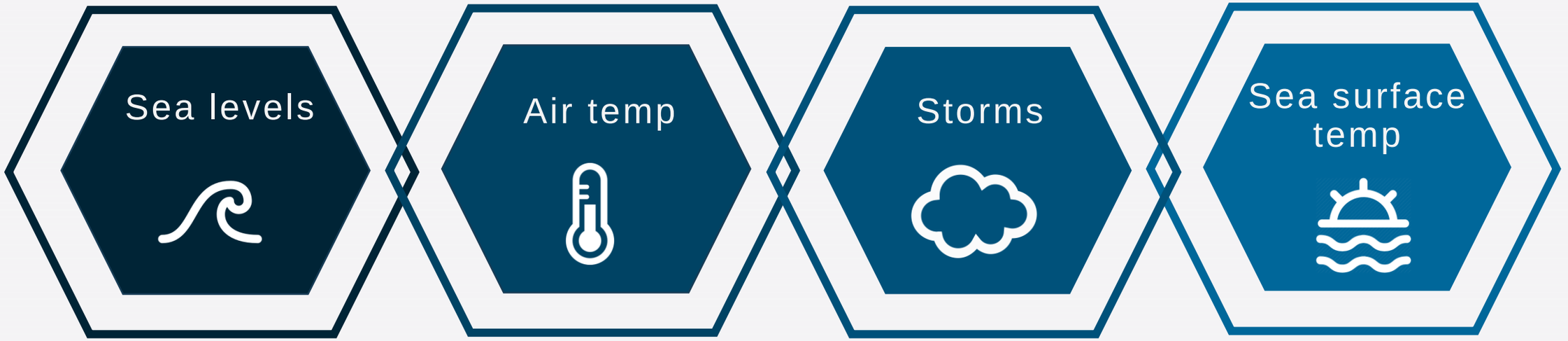
Resilience Based Risk Management

Conventional risk assessment

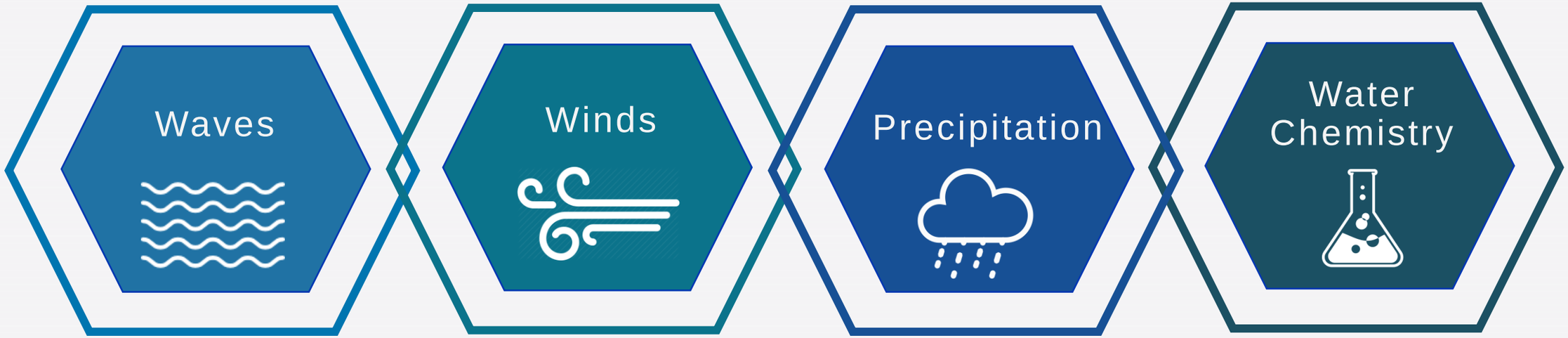
- Based on protection (making sure that limited damage occurs after severe event).
- No damage.

Resilience based risk assessment

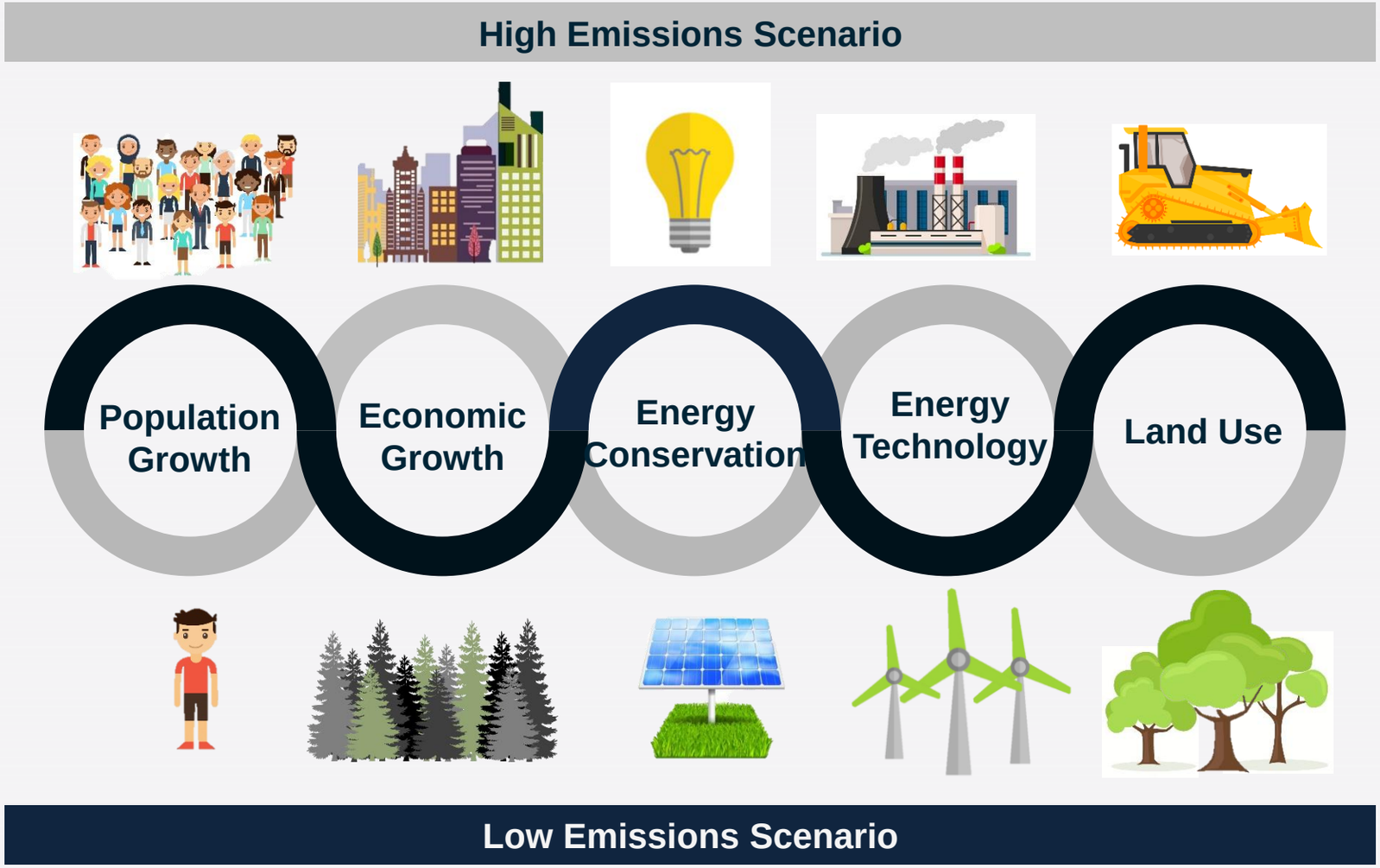
- Based on protection and recovery (making sure that structures and services are fully restore in an acceptable amount of time).
- Allows for some damage (as long as the damage is limited and the recovery is fast enough).



Climatic Influences



Future Climate



Climate Drivers and Impacts

	Navigation zone	Protection infrastructure	Maneuver area and berthing	Load/unload area	Port equipment	Storage	Hinterland connections
IMPACTS	Agitation Water depth Wind patterns Visibility	Coastal flooding Overtopping Wave loads	Agitation Water depth Currents Wind patterns Visibility	Coastal flooding Overtopping Agitation Wind patterns Visibility Precipitation	Coastal and inland flooding Wind patterns Visibility Contamination Precipittion	Coastal and inland flooding Wind patterns Contamination Precipitation	Coastal and inland flooding Visibility Visibility Precipitation
CLIMATE DRIVERS	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation	Mean Sea Level Astronomical Tide Storm Surge Waves Wind	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature

Source: PIANC WG178

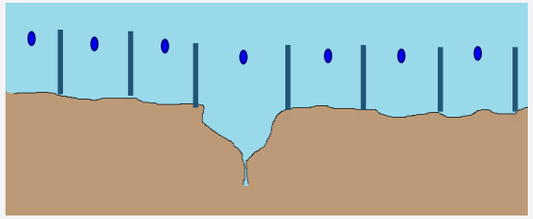
Impact Assessment

Impact Assessment Approach	Level of Complexity	Input Data Demand	Resource Demand	Uncertainty
Expert judgement	Very Low	None	Very Low	Very High
Indicators	Low	Low	Low	High
Formulas	Medium	Medium	Medium	Medium
Process based modelling	High	High (time series required)	High	Low

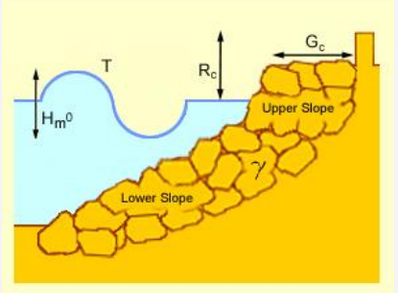
Impact Assessment

Expert Judgement:

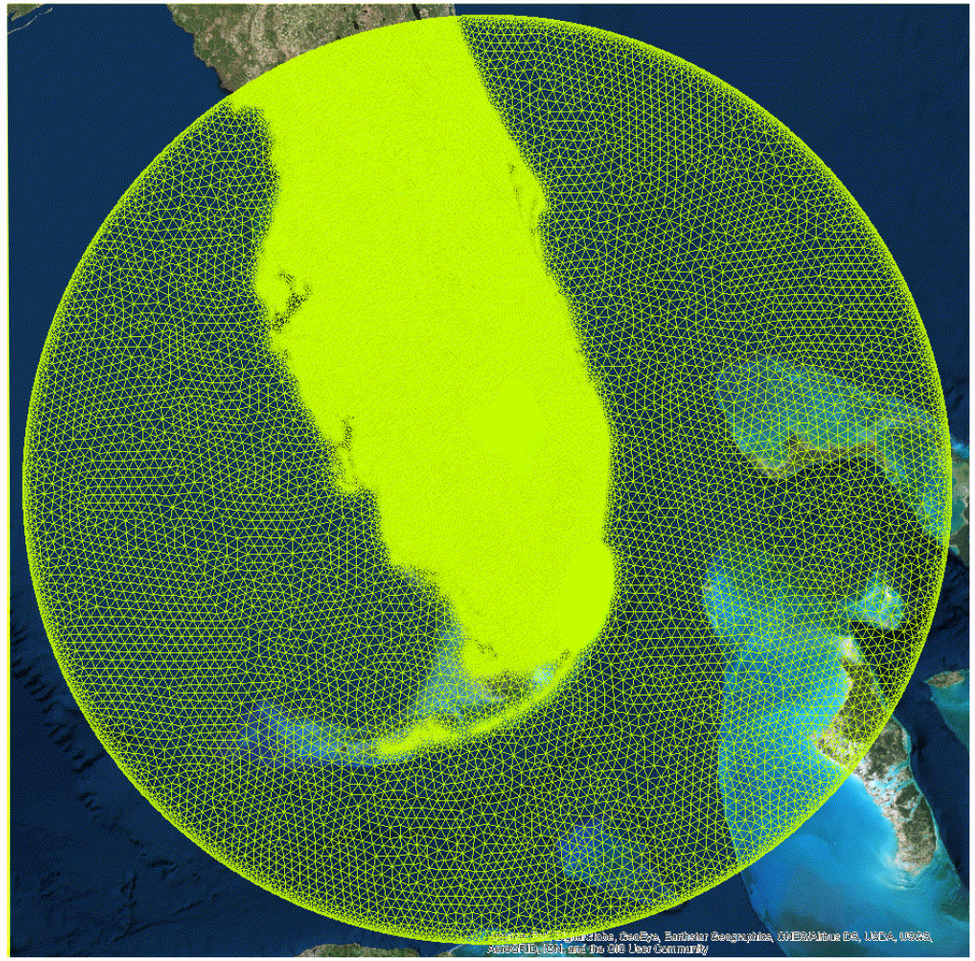
Indicators:



Formulas:



Process Based Modelling:



Telemac Model of Hurricane Irma hitting South Florida

Impact Assessment

Key Inputs:

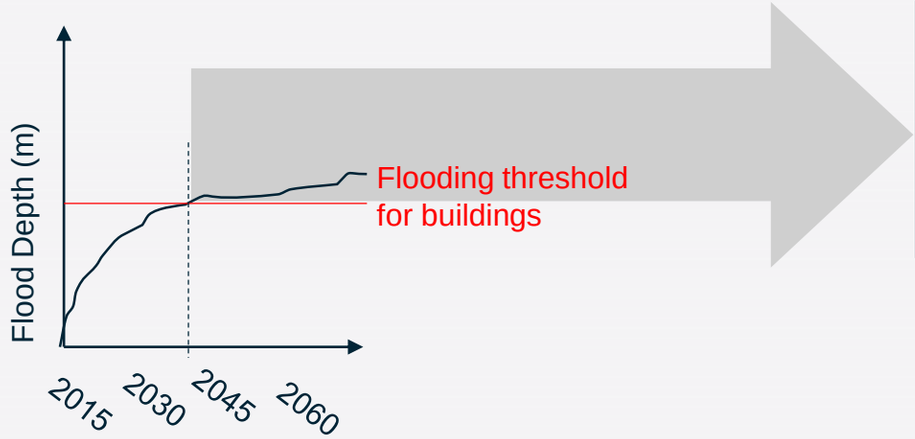
1. Climate Parameters
2. Damage Thresholds

Key Output:

Hazard Identification

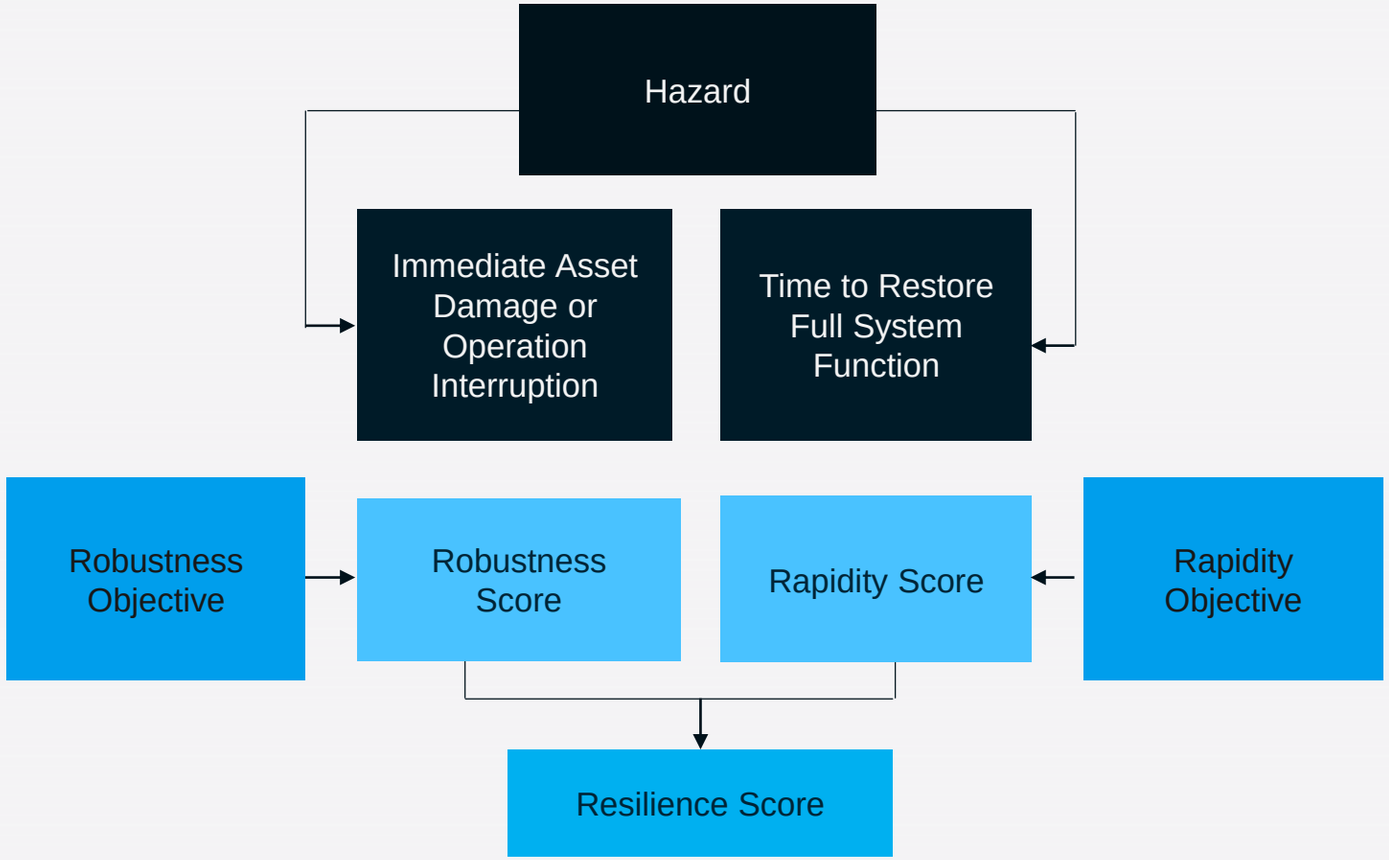
Impact Assessment

Climate Drivers:
Mean sea level
High astronomical tide
Storm surge
Sea level rise



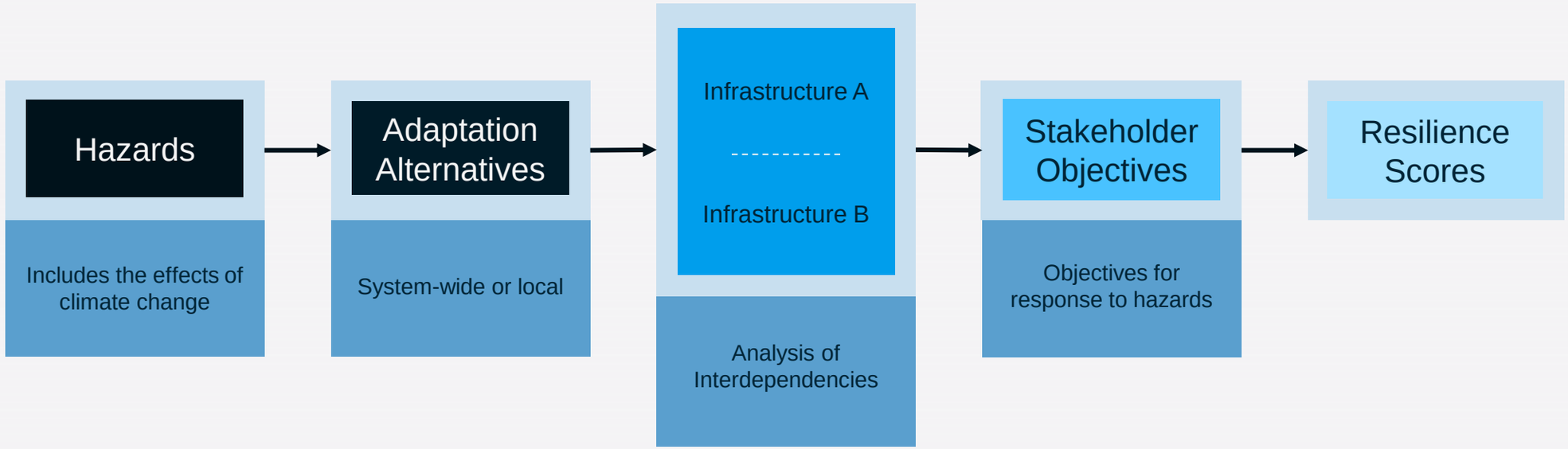
Flooding = HAZARD
In 2045 flooding will impact port infrastructure (buildings) and therefore is a hazard

Resilience Assessment



Resilience Assessment Framework

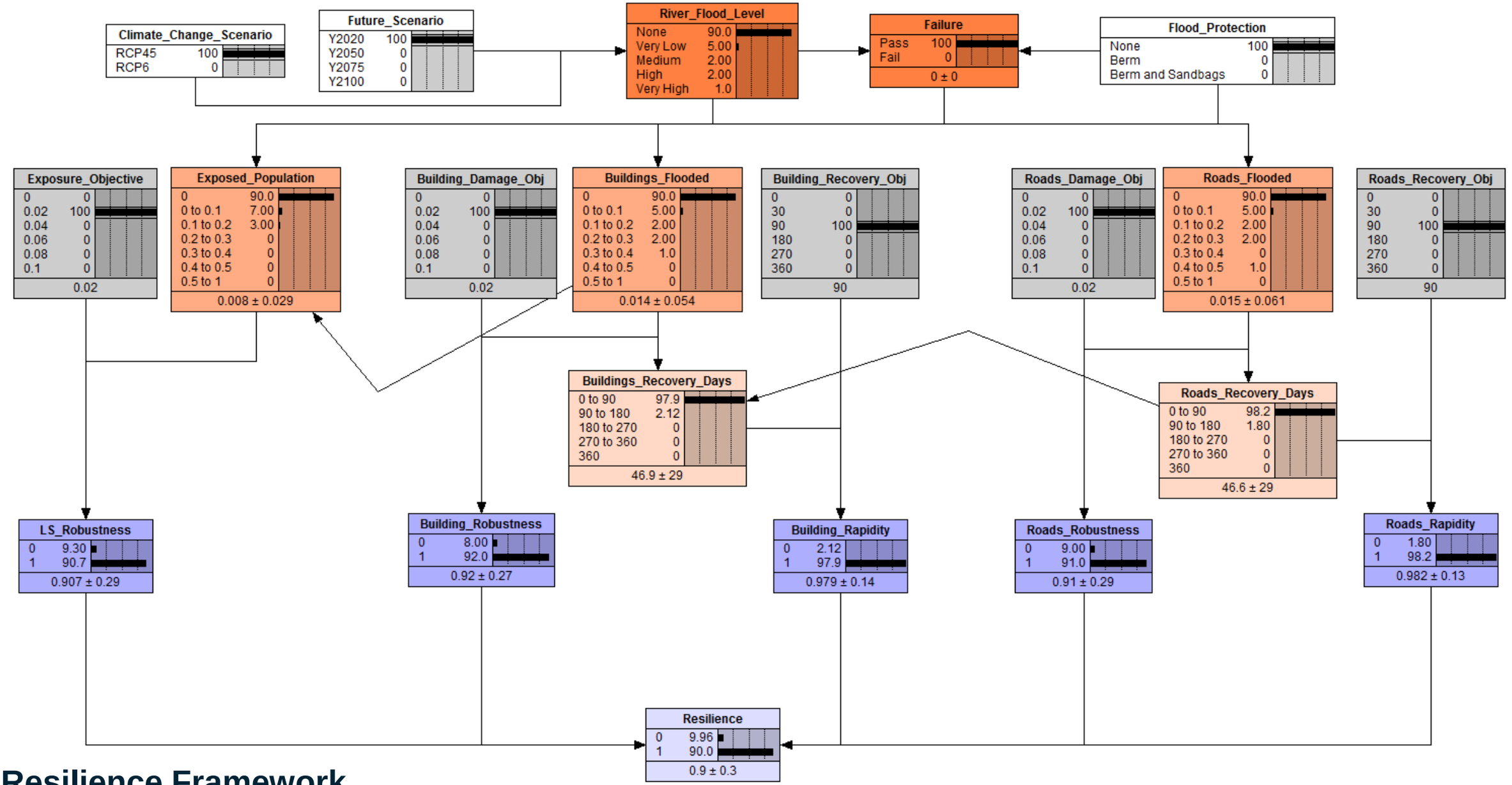
Framework takes relevant data and analyses and produces an interactive tool that allows stakeholders to assess objectives and resilience scores



Britannia, Ottawa

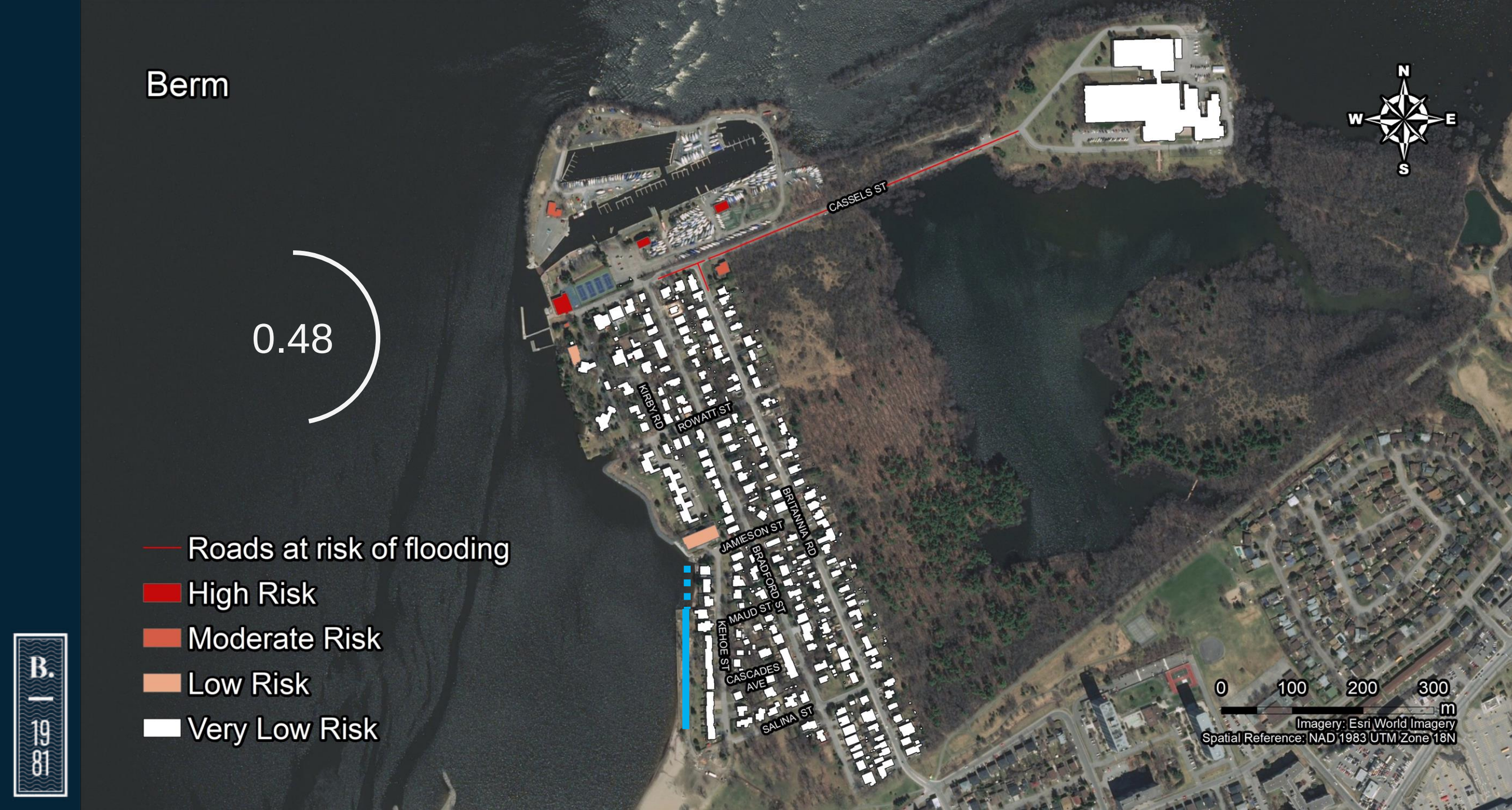
- Metrics
  - Life Safety
  - Roadway Damage
  - Building Damage

- Protection Alternatives
  - Berm
  - Emergency Sandbagging



Resilience Framework


Regulatory 100-year flood
- No berm
- No sandbags
0.28
Roads at risk of flooding
High Risk
Moderate Risk
Low Risk
Very Low Risk
N
W
E
S
CASSELS ST
KIRBY RD
ROWATT ST
JAMIESON ST
BRADFORD ST
BRITANNIA RD
MAUD ST
KEHOE ST
CASCADES AVE
SALINA ST
HOWE ST
POULIN AVE
VIOLET ST
CROYDON AVE
LINCOLN HEIGHTS RD
PLOVER LANE
RICHLIN CRES
ASSALY RD
0
100
200
300
m
Imagery: Esri World Imagery
Spatial Reference: NAD 1983 UTM Zone 18N


Berm
0.48
Roads at risk of flooding
High Risk
Moderate Risk
Low Risk
Very Low Risk
CASSELS ST
KIRBY RD
ROWATT ST
JAMIESON ST
BRITANNIA RD
BRADFORD ST
MAUD ST
KEHOE ST
CASCADES AVE
SALINA ST
N
W
E
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0
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m
Imagery: Esri World Imagery
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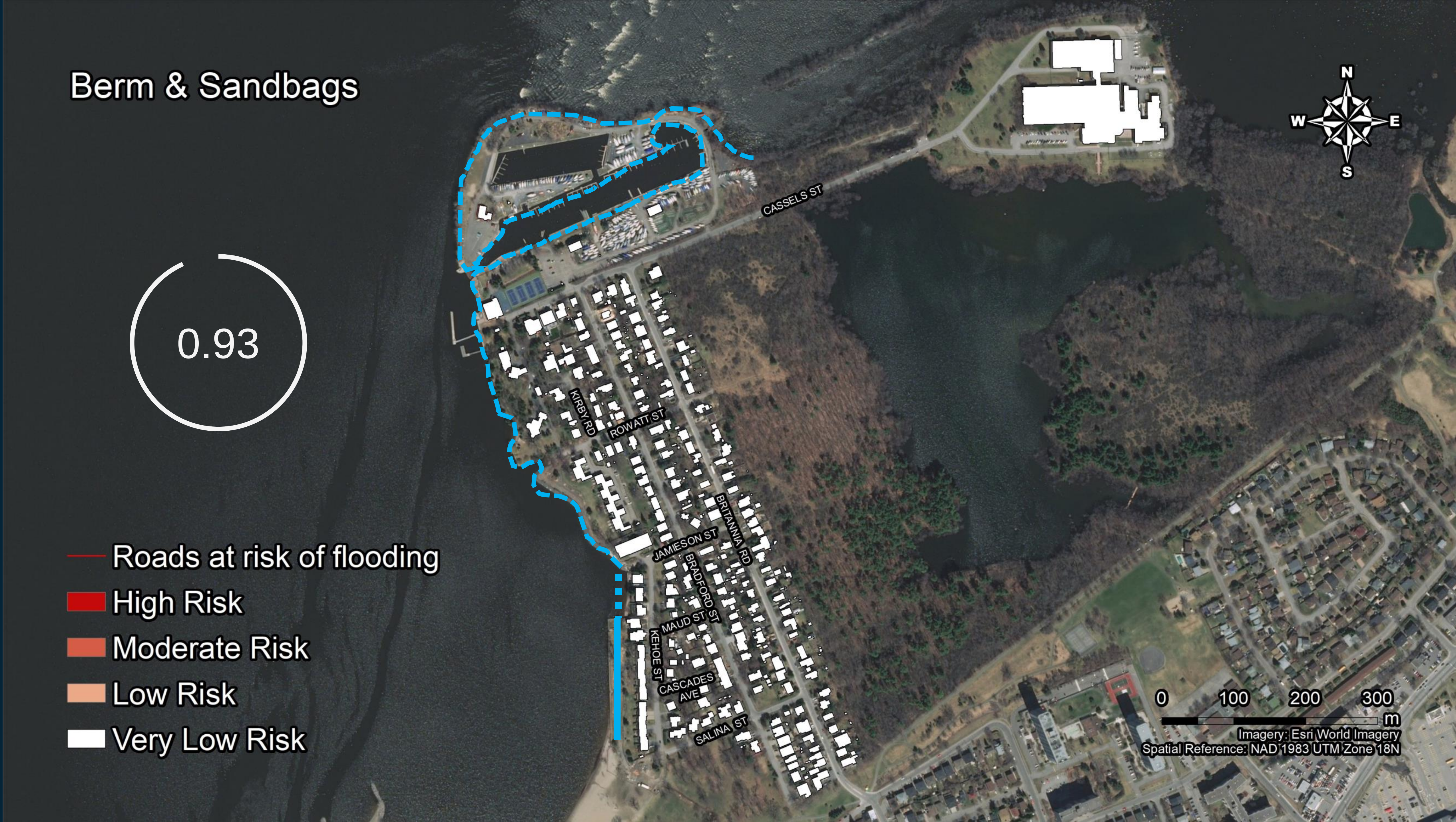

Berm & Sandbags
0.93
Roads at risk of flooding
High Risk
Moderate Risk
Low Risk
Very Low Risk
CASSELS ST
KIRBY RD
ROWATT ST
BRITANNIA RD
JAMIESON ST
BRADFORD ST
MAUD ST
KEHOE ST
CASCADES AVE
SALINA ST
N
S
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W
0
100
200
300
m
Imagery: Esri World Imagery
Spatial Reference: NAD 1983 UTM Zone 18N

Resilience Assessment Benefits

- Establish baseline resilience and identify weak points in the system
- Provide a metric for future planning taking into account uncertainty
- Look at the port (assets and operations) as a whole
- Compare adaptation alternatives
- Develop adaptive management strategies

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