“Climate Change Impacts and Adaptation for Coastal Transport Infrastructure in the Caribbean”

Identifying operational thresholds for vulnerability assessments – breakout sessions

By

Cassandra Bhat
ICF, Miami

Austin Becker and Gerald Bove
University of Rhode Island, USA
Objectives

• Understand:
  • The purpose of operational thresholds
  • How to identify operational thresholds for your facility
  • How to use operational thresholds to assess vulnerabilities
Agenda

- Introduction
- Breakout Exercise: Identify Operational Thresholds
- Report-outs
- Discussion
- Conclusion

Introduction

- Tidal Flooding
- Storm Surge
- Waves
- Heavy rainfall
- Wind
- Heat

Mean temperature increase of 0.75-1.04°C by 2030s
Operational Thresholds

What is an operational threshold?

Level of weather conditions at which a facility or piece of infrastructure experiences disruption, damage, or other impact.
Operational Thresholds

What is an operational threshold?
Level of weather conditions at which a facility or piece of infrastructure experiences disruption, damage, or other impact.

Who sets operational thresholds?
Thresholds are inherent to the individual facility or component.
- **Damage** thresholds – likely set within engineering or design specifications for the asset
- **Operational disruption** thresholds – set by facility managers based on safety and other risk considerations

Purpose of Operational Thresholds

*Within the methodology:*
- Identify specific climate data of interest
- Develop practical estimates of risk over time
- Identify priorities and timeline for adaptation investments

→ At what point will these thresholds be exceeded in the future? How often will these thresholds be exceeded in the future? What is the potential cost or other impact of exceeding these thresholds?

**Other Benefits**
- Establish a means to share and document critical institutional knowledge
- Inform monitoring and evaluation over time
- Identify any research needs (e.g., if local projections are not available for key thresholds)
Purpose of Operational Thresholds

Thresholds Provide the Link Between Climate Models and Impacts

- Can model:
  - Heat days
  - Storm surge
  - Sea levels
  - Precipitation rates (daily, monthly, annual)
  - Wind speeds

- Can’t model (directly):
  - Facility downtime
  - Worker productivity
  - Maintenance costs
  - Infrastructure damage
Five Key Concepts

- **Component** – The specific place, asset, or operational activity that may be of concern
  
  **Ports**: Docks, navigation channel, cranes, utilities, generators, buildings and warehouses, access roads, personnel, drainage system, ability of ships to dock, etc.
  
  **Airports**: Runways, terminals, air traffic control, flight operations, utilities, access roads, etc.

- **Hazard** – The climate hazard that may cause damage or interruption
  
  Tidal flooding, storm surge, waves, heavy rainfall, wind, heat, etc.

- **Variable** – The specific metric of that hazard (e.g., daily high temperature, 24-hour precipitation)

- **Threshold** – The specific measurement (e.g., wind speed, water level, rain/hour) at which the impacts occur. You may have multiple thresholds for any hazard and component, and which different types of impacts occur.

- **Impact** – What specific impact(s) are you concerned about that result from the hazard (e.g., generator gets flooded and stops operating, residents evacuate, road becomes impassible, crane is inoperable).

**Ports**: Docks, navigation channel, cranes, utilities, generators, buildings and warehouses, access roads, personnel, drainage system, ability of ships to dock, etc.

**Airports**: Runways, terminals, air traffic control, flight operations, utilities, access roads, etc.

Tip: Use **increments** to determine thresholds.

For example, what would be the impacts of 0.5 m vs 1 m vs 3 m?
### Example

<table>
<thead>
<tr>
<th>Component</th>
<th>Hazard</th>
<th>Variable</th>
<th>Threshold / Increment</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container Cranes</td>
<td>High winds</td>
<td>Max sustained winds</td>
<td>25 m/s</td>
<td>Crane operations suspended</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40 m/s</td>
<td>Cranes break free of tie downs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>55 m/s</td>
<td>Cranes blow over</td>
</tr>
<tr>
<td>Docks</td>
<td>Tidal flooding</td>
<td>Water levels above current MHHW</td>
<td>1 foot</td>
<td>Water reaches dock edge, increased risk of overtopping, minor damage to ships</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 feet</td>
<td>Water overtops dock, operations limited</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 feet</td>
<td>Water overtops dock, potential damage to ships</td>
</tr>
</tbody>
</table>

### Determining Operational Thresholds

**For each hazard and component/operation:**

1. In which conditions is the facility unable to operate?
   - Does the facility have official operational manuals that specify thresholds?
   - In which conditions has it been unable to operate in the past?

2. In which conditions would the facility be damaged?
   - In which conditions has it been damaged in the past?
   - What conditions is it designed to withstand?

### Information Sources:

- Generic standards and thresholds
- Facility managers
- After-action reports
- Proxy facilities
- Industry guidelines

Included in Framework guidance document
Determining Operational Thresholds

For each hazard and component/operation:
1. In which conditions is the facility unable to operate?
   - Does the facility have official operational manuals?
   - In which conditions has it been unable to operate in the past?
2. In which conditions would the facility be damaged?
   - In which conditions has it been damaged in the past?
   - What conditions is it designed to withstand?

Information Sources:
- Generic standards and thresholds
- Facility managers
- After-action reports
- Proxy facilities
- Industry guidelines

How to do this, in practice?
- Convene a workshop with facility staff
- Populate list of components, thresholds by component and hazards (start with defaults)

Breakout Group Activity
Breakout Groups

**Step 1** – Determine applicable **hazards** for your target component

**Step 2** – For each component/hazard combination, identify climate **variables** and **thresholds**

**Step 3** – Assign a **spokesperson** to report your findings to the larger group
Report-outs

Were you able to identify thresholds?

Are there common thresholds across facilities?

What is the greatest concern you identified?

What challenges did you face in this exercise?

With this information...

- Collect projections on specific climate variables
With this information…

- **Collect projections on specific climate variables**
- **Determine potential frequency of impacts over time**

### Key Takeaways

- **Methodology provides a structured process for collecting existing knowledge**
- **Thresholds may not already be documented**
- **The process is beneficial for several reasons**
  - #1 – Helps focus search for climate projections
  - #2 – Provides method to prioritize amongst risks
  - #3 – Provides method to ultimately quantify risks in economic and other terms

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**Table 1. Days of disruptions for the airports and seaports.**

<table>
<thead>
<tr>
<th>Climate Stressor</th>
<th>Sensitivity</th>
<th>Threshold Description</th>
<th>2000-2019</th>
<th>2040-2059</th>
<th>2080-2099</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Heat</td>
<td>Employee ability to work safely outdoors</td>
<td>Heat Index* over 30.8 °C (87.5 °F) with relative humidity 80% is “light” risk</td>
<td>2.56</td>
<td>13.2</td>
<td>53.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heat Index* over 32.9 °C (91.2 °F) with relative humidity 80% is “very high” risk</td>
<td>0</td>
<td>1.05</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boeing 737-500 aircraft would not be able to take off from IIA if the temperature exceeds 31.2°C without reducing aircraft loads</td>
<td>1.1</td>
<td>12.1</td>
<td>67.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boeing 737-400 aircraft would not be able to take off from IIA if the temperature exceeds 31°C without reducing aircraft loads</td>
<td>1.7</td>
<td>12.25</td>
<td>67.9</td>
</tr>
</tbody>
</table>

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**Source:** Saint Lucia Case Study
Objectives

- Understand:
  - The **purpose** of operational thresholds
  - **How to identify** operational thresholds for your facility
  - **How to use** operational thresholds to assess vulnerabilities

Next Steps

- Work with others at your facility to identify thresholds
  - List components
  - Identify thresholds for different component/hazard relationships
  - Identify priority climate data needs
- Collect projections on specific climate information
Thank you!

Cassandra Bhat, ICF
cassandra.bhat@icf.com

Austin Becker, URI
abecker@uri.edu

Gerald Bove, URI
gerald_bove@brown.edu
**Gathering Operational Thresholds**

**Generic Standards and Thresholds**

*Example thresholds and their impacts from a variety of vulnerability assessments and literature source.*

<table>
<thead>
<tr>
<th>Component</th>
<th>Hazard</th>
<th>Example Threshold</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>Extreme Heat</td>
<td>1°C warming = 5% increase in energy costs (in one illustrative terminal)</td>
<td>Energy costs</td>
</tr>
<tr>
<td>Paved surfaces</td>
<td>Depends on asphalt pavement grade</td>
<td></td>
<td>Asphalt pavement softening</td>
</tr>
<tr>
<td>Cranes</td>
<td>Heavy Rain</td>
<td>In Manzanillo, intense rainfall &gt; 20 mm within 24 hours reduces visibility enough to impair operations</td>
<td>Low visibility inhibits crane operation</td>
</tr>
<tr>
<td>Goods handling</td>
<td>Precipitation &gt; 1 mm within 24 hours</td>
<td></td>
<td>Inability to handle water-sensitive goods</td>
</tr>
<tr>
<td>Operations</td>
<td>Flooding</td>
<td>Conditions that cause flooding will vary by facility.</td>
<td>Flooding in some locations of the port could impair operations.</td>
</tr>
<tr>
<td>Docks</td>
<td>Tidal Flooding</td>
<td>Dock elevation/quay height</td>
<td>Flooding</td>
</tr>
<tr>
<td>Cranes</td>
<td>Wind Speeds</td>
<td>Varies by crane type. For example, 25 m/s (56 mph, 48.6 knots) for a CONTECON SSA</td>
<td>Ability to operate</td>
</tr>
<tr>
<td>Navigational channel</td>
<td></td>
<td>Varies by facility. For example, at Kingston Container Terminals (KCT) in Jamaica:</td>
<td>Ability to berth ships (due to waves)</td>
</tr>
<tr>
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<td>• Winds &gt; 18 m/s (40.3 mph, 35 knots) force operational shutdown</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• With winds of 12.8-18 m/s (28.8-40.3 mph, 25-35 knots), discretion is applied</td>
<td></td>
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<tr>
<td><strong>Airports</strong></td>
<td></td>
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<tr>
<td>Runways</td>
<td>Extreme Heat</td>
<td>Runway length requirement varies based on plane type, weight, and runway length. Rule of thumb: Runway length requirements increase by 1% for every 1°C by which the mean daily maximum temperature of the hottest month exceeds 15°C (assuming runway is at sea level) (ICAO, 2006)</td>
<td>Ability of aircraft to take off</td>
</tr>
<tr>
<td>Flight operations</td>
<td>47.7°C (118°F)</td>
<td></td>
<td>Aircraft maximum take-off operational temperature</td>
</tr>
<tr>
<td>Personnel</td>
<td>Heat Index* over 39.4°C (103°F) is “high” risk Heat Index* over 46°C (115°F) is “very high” risk</td>
<td>Reduced employee ability to work safely outdoors (need for more breaks)</td>
<td></td>
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<tr>
<td>Flight operations</td>
<td>Heavy rain</td>
<td>Varies by airport</td>
<td>May decrease runway friction to aircraft cannot take off</td>
</tr>
<tr>
<td>Flight operations</td>
<td>Flooding</td>
<td>Any flooding on the runway can impair operations. Conditions that cause flooding will vary by airport.</td>
<td>Inability of aircraft to land or take off</td>
</tr>
<tr>
<td>Flight operations</td>
<td>Sea Level Rise</td>
<td>Runway elevation</td>
<td>Flooding on the runway</td>
</tr>
<tr>
<td>Flight operations</td>
<td>Wind Speeds</td>
<td>Commercial airports: sustained winds of 20 m/s (45 mph, 39 knots) or frequent gusts of 26 m/s (58 mph, 50.4 knots) General Aviation airports: 11.2 m/s (25 mph, 21.7 knots)</td>
<td>Inability of aircraft to land or take off</td>
</tr>
</tbody>
</table>

*Heat Index is a function of temperature and relative humidity. See [http://www.nws.noaa.gov/om/heat/heat_index.shtml](http://www.nws.noaa.gov/om/heat/heat_index.shtml). For a relative humidity of 70%, Heat Index would exceed 39.4°C (103°F) at 32.2°C (90°F) and would exceed 46°C (115°F) at 34°C (94°F).*
UNCTAD Regional Workshop: "Climate change impacts and adaptation for coastal transport infrastructure in the Caribbean"

**Worksheet**

**Operational Thresholds:**

<table>
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