UNCTAD Regional Workshop

5 – 7 December 2017, Bridgetown, Barbados

"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

This expert paper is reproduced by the UNCTAD secretariat in the form and language in which it has been received. The views expressed are those of the author and do not necessarily reflect the views of the UNCTAD.

Identifying Operational Thresholds for Vulnerability Assessments

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

6 December, 2017

United Nations Conference on Trade and Development

Regional Workshop – Barbados

Cassandra Bhat, ICF

Austin Becker, URI

Gerald Bove, URI

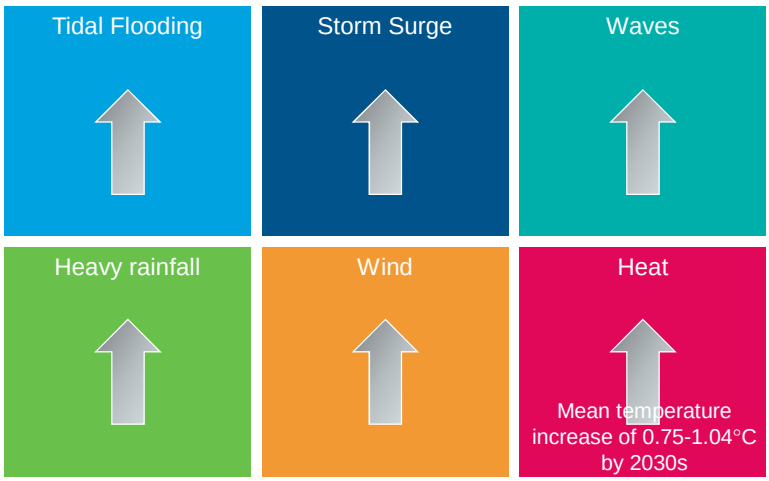
Objectives

- **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



Operational Thresholds

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:

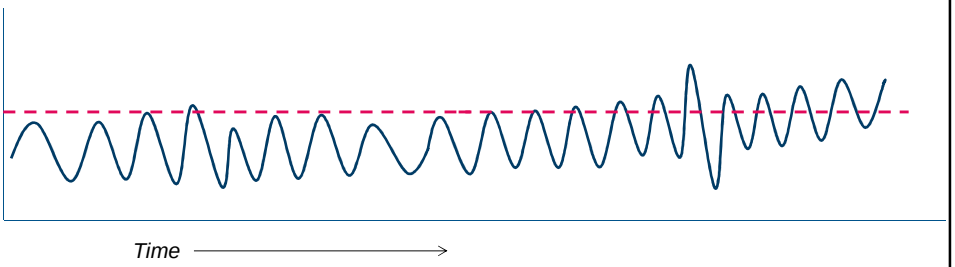
- **Identify specific climate data of interest**
- **Develop practical estimates of risk over time**
- **Identify priorities and timeline for adaptation investments**

→ 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).

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., dai
  hour precipitation)
- **Threshold –** The specific measurement (e.g., wi
  rain/hour) at which the impacts occur. You may hav
  hazard and component, and which different types of
- **Impact –** What specific impact(s) are you concerned
  hazard (e.g., generator gets flooded and stops opera
  road becomes impassible, crane is inoperable).

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

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

Example

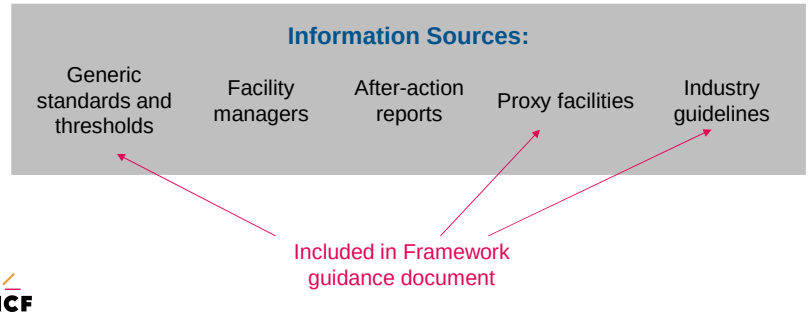
Component	Hazard	Variable	Threshold / Increment	Impacts
Container Cranes	High winds	Max sustained winds	25 m/s	Crane operations suspended
			40 m/s	Cranes break free of tie downs
			55 m/s	Cranes blow over

Component	Hazard	Variable	Threshold / Increment	Impacts
Docks	Tidal flooding	Water levels above current MHHW	1 foot	Water reaches dock edge, increased risk of overtopping, minor damage to ships
			2 feet	Water overtops dock, operations limited
			3 feet	Water overtops dock, potential damage to ships

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*



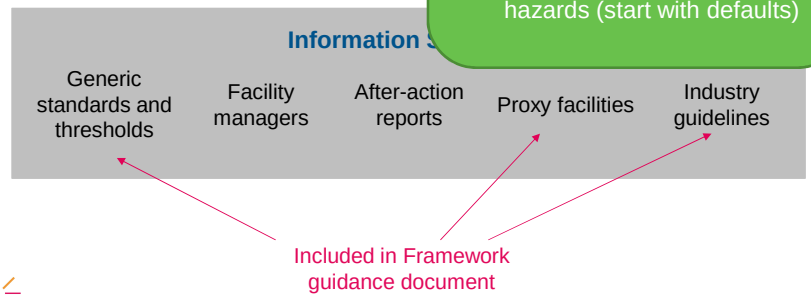
Determining Operational Thresholds

For each hazard and component/operation:

1. In which conditions is the facility unable to operate?
   - *Does the facility have official operational m*
   - *In which conditions has it been unable to o*
2. In which conditions would the facility be
   - *In which conditions has it been damaged ir*
   - *What conditions is it designed to withstand*

How to do this, in practice?

- Convene a workshop with facility staff
- Populate list of components, thresholds by component and hazards (start with defaults)



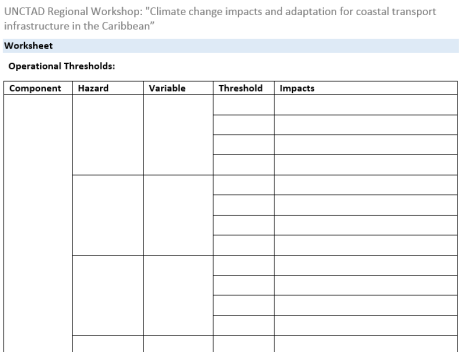
Breakout Group Activity

Breakout Groups

Airports:	#1 Flight operations	#2 Terminal buildings
Ports:	#3 Container cranes	#4 Ability of ships to dock

Breakout Group Instructions

- **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**



UNCTAD Regional Workshop: "Climate change impacts and adaptation for coastal transport infrastructure in the Caribbean"

Worksheet

Operational Thresholds:

Component	Hazard	Variable	Threshold	Impacts

Report-outs

Were you able to identify thresholds?

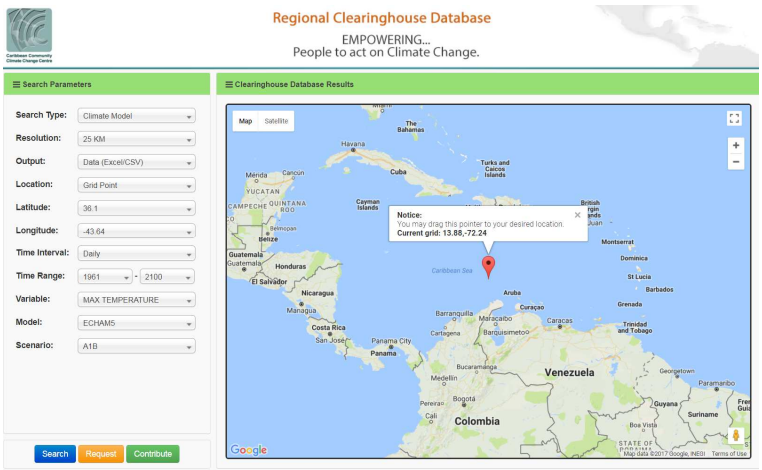
Are there common thresholds across facilities?

What is the greatest concern you identified?

What challenges did you face in this exercise?

With this information…

- **Collect projections on specific climate variables**
  - 5Cs clearinghouse – http://clearinghouse.caribbeanclimate.bz/



With this information…

- **Collect projections on specific climate variables**
  - 5Cs clearinghouse – http://clearinghouse.caribbeanclimate.bz/
- **Determine potential frequency of impacts over time**

Table 1. Days of disruptions for the airports and sea ports.

Climate Stressor	Sensitivity	Threshold	Disruptions (average days/year)		
			2000-2019	2040- 2059	2080 - 2099
Airports					
Extreme Heat	Employee ability to work safely outdoors	Heat Index* over 30.8 °C (87.5 °F) with relative humidity 80% is "high" risk	2.05	13.2	53.7
		Heat Index* over 32.9 °C (90.7 °F) with relative humidity 80% is "very high" risk	0	1.05	11.8
		Boeing 737-500 aircraft would not be able to take off from HIA if the temperature exceeds 31.2°C without reducing aircraft loads	1.1	12.1	67.5
		Boeing 737-400 aircraft would not be able to take off from HIA if the temperature exceeds 31°C without reducing aircraft loads	1.7	12.25	67.9

Source: Saint Lucia Case Study

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

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.

Component	Hazard	Example Threshold	Impact
Ports			
Operations	Extreme Heat	1°C warming = 5% increase in energy costs (in one illustrative terminal)	Energy costs
Paved surfaces		Depends on asphalt pavement grade	Asphalt pavement softening
Cranes	Heavy Rain	In Manzanillo, intense rainfall > 20 mm within 24 hours reduces visibility enough to impair operations	Low visibility inhibits crane operation
Goods handling		Precipitation > 1 mm within 24 hours	Inability to handle water-sensitive goods
Operations	Flooding	Conditions that cause flooding will vary by facility.	Flooding in some locations of the port could impair operations.
Docks	Tidal Flooding	Dock elevation/quay height	Flooding
Cranes	Wind Speeds	Varies by crane type. For example, 25 m/s (56 mph, 48.6 knots) for a CONTECON SSA	Ability to operate
Navigational channel		Varies by facility. For example, at Kingston Container Terminals (KCT) in Jamaica: • Winds ≥ 18 m/s (40.3 mph, 35 knots) force operational shutdown • With winds of 12.8-18 m/s (28.8-40.3 mph, 25-35 knots), discretion is applied	Ability to berth ships (due to waves)
Airports			
Runways	Extreme Heat	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)	Ability of aircraft to take off
Flight operations		47.7°C (118°F)	Aircraft maximum take-off operational temperature
Personnel		Heat Index* over 39.4°C (103°F) is "high" risk Heat Index* over 46°C (115°F) is "very high" risk	Reduced employee ability to work safely outdoors (need for more breaks)
Flight operations	Heavy rain	Varies by airport	May decrease runway friction to aircraft cannot take off
Flight operations	Flooding	Any flooding on the runway can impair operations. Conditions that cause flooding will vary by airport.	Inability of aircraft to land or take off
Flight operations	Sea Level Rise	Runway elevation	Flooding on the runway
Flight operations	Wind Speeds	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)	Inability of aircraft to land or take off

*Heat Index is a function of temperature and relative humidity. See 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).

Worksheet

Operational Thresholds:

Component	Hazard	Variable	Threshold	Impacts