

# **COASTAL ZONE MANAGEMENT UNIT**

**Joint ICTP-TWAS Workshop on Climate Change in  
Mediterranean and Caribbean Seas**

## **Trends in Winter Swell Wave Height and Impacts on Barbados**

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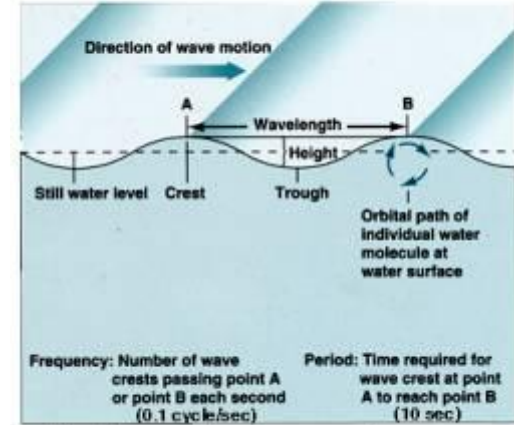


## **THIS PRESENTATION WILL INCLUDE THE FOLLOWING:**

1. What is a Swell wave?
2. Background on the wave climate of Barbados
3. Historic Swell Activity in Barbados
4. Analysis of measured wave data
5. Case Study 2008 Swell Event
6. Conclusions

# What is a Swell wave ?

Waves can be formed by wind



**Anatomy of a progressive wave**

Waves can be formed by extra regional events



# Background on the wave climate of Barbados

# Background on the wave climate of Barbados

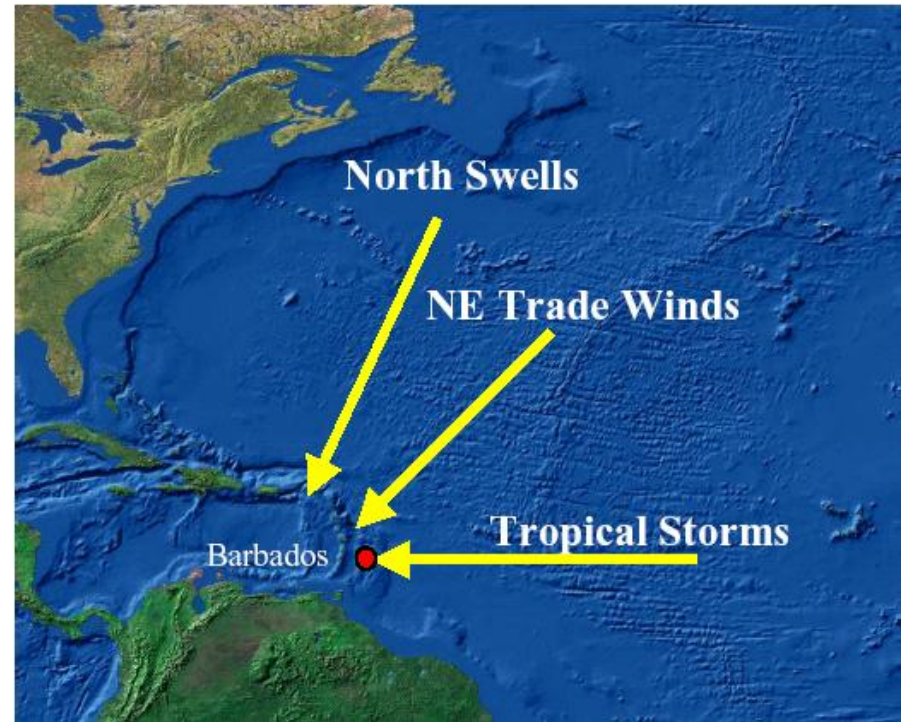
Barbados is the most easterly of the islands in the Lesser Antilles and is situated 100 kilometres (62 mi) east of the Windward Islands and the Caribbean Sea



# Background on the wave climate of Barbados

**Barbados is normally affected by waves generated by three sources. These three sources are:**

- North East Trade Winds
- Tropical Storms
- North Swells



# Background on the wave climate of Barbados

1. Swell waves affect the coast of Barbados all year round
2. Swell waves which affect Barbados are generated by low pressure systems in the North Atlantic.
3. Swell wave are usually highest during the months of the northern maritime winter (October-April).

# Historic Swell Activity in Barbados and its Impacts



# Historic Swell Activity in Barbados and its Impacts

## **Barbados and the entire Caribbean chain have early documentation of being affected by North Swells**

- April 4<sup>th</sup> to 6<sup>th</sup>, 1958 - The maximum wave height of 4.4 feet (1.3m) and a maximum wave period of 15 seconds [Donn and McGuinness, 1959]
- October 24<sup>th</sup> to 28<sup>th</sup>, 1958 - The maximum significant wave height of approximately 15 feet (4.6m) and a maximum wave period of nearly 18 seconds. [Donn and McGuinness, 1959]

# Historic Swell Activity in Barbados and its Impacts

1. The most severe damage from the northern maritime winter swells occur on the west coast
2. Damage is less severe on the east coast from the northern maritime winter swells
3. The south coast also experiences beach erosion indirectly due to the wrap-around of waves from the west and east coasts during these swell events.

# Analysis of measured wave data

# Analysis of measured wave data

AWAC



S4ADW



# Analysis of measured wave data

- The Coastal Zone Management Unit normally deploys six S4ADW wave gauges along the west, south and southeast coast of the island.
- The data used in this presentation was recorded by one of the S4ADW wave gauges deployed at a site 230m offshore Holetown and in 6.8m depth of water
- We have only collected long-term monthly wave data from this site from 2004.

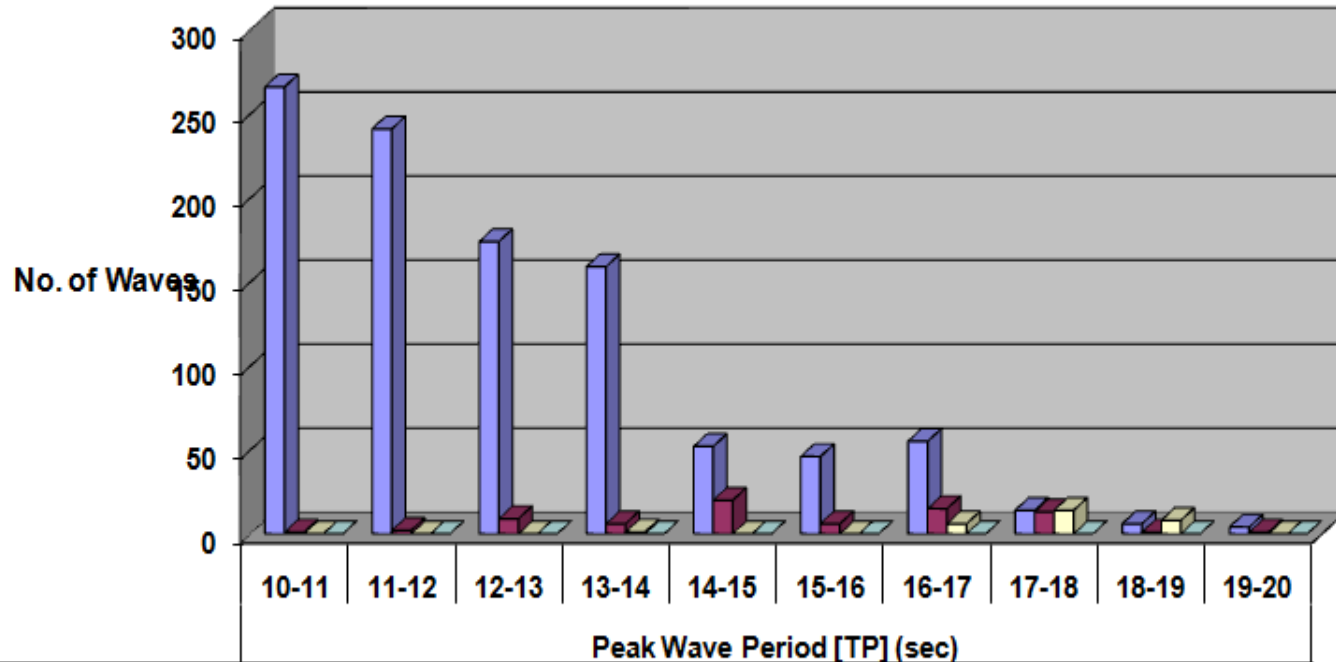
S4 LOCATIONS



S4ADW Locations

# Analysis of measured wave data

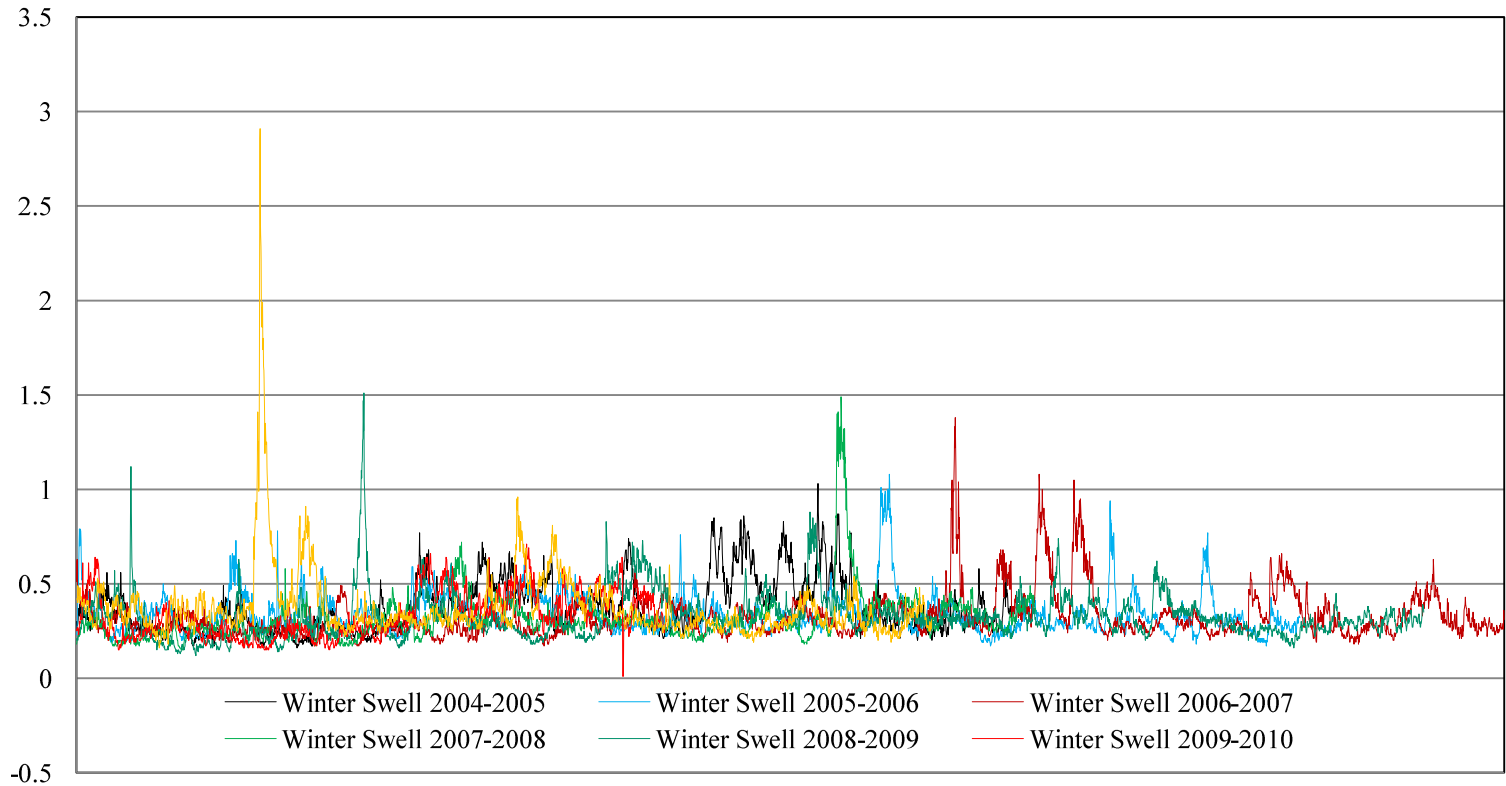
## Correlation Between Wave Heights and Peak Wave Periods For The Winter Swell 2007-2008



	Peak Wave Period [TP] (sec)									
	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Wave Heights (m) 0-0.5	266	241	174	159	52	46	55	14	6	4
Wave Heights (m) 0.5-1.0	1	2	9	6	20	6	15	13	1	1
Wave Heights (m) 1.0-1.5	0	0	0	1	0	0	6	14	8	0
Wave Heights (m) 1.5-2.0	0	0	0	0	0	0	0	0	0	0

# Analysis of measured wave data

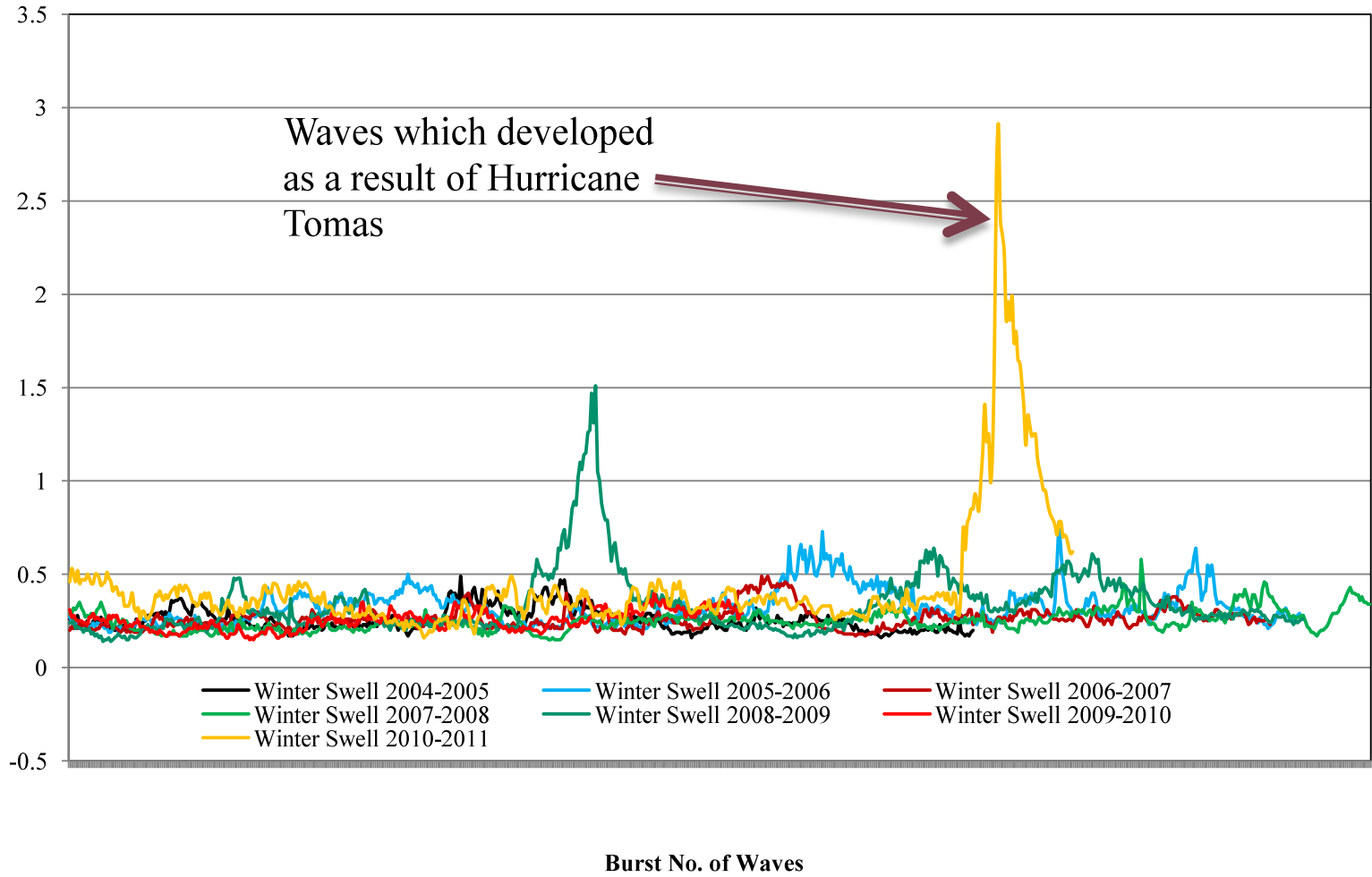
**Significant Wave Heights Corresponding to Wave Data During the Period of the Northern Winter Swells from 2004 - 2011**



**Burst Number of waves**

# Analysis of measured wave data

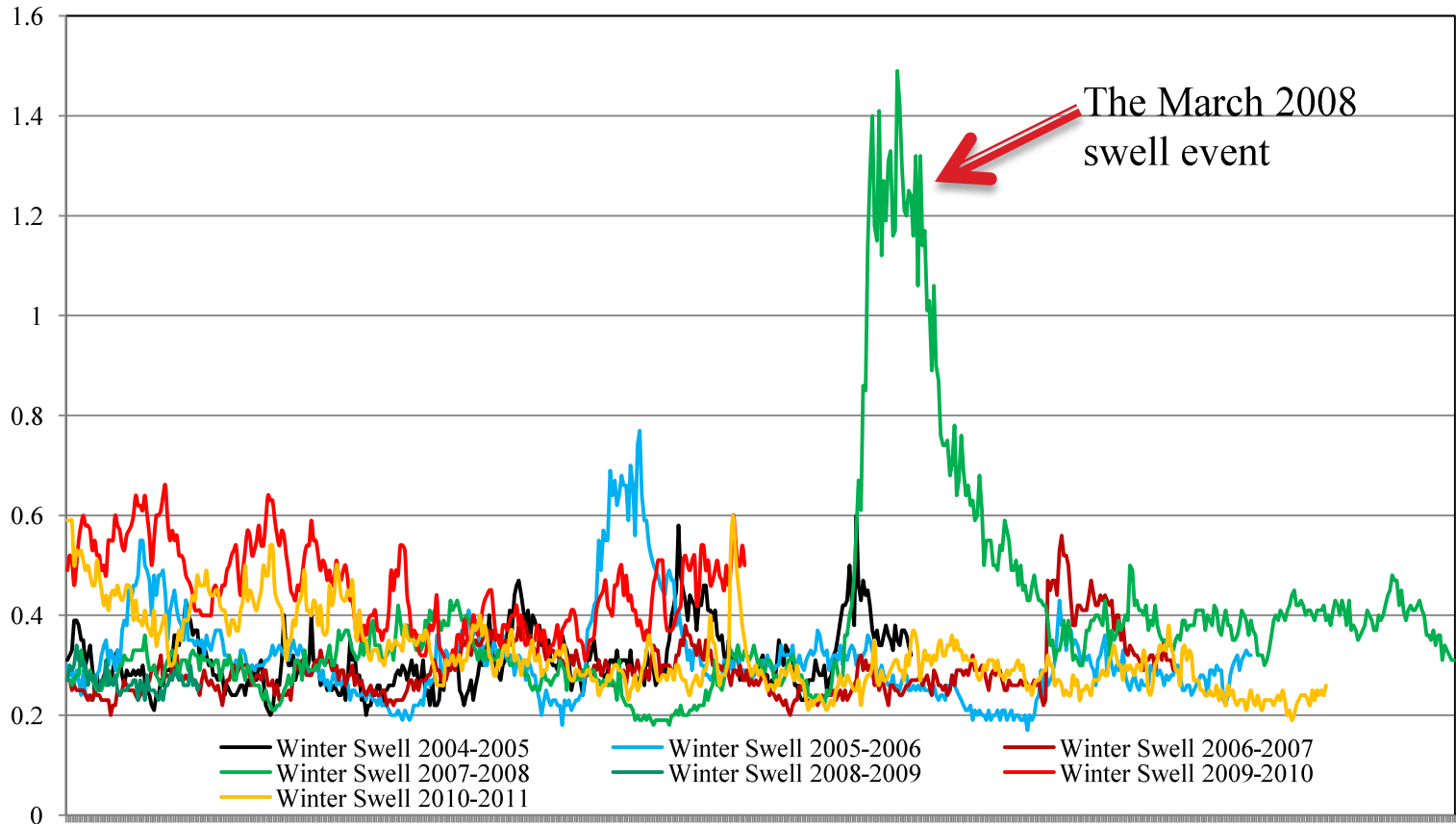
## Significant Wave Heights Corresponding to Wave Data During October 2004 - 2011





# Analysis of measured wave data

## Significant Wave Heights Corresponding to Wave Data During March 2004 - 2011



Burst No. of Waves

# Analysis of measured wave data

0.902m

		Year						
		2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
0.324m	1%	0.80	0.81	0.84	1.01	0.74	0.96	1.16
	5%	0.66	0.53	0.53	0.46	0.55	0.80	0.66
	10%	0.58	0.46	0.44	0.41	0.47	0.69	0.52
	20%	0.47	0.41	0.38	0.37	0.39	0.57	0.43
	30%	0.42	0.37	0.34	0.33	0.35	0.50	0.38
	40%	0.31	0.30	0.28	0.28	0.29	0.35	0.31
	50%	0.34	0.32	0.29	0.30	0.30	0.39	0.33

Average 0.341m

Average 9.568

	Year						
	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Mean Significant Wave Height	0.37	0.34	0.32	0.32	0.33	0.33	0.38
Mean Peak Period	10.36	10.14	10.16	9.88	9.77	7.36	8.87
Max Significacant Wave Height	1.03	1.08	1.38	1.49	1.51	0.96	2.91
Max Peak Period	19.14	22.51	19.14	19.14	19.88	19.14	18.45

# Case Study

# Case Study 2008 Swell Event

March 19<sup>th</sup> to 22<sup>th</sup> , 2008

- Swell waves affected the island for about 80 hours
- Worst hit areas had severe beach erosion due to high energy waves and high levels of accretion due to long period waves or littoral drift. There was also inundation of properties.
- The maximum significant wave height of approximately 1.49 m and a maximum wave period of 18.45 seconds

# Case Study 2008 Swell Event



# Case Study 2008 Swell Event



# Case Study 2008 Swell Event



# Case Study 2008 Swell Event





# Case Study 2008 Swell Event



Brandon's Beach, St Michael

# Case Study 2008 Swell Event



Damaged Deck at Mullins Beach Bar, St. Peter

# Case Study 2008 Swell Event



# Case Study 2008 Swell Event



Damaged  
sea wall

Damaged Seawall at Private Residence North of Discovery Bay  
Hotel, St. James

# Case Study 2008 Swell Event



Bath Beach, St John

# Case Study 2008 Swell Event

## Coastal Impacts

### Health of Nearshore fringing reefs

- The high wave energy some minor damage to the fringing reefs around Barbados

# Case Study 2008 Swell Event

## Coastal Impacts

### Tourism and Aesthetics

- Some beaches were covered in coral rubble
- Decrease in tourist and locals expectations in near shore water safety
- Narrowing of popular beaches around the island

# Case Study 2008 Swell Event

## Coastal Impacts

### Fishing Industry

- Damage to fishing Vessels
- Damage to jetties
- Difficulties launching boats after the swell



# Case Study 2008 Swell Event

## Coastal Impacts

### Drainage

- Blockage of discharge culvert mouths, storm drains and etc

# Conclusions

# Conclusion

The data we have collected only spans 7 years but we have noticed the following.

- The data collected shows that the average wave height remained similar except in the years 2004-2005 and 2010-2011
- No major north swell events in the last 3 years
- North swell waves heights have increased in size over the last 4 years

	Year						
	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
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## Conclusion

- An increase in appreciation of the need to incorporate extra regional wave events into design of coastal infrastructure from engineers.
- These swell events in recent times along with other coastal concerns have led Barbados to undertake another island wide study on the vulnerability of our coastline and reefs

Thank you

Questions?