



KFW



MAR INSURANCE CONCEPT FOR DISCUSSION



- This study was made possible thanks to the support of:



Willis Towers Watson



89°0'0"W

88°0'0"W

87°0'0"W

86°0'0"W

85°0'0"W

N

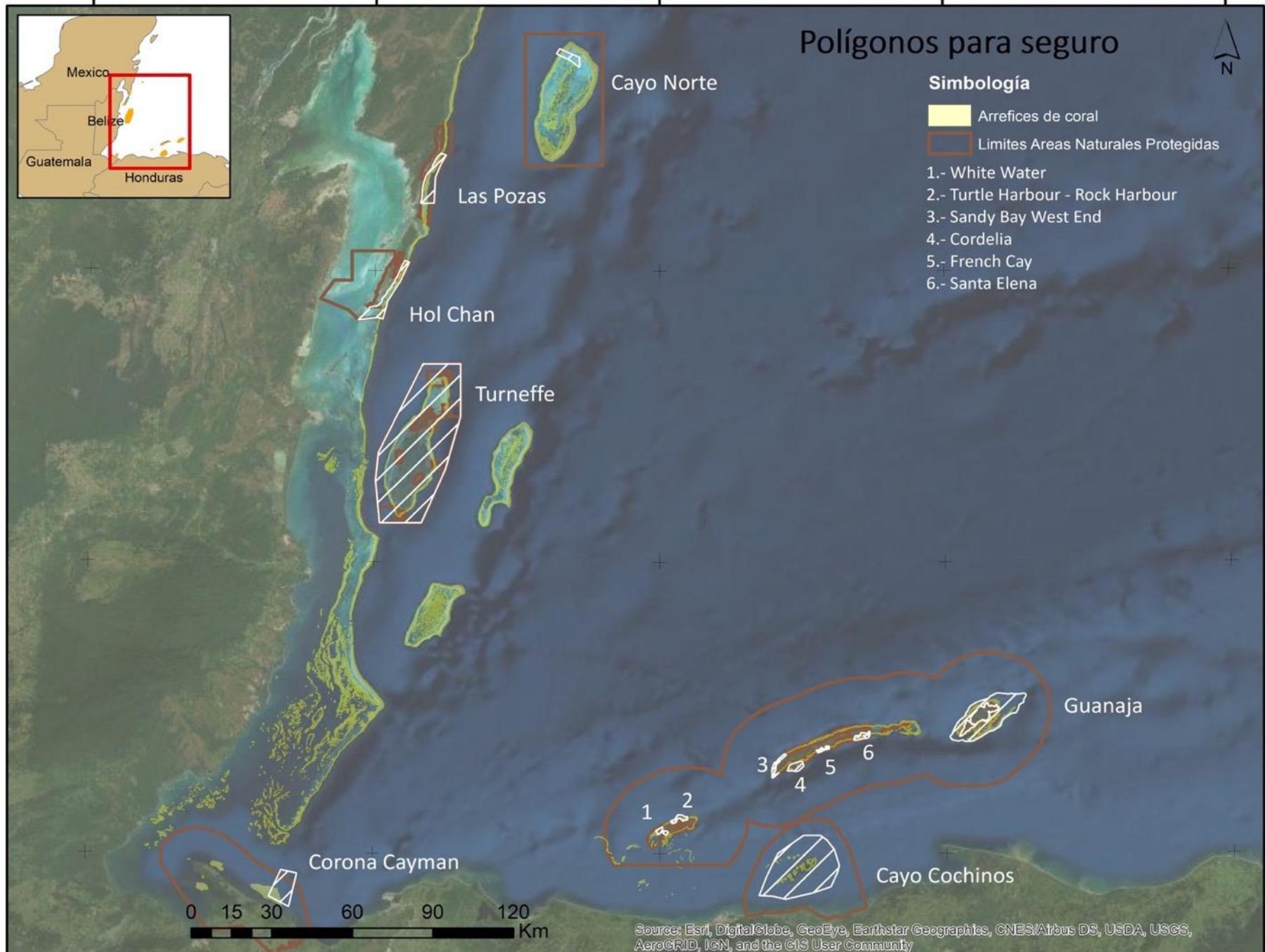
Polígonos para seguro

Simbología

Arrecifes de coral

Límites Areas Naturales Protegidas

- 1.- White Water
- 2.- Turtle Harbour - Rock Harbour
- 3.- Sandy Bay West End
- 4.- Cordelia
- 5.- French Cay
- 6.- Santa Elena



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

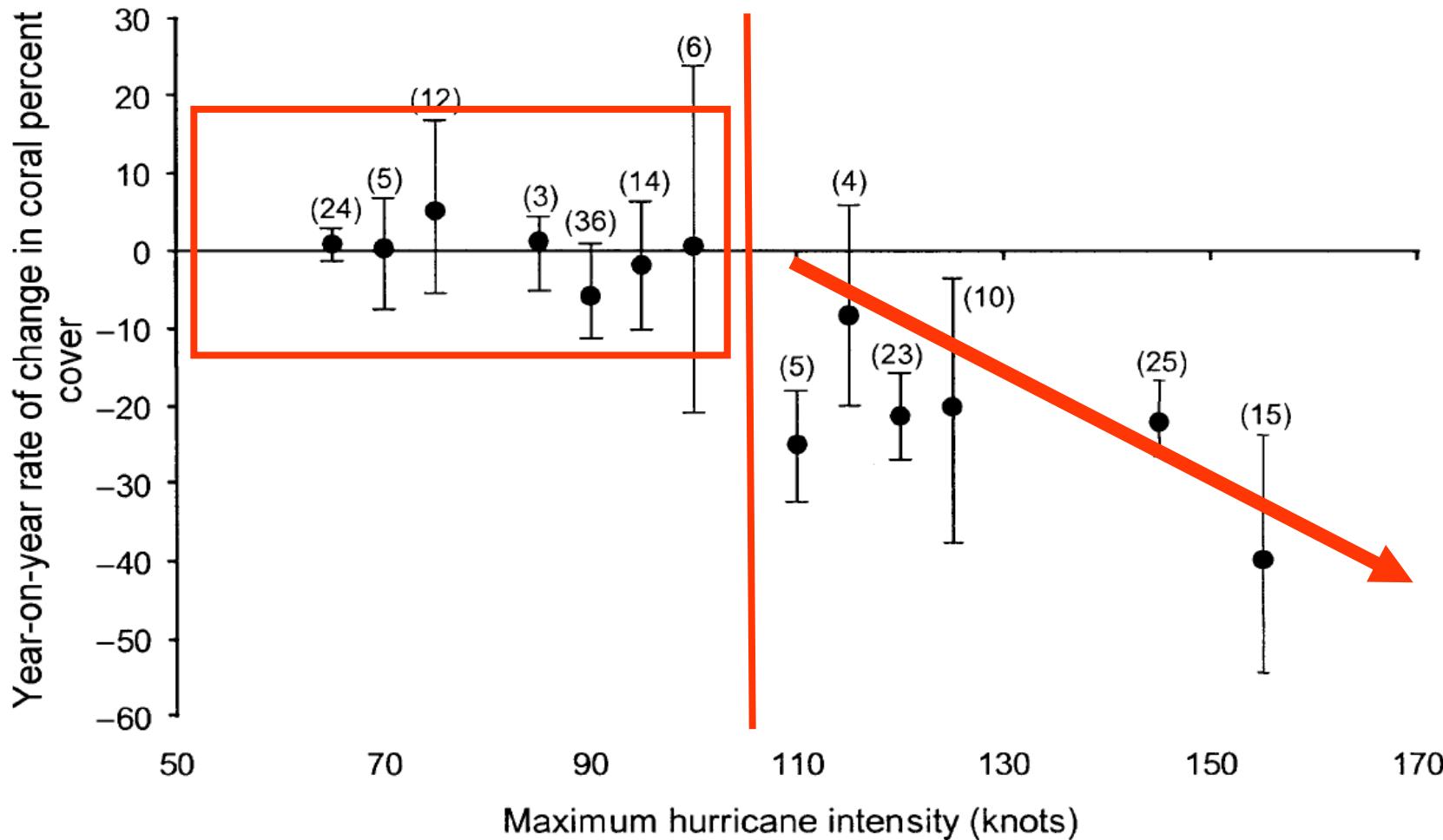
Characteristics of the sites relevant to the insurance

Insured site name	% live coral cover (HRI)	Coral surface	Estimated net live coral cover
	Average	(ha) Coral cover 2013	(ha)
Cayo Norte - Chinchorro	12.30	163	20.06
Las Pozas - Xcalak	17.70	1,785	315.87
Hol Chan	10.70	1,055	112.86
Turneffe	16.80	7,071	1,187.95
Corona Cayman – Punta Manabique	44.00	1,055	464.12
Utila	18.85	402	75.70
Roatan	30.28	741	224.37
Guanaja	19.30	4,406	850.36
Cayos Cochinos	16.10	1,447	232.98

Data to define the parameter and the threshold

Perez and Pardo, 2019, in collaboration with Lorenzo Alvarez, Claudia Ruiz and Fernando Secaira

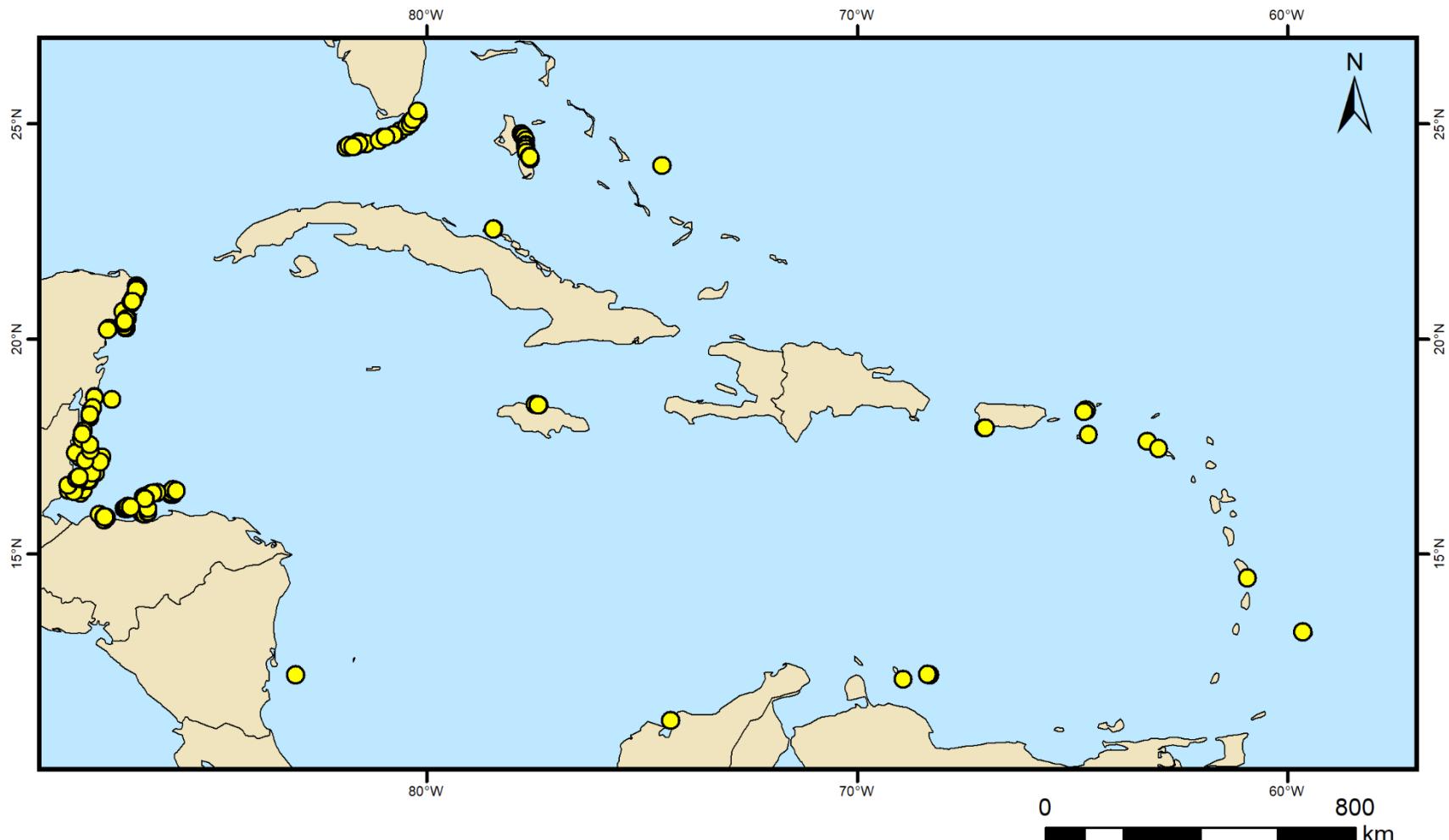
Severe damages are caused by maximum wind speed > 110 knots



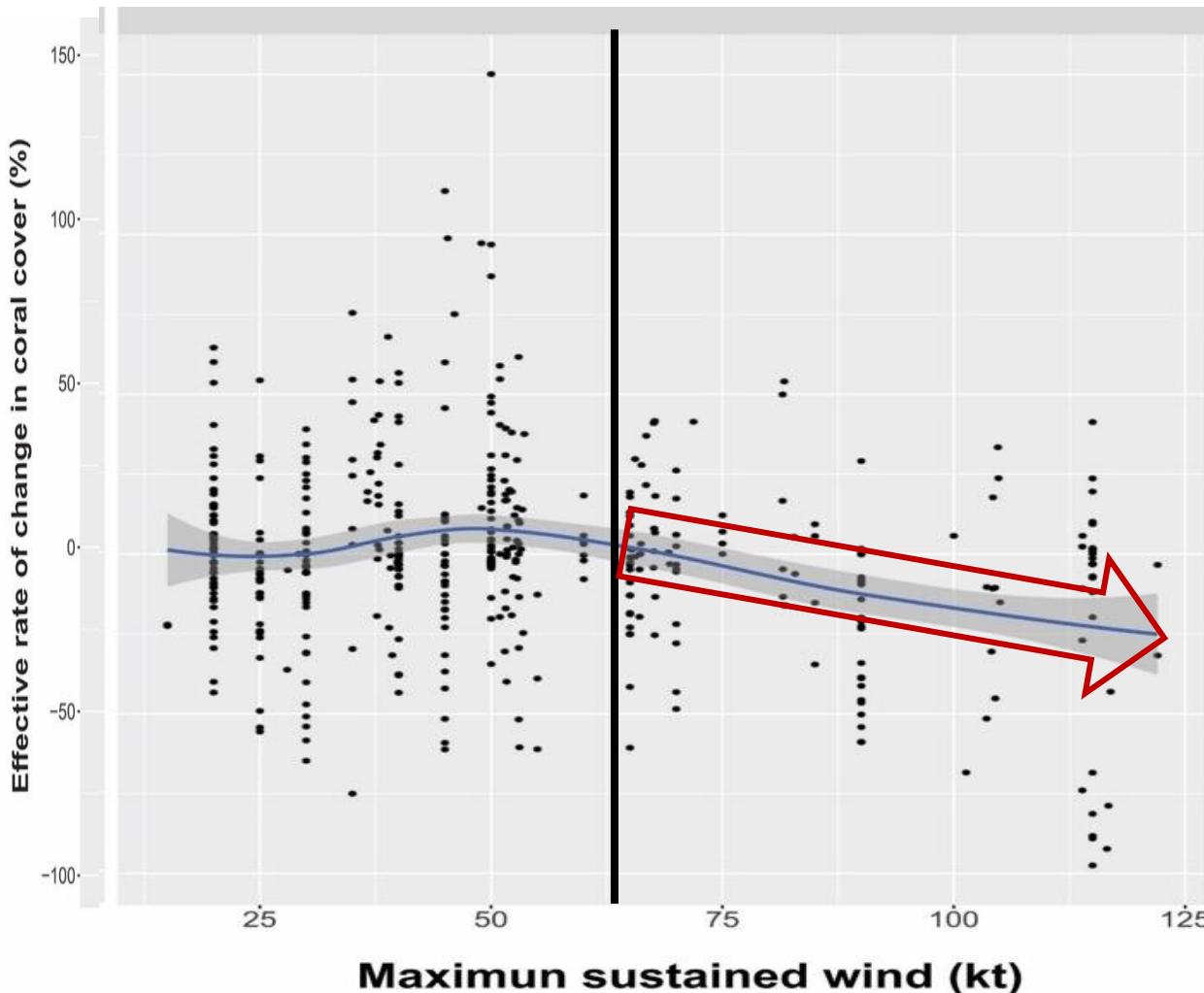
+200 sites (Gardner T. et al 2005)

Analysis of the correlation of reef damages with hurricanes and reef characteristics

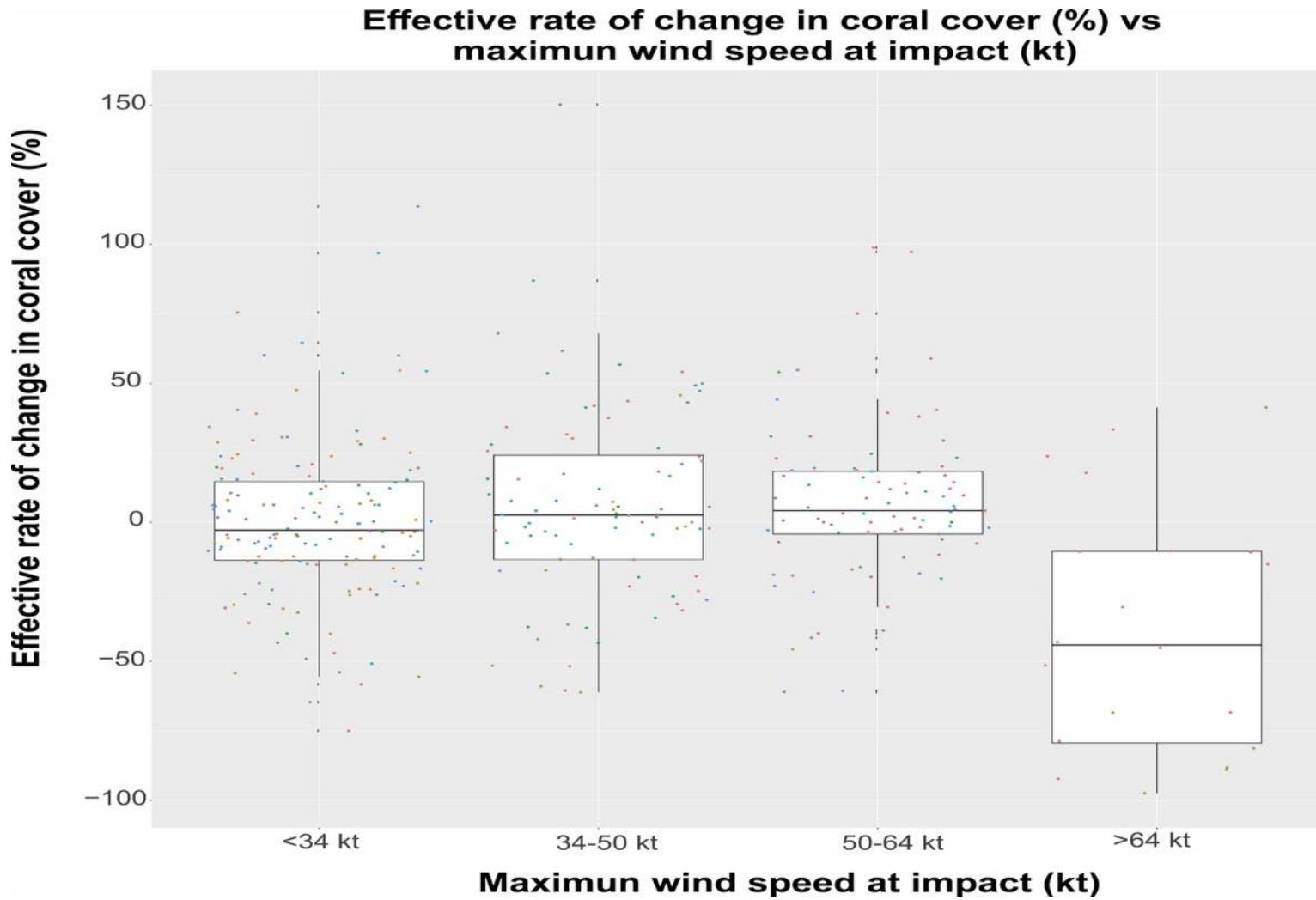
Meta analysis of 417 sites with data 1973-2017



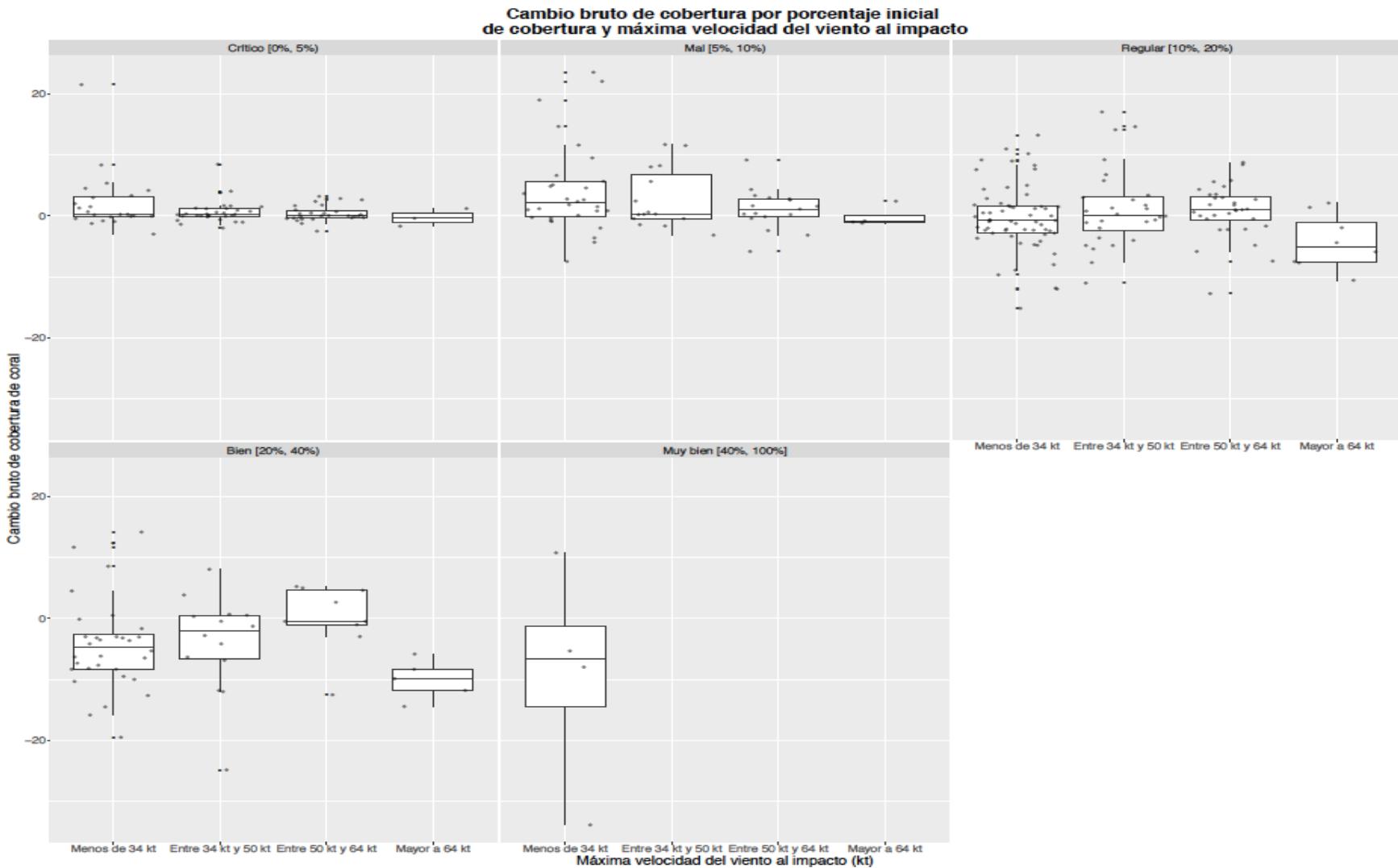
Maximum wind speed is correlated with damages to reefs



Wind speed at impact is the variable most correlated with damages to reefs



Initial coral cover is correlated with damages to reefs



Projected damages to reefs

-% of live coral cover -

- All sites are severely damaged by winds above 64 knots
- Roatan and Corona Cayman are damaged by winds less than 34 knots

Insured site	% of live coral cover	<34 knots	34-50 knots	50-64 knots	>64 knots
Cayo Norte (Chinchorro)	12.30	1.48			4.92
Las Pozas - Xcalak	17.70	2.12			7.08
Hol Chan	10.70	1.28			4.28
Turneffe	16.80	2.02			6.72
Corona Cayman	44.00	7.7	2.75	0.55	11.00
Utila	18.85	2.6	1.34	0.27	6.85
Roatan	30.28	4.93	2.40	0.48	9.52
Guanaja	19.30	2.32			7.72
Cayos Cochinos	16.10	1.93			6.44

Projected damages to live coral - hectares -

- Turneffe and Guanaja have the largest areas impacted
- Corona Cayman will suffer a significant loss with less than 34 knots.

Insured site	Estimated net live coral cover	Estimate loss of live coral cover caused by wind speed at impact (ha)	
		<34 knots	>64 knots
	ha		
Cayo Norte	20.06	2.41	8.02
Las Pozas	315.87	37.90	126.35
Hol Chan	112.86	13.54	45.15
Turneffe	1,187.95	142.55	475.18
Corona Cayman	464.12	81.22	116.03
Utila	75.70	10.42	27.55
Roatan	224.37	36.51	64.01
Guanaja	850.36	102.04	340.14
Cayos Cochinos	232.98	27.96	93.19

Payout required per site

Based on the cost of repairs and restoration in the MAR conducted by Whiterock, Capital Natural y Medio Ambiente (2019) under contract by MARFund.

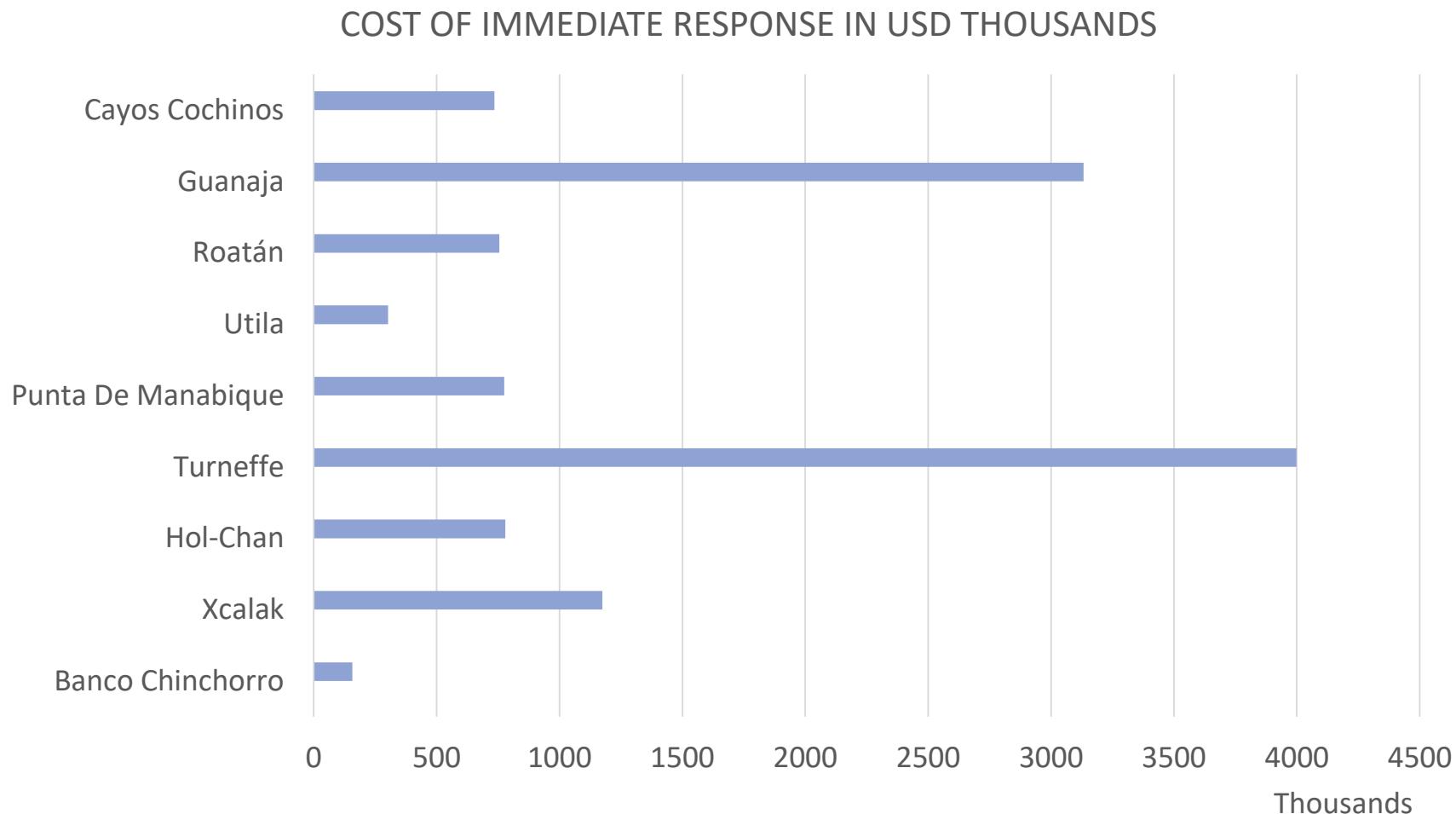
Costs of immediate response based on projected impacted area.

Costs are high and there is no capacity to implement

Site	Live Coral Cover area	USD Cost of response	USD Cost of response
	ha	25%	100%
C. Norte - Chinchorro	20.06	53,792	156,830
Las Pozas Xcalak	315.87	310,725	1,174,609
Hol-Chan	112.86	224,174	779,307
Turneffe	1,187.95	1,085,474	3,999,051
Corona cayman PM	464.12	216,204	774,841
Utila	75.70	98,220	302,579
Roatán	224.37	213,215	755,288
Guanaja	850.36	833,559	3,132,258
Cayos Cochinos	232.98	212,426	734,559
Total	3,484	3,247,790	11,809,322

Costs of immediate response based on projected impacted area

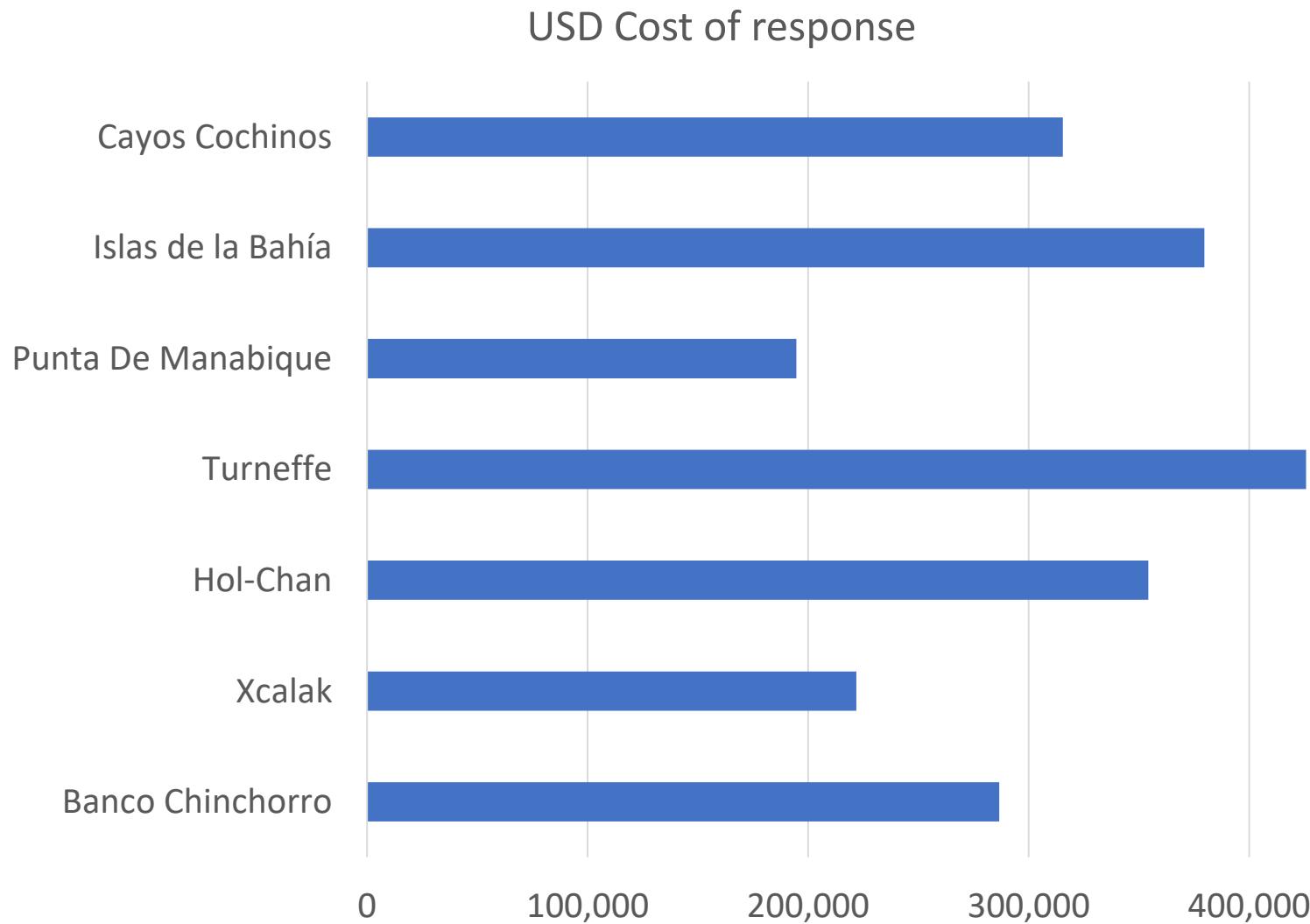
Costs are high and there is no capacity to implement



Cost of the response based on future capacity – 3 brigades per country

Site	Live Coral Cover area	Loss of live coral cover above 64kn	USD Cost of Intervention	USD Cost of Intervention
	Ha	Ha	25%	100%
Banco Chinchorro	20.06	8.02	91,016	286,602
Xcalak	315.87	126.35	69,474	221,778
Hol-Chan	112.86	45.15	118,295	354,313
Turneffe	1,187.95	475.18	142,125	425,742
Punta De Manabique	464.12	116.03	71,920	194,650
Utila	75.70	27.52	122,009	379,668
Roatán	224.37	70.58		
Guanaja	850.36	340.14		
Cayos Cochinos	232.98	93.19	105,557	315,464
Total	3,484	1,302	964,413	2,937,553

Cost of the response based on future capacity – 3 brigades per country



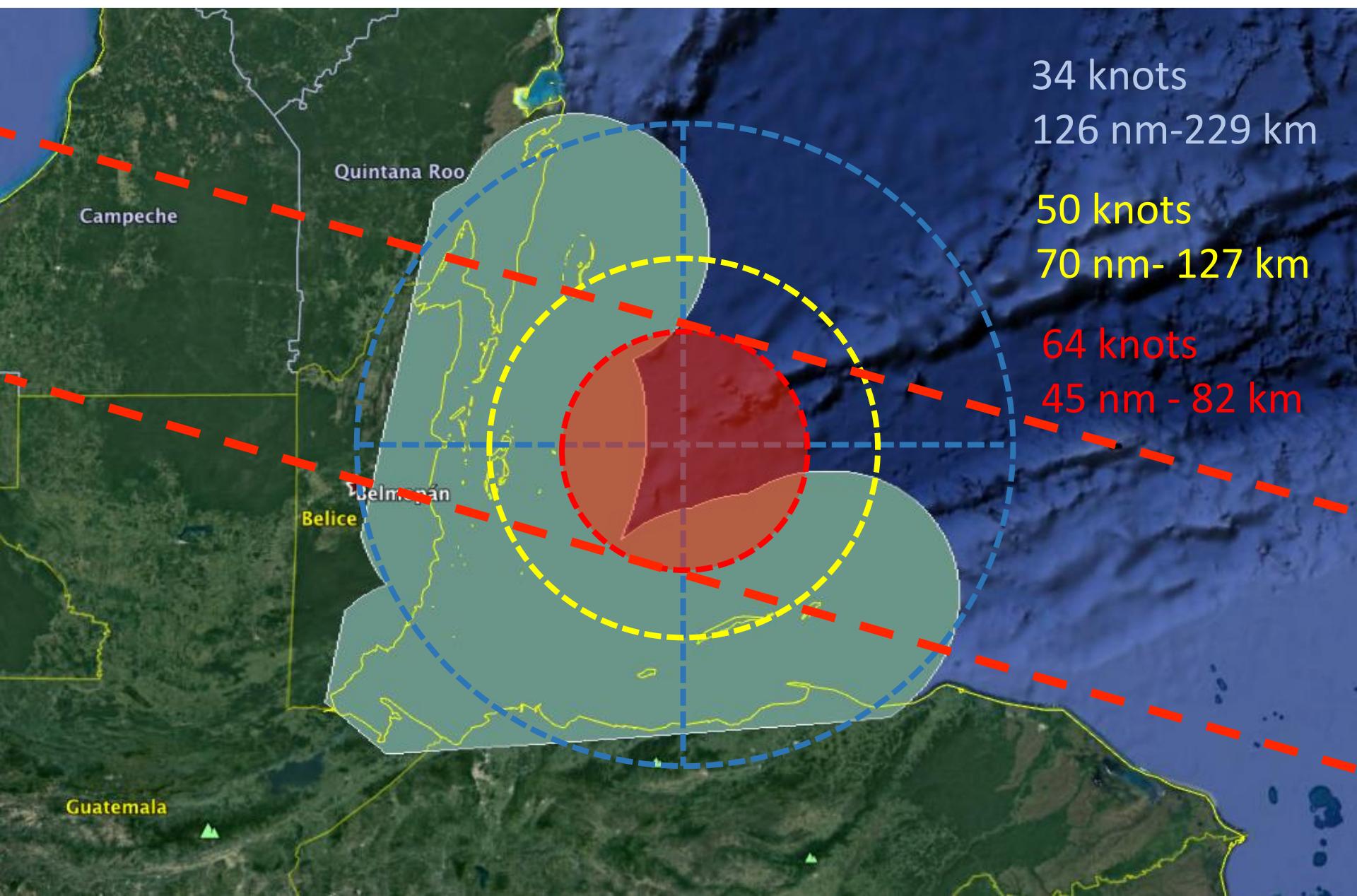
Key information to define the polygon

Extent of the hurricanes and the wind speed
around them

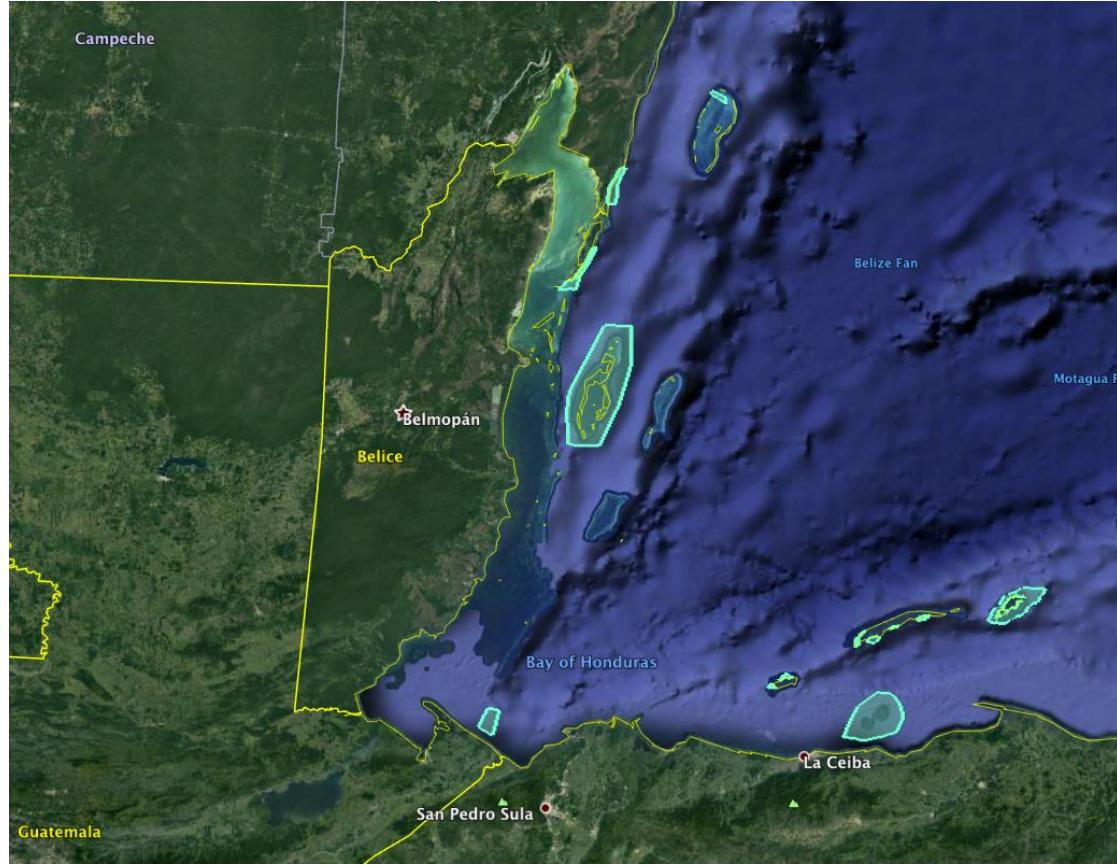
Average radius of hurricanes from center to 64 knots limit

	NE	NW	SE	SW	RADIO	
	Grupo	Promedio	Promedio	Promedio	Promedio	Promedio de promedios
64 kn	Grupo 1 (65-80)	34	33	36	31	33
	Grupo 2 (85-95)	40	31	36	27	33
	Grupo 3 (100-110)	43	37	37	29	36
	Grupo 4 (115-135)	50	43	41	31	41
	Grupo 5 (140-160)	53	49	46	31	45

Average extent of a category 3-5 hurricane.

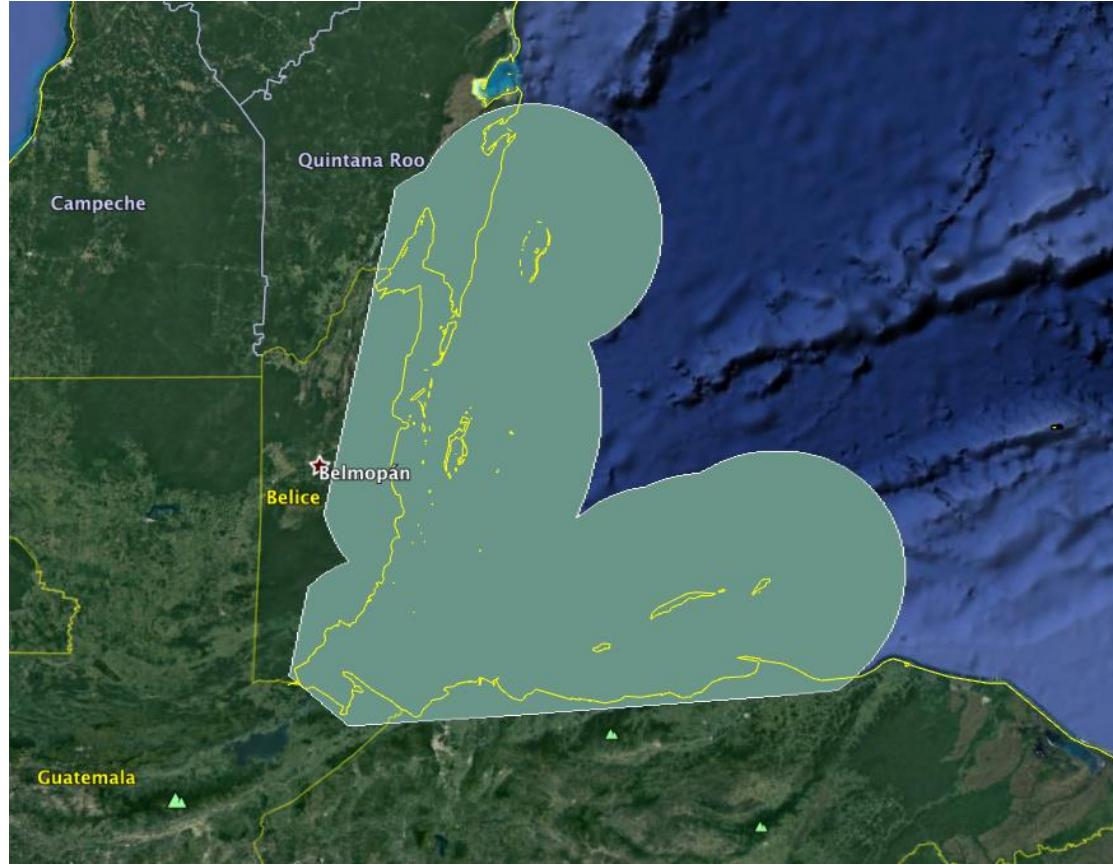


Polygon options



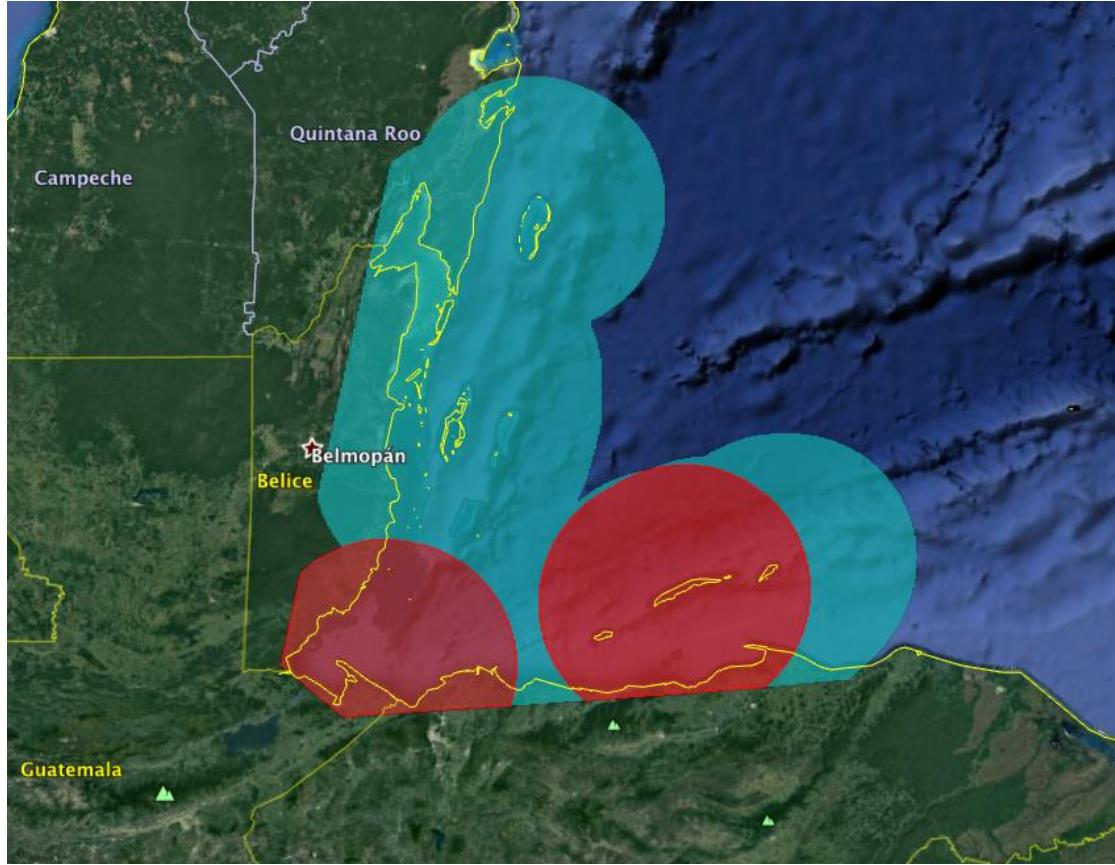
- **No buffer**
- **Parameter:** wind speed at impact
- **Trigger 1:** 64 knots
- **Trigger 2:** 50 knots for Cayman and Roatán

Option 1: Polygons are the proposed sites



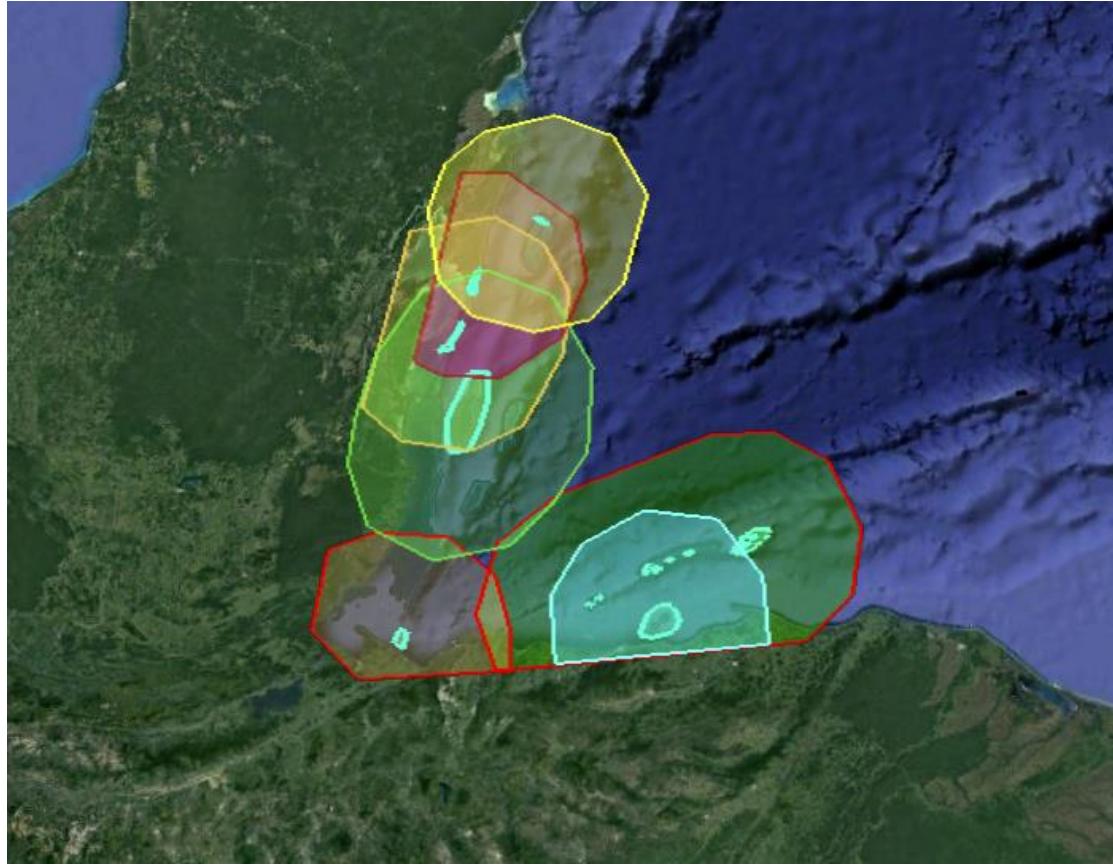
- **Buffer:** average distance from center to 64 knots wind speed
Parameter: maximum wind speed
- **Trigger:** 105 knots

Option 2:
Polygon with 45 nm (82 km) buffer



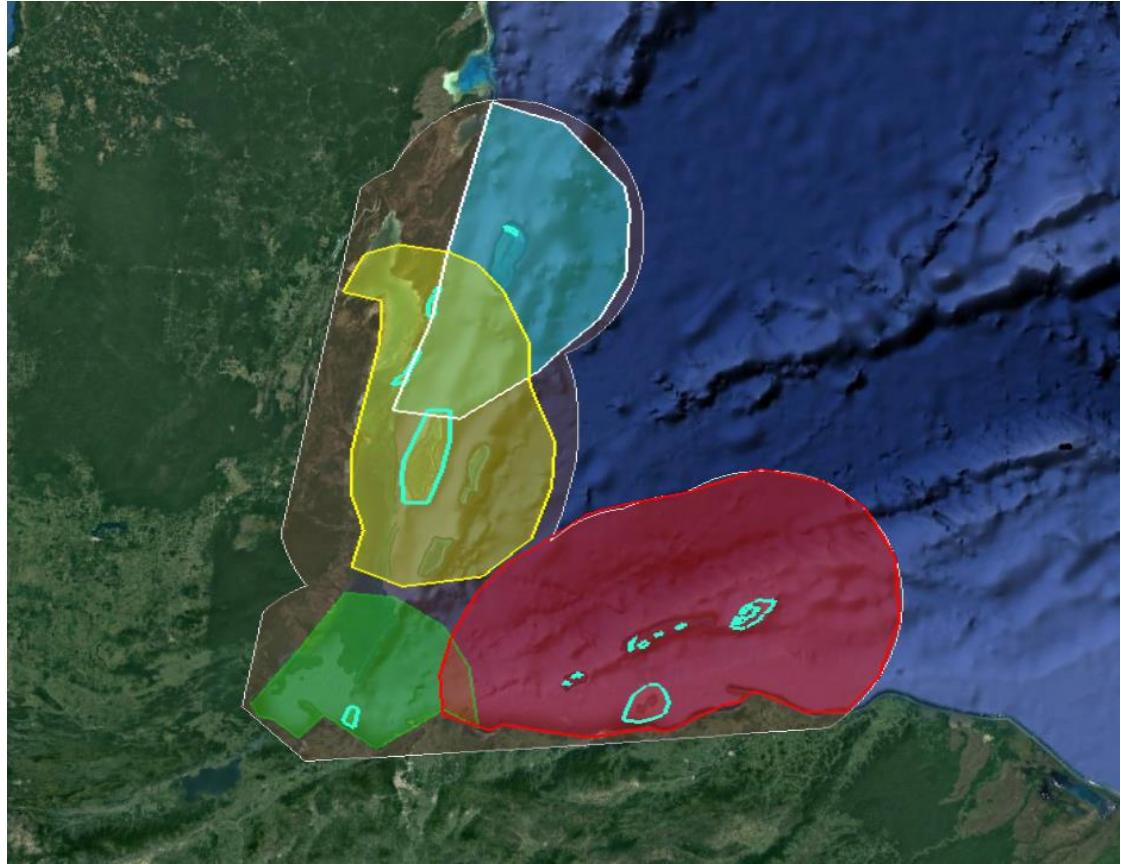
Option 3: Polygon with
45 nm buffer + polygons
for vulnerable sites

- **Buffer:** average distance from center to 64 knots wind speed
Parameter: maximum wind speed
- **Trigger 1:** 90 knots / Red polygons
- **Trigger 2:** 105 knots / Green polygon



- **Buffer:** average distance from center to 64 knots wind speed
Parameter: maximum wind speed
- **Trigger 1:** 90 knots (Corona Cayman and Roatan)
- **Trigger 2:** 105 knots

Option 4:
One polygon per site with
45 nm (82 km) buffer

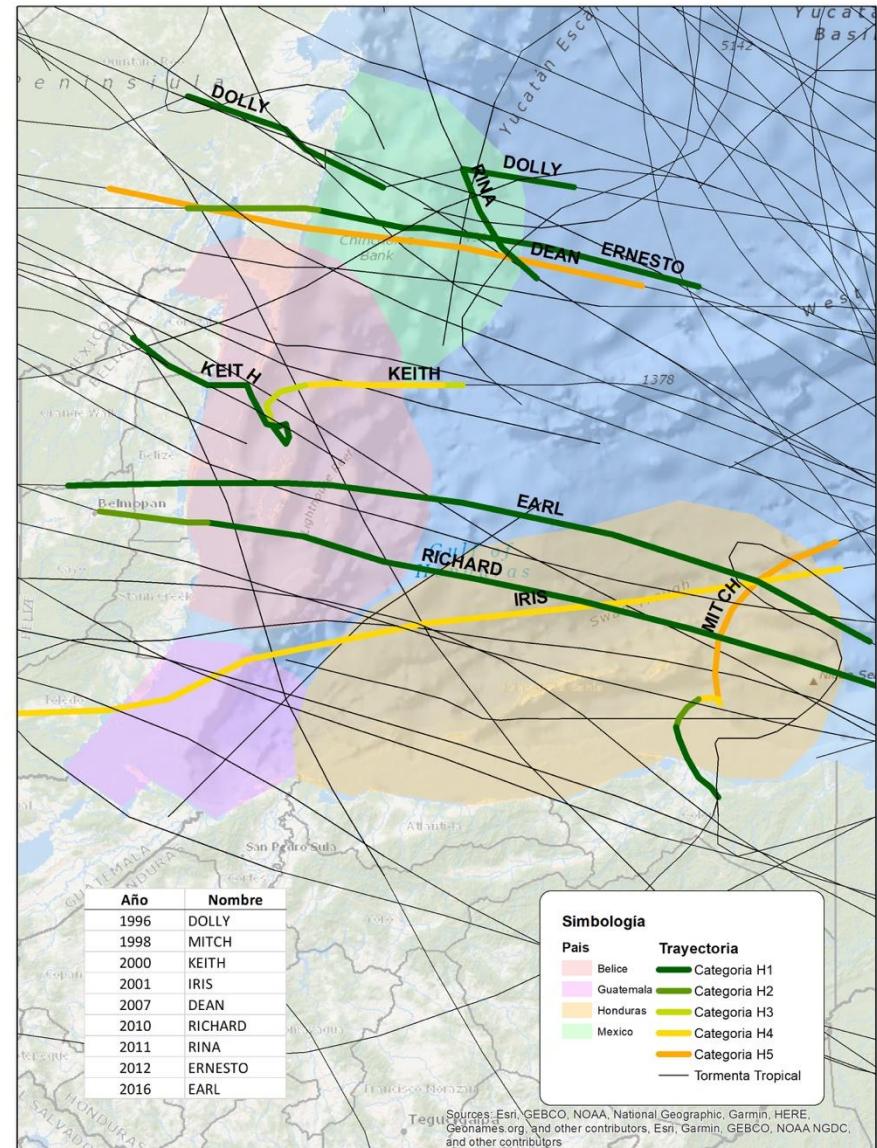
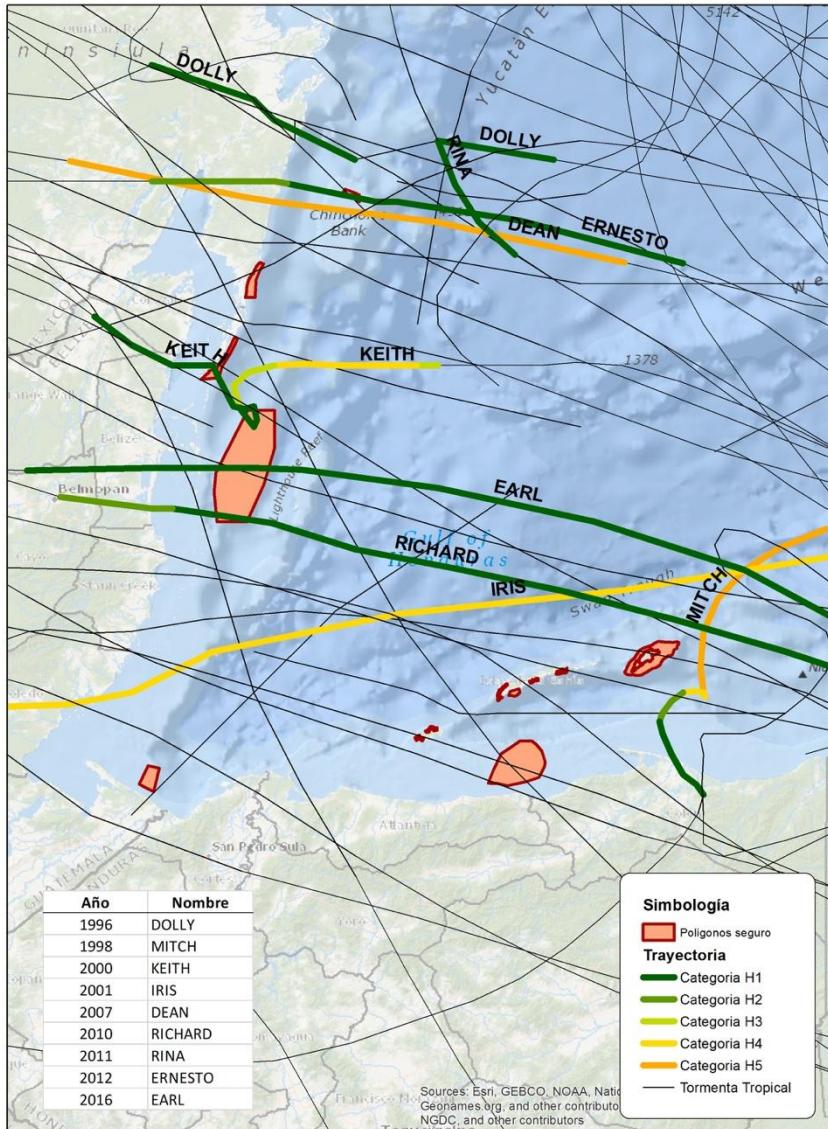


- **Buffer:** average distance from center to 64 knots wind speed
Parameter: maximum wind speed
- **Trigger 1:** 90 knots (Corona Cayman)
- **Trigger 2:** 105 knots

Option 5:
One polygon per country,
with 45 nm (82 km) buffer

Assessment of hurricanes impacting proposed polygons

Hurricanes and storms impacting the polygons. Tracks 1996-2018



Hurricanes impacting site's polygons 1996-2018

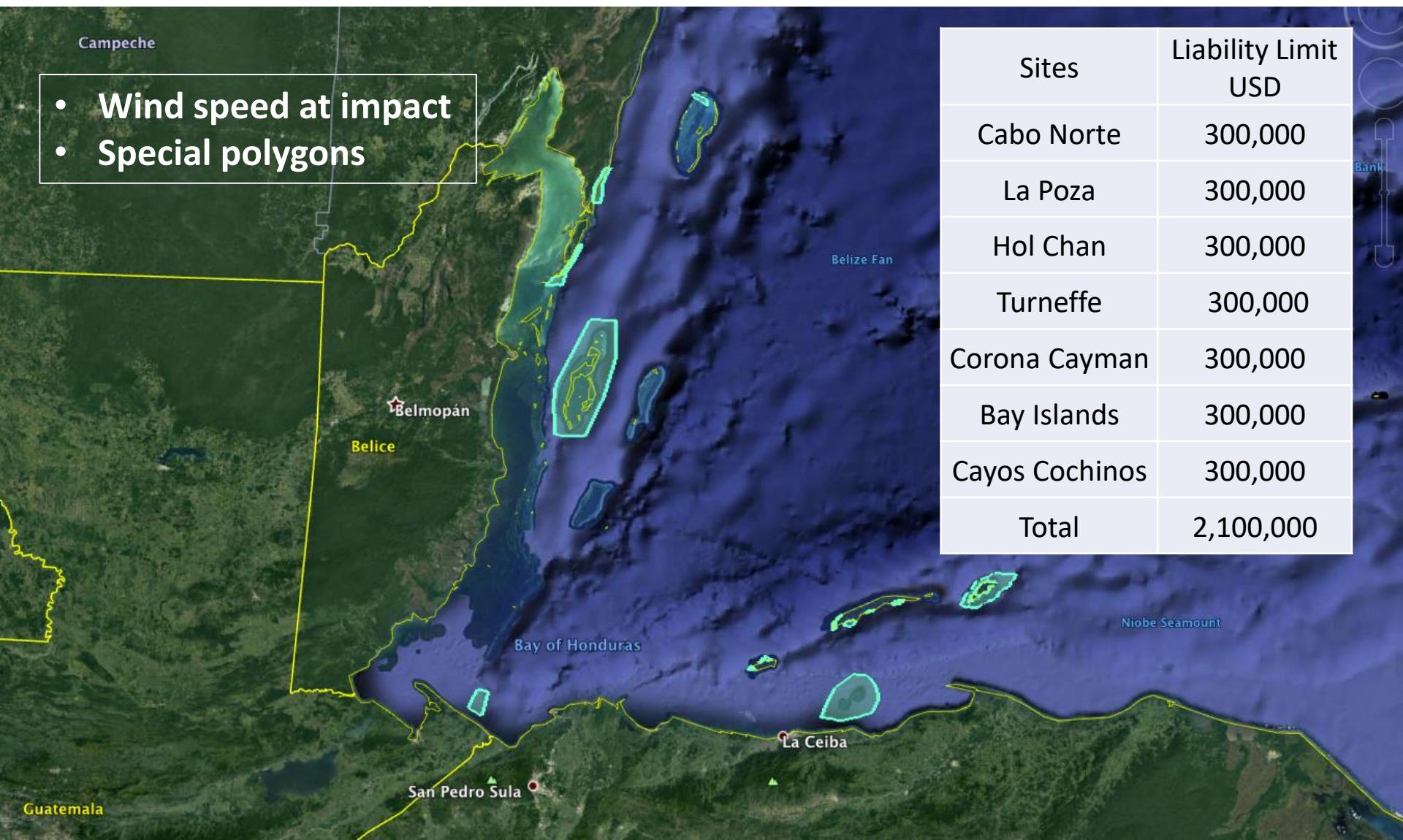
Hurricane		Maximum wind speed						
Year	Name	Cayo Norte	Las Pozas	Hol Chan	Turneffe	Islas de la Bahía	Cayos Cochinos	Cayo Corona
1996	Dolly	H5						
1998	Mitch					H5	H2	
2000	Keith		H4	H4	H4			
2001	Iris					H4	H4	H4
2007	Dean	H5	H5	H5				
2010	Richard			H1	H1	H1		
2011	Rina	H1						
2012	Ernesto	H1	H1					
2016	Earl			H1	H1	H1		

Hurricanes impacting countries polygons 1996-2018

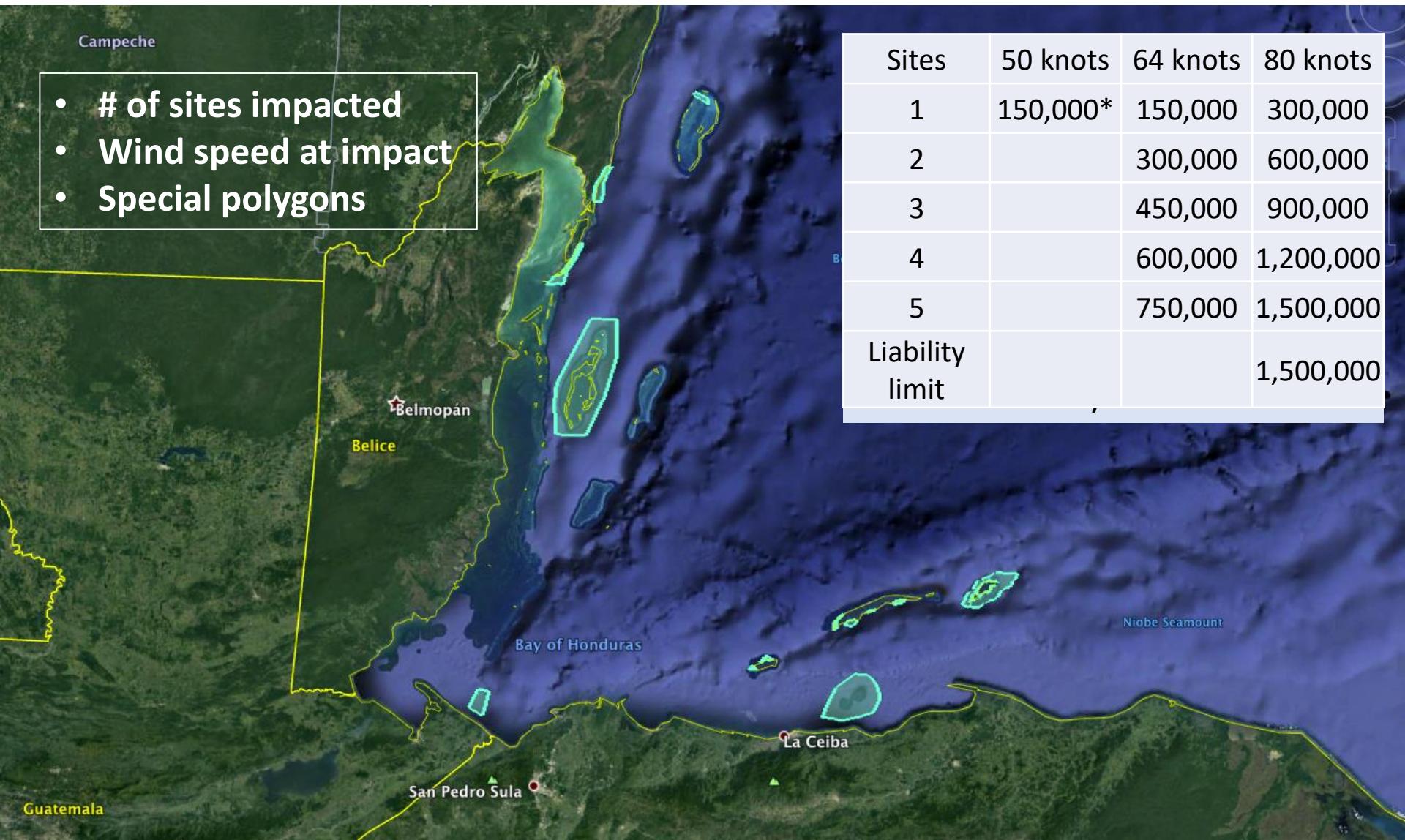
Hurricane		Maximum wind speed			
Year	Name	Mexico	Belize	Honduras	Guatemala
1996	Dolly	H1			
1998	Mitch			H5	
2000	Keith	H4	H4		
2001	Iris			H4	H4
2007	Dean	H5			
2010	Richard		H1	H1	
2011	Rina	H1			
2012	Ernesto	H1			
2016	Earl		H1	H1	

Payout options based on
different polygons,
parameters and triggers'
value

Seven policies with individual payments 64 knots and 50 knots for Corona and Roatan

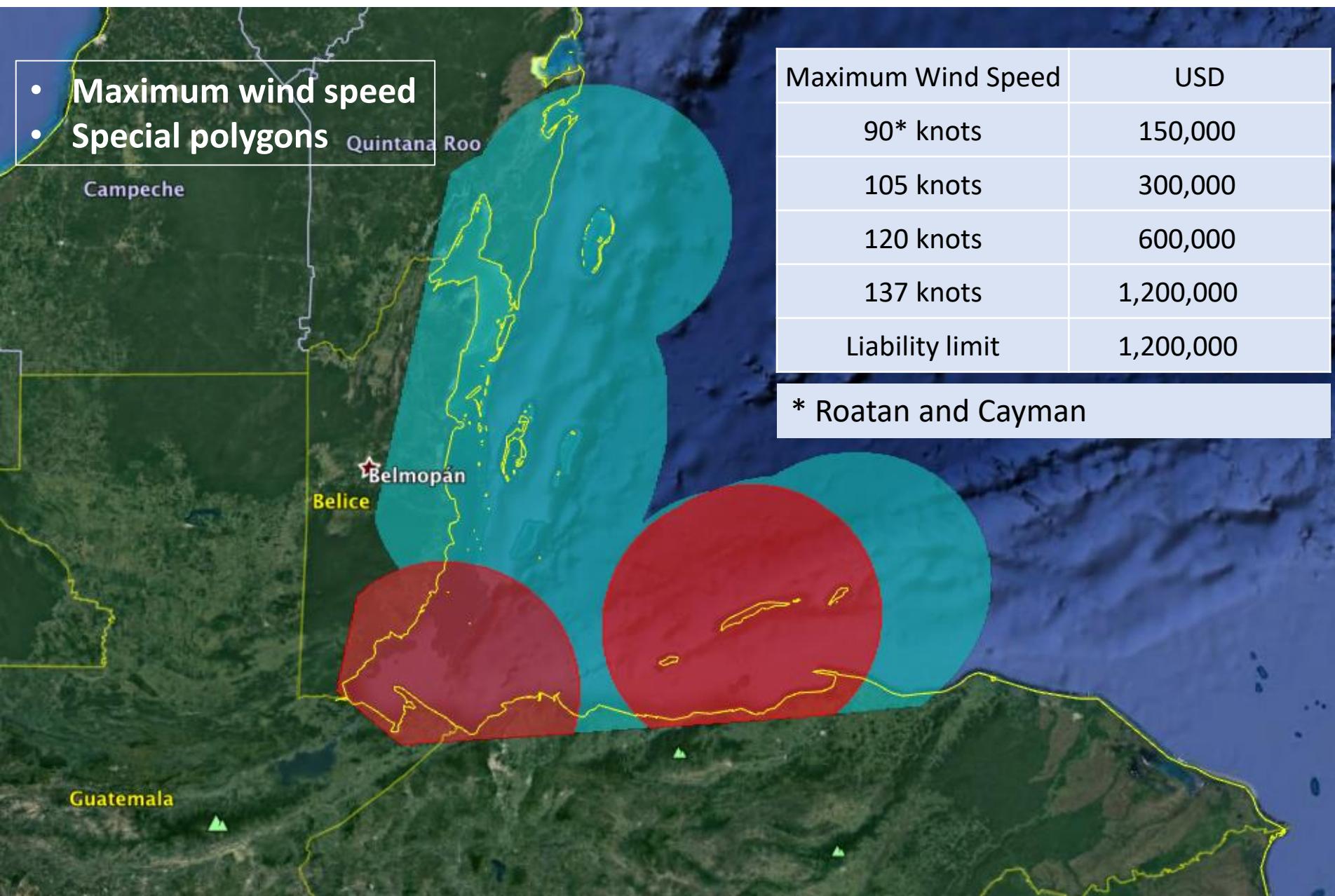


One policy, mutualized risk, payout with combined parameters

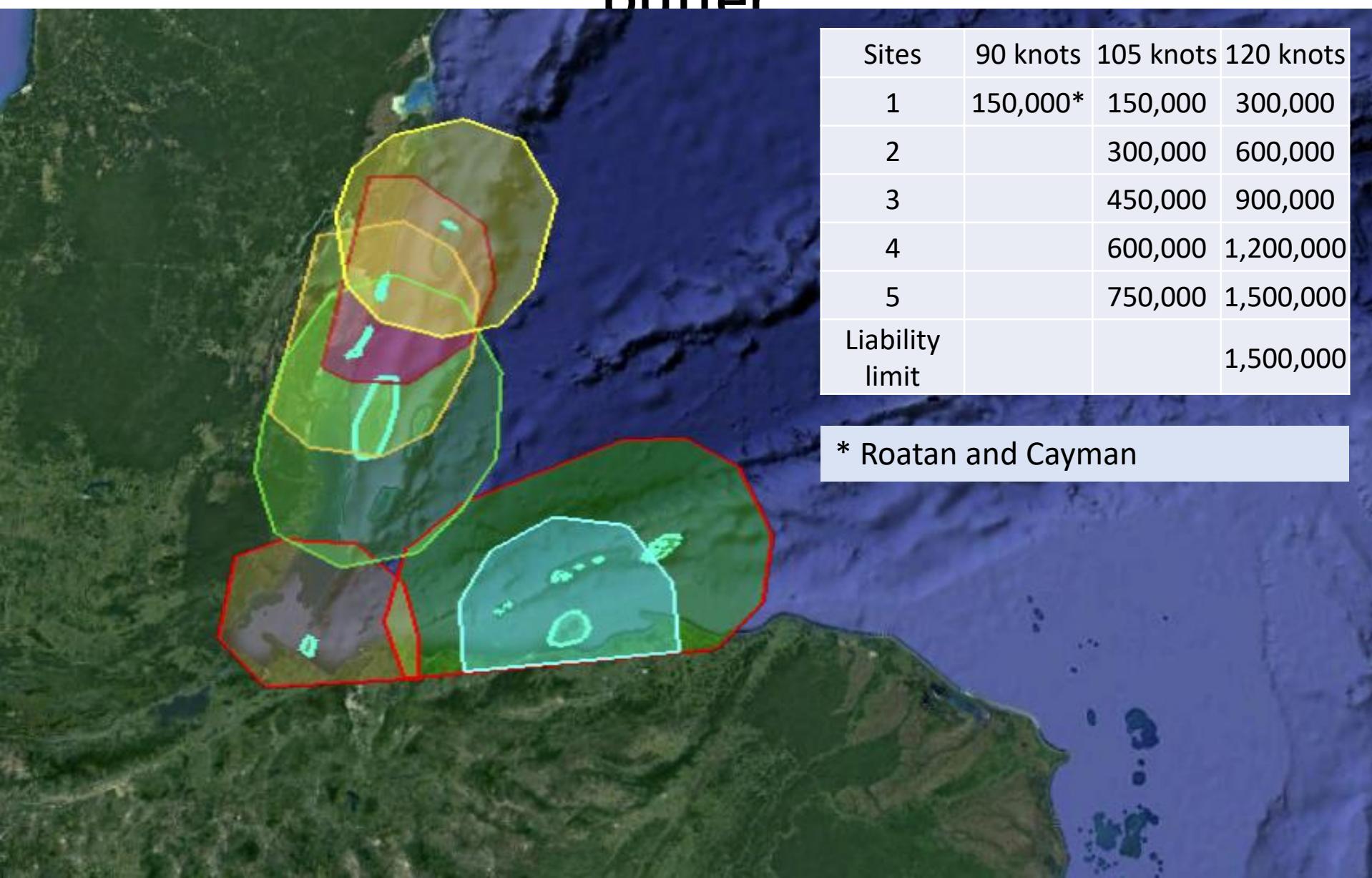


Payout increases with intensity

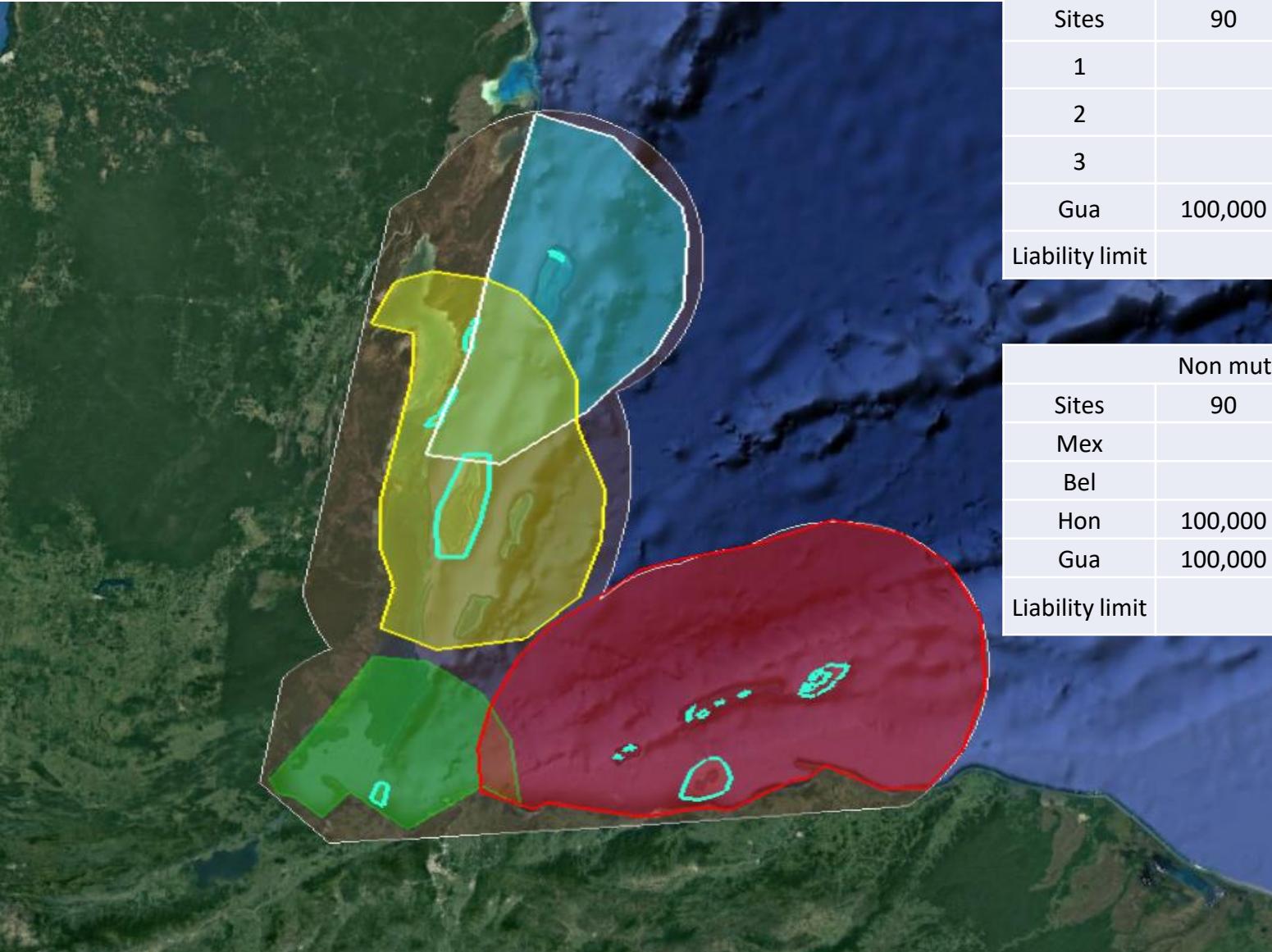
- Maximum wind speed
- Special polygons



Option: One polygon per site with 45 nm (82 km) buffer



One policy, mutualized risk, payout with combined parameters



Mutualized risk			
Sites	90	105	120
1		300,000	500,000
2		600,000	1,000,000
3		900,000	1,500,000
Gua	100,000	150,000	250,000
Liability limit			1,500,000

Non mutualized risk			
Sites	90	105	120
Mex		300,000	500,000
Bel		300,000	500,000
Hon	100,000	300,000	500,000
Gua	100,000	150,000	250,000
Liability limit			1,750,000

Criteria to assess options and select the most appropriate

Cost of the policy (% of payout)

Limit of liability enough to cover the needs

Easiness to distribute the cost and funds of the policy among stakeholders

Probability of a triggering event

Mutualization of risk