ASSESSMENT OF FLOOD RISK BOCA BARRANCO BEACH, CANARY ISLANDS, SPAIN

GUILHERME CLARINDO MARCOS[1]; GERMAN RODRIGUEZ RODRIGUEZ[1]; CONCEIÇÃO JUANA FORTES[2]; MARIA TERESA REIS[2] & JAVIER SANTANA CEBALLOS[1]

[1] FIMATA – Fisica Marina y Teledeteccion Aplicada - Departamento de Física – ULPGC

[2] LNEC / DHA – Laboratorio Nacional de Engenharia Civil – Lisboa, Portugal – Departamento de Hidraulica e Ambientes

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1.INTRODUCTION

1.1 Objectives

The present study aims to evaluate the occurrence of phenomena such as floods and overtopping on beaches as well as infrastructures existing in Boca Barranco Beach.

1.2 . Methodology

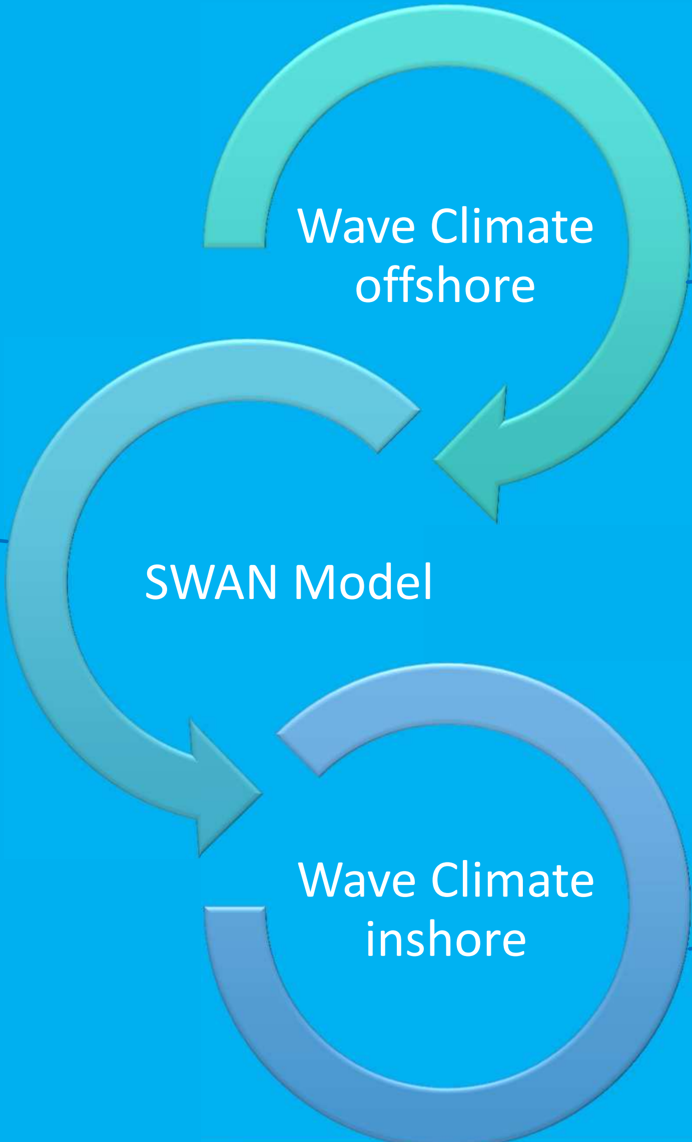
Inshore Wave climate characterization

Empirical models for wave run-up

Coastal flood risk assessment

Wave climate determination

Spectral model of wave climate propagation (Booij et al. 1999)



HINDCAST DATA
(22 YEARS)

Hs - significant height
Tp – peak period
Dm – mean direction

- Hs_p
- Tp_p
- Dm_p

Inshore Wave climate characterization

Empirical models for wave run-up

Coastal flood risk assessment

AUTORES	RUN- UP, R
Hunt (1959)	$R_{2\%} = \tan\beta * (H * L_0)^{0.5}$
	$R_{2\%} = 3 * H$
Holman (1986)	$R_{2\%} = H_0 * (0.83 * \xi_0 + 0.20)$
	$R_{2\%} = H_s * (0.78 * \xi_s + 0.20)$
Nielsen & Hanslow (1991)	$R_{2\%} = L_{RU} (-\ln(0.02))^{0.5}$
	$L_{RU} = 0.6 * \tan\beta * (H_{orms} L_0)^{0.5}$
	$L_{RU} = 0.05 * (H_{orms} * L_0)^{0.5}$
Stockdon *et al.* (2006)	$R_{2\%} = 0.043 * (H_0 L_0)^{0.5}$
	$R_{2\%} = 1.1 * (0.35 * \tan\beta * (H_0 L_0)^{0.5} + [(H_0 L_0 (0.563 * (\tan\beta)^{0.5} + 0.004))^{0.5}]/2)$
Teixeira (2009)	$R_{máx.} = 0.80 * H_s + 0.62$
	$R_{máx.} = 1.08 * H_s * \xi_0$
Ruggiero *et al.* (2001)	$R_{2\%}\ 0.27 * (\tan\beta * H_0 L_0)^{0.5}$
	$R_{2\%} = 0.5 * H_0 - 0.22$
Guza & Thornton (1982)	$R_s = 0.71 * H_0 + 0.035$

Once the models are applied in the desired coastal area

flooding level (referred to the hydrographic zero)

FL = ST + SS + Rmax

Astronomical Tides + Storm Surge + Results of models

Tide-gauge records of "Puertos del Estado"

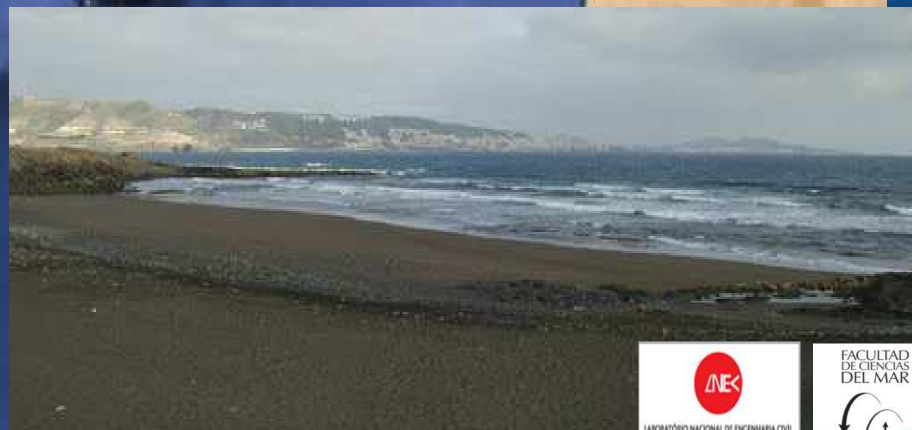
Inshore Wave climate characterization

Empirical models for wave run-up

Coastal flood risk assessment

Risk Assessmet

2.STUDY AREA



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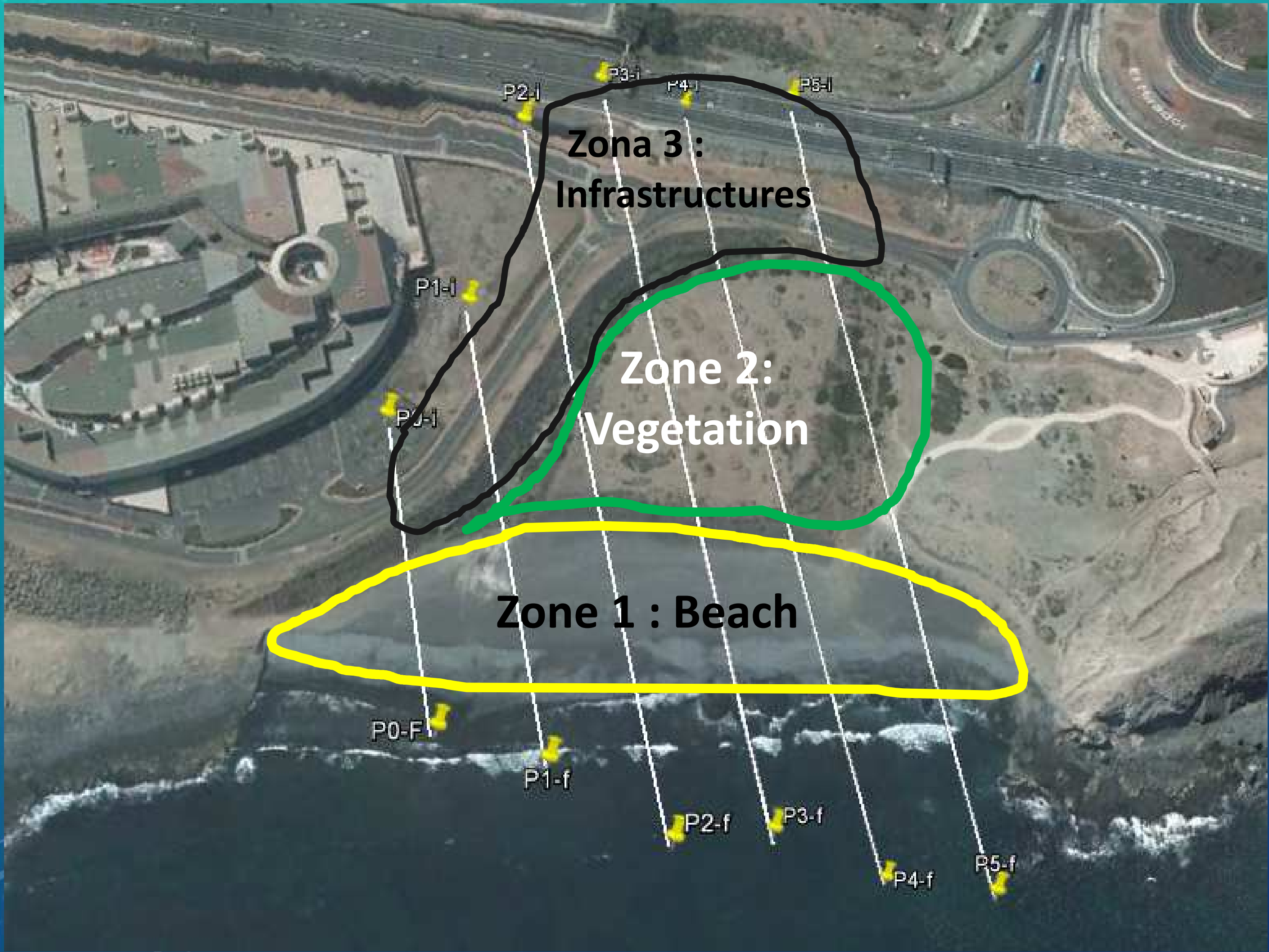
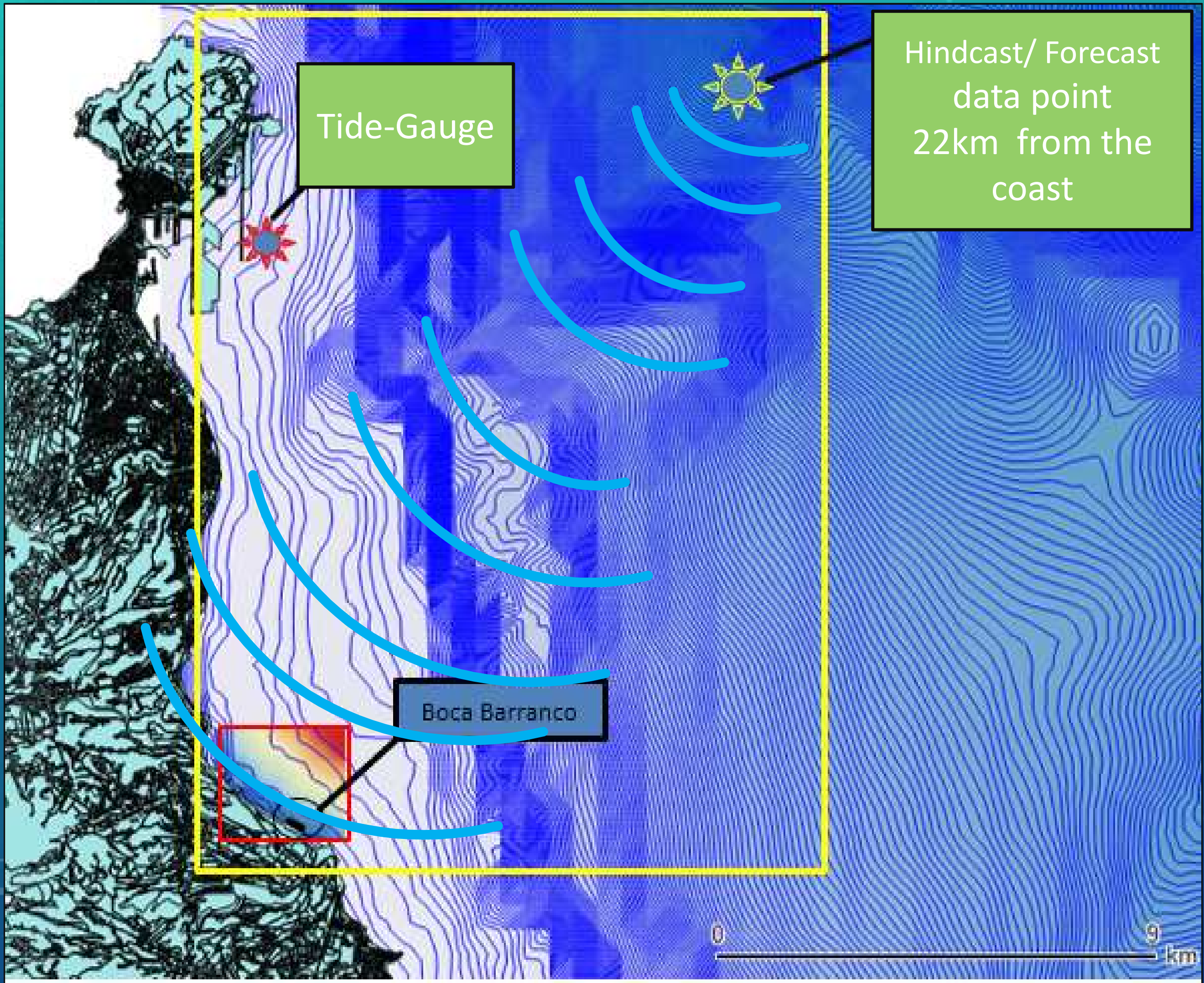
2.1 Profiles



6 PROFILES

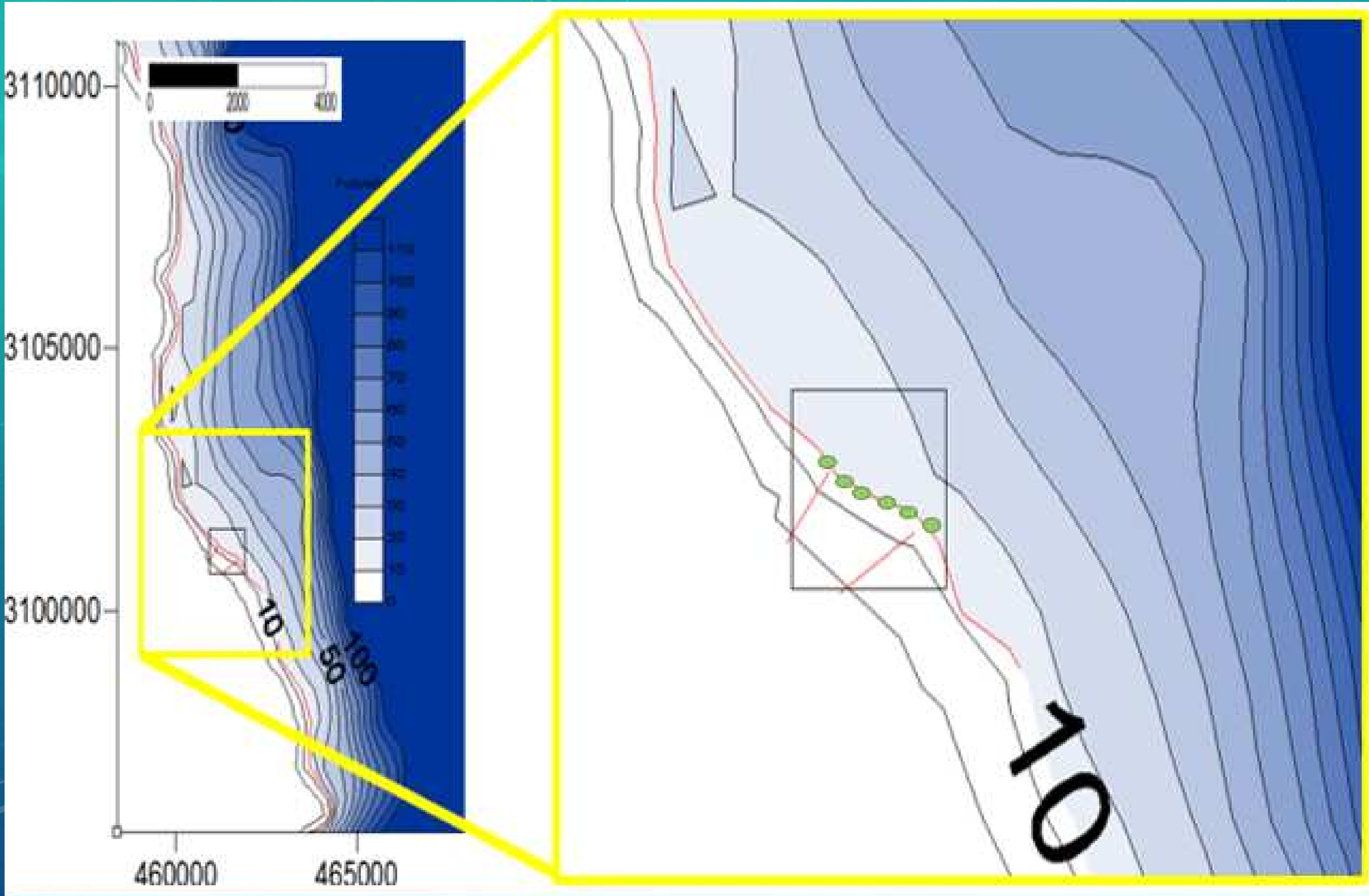
Crossing 3 case studies

3.WAVE CLIMATE



3.1 Baseline data and Wave propagation

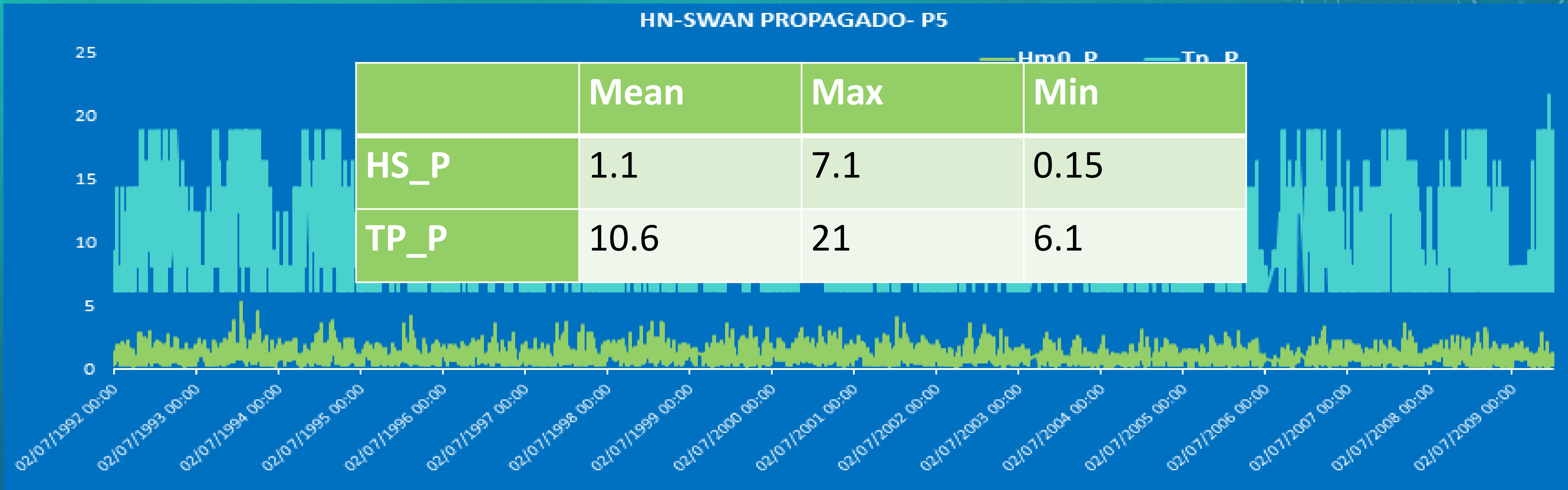
SWAN MODEL



SWAN OUTPUTS
Study points in front of the beach (6 points)

Depth = -10m
Before Surf zone

3.2 Results of the propagation



	Mean	**Max**	**Min**
HS_P	1.1	7.1	0.15
TP_P	10.6	21	6.1

4.EMPIRICAL MODELS

4.1Run-up Calculations and flood level

Authors and *RUN-UP models*

- Wave climate in offshore zone = Hm0, Tp, Dm
- Wave climate in inshore zone = Hm0, Tp, Dm
- The slope of the beach face (profile) = β

Authors	Run- up, R
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EMPIRICAL MODELS RESULTS

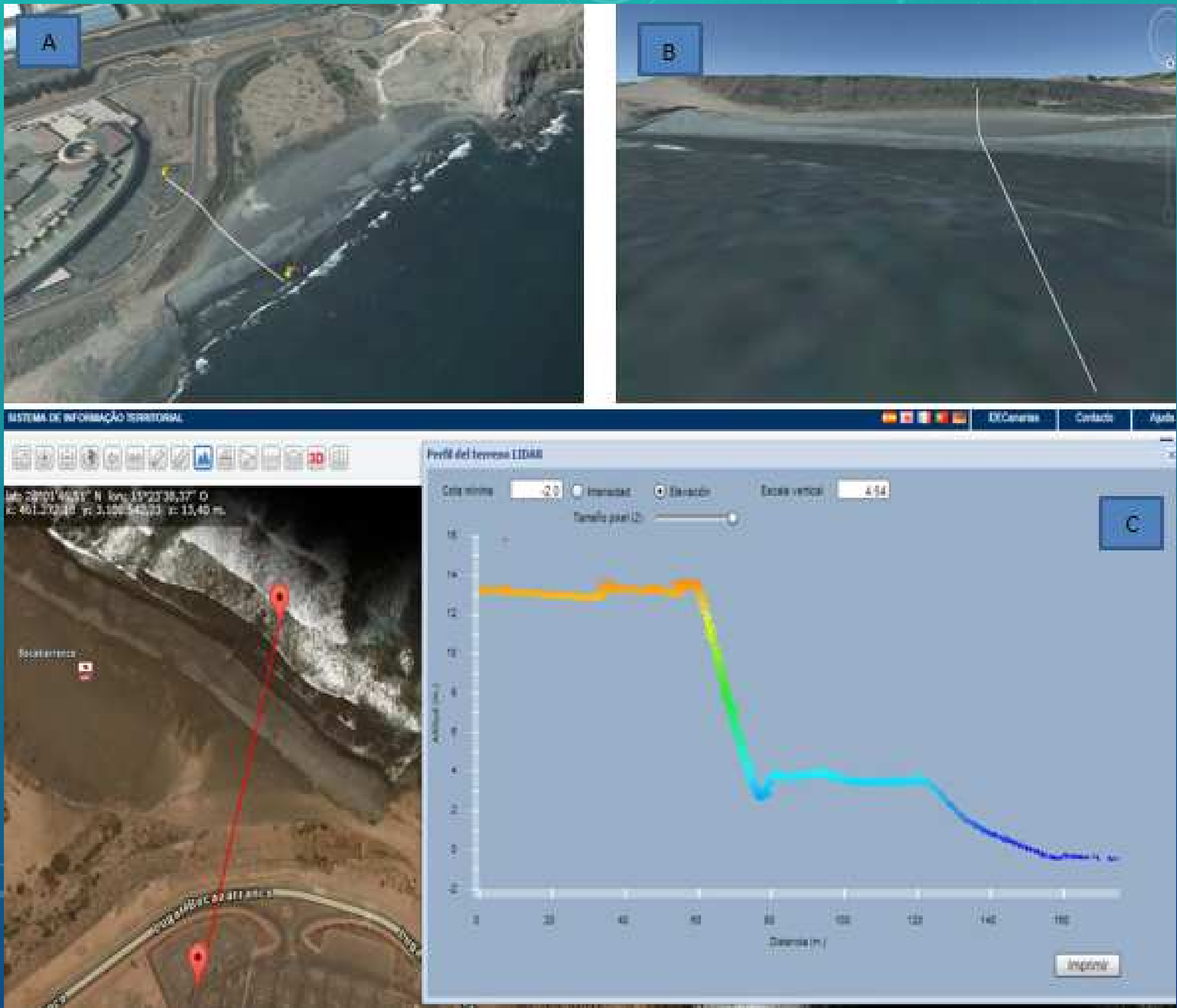
Expected as Hunt formulated his scale model tank with a waterproof base and regular waves.

R_{max} P0	Mean	Maximum	Minimum
Hunt (1959)	~~2.205~~	12.61	0.5
Holman (1986)	1.162		
Stockdon et al. (2006)	~~3.258~~		
Nielsen et al. (1991)	1.180	3.465	0.313
Ruggiero et al. (2001)	1.001	3.643	0.271
Guza et al. (1982)	1.246	7.771	0.219
Teixeira 1 (2009)	1.504	6.341	0.743
Teixeira 2 (2009)	1.220	3.434	0.33

The developing empirical formulas take into account the type of beach. However, the beach does not meet the conditions of application.

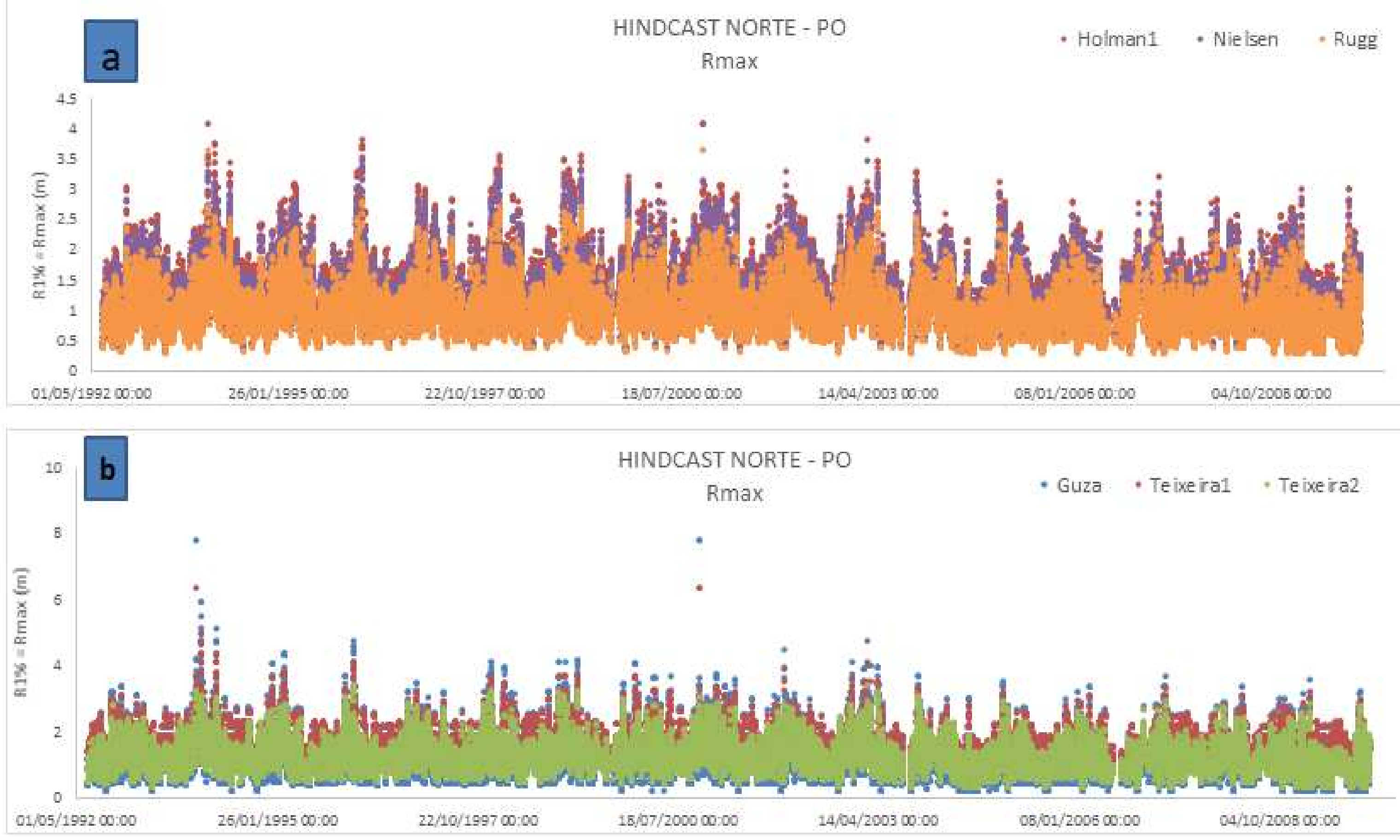
These models were rejected to calculate the flood level.

6 empirical models to test the flood level.



FLOOD LEVEL CALCULATION IN THE BEACH

PROFILE 0 TO EXAMPLE

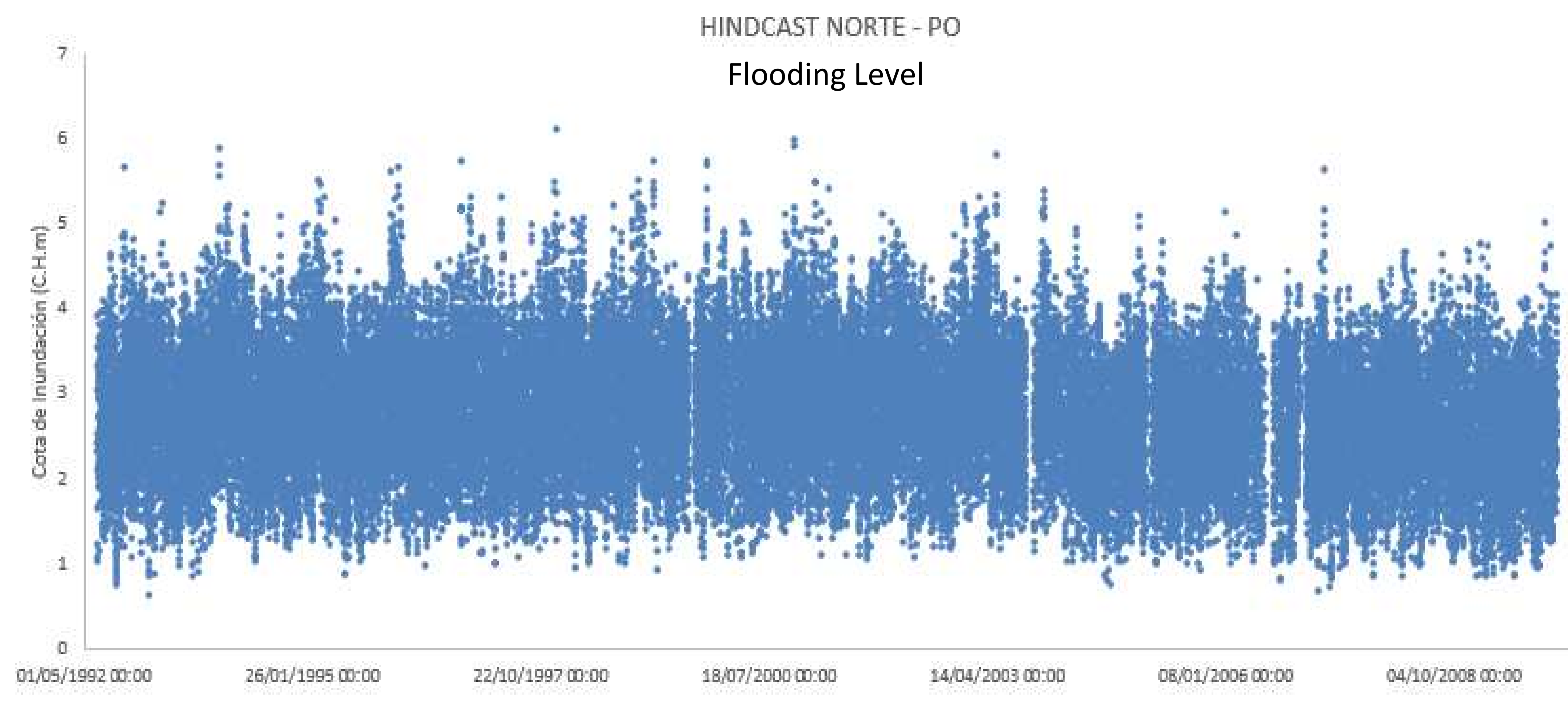


Flooding level (referred to the hydrographic zero)

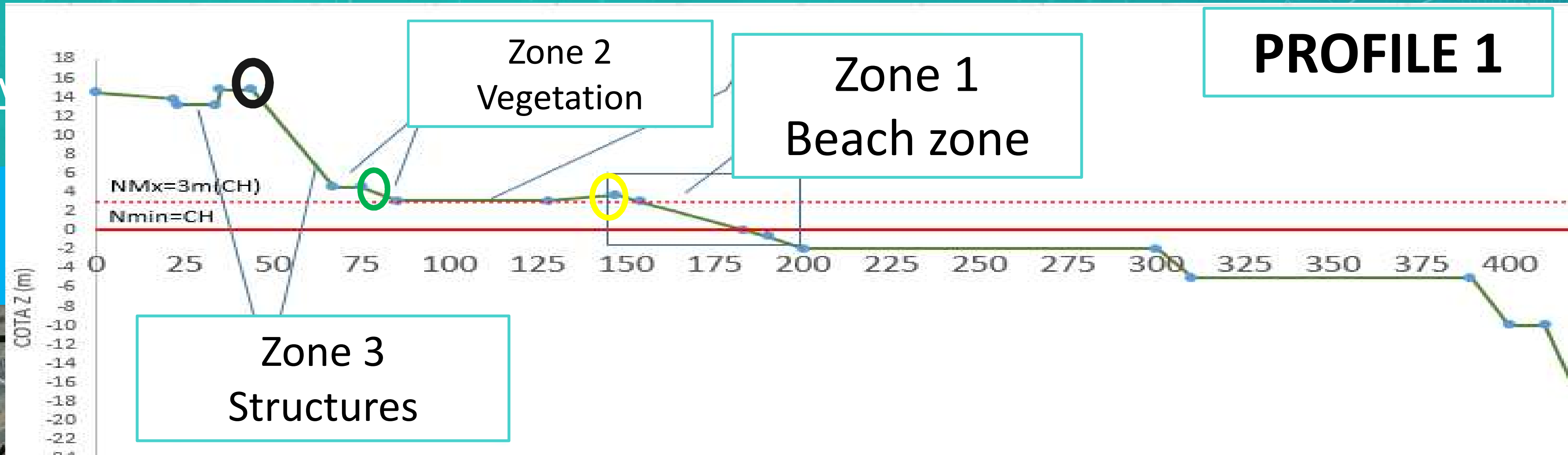
FL = ST + SS + Rmax

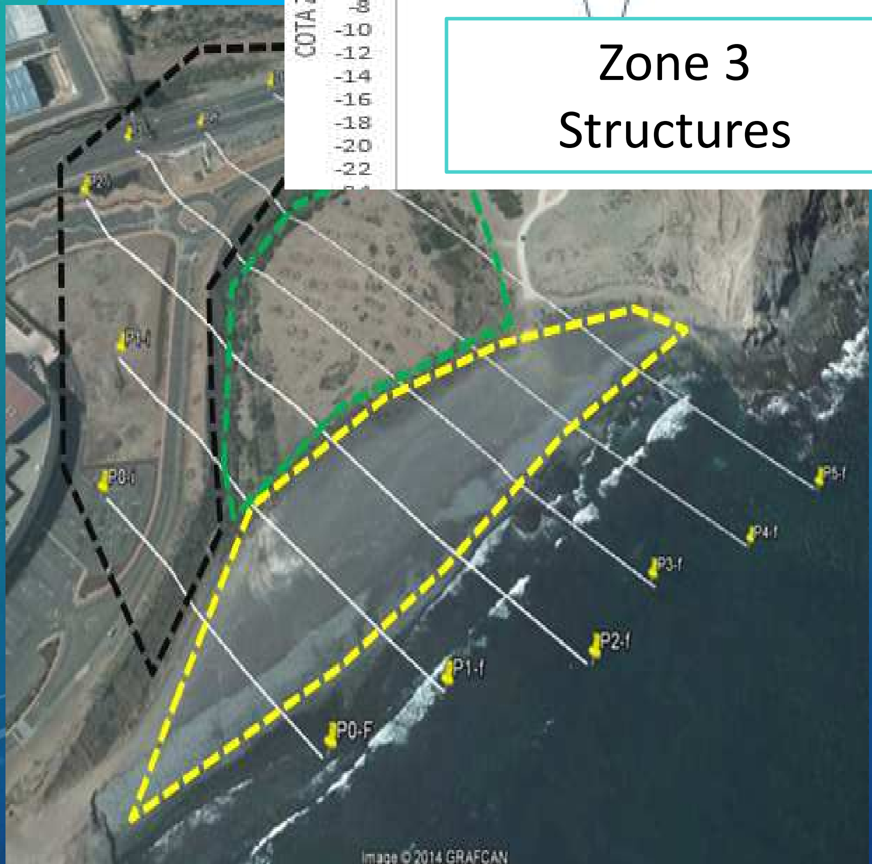
Astronomical Tides + Storm Surge + Results of models

Flood Level calculation



5. RISK A





Definition of flood level values			
Profile	***Zone 1 Beach***	***Zone 2 Vegetation***	***Zone 3 Infrastructures***
P0	3.5	-	14
P1	3	3.4	14.8
P2	3	3.8	15
P3	3	4	15.3
P4	3	5.8	14.8
P5	3	5.1	9

P1	C.I
Número de eventos	47452
Número de eventos que ultrapassam - 3m (zona ocio) - caso 1	16374
Número de eventos que ultrapassam - 3.4m – (Poca Vegetación) - caso 2	8258
Número de eventos que ultrapassam - 14.8 (Infra-estructuras) - caso 3	0
Probabilidad de ocurrencia (%) - caso 1	34.51
Probabilidad de ocurrencia (%) - caso 2	17.40
Probabilidad de ocurrencia (%) - caso 3	0
Grado de probabilidad de ocurrencia - caso 1	3
Grado de probabilidad de ocurrencia - caso 2	3
Grado de probabilidad de ocurrencia - caso 3	1

Number of events

Exceeding values

5.1 Probability of occurrence

Description	Probability of Occurrence (22 years)	Degree
UNLIKELY	0 – 3%	1
RARE	3 – 15%	2
OCCASIONAL	15 – 35%	3
PROBABLE	35 – 60%	4
FREQUENT	> 60%	5

Probability of occurrence degree

Raposeiro, P. D., & Ferreira, J. C. (2011)

5.2 CONSEQUENCES

Description	Consequence (Indicative script)	Degree
INSIGNIFICANT	Stable geological, natural sand beach, busy casual leisure premises and reduced ecological value.	1
CONSIDERABLE	Weak geological features, or possessing any shrub vegetation, areas of frequent leisure type.	2
VERY SERIOUS	Coastal protection infrastructure; relevant economic activities; very weak and unstable geological vegetation.	5
SEVERE	Permanent human occupation (urban areas); natural elements of great ecological value that are difficult to recover.	10
CATASTROPHIC	Permanent human occupation; absolutely unique areas with a great historical / natural value where the loss is irretrievable; beach-dune system.	25

Raposeiro, P. D., & Ferreira, J. C. (2011)

P1	C.I
Número de eventos	47452
Nún	[illegible]
Nún	[illegible]
Nún	[illegible]
Probabilidad de ocurrencia (%) - caso 1	34.51
Probabilidad de oc	17.40
Probabilidad de oc	[illegible]
Grado de probabili	[illegible]
Grado de probabilidad de ocurrencia - caso 2	3
Grado de probabilidad de ocurrencia - caso 3	1
Grado de consecuencia - caso 1	1
Grado de consecuencia - caso 2	5
Grado de consecuencia - caso 3	5
Grado de Riesgo - caso 1 (Grado de la Probabilidad x Grado de Consecuencia)	3
Grado de Riesgo - caso 2 (Grado de la Probabilidad x Grado de Consecuencia)	15
Grado de Riesgo - caso 3 (Grado de la Probabilidad x Grado de Consecuencia)	5
Aceptabilidad - caso 1	Insignificante
Aceptabilidad - caso 2	Indeseable
Aceptabilidad - caso 3	Reducido

INSIGNIFICANT — **Stable geological, natural sand beach, busy casual leisure premises and reduced ecological value.**

VERY SERIOUS — **Coastal protection infrastructure; relevant economic activities; very weak and unstable geological system and important vegetation.**

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Grado de Riesgo - caso 2 (Grado de la Probabilidad x Grado de Consecuencia)	15
Grado de Riesgo - caso 3 (Grado de la Probabilidad x Grado de Consecuencia)	5
Aceptabilidad - caso 1	Insignificante
Aceptabilidad - caso 2	Indeseable
Aceptabilidad - caso 3	Reducido

Risk Degree		Consequences				
		1	2	5	10	25
Probability of occurrence	1	1	2	5	10	25
	2	2	4	10	20	50
	3	3	6	15	30	75
	4	4	8	20	40	100
	5	5	10	25	50	125

Intersection matrix

Risk Degree = Probability of occurrence X Consequences

Acceptability

Risk Degree	Description	Risk Control
1-3	Insignificant	Negligible risk; not necessary to carry out risk control measures.
4-10	Reduced	Risk can be considered acceptable / tolerable if you select a set of measures to control the possible damage in a small zone.
15-30	Undesirable	Risk to be avoided if reasonably practical; requires detailed research and cost-benefit analysis; monitoring is essential.
40-125	Unacceptable	Intolerable risk; control of risk required (eg Remove the source of risks, alter the probability of occurrence or consequences, risk transfer, etc.).

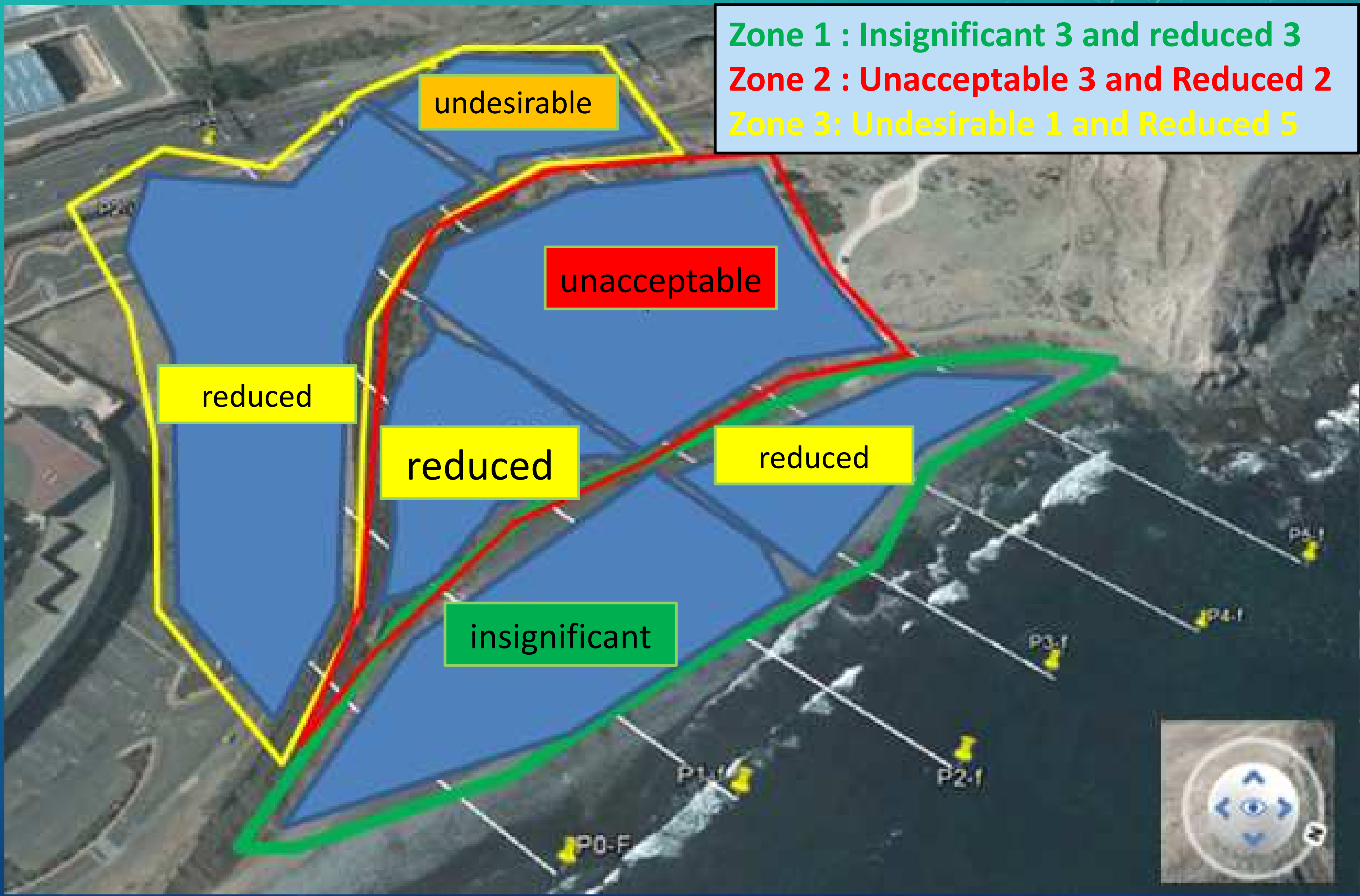
RESULTS

Prepare risk maps
to improve management

Zone 1 : Insignificant 3 and reduced 3
Zone 2 : Unacceptable 3 and Reduced 2
Zone 3: Undesirable 1 and Reduced 5

Profiles	*Zone*	*Risk Dregree*	*Acceptability*
P0	1	3	insignificant
			-
	3	5	reduced
P1	1	3	insignificant
	2	30	undesirable
	3	5	reduced
P2	1	3	insignificant
	2	10	reduced
	3	5	reduced
P3	1	4	reduced
	2	50	unacceptable
	3	5	reduced
P4	1	5	reduced
	2	50	unacceptable
	3	5	reduced
P5	1	5	reduced
	2	50	unacceptable
	3	25	undesirable

Risk Maps


Zone 1 : Insignificant 3 and reduced 3
Zone 2 : Unacceptable 3 and Reduced 2
Zone 3: Undesirable 1 and Reduced 5
undesirable
unacceptable
reduced
reduced
reduced
insignificant
P5-f
P4-f
P3-f
P2-f
P1-f
P0-F

6. CONCLUSION

The study identified:

- Zone 1 is occasionally flooded. Risk is insignificant or reduced.
  - *The most frequently flooded area is the beach zone (1), which does not present any risk.*
- Zone 2 is occasionally flooded. Risk is reduced for profiles 1 and 2.
  - 3, 4, and 5 is occasionally flooded and risk is unacceptable.
- Zone 3 is unlikely flooded and risk is reduced for profiles 0, 1, 2, and 3.
- Zone 3 is unlikely flooded and risk is undesirable for profiles 4 and 5.
  - *The area with lower probability of inundation is zone 3, but risk level is undesirable in the area including infrastructures.*
- *As a result of this, overtopping is not shown in the structures.*

THANK YOU VERY MUCH