European Geosciences Union
General Assembly 2012
Vienna | Austria | 22 – 27 April 2012

Modeling extreme beach retreat and erosion volumes. A tool for susceptibility analysis

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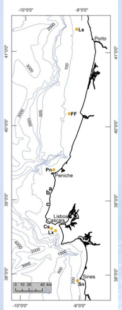
1. Introduction

Beaches are among the most dynamic systems in the coastal zone. This is due to the great variability in the main triggering factors that contribute to morphological change. Dramatic coast line retreat can occur in a short period of time due to episodic extreme wave events endangering people and property and therefore defining the local susceptibility to erosion. This research aims to determinate beach recession and volume erosion due to sediment loss during extreme wave events in non artificialized beaches of the Portuguese west coast, for susceptibility analysis.

2. Study area

The central west coast of Portugal is a wave dominated high energetic coastal environment. Storm frequency and magnitude are very important features on the definition of the annual local sediment budget and on the anthropogenic elements exposure to the direct action of waves through momentary or permanent coastline retreat.

Winter offshore mean significant wave values reach 2.5m and waves with a 5 year recurrence period can be higher than 9m.



3. Methodology:

(i)Morphodynamic data – 3 yr of beach profilling (2004 – 2007);

(ii)Sediment sampling in the most active sector of the beach profile and lab treatmente for granulometric analysis;

(iii)Offshore wave data processing;

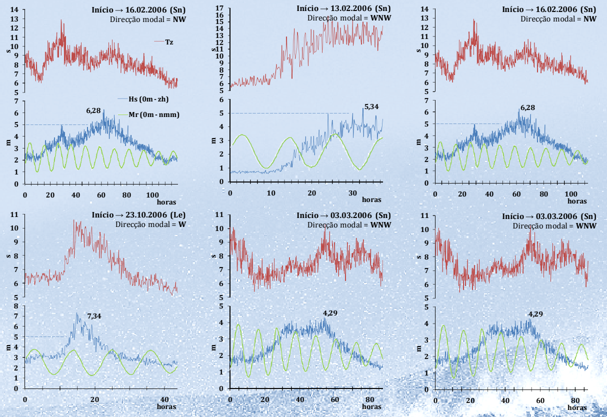
(iv)Storm surge values determination;

(v)Extreme volumetric predicted values (H_s^{R100}) based on SBEACH modelling.

4. Parametrization

(i) H_s ;
(ii) Spring tide mean level;
(iii) Storm surge;
(iv) Geometric properties of the measured beach profiles;
(v) Sediment properties of the beach profiles.

Hydrodynamic reference values



Morphodynamic reference values

	Days	Profile	Vol . budget (m³/m)
SR	15.02.2006 ↓ 01.03.2006	P1	-26,5
		P2	-16,8
		P3	-20,3
		P4	-15,9
		P5	+14,2
	14.06.2006 ↓ 28.11.2006	P1	-27,9
		P2	-16,3
		P3	-20,5
		P4	-0,9
		P5	-5,0

	Days	Profile	Vol . budget (m³/m)
AZ	31.01.2006 ↓ 14.02.2006	P1	-19,0
		P2	-22,1
		P3	-25,2
		P4	-18,7
		P5	-16,9
		P6	-47,7
	28.02.2006 ↓ 14.03.2006	P1	-6,7
		P2	-22,6
		P3	-11,7
		P4	-7,2
		P5	-3,8
		P6	-23,6

	Days	Profile	Vol . budget (m³/m)
LZ	13.02.2006 ↓ 02.03.2006	P1	-10,6
		P2	-20,5
		P3	-13,6
		P4	-52,5
		P5	-52,2
	02.03.2006 ↓ 15.03.2006	P1	-73,6
		P2	-70,7
		P3	-84,3
		P4	-47,6
		P5	-34,8

Empirical calibration

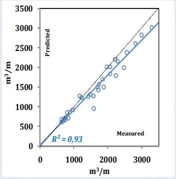
	SR (P1)	AZ (P1)	LZ (P1)
Measured pre-storm volume (m³/m)	173,9 (15.02.2006)	90,6 (31.01.2006)	340,1 (13.01.2006)
Measured post-storm volume (*a*) (m³/m)	147,4 (01.03.2006)	71,6 (14.02.2006)	329,5 (02.03.2006)
K (m⁴/N)	2,50*10⁻⁷	2,50*10⁻⁷	2,50*10⁻⁷
Є (m²/s)	0,005	0,005	0,005
Predicted post-storm volume (*b*) (m³/m)	131,4	69,9	301,6
Relative volume difference (*a* and *b*) (%)	-10,9	-2,3	-8,5

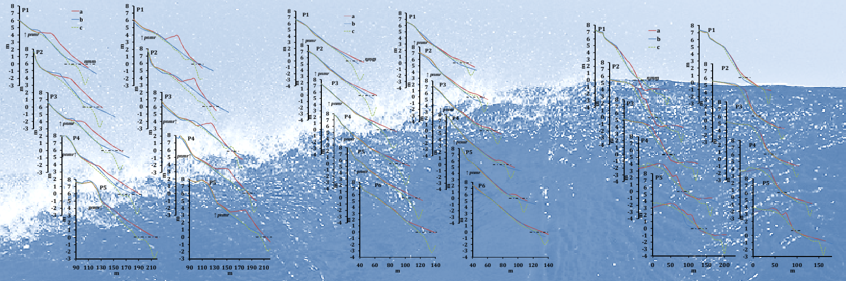
Model calibration

Successive adjustment of the K (transport rate term) and Є (slope dependent term) for **P1** in each beach system and on the first storm event to best fit measured results. In the worst case scenario the model explains over 89% of the measured profile.

Model validation

K and Є calibrated values where then applied to the rest of the 29 profiles in the three beach systems to access model performance and results validation. In most cases the model explains more than 90% (20 in 32 cases) of the measured changes due to storm events. The maximum relative difference value is -39,7%.





0m (msl) — System boundary — 0m recession [Dissipative profile] — 0m recession [Reflective profile] — 3m recession [Dissipative profile] — 3m recession [Reflective profile]

SBEACH Modeling (Larson & Kraus, 1989; Wise et al., 1996) → **Model calibration** → **Hydrodynamic reference values** / **Morphodynamic reference values** → ***K e Є empirical ajustment* (P1)** → **Validation of the volumetric budget (P2, P3, P4, P5 e P6)**