50 YEARS OF COASTAL EROSION ANALYSIS: A NEW METHODOLOGICAL APPROACH

Exposed beaches of Andalusian coast (South Spain)

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INTRODUCTION:

The Research Group *"Coastal Management and Territorial Information Technologies*" (RNM-177) has developed a new methodological approach for erosion rates calculation, analysis and web dissemination for all the exposed beaches of Andalusia (640 Kms). Although, erosion rates in Andalusia had been previously calculated using different proxies, photointerpretation criteria, time periods, scales and flights dates, none was carried out at regional scale and thus making difficult the integration of results for extracting regional trends of erosional processes. The proposed new method has three main contributions: **(i)** The use of different proxies digitized at detailed scale (1:2500) for the entire coast of Andalusia. The proxies were digitized by a unique interpreter using historical and modern public collection of ortophotographies.; **(ii)** The integration of related coastal thematic information (coastal typology, presence of infrastructures, foredunes width, etc.) to the geometry of the proxies in order to improve rates interpretation, analysis and further exploitation; **(iii)** The design of a complex data model (implemented in *PostgreSQL/PostGIS*) that integrates rates calculation results from different time periods with thematic information and specific tables for semiology treatment, enhancing indicator/index construction and web dissemination (using OGC services and a web geoviewer).

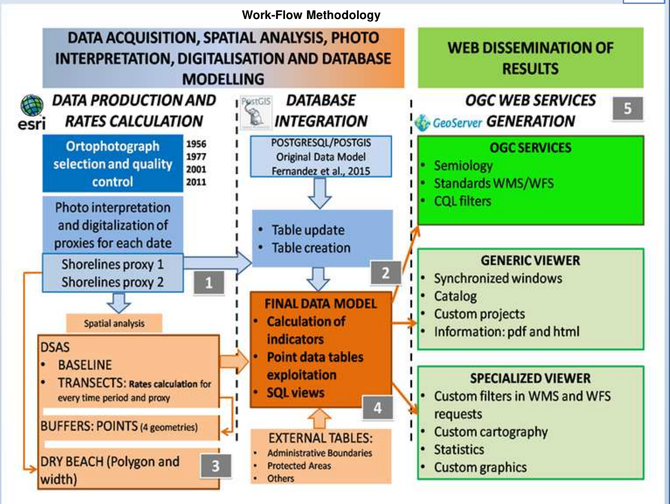
METHODOLOGY

1 **Data production:** Shorelines (proxies) were digitized at 1:2.500 within an ESRI geo-database file using ArcMap. Orthophotos from 1956 to 2011 (1956, 1977, 2001 & 2011) were used for photointerpretation. Two proxies were selected:

- Proxy 1: inner limit of the beach active profile (backshore/foredune, cliff or infrastructure limit if exists)
- Proxy 2: outer limit of the backshore (backshore/foreshore) i.e. the Mean High Water mark.

2 **Data model design and implementation:** Several thematic attributes related to natural and anthropogenic features of the coast (geomorphology, presence of engineering infrastructures, foredune width, built up areas, etc) were incorporated to each shoreline segment during proxies digitizing process. By updating and creating new tables within the original data model (Fernandez-Núñez et al., 2015) implemented in a spatial database (*PostgreSQL/PostGIS*).

Fig.1



3 **Erosion rates** were calculated using both proxies for different periods (1956-2011/ 1956-1977/ 1977-2001/ 2001-2011) with U.S. Digital Shoreline Analysis System (DSAS). Additionally, the *dry beach* width were geometrically calculated (distance between two proxies) for each date as a new indicator. New point entities layers were created parallel to shoreline, in order to enhance semiology treatment and further web dissemination.

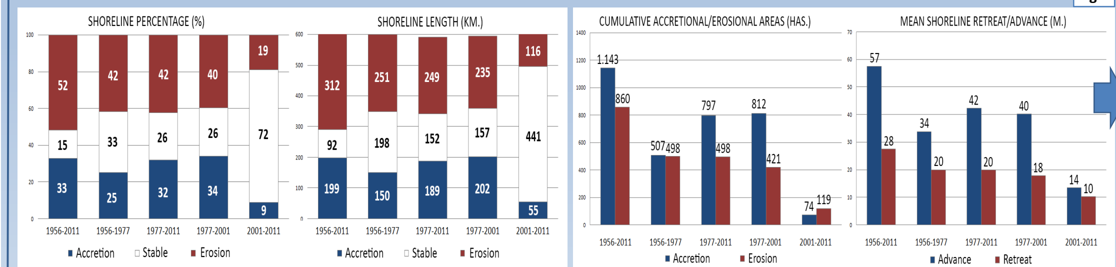
4 **Final Data Model:** results from erosion rates' calculation were incorporated to the final data model (**Fig. 1**), as well as the geometry and thematic information coming from the proxies and the points entities layer. The access and computation of complex coastal indicators/index (erosion rates + environmental and anthropogenic thematic data) are executed through simple SQL queries to the data model.

5 **Web dissemination:** by using Geoserver, WMS services (OGC standards) were generated to feed two tailor-made web viewers designed by RNM-177 (*see* EGU Poster by *Alvarez-Francoso et al., "Web access and dissemination of Andalusian coastal erosion rates"*).

RESULTS

1. Erosion Rates in Exposed Andalusian Beaches (proxy 1: backshore/foredune)

Fig.2



2. Effects of coastal infrastructures and proximity of urban areas

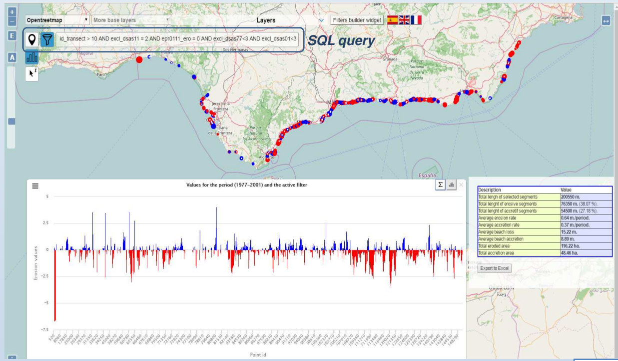


Fig. 3

Figure 2 shows progressive reduction of eroded and accreted sectors, especially for the more recent period (2001-2011), where the "stable sectors" represent 72/% of the total exposed beaches in Andalusia. The induced increment of stable sectors is explained by the proxy selected *(backshore/foredune, cliff or infrastructure)* along with the presence of coastal infrastructures (promenades, seawalls, breakwaters) or the proximity of urban areas which prevent the proxy from inland migration. By using a SQL query to the spatial database on the dedicated web viewer (**Fig.3**), erosion rates for the precedent temporal period (1977-2001) but **only** on those sectors were "the rates for the period 2001-2011 were "stable" **and** with presence of infrastructures or "build up areas" are selected. This allows to analyse which sectors have an erosive trend -38%- (and so, identify the sectors with high vulnerability) or an accretion trend -27%- (reflecting a sedimentary deficit).

3. Sensitivity index for assessing dry beach loss (as touristic resource) by erosional processes

Fig. 4

Coastal thematic information and erosion rates integration on the designed data model allows the construction of basic index (**Fig.4**) by using simple SQL queries *(Ojeda et al., 2013)*.

S= (Fdw+Bw+P)-E

S= Sensitivity Index for dry beach loss; Fdw= Foredune width; Bw= Backshore width; P= Progradation and E =Erosion

Figure 5 depicts higher (a) and lower (b) values of the *Sensitivity Index* calculated. Higher values are located on the Mediterranean coast, as this façade presents significant human pressure with an intense impact on coastal dunes. In addition, changes on coastal sedimentary balance, has induced an increase on the erosion rates. On the contrary, the configuration of the Atlantic façade (greater sediment availability, presence of protected coastal areas, etc.) have favored a larger degree of naturalness, less anthropogenic pressure and thus the preservation of coastal dunes fields in many sectors.

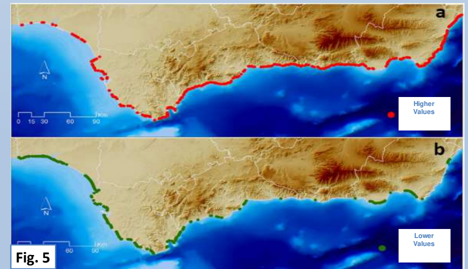


Fig. 5

Spatial distribution of rates (**Fig 1.**) shows a predominance of sectors under erosion (52% -312 Km – for the global period 1956-2011 and mean retreat of 28 m and 42% -249 km- for most recent period of time 1977-2011 and 20 m of mean retreat).

Paradoxically, when quantifying the intensity of rates (cumulative positive and negative changes) for each period, accretional areas appear to be greater tan erosional ones, due to the methodology considers coastal erosion as a two-dimensional process (distances between proxies) instead of a three-dimensional one.

- Erosional rates occurs usually on higher sedimentary features (cliffs, aeolian fields, etc.).
- By contrary, accretional rates are normally found along lower sedimentary areas (prograding beach barriers, spits, etc.).

CONCLUSION: The proposed methodology for coastal erosion calculation and its integration on a web-based viewer undoubtedly offers new opportunities for data exploitation, as combines natural and anthropogenic factors involved in coastal erosion/accretion in a simple but effective way.

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