Affection of sea level rise to the carrying capacity at Las Canteras beach, Gran Canaria (Spain)

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ABSTRACT

The carrying capacity is an important tool in beach management studies, since it allows to know the area of sand available to beach users. This topic became important in coastal areas, where tourism has increased significantly in the last decades. The increase of users in a certain area, can lead to negative impacts in the ecosystem as a result of the agglomeration of people. This study is focused in Las Canteras beach (Canary Islands, Spain), which is a typical urban beach but where the environmental issues are always taken into account. The method includes the use of orthophotos and digital images obtained from IDE Canarias in combination with ArcGis 10.1. To carry out this work, we registered the location of 19,500 users in 10 different moments between 2005 and 2013. The user's perception is very comfortable, because there are more than 5 m^2 available for each user. Nowadays, the sea level rise is a fact that, in littoral areas, results in a decrease of beach surface. This reduction will depend mostly on beach slope and wave exposition, but it which will certainly affect the carrying capacity. Currently for a comfortable perception from users (5 m^2/user), Las Canteras beach can accommodate about 28,000 people, which could be reduced to 16,600 in the worst scenario of sea level rise.

INTRODUCTION

Las Canteras beach is an urban beach about 3 kilometres in length, located in the city of Las Palmas de Gran Canaria, in the Confital bay.

One of the most outstanding features of the beach is the presence of a calcarenitic bar located inside the bay, about 200 meters from the current shoreline [1]. This beach rock runs parallel to the coast for more than 2 km, disappearing completely in the southern part of the beach, called la CICER. This bar determines the presence of different singular environments with a wide diversity of uses. For that reason there is a heterogeneous distribution in the location of users along the different sectors of the beach: Arco Norte, Playa chica, Los Lisos, Peña de la Vieja y la CICER (Fig. 1).

The carrying capacity relative to a beach area makes reference to the number and type of users who make use of it, without negative environmental impacts or an unacceptable social situation. In a coastal area, the load capacity changes depending on many factors, such as beach features (area, wave, tidal range, cleanliness ...), accessibility (parking spaces, accommodation, local infrastructure and facilities ...). And external factors (climate, season, expectations of users, safety ...). Moreover, the marine dynamics plays a key role regarding the area of beach available, which directly affects the distribution of users.

Considering a general use of sunbathing and swimming, [2] indicates for an urban beach in the Mediterranean, that to have an acceptable perception form users it is necessary to have a minimum area of 4-5 m^2/user.

Nowadays the sea level rise due to climate change is a reality. In most coastal areas, this rise involves an onshore migration of the coastline, which is faster depending on the general coastal slope. Most sandy beaches, and particularly those dissipative ones, shows a very gentle slope, which means that these areas will decrease a great portion of its surface. This fact will certainly affect its carrying capacity.

Fig. 1. Location of the study area, Las Canteras beach.

MATERIAL & METHODS

Different aerial images and orthophotos of the study area were selected form the Spatial Data Infrastructure of the Canary Islands (IDE Canarias) database. Only those very high quality images were chosen, since we had to identify individual users both, walking or lying on the beach.

A set of ten images corresponding to the period 2005-2013 was used, and the analysis was performed with ArcGis 10.1 software. Different layers of information were processed:

- Area of the different beach sectors (m^2): The beach was divided in 5 sectors (Fig.1??). The two largest ones were located at both ends (Arco Norte and CICER), while the three smaller ones were in between (Playa Chica, Los Lisos and Peña de la Vieja). The limits were the avenue facing the beach as the upper limit, and the sand-water contact as the lower limit.

- Location and number of users at each sector and for each image.

- From previous layer three zones were defined according to [2, 3]: the free zone, where there are no users, normally in the upper part of the beach; the resting zone, mostly used for sunbathing; and the active zone, where people walks either along the coast or to/from the sea.

- The density of users (or the beach surface available per user) was computed from previous layers of information.

RESULTS & DISCUSSION

It has been counted a total of 19,500 users. The day with maximum number of users on the beach was 17/02/2013, with nearly 4,000 people at the time the snapshot was obtained, and 30/10/2009 the least with only 770 users.

The analysis of the user's location by areas reveals that nearly 66% of users choose Arco Norte, 19% are in CICER and the remaining 15% are located in between Playa Chica, Los Lisos and Peña de la Vieja. This heterogeneous distribution of users can be motivated by the preferences of user regarding a particular area of the beach, by permitted uses (sports areas, or areas of sun and bath) or by available services.

Considering the areas of use described by [3], those with higher density of users (the more saturated ones) correspond to the resting zone both in Arco Norte and in Playa Chica. However, even in those cases, users have more than 5 m^2 for use and enjoyment, so their general perception is comfortable.

Climate change greatly affects coastal areas, causing retreat of the shoreline. Applying the values of sea level rise proposed for our study area by [4], and possible scenarios of sea level rise locally calculated [5], we can know how it will be this reduction in area, using an updated topography of the beach. Dividing the resulting area between the square meters available for each user, we can know the number of users that can fit on the beach (Table 1).

Table 1. Number of users for each carrying capacity potential, considering the beach area available for each rising sea level.

		Total users for each level of potential load (m2 / user)				
	Sea level rise (m)	< 2	3	4	5	10
		Intolerable	Saturation	Acceptable	Comfortable	Very comfortable
Current level	0	69644	46429	34822	27858	13929
IPCC	0,4	57537	38358	28709	23015	11507
	0,47	55636	37090	27818	22254	11127
	0,63	51485	34323	25743	20594	10297
Fraile	0,703	49747	33165	24874	19899	9949
	0,83	47012	31341	23506	18805	9402
	1,122	41526	27684	20763	16610	8305

Currently for a carrying capacity situation defined as comfortable (5 m^2/user), Las Canteras beach can fit about 28,000 people (Table I). However, in the best of all possible scenarios considered by [4] (RCP 2.6), with a sea level rise of 0.4 m above the current level, an area of 24,200 m^2 would be lost, and it represents nearly potential 5,000 users less on the beach.

According to local predictions [5], in same RCP 2.6 scenario, the sea level rise will be much higher, reaching an increase of 0.703 m above the current level, which leads to a loss of 100,000 m^2 of area and 10,000 potential user less on the beach.

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