UNIVERSIDAD DE LAS PALMAS
DE GRAN CANARIA

Tesis doctoral

Doctorado en Oceanografía y Cambio Global

Valoración del patrimonio natural y cultural de sistemas costeros insulares de cara a su recuperación, difusión y gestión

Eva Pérez Hernández

Las Palmas de Gran Canaria

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Presentación

La presente Tesis Doctoral, titulada "Valoración del patrimonio natural y cultural de sistemas costeros insulares de cara a su recuperación, difusión y gestión", se enmarca en el Programa de Doctorado en Oceanografía y Cambio Global de la Universidad de Las Palmas de Gran Canaria (ULPGC). La investigación se ha realizado en el seno del Grupo de investigación *Geografía Física y Medio Ambiente* (GFyMA) del *Instituto de Oceanografía y Cambio Global* (IOCAG) de la ULPGC, bajo la dirección del Dr. Luis Hernández Calvento. La Tesis Doctoral se inserta en las líneas de investigación "Costas de las islas volcánicas: procesos naturales e interacciones humanas" y "Sistemas de dunas costeros áridos: procesos naturales e interacciones humanas", de dicho Grupo y, de forma relacionada, en la línea "Oceanografía Biológica, Biotecnología y Medioambiente" del citado Programa de Doctorado.

El desarrollo del trabajo de investigación ha sido posible gracias a una subvención del Programa de Ayudas de Formación del Personal Investigador (nº referencia: TESIS2017010042), inserto en los programas oficiales de Doctorado en Canarias de la Agencia Canaria de Investigación, Innovación y Sociedad de la Información (ACIISI) del Gobierno de Canarias, cofinanciadas con el Fondo Social Europeo, correspondiente a la convocatoria 2017.

La difusión de los resultados de la investigación ha sido posible gracias a la vinculación de esta Tesis con los proyectos competitivos titulados "Caracterización de procesos socio-ecológicos de los sistemas playa-dunas de Canarias como base para su gestión sostenible" (Ref. CSO2013-43256-R)" y "Análisis de procesos naturales y humanos asociados a los sistemas playa-duna de Canarias" (Ref. CSO2016-79673-R) del Programa Estatal de I+D+i Orientada a los Retos de la Sociedad, del Plan Estatal de

Investigación Científica y Técnica y de Innovación del Gobierno de España, cuyo investigador principal fue el Dr. Luis Hernández Calvento.

Desde la perspectiva científica, la selección del objeto de estudio de esta Tesis Doctoral (el patrimonio en las costas de las islas Canarias), está motivada por dos razones concatenadas: en primer lugar, porque existe una preocupación creciente en la sociedad acerca de la evolución de los espacios costeros y la pérdida de su patrimonio. Esta preocupación está causada por el proceso de litoralización que se ha venido produciendo, a escala global, en los últimos siglos, al concentrarse la mayor parte de la población mundial en la franja litoral (Wong et al., 2014). Las consecuencias que este proceso ha tenido para los elementos del patrimonio natural y cultural costero han sido, en términos generales, muy negativas. En paralelo a este amplio proceso, se vienen produciendo cambios en las áreas costeras del planeta como consecuencia del actual cambio climático de origen antropogénico (Observatorio de Sostenibilidad y Greenpeace, 2019). En este contexto, esta Tesis Doctoral trata de aportar respuestas, desarrollando metodologías de evaluación y valoración del patrimonio costero; y, en segundo lugar, porque entendemos que las costas de las islas Canarias pueden ser un laboratorio adecuado para desarrollar este tipo de estudios, dadas sus condiciones de partida, naturales y antrópicas. Al respecto, se trata de espacios insulares (bastante únicos, desde el punto de vista global, pues las islas volcánicas de punto caliente representan tan solo un 0,04% de la superficie terrestre emergida; Ferrer-Valero et al., 2018) y, por lo tanto, acotados espacialmente, pero donde se desarrollan los mismos procesos que en las áreas continentales. Por otra parte, el amplio desarrollo urbano y turístico que se ha producido en las áreas costeras de las islas Canarias en los últimos siglos, y especialmente en las últimas décadas, es un elemento que también cobra peso en la elección del área de estudio, pues comparte este desarrollo con muchas otras áreas costeras del mundo. Partiendo de estas premisas de representatividad, entendemos que también las vicisitudes que del estudio de estos sistemas costeros insulares se deriven, ya sean a nivel de planteamiento del problema o de desarrollo metodológico, pueden ser aplicables, con los consiguientes ajustes, a otras áreas del Planeta.

Desde la perspectiva académica, este estudio supone un avance sobre un Trabajo Final del Máster (TFM) previo, desarrollado en el Máster Oficial en Patrimonio Histórico, Cultural y Natural de la ULPGC, titulado “El Patrimonio perdido: reconstrucción de las características de las “mareas” del litoral oriental de Las Palmas de Gran Canaria”. En este trabajo se identificaron los elementos del patrimonio perdido, natural y cultural, como consecuencia de la prolongación de la carretera Las Palmas de Gran Canaria-Sur, GC-1, hacia el puerto de Las Palmas. Este tramo de vía, conocido como Avenida Marítima de Las Palmas (Avenida de Canarias-Alcalde José Ramírez Bethencourt), se desarrolló en los años setenta del pasado siglo, sobre la línea de costa existente hasta ese momento. Ampliar los objetivos y los planteamientos metodológicos que se hicieron entonces, desarrollando estudios pormenorizados sobre aspectos concretos, conforma, desde la perspectiva académica, uno de los objetos fundamentales de esta Tesis Doctoral.

Desde el punto de vista aplicado, entendemos que este trabajo puede tener interés social y cultural, especialmente en su vertiente de recuperación de la memoria, una vez que algunos de estos elementos patrimoniales, o los sistemas en sí, se han perdido. Este interés puede ser considerado tanto desde la perspectiva de la ciudadanía, como desde la perspectiva de los visitantes. Unos y otros demandan información sobre los elementos, los espacios y las actividades perdidas y preservadas, que forman parte de la identidad local. De esta manera, la aplicabilidad de este estudio podría ser la difusión de los resultados, de cara a facilitar una gestión adecuada y proporcionar proyectos educativos y turísticos que acerquen y mejoren la percepción de estos entornos.

La Tesis Doctoral se presenta a través del formato *por compendio de publicaciones*, conformando el *corpus* de la Tesis tres artículos publicados en revistas internacionales con factor de impacto (JCR y SJR) y los resultados de un cuarto artículo en proceso de revisión por pares (estado: *under review*) en una revista indexada. El texto se estructura en ocho capítulos. El primero de ellos, de introducción, se ha dedicado a señalar los conceptos y la importancia del patrimonio, así como a presentar las características de las áreas costeras, en general, y de los sistemas playa-duna, en particular, poniendo de relieve los desafíos y la problemática a la que se enfrentan. En el segundo capítulo se establecen la hipótesis de partida de esta investigación, así como sus objetivos generales y específicos. El tercer capítulo expone las características del área de estudio en el que ha trabajado esta investigación. En el cuarto capítulo se presenta el diseño metodológico para alcanzar los objetivos y contrastar la hipótesis. El quinto capítulo muestra los resultados obtenidos, representados por los siguientes artículos:

1) *Beach surface lost historically: the case of the eastern coast of Las Palmas de Gran Canaria (Canary Islands, Spain)* [**Pérez-Hernández, E**., Santana-Cordero, A.M., Hernández-Calvento, L., Monteiro-Quintana, M.L. (2020). Ocean and Coastal Management, 185, 105058]*;* *https://doi.org/10.1016/j.ocecoaman.2019.105058; factor de impacto 2.595 (JCR) / 0.822 (SJR),* Q1 y Q2-SJR (Q1 en *Agricultural and Biological Sciences y Q2 en Earth and Planetary Sciences y Environmental Science)* y Q2-JCR (en *Water Resources* y en *Oceanography*).

2) Lost and preserved coastal landforms after urban growth. The case of Las Palmas de Gran Canaria city (Canary Islands, Spain) [**Pérez-Hernández, E**., Ferrer-Valero, N., Hernández-Calvento, L. (2020). Journal of Coastal Conservation, 24 (26), 1-17*;* https://doi.org/10.1007/s11852-020-00743-x; factor de impacto 1.264 (JCR) / 0.399

(SJR); Q2 y Q3-SJR (Q3 en *Earth and Planetary Sciences* y Q2-Q3 en *Environmental Science*) y Q3 y Q4-JCR (Q3 en *Marine Freshwater* y Q4 en *Environmental Sciences*).

3) Assessing lost cultural heritage. A case study of the eastern coast of Las Palmas de Gran Canaria city (Spain) [**Pérez-Hernández, E**., Peña-Alonso, C., Hernández-Calvento, L. (2020). Land Use Policy, 96, 104697]*;* https://doi.org/10.1016/j.landusepol.2020.104697; factor de impacto 3.573 (JCR) / 1.479 (SJR); Q1-SJR (en *Agricultural and Biological Sciences*, *Environmental Science* y *Social Sciences*) y Q1-JCR (en *Environmental Studies*).

4) *Assessing the scenic quality of transgressive dune systems on volcanic islands. The case of Corralejo (Fuerteventura island, Spain).* [**Pérez-Hernández, E**., Peña-Alonso, C., Fernández-Cabrera, E., Hernández-Calvento, L. (En revisión)].

El sexto y séptimo capítulo corresponden, respectivamente, a la discusión general de la investigación, en la que se confrontan los objetivos de la Tesis con los resultados de los artículos, y a las conclusiones generales. Por último, en el octavo capítulo se proponen perspectivas futuras que se abren desde esta Tesis, en cuanto a posibles líneas de investigación, así como en cuanto a la propia gestión del patrimonio costero.

Resumen

Esta Tesis Doctoral presenta los resultados de una investigación llevada a cabo, entre 2016 y 2020, en el seno del Grupo de Investigación *Geografía Física y Medio Ambiente* del Instituto de Oceanografía y Cambio Global (IOCAG) de la Universidad de Las Palmas de Gran Canaria (ULPGC), Unidad asociada al CSIC (Unidad *Océano y Clima*). Se enmarca esta memoria de investigación en el programa de Doctorado *Oceanografía y Cambio Global* de la ULPGC. Desde el punto de vista formal, la Tesis se presenta en el formato *por compendio de publicaciones*.

La investigación plantea valorar la riqueza patrimonial natural, cultural y paisajística de dos ámbitos costeros de las islas Canarias: un sistema ya desaparecido, como es la franja natural costera oriental de la ciudad de Las Palmas de Gran Canaria (LPGC), y otro que, aunque conservado en sus formas esenciales, presenta una fuerte presión antrópica, como es el sistema playa-duna de Corralejo (Fuerteventura). El trabajo aborda los objetivos mediante dos vías: por un lado, analiza los cambios experimentados durante cientos de años en la primera zona de estudio indicada, partiendo de un sistema escasamente intervenido; por otro lado, analiza, para ambos casos, aunque desde diferentes perspectivas, el papel que ha jugado la sociedad en estos espacios, al desarrollar usos que interfieren con los procesos naturales y que alteran los elementos culturales y paisajísticos. Ambas vías están englobadas en una amplia perspectiva patrimonial. El desarrollo de la investigación se ha realizado aplicando un enfoque metodológico multidisciplinar, basado en la implementación de diversas herramientas y técnicas mixtas, históricas y geográficas. Este enfoque mixto ha aportado resultados novedosos acerca de los valores, las características, las prácticas y las funcionalidades de los elementos estudiados. De forma concreta, se ha logrado recomponer, evaluar y valorar el patrimonio

natural y cultural costero de LPGC desde finales del siglo XIX, así como valorar la calidad paisajística del sistema playa-dunas de Corralejo. Estos resultados pueden contribuir de manera importante en la concienciación, la sensibilización y la preservación del patrimonio natural y cultural costero, con vistas a mejorar su planificación y gestión futura, especialmente teniendo en cuenta el interés que, como recursos atractivos, suponen para la población local y turista.

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¡Oh tiempo!

¡Oh tiempo, tiempo! tu invisible planta
Todo en su grave paso lo atropella...
Tras ti sólo el recuerdo se levanta;
Que son del tiempo los recuerdos huella.

¿Qué queda ya de mi niñez serena
Del agitado mar en las orillas?
La playa sola en cuya azul arena
Conchas buscaba y blancas piedrecillas.

¿Qué ha dejado mi dicha en la ribera?
Una peña, dulcísima memoria
De cariño y placer, que guarda entera
De mi secreto corazón la historia.

Antonio Rodríguez López (1836-1901). Santa Cruz de La Palma.

1. INTRODUCCIÓN

*Playa de San Agustín y Maspalomas al fondo (Fuente: Elaboración propia, 2017).

1.1. Patrimonio: definición y características generales.

1.1.1. Definición

El término "patrimonio" tiene varias definiciones, según la procedencia y la concepción de los autores y organizaciones que lo interpreten (Berzunza, 2003; Nicu, 2017). Según la Real Academia Española (2020), presenta cuatro significados: 1) hacienda que alguien ha heredado de sus ascendientes; 2) conjunto de los bienes y derechos propios adquiridos por cualquier título; 3) patrimonialidad y 4) conjunto de bienes pertenecientes a una persona natural o jurídica, o afectos a un fin, susceptibles de estimación económica. La Unesco (1972), por su parte, lo define como un legado que se recibe del pasado, se vive en el presente y que debe ser transmitido a las generaciones futuras (Prats, 1999; Ayuso et al., 2009; Sánchez, 2012). Considerando en conjunto estas definiciones, podemos entender el patrimonio como una evidencia o testimonio del desarrollo de una comunidad local pasada a través de sus costumbres, valores o expresiones artísticas y arquitectónicas que han sido heredadas y serán transmitidas a las generaciones futuras con el propósito de preservar, continuar y aumentar dichos valores (DeCarli, 2007; Allan et al., 2017; Nicu, 2017).

1.1.2. Tipología

Este patrimonio se puede dividir en tres tipos: natural, cultural y mixto (Convención para la Protección del Patrimonio Mundial, 1972 y 1992):

- *Patrimonio natural*. Se define como "conjunto de bienes y recursos de la naturaleza fuente de diversidad biológica y geológica, que tienen un valor relevante medioambiental, paisajístico y científico" (Ley 42/2007, de 13 de diciembre, del Patrimonio Natural y de la Biodiversidad). Por lo tanto, estaría conformado por monumentos naturales, formaciones geológicas, lugares y paisajes naturales, etc.

- *Patrimonio cultural.* Está constituido por elementos de carácter arquitectónico, arqueológico, etnográfico, etc., que tienen interés y un valor excepcional desde el punto de vista histórico, artístico, científico y etnológico, entre otros. Este patrimonio se divide en dos tipos, *tangible* e *intangible*. El primero es la expresión de las culturas a través de realizaciones materiales, por lo que se puede clasificar en *inmueble* (obras complejas, como edificaciones, lugares, zonas arqueológicas, obras de ingeniería, conjuntos arquitectónicos, jardines, etc.) o *mueble* (obras de arte, libros, manuscritos, artefactos históricos, fotografías, documentos audiovisuales, piezas de artesanía, etc.). El patrimonio *intangible* es el conjunto de rasgos distintivos, espirituales y materiales, intelectuales y afectivos que caracterizan a una sociedad o un grupo social, como los sistemas de valores, las tradiciones y las creencias (Unesco, 1972).

- *Patrimonio mixto*. Son considerados en esta categoría aquellos bienes que engloban "parcial o totalmente las definiciones de patrimonio cultural y natural" (Unesco, 1972). Según Ayuso et al. (2009), este patrimonio puede denominarse también como *patrimonio paisajístico*. Dentro de este tipo, la Unesco incorporó en su Convención del Patrimonio Mundial (1992) la categoría de *paisajes culturales*, los cuales representan las "obras conjuntas del hombre y la naturaleza". Los elementos del patrimonio mixto son, por lo tanto, el resultado de la interacción de las actividades humanas con los elementos naturales en un territorio concreto, e ilustran la evolución y la adaptación de la sociedad al medio. Estos se pueden dividir en tres tipos: *1) paisaje diseñado, 2) paisaje que ha evolucionado orgánicamente y 3) paisaje asociativo*. El primero de ellos, corresponde a "parques y jardines creados intencionadamente por el hombre". El segundo "ha alcanzado su forma actual como respuesta a su entorno natural, reflejándose en su forma y su composición". Éste se subdivide en dos tipos: *paisaje relicto (o fósil)*, aquel que ha experimentado un proceso evolutivo que se ha detenido en algún momento del pasado, ya sea bruscamente o a lo largo de un periodo; y *paisaje vivo*, el que conserva una función social activa en la sociedad contemporánea, estrechamente vinculada al modo de vida tradicional. Por último, el *paisaje asociativo* engloba distintas asociaciones culturales, religiosas o artísticas en sus componentes naturales (Unesco, 2005).

1.1.3. Contribución e importancia del patrimonio en la sociedad.

El patrimonio ha cobrado importancia en las últimas décadas (Sánchez, 2012), motivado por las distintas dimensiones culturales, científicas, históricas, éticas, identitarias, sociales y educativas que ofrece. Estas nuevas perspectivas han influido o contribuido a la sociedad de diversas formas. Así, en primer lugar, el patrimonio permite conocer el pasado, comprender el presente y el origen de posicionamientos futuros (González Monfort, 2007; Cuenca et al., 2012; Sánchez, 2012; Pinto et al., 2015). La comprensión de estas ideas es esencial para la continuidad de determinados elementos y del conocimiento sobre costumbres, tradiciones o practicas sociales (Sebastiá y Tonda, 2016), y, así, poder trasmitirlas a las generaciones futuras. En segundo lugar, el patrimonio fomenta el conocimiento y el desarrollo de actitudes y valores que contribuyen a su mantenimiento (Feliu y Hernández, 2011), al impulsar la conservación, la curiosidad por conocer la cultura, la biodiversidad y la historia. En tercer lugar, según Ávila (2003), el patrimonio es un recurso educativo de gran importancia, al contribuir a la formación del pensamiento autónomo, reflexivo y crítico. Este estimula la apreciación de creencias e identidades de manera colectiva e inclusiva (Pintó et al., 2015). Asimismo, contribuye a la formación ciudadana y a la cohesión social, al desarrollar un sentido de la responsabilidad compartida, tanto en el ámbito natural como el cultural.

Además, estas numerosas funciones del patrimonio aportan diferentes recursos (económicos, turísticos, sociales, materiales, etc.), que potencian el desarrollo de la sociedad (Ortega, 1999; Guerrero, 2008). Así, el patrimonio ha impulsado numerosas actividades recreativas, que han diversificado la oferta a la comunidad y que han estimulado y reactivado bienes para uso recreativo y de disfrute (Velasco, 2009). De esta forma, el patrimonio ha dejado de contemplarse como un legado, para valorarse como un recurso que aporta nuevas oportunidades o intereses socioeconómicos a la población (Vaquero y García, 1998).

Desde esta perspectiva, y considerando el actual contexto de globalización, la sociedad se halla inmersa en un proceso de transformación continua, en el cual los elementos patrimoniales son vulnerables. Ello es así porque se trata de un conjunto de recursos frágiles, frecuentemente, no renovable, por lo que se requiere de iniciativas de protección y gestión para su conservación y preservación (Ayuso et al., 2009). Está claro que es imposible preservar todo el patrimonio y, por ello, es necesario que exista un equilibrio entre continuidad y cambio (Sebastiá y Tonda, 2016). Cualquier objeto puede ser considerado patrimonio, pero finalmente sólo logrará trascender un conjunto, seleccionado según ciertos criterios, relacionados con su naturaleza, su historia, su originalidad y su valor (Claesson, 2011). Por ello, según González y Pagés (2005), para otorgar a un elemento la categoría de patrimonio, debe cumplir los siguientes valores: 1) valor de uso o utilidad de ese bien; 2) valor formal, es decir, la atracción que despierta a través de los sentidos; y 3) valor simbólico, por ser testimonio de ideas, valores, de hechos o de situaciones del pasado, concepciones y creencias, provocar un sentimiento de afecto y emoción en la sociedad. Sin embargo, la principal capacidad que debe poseer es que sea reconocido como valioso o relevante por los ciudadanos y por las instituciones, pues con ello se consigue aumentar la conexión-atracción social y la conciencia sobre su propia trascendencia, siendo el primer paso para su conservación, puesta en valor y difusión (Velasco, 2009; López-Arroyo, 2013).

1.2. El patrimonio costero: características generales y amenazas

1.2.1. El patrimonio de las áreas costeras.

Las áreas costeras del Planeta se extienden entre unos 620.000 km y 1.000.000 km de longitud (Bird, 2008; NASA Science, 2018), dependiendo de la escala de observación. En ellas se desarrollan sistemas complejos y dinámicos (Kurt et al., 2010; Ponte et al., 2016), formados por la interacción de procesos marinos y terrestres, que dan lugar a una gran diversidad de geoformas (acantilados, plataformas costeras, playas, sistemas dunares…) (Nichols et al., 2019). Si bien la costa se limita a la zona donde la tierra, el mar y el aire (litosfera, hidrosfera y atmósfera) se encuentran e interactúan (Bird, 2008), en sentido amplio, las áreas costeras están conformadas por una franja, más o menos variable en anchura, que se extiende desde la línea de rompiente del oleaje hasta un límite interior, marcado por la influencia marina (como, por ejemplo, la base de un acantilado).

La dinámica costera está sujeta a una amplia variedad de procesos abióticos y bióticos (tales como la fricción, las actividades biológicas o las reacciones químicas, por ejemplo), que interactúan entre ellos a distintas escalas espacio - temporales y con distinta intensidad, dando lugar a otros procesos. A nivel general, los movimientos tectónicos, los cambios en el nivel del mar, los efectos de las olas y de las corrientes marinas, las variaciones de temperatura y de presión, la acción del viento, la erosión del material rocoso y la deposición/suministro de sedimentos, entre otros (Nichols et al., 2019) son los principales responsables de dar forma a las áreas costeras, al estar en constante cambio (Davidson-Arnott, 2010).

Entre los diversos ambientes que se pueden encontrar en las áreas costeras del Planeta, las playas y las dunas son los más dinámicos (Barragán, 1994; Peña-Alonso, 2015). Las playas ocupan aproximadamente un 40% de la línea de costa global (Bird, 1996). Se trata de acumulaciones de sedimentos no consolidados, como arena, grava o cantos rodados, que han sido transportados y depositados por las olas y las corrientes a lo largo de la costa (Davidson-Arnott, 2010; Nichols et al., 2019). Por su parte, los sistemas dunares son depósitos sedimentarios constituidos por montículos o crestas de arena, principalmente, formados por el transporte eólico de sedimentos desde las playas, en los cuales la vegetación actúa de barrera (Bird, 2018). Las interacciones playa-duna se manifiestan en forma de transporte sedimentario cuando los vientos transportan arena desde las playas hacia las dunas, o viceversa, o cuando las olas erosionan la arena de las dunas costeras, para incorporarla a las playas sumergidas (Psuty, 1988; Davidson-Arnott, 2010). Dependiendo del grado de movilidad de los depósitos arenosos, se puede distinguir entre campos de dunas móviles, semi-móviles y estabilizadas.

Estas interacciones suscitan que los sistemas arenosos costeros sean una de las zonas naturales más frágiles del planeta (Hernández-Calvento, 2002), al ser susceptibles de sufrir cambios en su dinámica natural. Las acciones antrópicas son las que más alteraciones producen en su evolución (Martínez et al., 2007) por interrumpir o condicionar el funcionamiento natural de los sistemas a través de instalaciones que obstaculizan el transporte de los sedimentos eólicos o marinos (Nordstrom, 1994). Según Hernández-Cordero et al. (2018), en estas áreas se producen cambios geomorfológicos debido a los impactos desarrollados por el uso urbano, de gestión (servicios de la playa) y por las actividades de los usuarios, siendo los seis más frecuentes: 1) las edificaciones, 2) la extracción de recursos, 3) caminar o conducir en estos sistemas, 4) modificar la superficie para acomodar instalaciones recreativas, 5) redistribuir o remoción de sedimentos plantando vegetación para aumentar el nivel de protección o estabilizar dunas naturalmente móviles, y 6) la alteración de la superficie para removilizar paisajes estabilizados.

En definitiva, las áreas costeras constituyen espacios de interacción entre procesos marinos y terrestres, cuya imbricación da lugar a fenómenos distintivos, con características propias, ya sean éstas geológicas, geomorfológicas o bióticas. Desde la perspectiva del patrimonio, muchas áreas costeras del Planeta constituyen claros ejemplos de elementos del patrimonio natural. Así, las áreas costeras presentan, por lo general, una alta geodiversidad (Gray, 2008; Brocx y Semeniuk, 2010), con conjuntos únicos, asociados a procesos característicos (Gray, 2008; Rodrigues y Silva, 2012; Santos et al., 2017).

La diversidad de valores naturales que presentan estas áreas ha supuesto un motivo de atracción para la población humana (Martínez et al., 2007; Ariza, 2010). Los distintos colectivos que se han asentado en torno a las áreas costeras, al crear usos y costumbres en torno a ellas, han añadido valores culturales y paisajísticos, incorporando nuevos elementos patrimoniales. En consecuencia, las áreas costeras son, por lo general, espacios muy valorados desde el punto de vista patrimonial (Rangel-Buitrago, 2019).

1.2.2. El patrimonio costero: amenazas.

El patrimonio natural y cultural está sufriendo un proceso de desaparición a nivel mundial. Según la Unesco (1972), entre las principales amenazas que provocan esta desaparición destacan los desastres naturales y las causas antrópicas, siendo las áreas costeras los lugares donde estos problemas están afectando más gravemente (Flatman, 2009; Donelson et al., 2019b).

La degradación de los ecosistemas costeros no se produce de manera aislada. Los procesos (naturales y antrópicos) que provocan esa degradación no ocurren ni afectan de manera independiente, sino que, como norma general, se desarrollan de forma combinada, pues tienden a estar interconectados, pudiendo llegar a ser desencadenantes los unos de los otros (Wong et al., 2014). Además, juegan en esta interacción de procesos dos condiciones fundamentales, como son la escala temporal y la intensidad. Así, según Nichols et al. (2019) cuanto más lentos sean los procesos, más difíciles de percibirlos; y cuanto más rápidos, mayores serán los impactos que produzcan.

Entre los fenómenos naturales que afectan a los elementos patrimoniales destacan distintos de carácter climático, así como terremotos, inundaciones, deslizamientos de tierra o tsunamis. Si bien estos fenómenos han afectado a los elementos patrimoniales a lo largo de la historia, en las últimas décadas su impacto se ha incrementado (Nicu, 2017). El daño resultante de este tipo de adversidades puede tener consecuencias en los servicios del ecosistema (Olsson et al., 2019). Los efectos destructivos dependerán de la ubicación, la intensidad y el tamaño de cada fenómeno. En cuanto a los *climáticos*, pueden deberse a “episodios complejos, como el Niño y la Niña, o eventos extremos, como ciclones tropicales. Estos eventos episódicos afectan negativamente a la biodiversidad de los sistemas costeros, a través de la propagación de especies invasoras, la mortalidad masiva de ejemplares de distintas especies y la pérdida de hábitat. Las fuertes lluvias e inundaciones erosionan el suelo, desvían ríos y causan daños severos a los hábitats, la infraestructura y a poblaciones naturales enteras” (Nichols et al., 2019). Por su parte, las *inundaciones* se encuentran entre los eventos naturales más comunes, y generan impactos complejos y de largo alcance. En las áreas costeras éstas suelen ser causadas por tormentas marinas, ríos que exceden su capacidad de carga habitual y lluvias torrenciales. También los *deslizamientos de tierra* causan daños a los ecosistemas costeros, al volcar los horizontes del suelo, enterrar la vegetación, contaminar los cuerpos de agua y dañar hábitats enteros (Nichols et al., 2019). Según Nicu (2017), este peligro natural (junto con la erosión) es el que con mayor frecuencia afecta a los elementos patrimoniales costeros. Las áreas más vulnerables ante estos sucesos incluyen los acantilados costeros de todo el mundo pues, junto con los *terremotos* y las *erupciones volcánicas*, los deslizamientos pueden causar *tsunamis*. Estos últimos desplazan grandes cantidades de agua, creando olas de largo período, que son sostenidas por la gravedad a medida que viajan hacia la tierra a grandes velocidades (Nichols et al., 2019).

Por su parte, entre las causas antrópicas destacan las guerras, los cambios en los usos del suelo, la expansión urbana y los intereses económicos, entre otros. Estos problemas han alterado y han producido transformaciones en nuestros paisajes costeros a diferentes escalas espacio - temporales (Vallecillo, 2009), destruyendo la estructura de monumentos culturales o modificando el funcionamiento de los ecosistemas (Ivanišević et al., 2015). De entre todos ellos, los cambios en los usos del suelo son considerados la principal causa directa de la degradación de la tierra, debido a su gestión insostenible (Olsson et al., 2019). Este fenómeno se encuentra estrechamente vinculado al fenómeno de expansión urbana, al ser el que mayores transformaciones ha ocasionado.

Así, la expansión urbana y urbano-turística que ha acaecido especialmente en el último medio siglo, a escala mundial, ha sido uno de los procesos que más ha perjudicado al patrimonio costero (Nordstrom, 1994; Bajocco et al., 2012; Malavasi et al., 2013; Ponte et al., 2016). Los espacios litorales son áreas que, dados sus múltiples valores naturales y estratégicos, han atraído a la población humana, especialmente desde mediados del siglo XX (Martínez et al., 2007; Ariza, 2010), de modo que, en la actualidad, entre el 50% y el 70% de la población mundial se concentra a menos de 100 kilómetros de la costa (Mimura et al., 2007; Dawson, 2017) y cerca del 30% de las áreas costeras del Planeta han sido directamente alteradas por actividades relacionadas con el desarrollo humano (Martínez et al., 2007; Ferrer-Valero et al., 2017). Según Rangel-Buitrago (2019), en la región mediterránea se ha perdido un 40% del litoral en las dos últimas décadas; para el año 2025 se espera que el 50% de esta franja litoral sea artificial (Benoit y Comeau, 2005). El desarrollo de usos y actividades antrópicas (especialmente de ocio), junto con el establecimiento de edificaciones, infraestructuras y equipamientos, ha provocado un proceso diferenciador, que ha venido a denominarse "litoralización" (Lin, 1996; Davidson, 2010; Bajocco et. al. 2012). Este proceso es causante de importantes cambios en las áreas costeras del Planeta y, en algunos casos, de la desaparición de los valores característicos de tramos enteros del litoral. Las transformaciones producidas son, en muchos casos, irreparables.

Por otro lado, el riesgo de desaparición de elementos patrimoniales costeros se ha visto incrementado por el actual cambio climático de origen antropogénico. En consecuencia, en la actualidad se plantean serias amenazas a la protección, preservación y transmisión a las generaciones futuras de recursos patrimoniales no renovables (Flatman, 2009; Durán et al., 2015; Reeder-Myer, 2015; Fatoric and Seekamp, 2017). En las próximas décadas, es ampliamente aceptado que el cambio climático se manifestará de forma clara en las áreas costeras, a través del aumento del nivel del mar y de la altura de las olas, de cambios en las corrientes y en la magnitud y la recurrencia de los temporales marinos y, en consecuencia, a través de la erosión costera. También es esperable un aumento de las temperaturas y, en consecuencia, en la magnitud de procesos de degradación de la tierra, deforestación, desertificación, deshielo, olas de calor y modificaciones hidrológicas que afectarán a la descarga de los ríos a las costas. Todos estos cambios, finalmente, tendrán consecuencias en la evolución de los ecosistemas costeros, y supondrán una pérdida de hábitats. En definitiva, estos procesos tenderán a acelerar la alteración que ya de por sí experimentan los sistemas litorales (Wong et al., 2014; Duraiappah et al., 2015; Zinnert et al., 2016; Donelson et al., 2019b; Olsson et al., 2019; Oppenheimer et al., 2019).

El impacto directo sobre el patrimonio costero será una consecuencia de estos cambios (Hunt y Watkiss, 2010). Para Murphy et al. (2009), los impactos esperables se dividen en cuatro categorías principales: 1) impactos físicos directos causados por procesos costeros (predominantemente por la erosión y las inundaciones); 2) impactos indirectos a consecuencia de decisiones a tomar por parte de las administraciones competentes en la gestión costera, como parte de la adaptación a los efectos del cambio climático (como los enfoques de "no intervención" para la defensa costera); 3) impactos indirectos relacionados con actuaciones encaminadas a mitigar el cambio climático (principalmente la expansión del sector de energías renovables); y 4) expansión de la fauna alóctona.

En definitiva, la conjunción desarrollo urbano-turístico y cambio climático no sólo provoca, y provocará, la degradación de las áreas costeras (Bajocco et al., 2012), sino que también incide en la desaparición de numerosos bienes patrimoniales culturales y, por consiguiente, en la transformación de las prácticas sociales y comunitarias que forman parte del patrimonio cultural inmaterial (Durán et al., 2015).

1.2.3. El patrimonio costero en islas: el caso de las islas Canarias.

Debido a que los recursos insulares son más limitados y escasos con respecto a lo que, por lo general, sucede en las áreas continentales, los procesos de degradación del patrimonio natural y cultural tienen mayores consecuencias en las islas (Mimura et al., 2007; Hay, 2013; Nurse et al., 2014; Santana-Cordero et al., 2016; Ferrer-Valero et al., 2017).

Un claro ejemplo de estos procesos y afecciones los podemos encontrar en las islas Canarias, cuyas áreas costeras han sido ampliamente ocupadas por urbanizaciones, infraestructuras y equipamientos, especialmente desde mediados del siglo XX, debido a sus mejores condiciones climáticas y topográficas. A partir de la década de los sesenta, el modelo socioeconómico del archipiélago basado en la actividad agraria pasó a estar centrado en el sector servicios, concretamente en el turismo (Pérez-Chacón et al., 2019). Este proceso favoreció la migración de la población rural del interior de las islas hacia las zonas costeras debido a la demanda de mano de obra para las nuevas construcciones urbanas y turísticas (Ferrer-Valero et al., 2017). Estos nuevos usos, que han ido sustituyendo a coberturas naturales y usos agrarios, han supuesto una pérdida de elementos del patrimonio natural, cultural e histórico costeros. Esto ha ocurrido, de forma especial, en el entorno de los sistemas arenosos (espacios de alta fragilidad) (Hernández-Cordero et al., 2017), donde muchos de sus procesos naturales característicos han sido modificados o eliminados por las actividades humanas, a pesar de ser los principales reclamos para el turismo de masas, de sol y playa, en el que las islas se han especializado. Una de las principales características de esta actividad turística es la afluencia continua de visitantes durante todo el año, debido a su clima templado (Peña-Alonso et al., 2018b). Estas circunstancias han contribuido ampliamente al desarrollo de un modelo territorial urbano-turístico en las islas (Pérez-Chacón et al., 2019) en el cual las urbanizaciones, equipamientos y actividades vinculadas con el turismo han sido el mayor agente transformador de los paisajes costeros.

En este contexto, este trabajo parte de un caso que ha desaparecido, como es el litoral oriental y la geomorfología costera de la ciudad de Las Palmas de Gran Canaria (Gran Canaria) a otro sistema playa-duna que se conserva en la actualidad como es Corralejo (Fuerteventura).

En el caso de Gran Canaria, las transformaciones de mediados del siglo XX ocasionaron un proceso de crecimiento urbano-turístico principalmente en las costas del noreste, este y sur de la isla (Morales Matos y Santana Santana, 1993). La expansión de las infraestructuras, equipamientos y núcleos urbanos – turísticos hacia la costa ha supuesto que el 14% de los accidentes costeros de la isla hayan desaparecido total o parcialmente y que un 29% se encuentren afectados en distintas escalas de degradación (Ferrer-Valero et al., 2017). Estos mismos autores (Ferrer-Valero et al., 2017), observaron como las geoformas costeras sedimentarias han sido las más afectadas, especialmente, los sistemas de dunas, al haber desaparecido el 65% de su extensión y un 32% se encuentra parcialmente destruido o en proceso de degradación. En el caso de las playas detectaron como en las áreas del noreste y suroeste de la isla han abarcado los mayores procesos de desaparición de este tipo de geoforma. Como ejemplo, merece la pena resaltar el caso de Las Palmas de Gran Canaria, al tratarse de un claro ejemplo de cambios inducidos por actividades humanas sobre un sistema costero. Así, el sector norte de la ciudad, y especialmente su franja oriental, experimentó intensas transformaciones desde finales del siglo XIX y, especialmente, en los años sesenta del siglo XX, como consecuencia de la expansión de la ciudad hacia el mar para obtener espacio edificable, prolongar la carretera GC-1 hacia el Puerto de Las Palmas y expandir las infraestructuras portuarias. Esas transformaciones implicaron cambios importantes en los usos de suelo, con la consecuente transformación de la geomorfología costera y la alteración de la línea de costa. Esto ha implicado la pérdida de distintos elementos del patrimonio natural y cultural, como el campo de dunas de Guanarteme (Santana-Cordero et al., 2014; 2016a) o sus “mareas” orientales (Pérez-Hernández, 2015).

Otro caso significativo es el campo de dunas de Corralejo, espacio protegido por diversas figuras, a escala regional e internacional, por presentar un conjunto de características particulares (fruto de la disponibilidad de arena y de presentar altas temperaturas a lo largo del año, principalmente) que le otorga relevancia desde el punto de vista natural. Sin embargo, esas mismas características lo han convertido en un espacio de interés para el desarrollo del turismo de masas. El desarrollo de esta actividad recreativa, en un sentido amplio, ha interferido en los procesos característicos de estos sistemas, alterándolos (Cabrera-Vega et al., 2013; Hernández-Calvento et al., 2014), ha ejercido una fuerte presión sobre sus hábitats naturales (García-Romero et al., 2016; Peña-Alonso et al., 2018b) y ha transformado su paisaje (Pérez-Chacón et al., 2007; Hernández-Cordero et al., 2018).

Si bien hasta ahora ambas áreas han sido analizadas desde diversas perspectivas, y con distintas metodologías, se entiende, desde esta Tesis Doctoral, que aún hay lagunas en el conocimiento sobre los elementos patrimoniales perdidos a lo largo de estos procesos. De igual forma, falta por conocer, con mayor exactitud a la establecida hasta ahora, el grado de interferencia que las actividades humanas, tradicionales, recientes y actuales, han tenido en la dinámica natural de estos sistemas. Además, desde esta Tesis Doctoral, la recuperación de esos rasgos naturales y humanos permitiría su revitalización como parte del patrimonio natural y cultural de la sociedad canaria, con vistas a ofrecerlos a las generaciones que no han tenido ocasión de conocerlos, así como a los visitantes con interés en la historia y la cultura de las islas. En este sentido, se entiende que es posible su utilización como recursos turísticos de calidad. Por último, se entiende que, con base en estos conocimientos se podrían aportar juicios de valor, desde la perspectiva de la preservación de estos sistemas, con vistas a mejorar su gestión futura, teniendo en cuenta los atractivos paisajísticos que suponen para la población local y turista.

2. OBJETIVOS E HIPÓTESIS

* (Fuente: Elaboración propia).

Considerando los antecedentes expuestos, esta Tesis Doctoral se plantea valorar la riqueza patrimonial de áreas costeras de las islas Canarias y analizar su evolución y los cambios experimentados a lo largo de los años. En este contexto, tiene también relevancia conocer el papel que ha jugado la sociedad en estos espacios, al desarrollar usos que interfieren con los procesos naturales y alteran los elementos culturales.

Para ello, esta Tesis Doctoral toma como áreas de estudio dos ámbitos arenosos de las islas Canarias: la franja costera oriental de la ciudad de Las Palmas de Gran Canaria (LPGC) y el sistema playa-duna de Corralejo (Fuerteventura). Como método de aproximación se plantea una perspectiva geográfica e histórica.

Para el desarrollo de la investigación, se proponen los siguientes objetivos e hipótesis:

2.1. Objetivo general

El objetivo general de la Tesis es identificar, reconstruir y valorar el patrimonio natural y cultural perdido o en riesgo de desaparecer en dos tramos costeros de las islas Canarias, así como aportar recursos turísticos y didácticos que fomenten el respeto, la protección y la preservación hacia los espacios costeros insulares.

2.2. Objetivos específicos

1. Reconstruir las características patrimoniales naturales, históricas y culturales.

   1.1. Identificar y describir las playas naturales que existían a lo largo de la costa oriental de LPGC antes de la expansión de la ciudad sobre este tramo de costa. *[Objetivo del artículo 1]*

1.2. Identificar y caracterizar la naturaleza, usos del suelo, funciones y rasgos culturales de las playas naturales de la costa oriental de LPGC y sus cambios a lo largo del tiempo. *[Objetivo del artículo 1]*

1.3. Reconstruir las características geomorfológicas de la franja costera de LPGC previas a su expansión (1879). *[Objetivo del artículo 2]*

2. Conocer en profundidad los aspectos naturales costeros del pasado.

2.1. Cuantificar el área de playa perdida y la cubierta terrestre ahora desaparecida en LPGC. *[Objetivo del artículo 1]*

2.2. Cuantificar las formas del relieve perdidas en el proceso de expansión urbana de LPGC. *[Objetivo del artículo 2]*

2.3. Evaluar la pérdida, frente a la preservación, de superficies caracterizadas por presentar formas del relieve costeras en LPGC antes de 1879. *[Objetivo del artículo 2]*

2.4. Evaluar la preservación de las formas del relieve costeras actuales en LPGC. *[Objetivo del artículo 2]*

3. Identificar y valorar los elementos patrimoniales costeros culturales y paisajísticos.

3.1. Identificar, describir y valorar los elementos del patrimonio cultural que existían a lo largo de la costa oriental de LPGC antes de la expansión de la ciudad sobre este tramo de costa, en la década de los sesenta del siglo XX. *[Objetivo del artículo 3]*

3.2. Valorar el patrimonio paisajístico del sistema playa-dunas de Corralejo mediante una serie de indicadores y a través de la percepción de los usuarios de estos sistemas. *[Objetivo del artículo 4]*

4. Establecer propuestas de recuperación y gestión, de cara a la posible explotación turística, didáctica y cultural de estos dos espacios costeros insulares. *[Perspectivas]*

2.3. Hipótesis de partida

Como hipótesis de partida se plantea que la investigación, a través de fuentes y métodos geográficos e históricos, permite identificar y valorar las características patrimoniales naturales, históricas y culturales perdidas y actuales de áreas costeras de islas, de cara a favorecer la gestión de sus elementos patrimoniales.

3. ÁREA DE ESTUDIO

* Las islas Canarias vista desde el espacio. (Fuente: NASA, 2019).

El área de estudio está compuesta por dos áreas costeras ubicadas en dos islas orientales del archipiélago canario: Las Palmas de Gran Canaria, en Gran Canaria, y Corralejo, en Fuerteventura (Figura I).

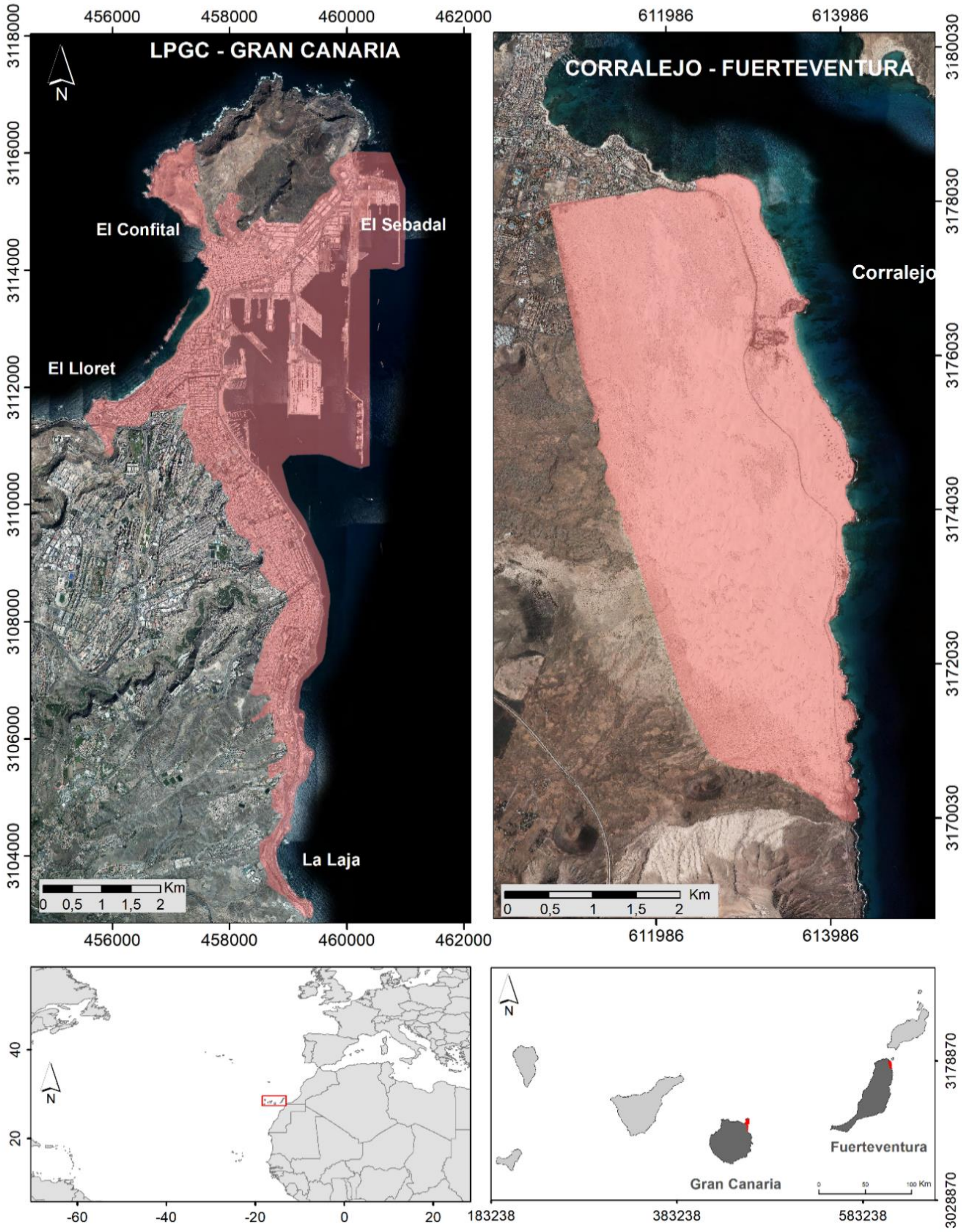


Figura I. Área de estudio.

Las islas Canarias son un archipiélago de naturaleza volcánica de punto caliente localizado en el océano Atlántico al noroeste del continente africano. El archipiélago, conformado por ocho islas y cinco islotes, se extiende 515 km de este a oeste entre 27º - 30º de latitud norte y 13º-19º de longitud oeste (Hernández-Cordero et al., 2019). Su formación volcánica abarca desde el Mioceno (unos 20,6 millones de años) hasta la actualidad, en el cual, dentro de este contexto geológico, las islas orientales son las más antiguas y las occidentales las más jóvenes (Carracedo et al., 1998). Esta particularidad se refleja en las áreas costeras donde las más recientes presentan un litoral escarpado con pequeñas calas formadas por arenas negras y piedras asociadas a desembocaduras de barrancos o acantilados y, las orientales, muestran mayor presencia de llanuras costeras extensivas y rectilíneas debido a su exposición progresiva a los procesos erosivos (Pérez-Chacón et al., 2019). Estos sistemas sedimentarios costeros están presentes en todas las islas y ocupan en la actualidad el 2,54% de superficie (Hernández-Cordero et al., 2019), pero, es en las islas orientales, donde se desarrollan más predominantemente por dominar geoformas costeras bajas de composición arenosa y orgánica. El clima de las islas Canarias es subtropical donde la aridez caracteriza sus áreas costeras al tener temperaturas medias anuales superiores a 18ºC y precipitaciones irregulares e inferiores a 100 mm por año (Cabrera-Vega et al., 2013) .

Estas características insulares hacen que sus áreas costeras presenten una alta singularidad y rareza debido a su naturaleza volcánica, sus condiciones oceánicas y climáticas, su biodiversidad y su ocupación antrópica (Pérez-Chacón et al., 2019). Si consideramos todos estos factores, los procesos costeros de estas islas dan lugar a diversas formas geomorfológicas que hacen que estos espacios sean únicos y diferentes con respecto a otras áreas continentales (Cabrera-Vega et al., 2013). En ellas, los sistemas sedimentarios son lugares singulares por su rareza en las islas oceánicas de puntos calientes debido a: 1) la aridez; 2) a las diferencias del tamaño y cobertura vegetal por sus especies endémicas o comunidades similares a las de las costas africanas y macaronésicas (Hernández-Cordero et al., 2015a); 3) por sus sedimentos principalmente de origen marino (chonchas, moluscos etc.) o volcánicos (por erosión de barrancos y acantilados) (Hernández-Calvento y Mangas, 2004); y 4) por los vientos constantes e intensos (alisios) que hacen que su dinámica sedimentaria corresponda a un modelo cíclico de entrada y salida de sedimentos (Hernández Calvento 2006; García-Romero et al., 2016). Pero a su vez, estas particularidades hacen que las áreas litorales de las islas de Canarias y, especialmente, los sistemas sedimentarios eólicos, sean altamente vulnerables y frágiles debido a los diversos factores naturales (relacionados con la insularidad y localización) y por las alteraciones producidas por las acciones antropogénicas durante todo el año por no haber estacionalidad vacacional (Peña-Alonso et al., 2018b; Hernández-Cordero et al., 2019).

3.1. Las Palmas de Gran Canaria (LPGC)

La ciudad de Las Palmas de Gran Canaria se encuentra situada al noreste de la isla de Gran Canaria. Gran Canaria, con unos 14,5 millones de años (Pérez Torrado 2000), es la tercera isla más antigua del archipiélago (Carracedo et al., 1998). Su historia geológica se compone de 3 períodos volcánicos principales (el Ciclo I tuvo lugar durante el Mioceno, el Ciclo II durante el Plioceno y el Ciclo III durante el Cuaternario), separados en el tiempo por periodos de inactividad volcánica dominada por procesos erosivos (IGME, 1990). La diversidad geomorfológica de Gran Canaria caracterizada por un relieve abrupto erosivo se representa expresamente en la costa, al predominar las costas rocosas, los acantilados marinos y las plataformas costeras (Ferrer-Valero et al., 2017).

LPGC se extiende mayoritariamente sobre una plataforma sedimentaria de dos niveles. El nivel superior, donde se asienta la “ciudad alta”, está compuesto por la Formación

Detrítica de Las Palmas (FDLP), resultado de la erosión del edificio insular en largos periodos de inactividad volcánica durante el Mioceno superior y Plioceno (de ~9 a ~2,8 ma. AP.). Con posterioridad, se habría producido una significativa elevación isostática de la costa hasta su nivel actual. El nivel inferior, donde se emplaza la “ciudad baja”, está compuesta por la terraza Jandiense, o Terraza Baja de Las Palmas, cuya formación se atribuye a una transgresión marina hace aproximadamente 110.000 años. Este nivel se caracteriza por la presencia, a 8-14msnm, de depósitos marinos con *Strombus bubonius* y *Thais haemastoma* (Linné), fauna típica de aguas más cálidas. Entre ambos episodios (de ~1 m.a. a ~37.000 años) se desarrolló, al noreste, el complejo volcánico de La Isleta. La posición de La Isleta respecto a los vientos y corrientes marinas dominantes favoreció la acumulación sedimentaria y la formación de un tómbolo, que constituye el istmo de Guanarteme, que une La Isleta con el resto de la isla. Este espacio se enmarcaba por la presencia de dos playas arenosas: al oeste Las Canteras y al este Las Alcaravaneras (Santana-Cordero et al., 2014).

La desaparición o alteración de diversos accidentes geomorfológicos costeros de la ciudad como campos de dunas, terrazas costeras, desembocaduras de barrancos, acantilados o playas se ha producido constantemente durante el periodo de 1879 y 1980 para dar respuesta al crecimiento poblacional, ampliar y modernizar instalaciones portuarias, generar nuevas vías de comunicación y espacios edificables. Estas transformaciones implicaron la pérdida de elementos patrimoniales tanto naturales como culturales. Como resultado de estos cambios, el sector noroccidental de nuestra área de estudio se encuentra protegida mediante la figura legislativa regional “Paisaje Protegido de La Isleta” (Gobierno de Canarias) que protege el paisaje natural volcánico de La Isleta y parte de El Confital, los cuales, se han podido conservar ante la incesante extensión urbana.

3.2. Corralejo

El sistema dunar de Corralejo, con una extensión actual de 1812,4 ha y orientado en dirección N-S (García-Romero et al., 2016) se encuentra situado en el norte de la isla de Fuerteventura, en el municipio de la Oliva. Fuerteventura, con unos 20,2 millones de años, es la isla más antigua del archipiélago y la más próxima al continente africano. Su historia geológica está compuesta por diferentes fases eruptivas sub-aéreas formadas por tres escudos independientes (orientados de NE a SO), entre el Mioceno Inferior y Medio (hasta 12 Ma), por una fase prolongada de inactividad volcánica y por otra de reactivación durante el periodo Plio-Cuaternario (<5 Ma) (Ferrer-Valero et al., 2018; Hernández-Cordero et al., 2019; Pérez-Chacón et al., 2019).

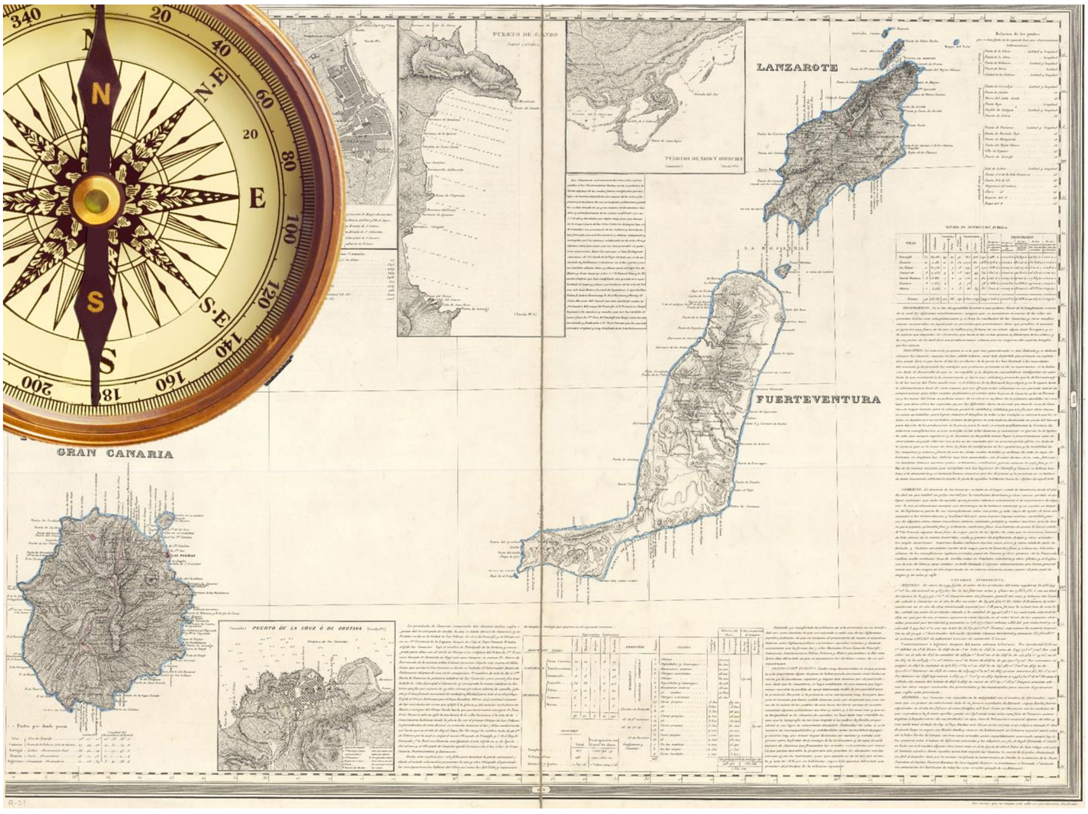
Este sistema de dunas costeras áridas pre-Cuaternarias es, según la clasificación de Hesp y Walker (2013), un campo de dunas transgresivo, en el cual sus arenas se han depositado sobre una plataforma de lava formando un entorno único con características mixtas eólico-volcánicas (García-Romero et al., 2016). El sistema realiza una dinámica eólica-marina cíclica en el cual las arenas alcanzan el interior del sistema por el norte y noreste de la isla, son desplazadas hacia el sur por los vientos alisios donde vuelven al mar y éste los devuelve de nuevo a sus áreas de entrada (Malvárez et al., 2013).

El entorno del campo de dunas está configurado hacia el oeste y sur por malpaíses y centros de erupción volcánica como la montaña Roja (312 m). Hacia el norte se encuentra la urbanización de Corralejo, al noreste la isla de Lobos y al este se encuentra delimitado por el litoral y sus playas. Según Criado et al. (1987; 2004), se diferencian tres ámbitos en el sistema: la vieja jable, el jable de arcilla y el jable actual. Las dos primeras presentan dunas estabilizadas por la vegetación y sectores donde afloran acumulaciones de areniscas consolidadas de coloración rojiza. Mientras que en la vieja Jable presenta arenas organógenas cementadas con carbonato de calcio, en la Jable de arcilla sus areniscas son de composición terrosa debido a su alto porcentaje de limos y arcillas y, además, por su combinación con rocas volcánicas y arenas no cementadas eólicas (García-Romero et al., 2016). Por su parte, el Jable actual está integrado por arenas y dunas móviles generalmente, de tipo barjana, y también por dunas transversales. Todas ellas están integradas por depósitos marinos antiguos, procedentes de la plataforma litoral que se extiende al norte y noreste de Fuerteventura (Alonso et al., 2011). En cuanto a la vegetación, predominan los arbustos xerófilos y halófilos como *Traganum moquinii* (presente en la costa noroccidental africana), *Salsola vermiculata, Polycarpaea nivea, Launaea arborescens, Euphorbia paralias, Cyperus capitatus*, entre otras (Hernández-Cordero et al. 2015b; Peña- Alonso 2015).

Las alteraciones percibidas en el sistema dunar de Corralejo se deben a la incidencia del desarrollo turístico en el núcleo urbano-turístico construido al norte del área (zona de entrada de sedimentos), a la infraestructura viaria longitudinal y dos hoteles que atraviesan al sistema (Pérez-Chacón et al., 2019). Este bloqueo sedimentario que ha cambiado la dinámica eólica junto con el agotamiento e insuficiencia de los bancos de sedimentos marinos que alimentan al campo dunar (Jiménez et al., 2006; Hidtma-Iberinsa, 2005) han disminuido los aportes y el movimiento de las dunas (Alonso et al., 2011). La pérdida sedimentaria ha transformado significativamente su geomorfología litoral al haber disminuido las dunas libres y por el contrario aumentado las dunas estabilizadas y de montículos o al surgir superficies de deflación (García et al., 2016).

Como resultado de estas interacciones, este espacio se encuentra protegido por diversas figuras legales regionales e internacionales (Parque Natural-Gobierno de Canarias; Áreas Especiales Protegidas para Aves [ZEPA]-Unión Europea y Áreas Especiales de Conservación [SAC]-Unión Europea) debido a sus características y valores naturales que lo han convertido en un sistema singular (Pérez-Chacón et al., 2019).

4. FUENTES Y MÉTODOS GENERALES



* Mapa islas Canarias 1849. (Fuente: Imágenes de Google; IGN, 2019).

Con el fin de dar respuesta a los objetivos planteados, la metodología desarrollada en este trabajo se basa en la secuencia representada en la figura II, cuya base es la utilización de fuentes y técnicas mixtas, históricas y geográficas.

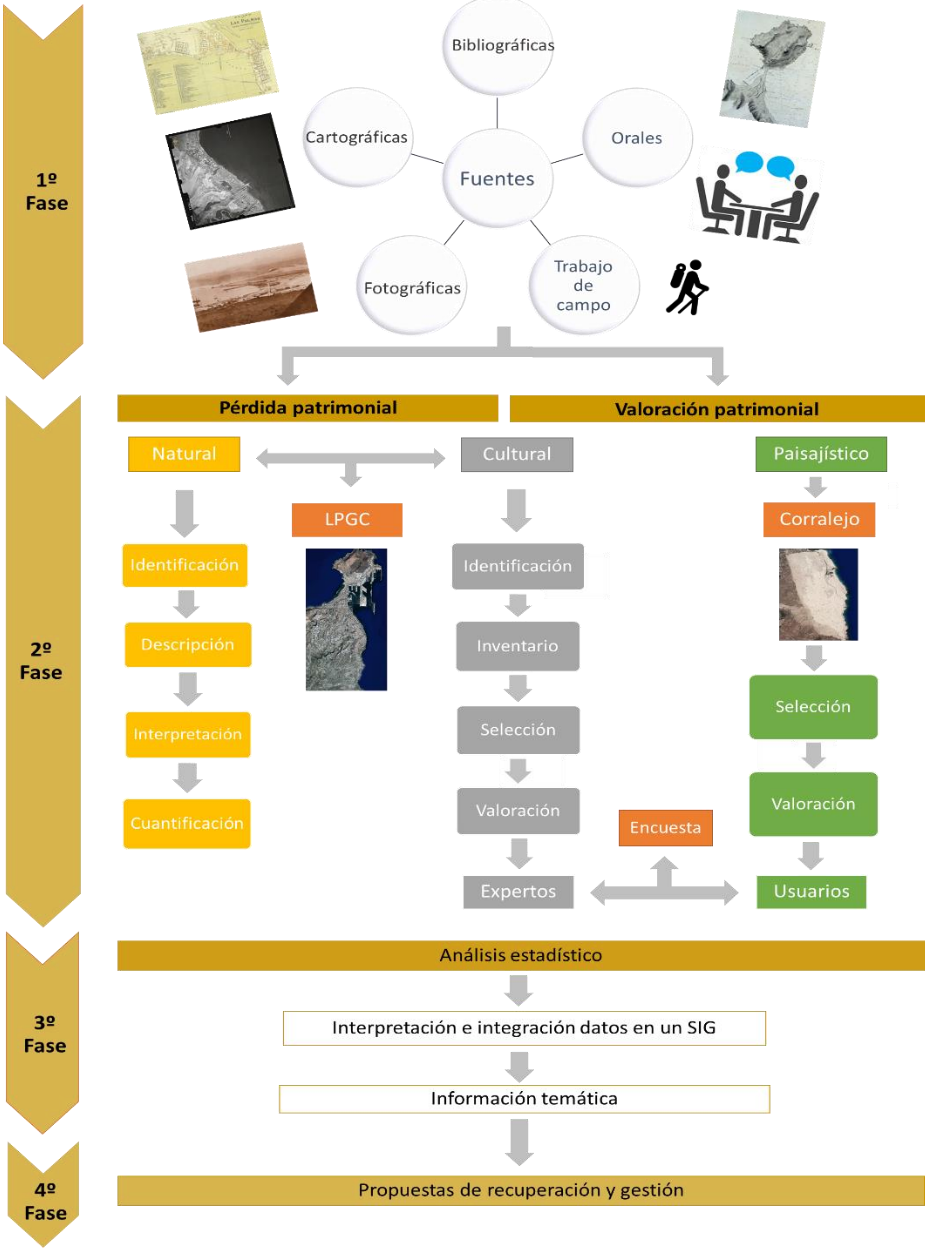


Figura II. Secuencia metodológica seguida en esta investigación.

La metodología ha estado conformada por cuatro fases: la primera se ha basado en la búsqueda y consulta de diferentes fuentes bibliográficas, cartográficas, fotográficas, orales y trabajo de campo (tabla I). La segunda, ha conformado el cuerpo de la investigación, al presentar las etapas de identificación, inventario, descripción, selección, cuantificación y valoración del patrimonio desaparecido y preservado. La tercera etapa, ha consistido en la integración de esa información en herramientas estadísticas y en sistemas de información geográfica (SIG) con el fin de analizar e interpretar los resultados de manera temática y analítica (tabla I). Por último, la cuarta etapa plantea una serie de propuestas para la mejora de la gestión patrimonial de los ámbitos costeros estudiados.

Tabla I. Características de las fuentes y metodología usada en la investigación.

<table>
<tr><th rowspan="14">*Fuentes*</th><th colspan="2">TIPO</th><th colspan="2">CARACTERÍSTICAS</th><th>REFERENCIAS</th></tr>
<tr><td colspan="2">Bibliográficas</td><td colspan="2">Publicaciones locales e internacionales históricas y actuales</td><td>Capítulo “referencias”</td></tr>
<tr><td rowspan="3">Cartográficas</td><td>Históricas</td><td colspan="2">Plano de la ciudad de Las Palmas de Fernando Navarro, de 1910
Plano de Benito Chías Carbó, en 1914.
Plano de la bahía de Las Palmas de 1879, de la Dirección de Hidrografía.</td><td>Tous y Herrera (1995).</td></tr>
<tr><td rowspan="2">Actuales</td><td colspan="2" rowspan="2">Mapa topográfico
Modelo digital del terreno
Mapa geológico</td><td>IDECanarias (2019)</td></tr>
<tr><td>IGME (2019)</td></tr>
<tr><td rowspan="4">Fotográficas</td><td rowspan="2">Aéreas</td><td colspan="2">Fotografía aérea 1954</td><td>CECAF (1954)</td></tr>
<tr><td colspan="2">Fotografía aérea 1981</td><td>IDE Gran Canaria (2019)</td></tr>
<tr><td>Ortofotos</td><td colspan="2">Ortofoto 1966
Ortofoto 2002
Ortofoto 2006
Ortofoto 2018</td><td>IDECanarias (2019)</td></tr>
<tr><td>Convencional</td><td colspan="2">Fotografías localizadas en distintas páginas web locales.</td><td>FEDAC (2019)
Las Palmas ayer y hoy (2019)
Recuerdos de Gran Canaria (2019)
Gran Canaria: Imágenes del ayer (2018)</td></tr>
<tr><td colspan="2">Orales</td><td colspan="2">Nueve entrevistas a personas nacidas entre 1919-1953</td><td>Entrevistas</td></tr>
<tr><td colspan="2">Trabajo de campo</td><td colspan="2">3 campañas en 2018
1 campaña en 2020</td><td>Trabajo de campo</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="6">*Metodología*</td><td colspan="2" rowspan="3">Estadísticas</td><td colspan="2">Cálculos %, media, desviación típica etc.</td><td rowspan="3">Representación por medio de gráficos y tablas</td></tr>
<tr><td colspan="2">Correlación de Spearman</td></tr>
<tr><td colspan="2">Análisis de diferencias significativas (Test de Kruskal-Wallis)</td></tr>
<tr><td colspan="2" rowspan="2">Encuestas</td><td>Online</td><td>2 de marzo a septiembre 2018</td><td rowspan="2">Encuestas</td></tr>
<tr><td>Presencial</td><td>Marzo - octubre 2020</td></tr>
<tr><td colspan="2">Integración en un SIG</td><td colspan="2">Mapa localización playas del litoral oriental de LPGC
Mapa localización elementos patrimoniales cultural del litoral oriental de LPGC.
Mapas geomorfológicos (3)
Mapa trama urbana
Mapa usos de suelo
Mapa estado de preservación de las geoformas</td><td>Geographic Information Systems (GIS). ArcGIS.</td></tr>
</table>

No obstante, en cada artículo que se presenta en el apartado de resultados, se especifican de forma detallada los aspectos metodológicos.

5. RESULTADOS

* Punta de Tivas (Corralejo, Fuerteventura). (Fuente: Elaboración propia, 2020).

En este apartado se presentan los resultados de esta Tesis Doctoral. La investigación está conformada por cuatro artículos (tabla II), de los cuales, tres han sido publicados en revistas internacionales con índice de impacto y el último se encuentra en revisión.

Tabla II. Características de las publicaciones que conforman esta Tesis Doctoral.

<table>
<tr><th rowspan="2">Publicaciones</th><th rowspan="2">Revistas</th><th rowspan="2">Índice impacto</th><th colspan="2">Cuartil</th><th rowspan="2">Revisiones</th><th rowspan="2">Revisores</th></tr>
<tr><th>SJR</th><th>JCR</th></tr>
<tr><td>Artículo 1*</td><td>Ocean & Coastal Management</td><td>2.595</td><td>Q1-Q2</td><td>Q2</td><td>1</td><td>3</td></tr>
<tr><td>Artículo 2**</td><td>Journal of Coastal Conservation</td><td>1.264</td><td>Q2-Q3</td><td>Q3-Q4</td><td>1</td><td>1</td></tr>
<tr><td rowspan="3">Artículo 3***</td><td rowspan="3">Land Use Policy</td><td rowspan="3">3.573</td><td rowspan="3">Q1</td><td rowspan="3">Q1</td><td rowspan="3">3</td><td>3</td></tr>
<tr><td>2</td></tr>
<tr><td>2</td></tr>
<tr><td>Artículo 4****</td><td>En revisión</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

* ***Artículo 1:*** Pérez-Hernández, E; Santana-Cordero, A.M., Hernández-Calvento, L., Monteiro-Quintana, M.L. (2020). Beach surface lost historically: the case of the eastern coast of Las Palmas de Gran Canaria (Canary Islands, Spain). *Ocean and Coastal Management*, 185, 105058.

** ***Artículo 2:*** Pérez-Hernández, E; Ferrer-Valero, N; Hernández-Calvento, L. (2020). Lost and preserved coastal landforms after urban growth. The case of Las Palmas de Gran Canaria city (Canary Islands, Spain). *Journal of Coastal Conservation*, 24(26), 1-17.

*** ***Artículo 3:*** Pérez-Hernández, E; Peña-Alonso, C; Hernández-Calvento, L. (2020). Assessing lost cultural heritage. A case study of the eastern coast of Las Palmas de Gran Canaria city (Spain). *Land Use Policy*, 96, 104697.

**** ***Artículo 4:*** Pérez-Hernández, E; Peña-Alonso, C; Fernández-Cabrera, E; Hernández-Calvento, L. (En revisión). Assessing the scenic quality of transgressive dune systems on volcanic islands. The case of Corralejo (Fuerteventura island, Spain).

A continuación, se presentan los cuatro artículos que conforman la investigación:

5.1. Beach surface lost historically: the case of the eastern coast of Las Palmas de Gran Canaria (Canary Islands, Spain)

Eva Pérez-Hernández, Aarón M. Santana-Cordero, Luis Hernández-Calvento, María L. Monteiro-Quintana

Ocean and Coastal Management, 185, 105058

https://doi.org/10.1016/j.ocecoaman.2019.105058

*Playa de Santa Catalina (Alcaravaneras), 1940-1950. (Las Palmas ayer y hoy, 2019).

Abstract

Land use changes cause significant loss of natural and cultural elements. This is the case of the eastern coast of Las Palmas de Gran Canaria (LPGC) (Canary Islands), which was heavily transformed between the late XIX century and the 1960s by increased urban sprawl. Most of the beaches were covered by the city and, therefore, disappeared. The aim of the study is to identify and describe the natural characteristics of the beaches lost between 1879 and 2017 along the eastern coastline of LPGC, as well as to quantify the lost surface area. The changes in land uses that have taken place around these beaches are also addressed. For these purposes, historical sources (documentary, graphic, cartographic and oral) and geographic information systems (GIS) have been used. The results show that, since 1879, eleven beaches, with an extension of 13.19 ha, have disappeared and, with them, their natural and cultural features. Eight land uses were identified: fishing, defensive, agriculture, port, industrial, commercial, residential and recreational. It was also found that beaches from the northern and central sectors had more varied uses than those of the southern sector, which tended to be mainly used for fishing. The results are analyzed at both global and local scale. At global scale, different effects of globalization on coastal urban areas are discussed. At local scale, a discussion is undertaken on how the knowledge acquired can be used to improve future urban planning and to rebuild the memory of the city's coast for its inhabitants and visitors.

Keywords: Coastal transformation, land cover, lost beach area, Canary Islands.

1. INTRODUCTION

Coastal lands are areas with numerous natural and strategic values that have long attracted human populations, especially since the mid-XX century (Martínez et al., 2007;

Ariza, 2011). Currently, 50-70% of the global population is concentrated in such areas (Mimura et al., 2007) and nearly 30% of coastal land has been altered as the result of human activities (Martínez et al., 2007; Ferrer-Valero et al., 2017). Land use development and human activities have triggered an important littoralisation process, leading to significant changes to the coast (Lin, 1996; Bajocco et. al., 2012) and, in some cases, to the disappearance of previous land cover over entire coastal stretches (Santana-Cordero et al., 2014). Coasts are dynamic, complex systems and their features are constantly changing because of both natural and human factors (Kurt et al., 2010; Ponte et al., 2016). The natural processes that induce such changes include, amongst others, sea level variations due to global warming, wave climate alterations and coastal drift (Schnack, 2002; Caires et al., 2006; Stanica and Ungureanu, 2010; Hemer et al., 2013; IPCC, 2014; Dabrio and Polo, 2015; Johnson et al., 2015; Preston et al., 2018; Glavovic et al., 2019). The transformations to them that human activities can result in are, in many cases, irreparable. One of the most damaging activities for these areas has been urban expansion and, since the mid-XX century, the growth of tourism (Nordstrom, 1994; Gormsen, 1997; El Banna and Frihy, 2009; Kiss et al., 2009; Dawson and Smithers, 2010; Kurt et al., 2010; Bochev van der Burgh et al., 2011; Jackson and Nordstrom, 2011; Bajocco et al., 2012; Hepcan et al., 2013; Flor-Blanco et al., 2013; Malavasi et al., 2013). Residential use, port and tourist infrastructures, and recreational activities place great pressure on the natural processes (e.g. aeolian transport, sea currents, wind flows) that form the coastal landscape (Faggi and Dadon, 2011). These processes are aggravated in islands, which are especially vulnerable areas due to their more limited and scarce resources (Mimura et al., 2007; Hay, 2013; Santana-Cordero et al., 2016; Ferrer-Valero et al., 2017).

A clear example of these changes induced by human activities can be found on the eastern coast of Las Palmas de Gran Canaria (LPGC) city (Canary Islands, Spain). The evolution experienced by this city has had important consequences for land use and land cover, with major alterations to the shoreline. This particular stretch of coast has experienced several transformations since the late XIX century, especially in the 1960s, as a consequence of socioeconomic changes (Martín Galán, 1980, 2001, 2007, 2008, 2009; Santana-Cordero et al., 2017). Occupation of this zone increased in this latter period due to expansion of the port and road infrastructures, as well as the desire to acquire new land for the construction of buildings. Population growth can be added to the constant modernization of buildings and infrastructures as causes of the transformation of most of this coast. In this process, many natural features were eliminated and, to a large extent, virtually forgotten about.

In view of all the above, in this research work we consider the following questions: How was this coast before its transformation? What were the uses and functions of the beaches? How much of the original beach area has been lost?

To answer these questions, we undertook a historical reconstruction of the changes that have taken place, defining what this coastal area was like in terms of its natural features and determining its previous uses and functions. Research studies of this type has been taking place for roughly four decades for various kinds of environment which have experienced historical changes due to the development of human activities (Bürgi and Gimmi, 2007; Grossinger et al., 2007; Hoffman and Rohde, 2007; Ouzts, 2007; McAllister, 2008; Stäuble et al., 2008; Bator, 2009; Gautreau, 2010; McLeman et al., 2010; Stein et al., 2010; Jackson and Nordstrom, 2011; Bajocco et al., 2012; Roig Munar et al., 2012; Ponte et al., 2016, Santana-Cordero et al., 2016).

In this kind of research, historic sources, in addition to others, geographic and bibliographic, are of primary importance to enable an accurate reconstruction of the processes that have taken place. Precisely because this type of research works with historic sources, these studies are frequently faced with the difficulty of finding detailed information as, in many cases, there are no written or graphic records of the elements or events that are of interest for the study. For these reasons, oral sources can be essential for the reconstruction of recent events (to around 50 years ago), enabling information obtained from other sources to be contrasted as well as providing new data (Sloan, 2008; Hernández Calvento et al., 2013).

Given these observations and in accordance with the aforementioned research questions, the general aim of this paper is to identify and describe the natural beaches that existed along the eastern coast of LPGC before the expansion of the city over this stretch of coast. In line with this general aim, the specific objectives of this study are: (1) to identify and characterize the nature, land uses, functions and cultural traits of the natural beaches of the eastern coast and their changes over time; and (2) to quantify the lost beach area and now-disappeared land cover.

2. STUDY AREA

The city of LPGC is located in the NE of Gran Canaria island (Canary Islands, Spain). This study focuses on the eastern coastline of LPGC, from the beach of El Sebadal (in the north) to that of La Laja (in the south). The length of the studied shoreline is 19.74 km and the total area is 16.35 ha (Figure 1).

From a geological point of view, the northern sector overlies Cycle III lava flows (less than 2 Ma) and a geological layer called *Terraza Baja de Las Palmas* (Lower Terrace of Las Palmas), a narrow sedimentary coastal platform that has fossiliferous marine deposits containing *Strombus bubonius* and *Thais haemastoma* (Linné), typically found today in warmer climate zones of equatorial Africa (IGME, 1990). This sector of the eastern coast of LPGC was characterized by organic sand beaches of the dune system located on the Guanarteme isthmus. Further south, the geological setting changes: lava flows appear, one from the first volcanic period (14-8 Ma) and another, further south again, from the second one (about 5 Ma). Consequently, towards the south, the coast was mainly formed by rolling stone beaches with abundant beachrock. At low tide, wide surfaces of dark sand (due to the dominance of volcanic materials) would be revealed (Pérez Hernández and Hernández Calvento, 2017). From an ecological point of view, the vegetation in the study area is disperse and scarce. The species found include *Traganum moquinii, Zygophyllum fontanesii, Lotus kunkelii* (endemic species), *Euphorbia paralias, Cyperus laevigatus, Polycarpaea nivea, Schizogyne sericea* and *Astydamia latifolia* (Banco de Datos de Biodiversidad de Canarias, 2016; GEVIC, 2016). Additionally, in the sea were abundant algae and *Cymodocea nodosa*, among others (Banco de Datos de Biodiversidad de Canarias, 2016; GEVIC, 2016). Avifauna, including Alcaraván (*Burhinus oedicnemus distinctus*) and other migratory birds, and marine fauna associated with no longer existing reefs were also found in this area.

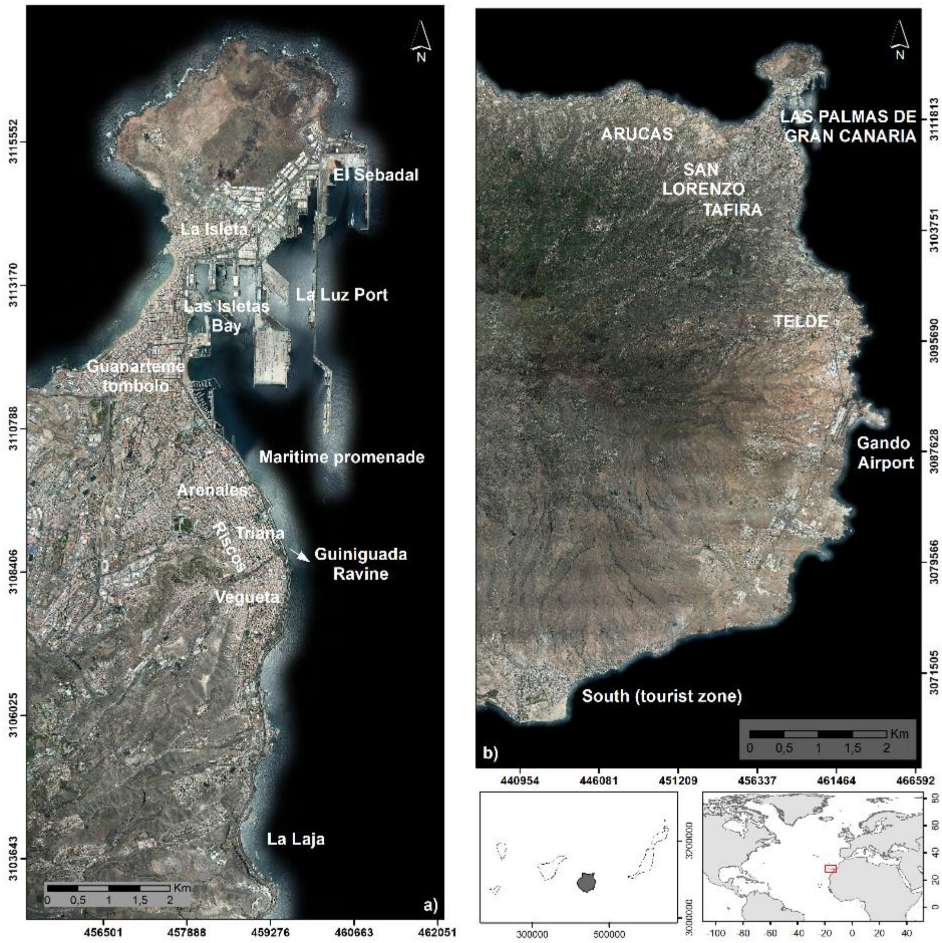


Figure 1. a) Study area; b) Partial maps of Gran Canaria with main place names cited in the historic context.

The city of LPGC was founded by Spanish conquerors in 1478 in the area now known as Vegueta. The city gradually began to spread in the direction of the Guiniguada ravine. A commercial district named Triana became established as the result of slow but continuous growth which continued to the late XVI century (Martín Galán, 1980). In this phase, the city was walled, forming the historical perimeter of the city which was then comprised of the areas or districts of Vegueta and Triana. In the following two centuries, there were no important changes to the urban fabric of the city, except for the emergence of the first suburbs, called '*riscos*' (this term, "cliffs" in English, refers to neighborhoods built on the slopes of the ravines and the high marine terrace), inhabited by the most disadvantaged classes.

Towards the end of the XVIII century, with the expansion of foreign trade and a modernizing impulse in line with the ideas of the Enlightenment, the city partly changed its physiognomy, although it continued to be comprised of the same districts.

In the XIX century, an expansion of the city took place following access routes that connected the city with other inland towns: to the south with Telde, to the west with Tafira and San Lorenzo, and to the northwest with Arucas (Martín Galán, 1980). This stage concluded in 1883 when construction of the port of Las Palmas, Puerto de (Refugio de) La Luz, began. In the mid-XIX century, the collapse of the northern walls took place in the direction of the future port, with a new district emerging (Arenales) from 1858 onwards. The construction of the port saw the city experience a major transformation (Santana-Cordero et al., 2016a). The resulting significant changes to its physiognomy saw the appearance of Guanarteme district on the tombolo between the city and La Isleta (Martín Galán, 1980). Conurbation between the original city and the port thus began to take place. In the period 1877-1930, the city population grew from 20,756 to 78,214 inhabitants (Noreña and Pérez, 1992) as people from the inland regions of the island, and from Lanzarote and Fuerteventura, came to the new city neighborhoods. This rise in population resulted in increased urban functionality and a growth in port activity.

For the Canary Islands as a whole, the 1960s saw the commencement of the mass-tourism industry, especially in Gran Canaria and Tenerife. Tourism became the economic growth engine of these islands, triggering a transformation from an agriculture-based to a tourism-based socioeconomic system (Santana-Cordero et al., 2017). Construction, transport, and tourism with its associated services were the main lines of development of the Canary Island economy. In Gran Canaria, tourism was developed mainly in the south of the island, exploiting its exceptional climate and the presence of sandy beaches. In this context, the rapid growth in airline connections with different European cities made Gran Canaria airport and the roads that connected it the main development axes of the island.

In this context, port extensions developed eastwards, occupying the south coast of La Isleta and leaving free almost all the coastal front, except for a marina constructed beside *Las Alcaravaneras* (Martín Galán, 2008). The city continued to grow. In the 1960s and 1970s, the most notable urban interventions were the spread of Triana district towards the coast (CIDELMAR project drawn up by Secundino Zuazo in 1962), the “Plan Parcial del Paseo Marítimo” from 1964, and the development of the highway to the south of the island (Machín and Ruiz, 2006) which also involved construction of a 7 km long coastal road in Las Palmas. Through these projects, some 250 m were gained in the direction of the sea, using the former harbor of *Las Palmas* as a limit of the expansion towards the north.

In short, the fact that space had to be gained from the sea along the eastern coast was due to the need to build a new, wide-gauge road that would facilitate the transport of goods and passengers along the eastern axis of the island, joining the main port (La Luz, in LPGC), the airport and the new tourist areas in the south of the island (Martín Galán, 2008). However, this new road could not cross the tombolo of Guanarteme which, along with its dune system, had disappeared by this time and had been fully built over (Santana-Cordero et al., 2014; 2016a). The option of building this new highway along the west coast, after circling the city, was not an option either due to the economic interests of the concentrated urban-tourism development that had taken place in the area, with the construction of numerous hotels, apartments and residences, as well as the presence of Las Canteras, one of the island’s longest and most impressive sand beaches (Di Paola et al., 2018).

3. MATERIALS AND METHODS

Bibliographic references from scientific articles and local publications on the study area - particularly those of Martín Galán (2001, 2007, 2008, 2009) - were an important resource for this work. Also important were various historical maps, most notably the 1879 *Plano de la Bahía de Las Palmas* (Map of the Bay of Las Palmas) which shows the coastline before the rapid growth of urban expansion, and 3 maps of different dates (*Plano de la ciudad de Las Palmas* and *Plano del ensanche del Puerto de la Luz* by Fernando Navarro and *Plano de Las Palmas* by Benito Chías Carbó) (details in Table 1), contained in the map collection of Tous and Herrera (1995). These cartographic documents enabled the identification of natural coastal heritage sites (beaches) as well as the toponymical names used at the beginning of the XX century. Current maps were also used, including the geologic map consulted using the SDI (spatial data infrastructure) of the Canary Islands (Grafcan, S.A. – Government of the Canary Islands), the geologic map of LPGC and Santa Brígida (scale: 1: 25,000), from the *Instituto Tecnológico Geominero de España* (Geological and Mining Institute of Spain) and *Google Earth.*

Table 1. Characteristics of historic maps and other cartographic documents.

Date	Document type / title	Scale / resolution	Producer	References
1879	*Plano de la bahía de Las Palmas*	1:20000	Directorate of Hydrography	Tous and Herrera, 1995
1910	*Plano de la ciudad de Las Palmas*	1:5000	Fernando Navarro	Tous and Herrera, 1995
1910	*Plano del ensanche del Puerto de la Luz*	1:5000	Fernando Navarro	Tous and Herrera, 1995
1914	Plano de Las Palmas	1:13000	Benito Chías Carbó	Tous and Herrera, 1995
1990	Geologic map (Las Palmas de Gran Canaria and Santa Brígida)	1:50000	Geological and Mining Institute of Spain	IGME, 1990
2010	Geologic map	1:50000	SDI Canary Islands	IDECanarias, 2019
1954	Aerial photographs	1:2650	CECAF	CECAF, 1954
1966	Orthophoto	1:7000	SDI Canary Islands	IDECanarias, 2019
2017	Orthophoto	25 cm/pixel	SDI Canary Islands	IDECanarias, 2019

Aerial photographs from 1954, acquired from the *Centro Cartográfico y Fotográfico del Ejército del Aire de España* (Cartography and Photography Centre of the Air Force of Spain) (CECAF, 1954), were used to enable identification and mapping of the areas of interest, as well as two orthophotos from 1966 and 2017.

Several pictures were consulted from the FEDAC catalogue (*Fundación para la Etnografía y el Desarrollo de la Artesanía Canaria* - Foundation for Ethnography and the Development of Canarian Crafts, 2019), as well as the websites *Las Palmas Ayer y Hoy* (2019), *Recuerdos de Gran Canaria* (2019) and *Gran Canaria. imágenes del ayer* (2018) (unpublished images). These were used to identify specific elements in the territory from the late XIX century to the 1970s.

Fieldwork was also performed to collect oral sources. A total of nine interviews were conducted with a group of people who were born between 1919 and 1953. The selection of the people who were interviewed was based on two criteria: (1) people who lived close to the city coast before its transformation; and (2) distribution over the three sectors of the coast which formed the area of study in this work (3 in the northern sector; 5 in the central sector and 1 in the southern sector). The interviews, carried out in 2015 between March and May, allowed information gaps to be filled and information obtained from other sources to be contrasted. The interview comprised a semi-structured conversation between two people (interviewer and narrator) (Fogerty, 2005) in which different resources were used to correctly identify the natural heritage, including a guide with a series of open and closed questions (Figure 2), a tape recorder and historic photographs.

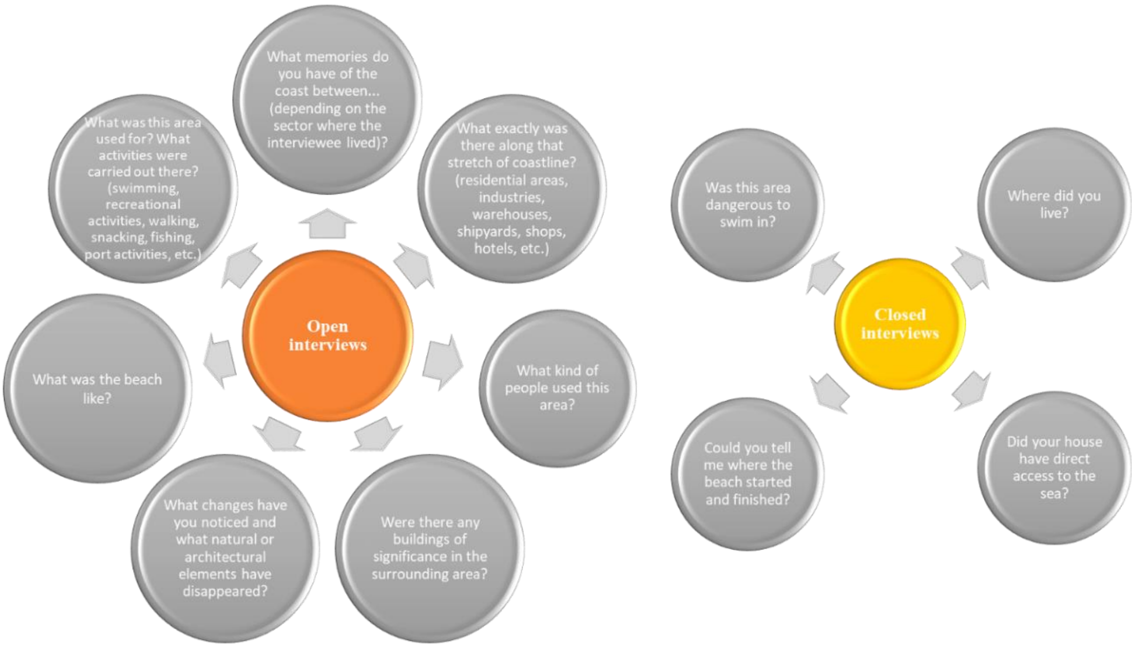


Figure 2. Type of question asked during the interviews.

The information obtained was integrated into a GIS, which allowed us to locate all elements of interest on the aerial photograph from 1954 and the current orthophoto (2017). In doing so, it was necessary to geometrically correct the 1954 aerial photographs. This allowed us to detect and show the coastal changes between 1954 and 2017, using the wet mark to digitalize the shorelines (Ojeda, 2000) and calculate the dry beach areas. The two documents were compared to determine which of the studied places no longer existed. Finally, this process enabled a calculation of the so-called lost heritage.

Notwithstanding the above, it should be acknowledged that the two documents contained a series of errors due to both the geometric adjustment and digitalization processes. These errors (Table 2) were calculated following Robinson et al. (1987) and García Romero et al. (2016). It should also be noted that there may be some temporal variation in the coastline, because the tidal range in the study area is about 3 m maximum. However, the fact that, in general, the coast in the study area is reflective and presents a rocky basement minimizes the effect of the tidal range. In any case, the accumulated values of these errors are lower than the changes produced in the coastline by urban expansion, some 250 m, as previously mentioned in the Study Area section.

Table 2. Geometric adjustment and delineation errors

Document type	RMS (m)	Error delineation (m)
Orthophoto (2017)	< 1.5 m	1 m
Aerial photographs (1954)	3 m (max.)	0.54

4. RESULTS

4.1. Beach identification

The reconstruction made using the historic sources allowed us to identify the existence in 1879 of 14 natural beaches along the eastern coastline of LPGC, and in 1954 of 12. Of these, only three remain (Figure 3; Table 3). According to their location and considering the type of geological material, the beaches can be divided into three sectors: northern (*Sebadal, La Luz* and *El Refugio*); central (*Santa Catalina-Alcaravaneras, Lugo, El Caletón, Venegas, Triana* and *San Agustín*) and southern (*Las Tenerías, San Cristóbal, La Cardosa, Aguadulce, Bajo de La Laja* and *La Laja*) (Figure 3; Table 3).

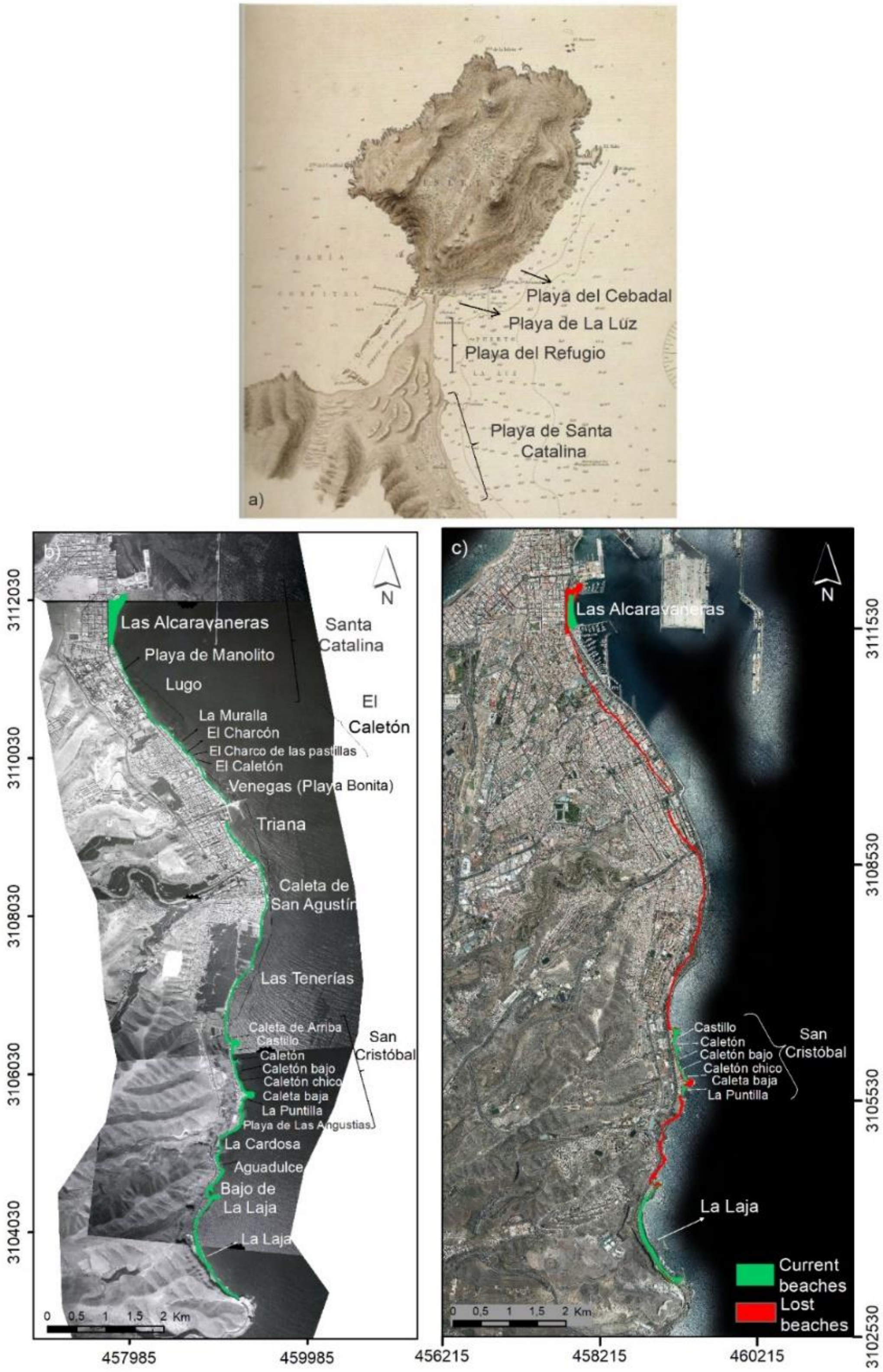


Figure 3. a) Location of beaches on the 1879 map; b) Location of beaches in 1954; and c) in 2016. From the 1879 map, the first beaches to disappear were due to construction of Puerto de La Luz and the urban growth of the city towards the east. For these reasons, in map b), from the 1954 aerial photograph, the port zone has been excluded since no beach existed there.

Table 3. Toponymy according to the historical moment (late XIX century, beginning and mid-XX century and current times), and following a north-south direction.

<table>
<tr><th></th><th colspan="2">End of the XIX century</th><th colspan="2">Beginning of the XX century</th><th colspan="2">Middle of the XX century</th><th colspan="2">Current</th></tr>
<tr><td rowspan="3">Northern sector</td><td colspan="2">Playa del Sebadal</td><td colspan="2">-</td><td colspan="2"></td><td colspan="2">-</td></tr>
<tr><td colspan="2">Playa de La Luz / Playa de Las Isletas</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td colspan="2">Playa del Refugio</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td rowspan="11">Central sector</td><td colspan="2" rowspan="3">Playa Santa Catalina</td><td colspan="2">Playa Santa Catalina</td><td colspan="2">Playa Las Alcaravaneras</td><td colspan="2">Playa Las Alcaravaneras</td></tr>
<tr><td colspan="2">Playa Las Alcaravaneras</td><td colspan="2">Playa de Manolito</td><td colspan="2">-</td></tr>
<tr><td colspan="2">Playa de Lugo</td><td colspan="2">Playa de Lugo</td><td colspan="2">-</td></tr>
<tr><td colspan="2" rowspan="5">El Caletón</td><td rowspan="5">El Caletón</td><td>Aguadulce</td><td rowspan="5">El Caletón</td><td>Aguadulce</td><td colspan="2" rowspan="5">-</td></tr>
<tr><td>La Muralla</td><td>La Muralla</td></tr>
<tr><td>El Charco de las Pastillas</td><td>El Charco de las Pastillas</td></tr>
<tr><td>El Charcón</td><td>El Charcón</td></tr>
<tr><td>El Caletón</td><td>El Caletón</td></tr>
<tr><td colspan="2">San Sebastián / Charcón de Arenales</td><td colspan="2">Playa Bonita / Venegas</td><td colspan="2">Playa Bonita / Venegas</td><td colspan="2">-</td></tr>
<tr><td colspan="2">Playa de Triana / San Telmo</td><td colspan="2">Playa de Triana</td><td colspan="2">Playa de Triana / La Marina</td><td colspan="2">-</td></tr>
<tr><td colspan="2">Playa de San Agustín / Caleta de San Agustín</td><td colspan="2">Playa de San Agustín</td><td colspan="2">Playa de San Agustín</td><td colspan="2">-</td></tr>
<tr><td rowspan="13">Southern sector</td><td colspan="2">Playa de las Tenerías</td><td colspan="2">Playa de las Tenerías</td><td colspan="2">Playa de las Tenerías</td><td colspan="2">-</td></tr>
<tr><td rowspan="8">San Cristóbal</td><td>Caleta de Arriba</td><td rowspan="8">San Cristóbal</td><td>Caleta de Arriba</td><td rowspan="8">San Cristóbal</td><td>Caleta de Arriba</td><td rowspan="8">San Cristóbal</td><td>-</td></tr>
<tr><td>Castillo</td><td>Castillo</td><td>Castillo</td><td>Castillo</td></tr>
<tr><td>Caletón</td><td>Caletón</td><td>Caletón</td><td>Caletón</td></tr>
<tr><td>Caletón Chico</td><td>Caletón Chico</td><td>Caletón Chico</td><td>Caletón Chico</td></tr>
<tr><td>Caletón Bajo</td><td>Caletón Bajo</td><td>Caletón Bajo</td><td>Caletón Bajo</td></tr>
<tr><td>Caleta Baja</td><td>Caleta Baja</td><td>Caleta Baja</td><td>Caleta Baja</td></tr>
<tr><td>Puntilla</td><td>Puntilla</td><td>Puntilla</td><td>Puntilla</td></tr>
<tr><td>Playa de Las Angustias</td><td>Playa de Las Angustias</td><td>Playa de Las Angustias</td><td>-</td></tr>
<tr><td colspan="2">La Cardosa or El Cardoso</td><td colspan="2">La Cardosa or El Cardoso</td><td colspan="2">La Cardosa or El Cardoso</td><td colspan="2">-</td></tr>
<tr><td colspan="2">Aguadulce</td><td colspan="2">Aguadulce</td><td colspan="2">Aguadulce</td><td colspan="2">-</td></tr>
<tr><td colspan="2">Bajo de La Laja</td><td colspan="2">Bajo de La Laja</td><td colspan="2">Bajo de La Laja</td><td colspan="2">-</td></tr>
<tr><td colspan="2">La Laja / Caleta de San Sebastián or Laxa</td><td colspan="2">La Laja</td><td colspan="2">La Laja</td><td colspan="2">La Laja</td></tr>
</table>

4.2. Land uses and cultural traits.

The sources consulted revealed that the land uses of this coast were various and evolved progressively in accordance with the growth and modernization of the city (Figure 4). Before the XIX century, the coast was an uninhabited, marginal and undervalued zone, considered unsafe and unhealthy (Martín Galán, 2008). As such, this zone was configured as an area for defense where agriculture and fishing activities were also undertaken. After work began on the construction of *Puerto de la Luz* (1883) and with the gradual incorporation of the customs of foreign people who came to visit and live in the islands, this situation began to evolve, the coast started to be revalued and new land uses appeared.

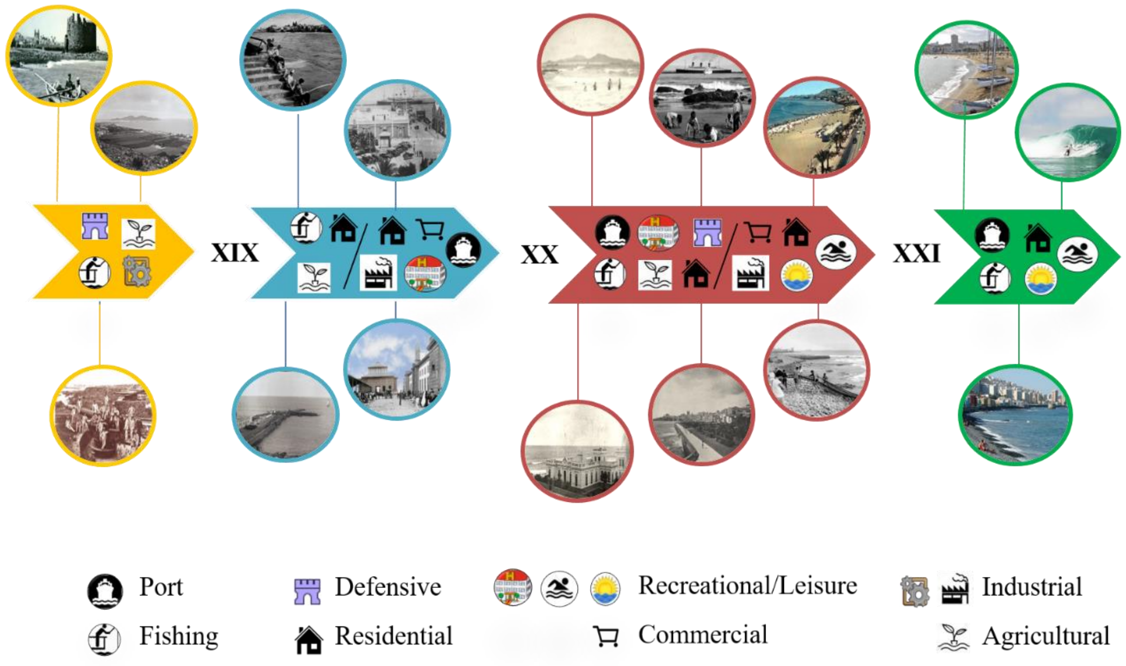


Figure 4. Evolution of land use along the eastern coast of LPGC (photos: *Las Palmas Ayer y Hoy, 2019; Recuerdos de Gran Canaria,2019* and *FEDAC, 2019*).

Thus, in this coast we can find eight different land uses (Table 4). Depending on its characteristics and localization, each beach had a different function (Figures 5, 6 and 7) for which various land uses were developed.

Table 4. Description of the land uses identified.

L.U	Main features	Further data	
Fishing	Fishing played a fundamental role in this sector of the city. It was most commonly practised by family groups.	Northern S.	Commonly practiced by family groups in the port area.
		Central S.	Commonly practiced by family groups in this sector. In Las Alcaravaneras, the fishing technique was practiced known as *el chinchorro* (type of trawler fishing with nets which lines of fishermen would haul to shore).
		Southern S.	San Cristóbal and La Laja were ‘professional family” beaches, contributing to the family economy in these neighborhoods. One of the most important practices was *el chinchorro*
Defensive	After the Spanish conquest of the islands (XV century), and as a result of their growing strategic importance, numerous fortifications were constructed along the coast to protect the city against external attack. These defenses were reinforced with the incorporation, during the Second World War (1939-1945) of a set of machine gun nests.	Northern S.	Batteries: *San Fernando* and *La Esfinge* were located in *El Sebadal* and *La Isleta*, respectively Fortification: Castillo de La Luz in La Luz beach
		Central S.	Fortifications: in Santa Catalina the Castillo de Santa Catalina, in Triana and San Agustín the Cubelo de Santa Ana and Santa Isabel (both from the XVI century) Machine gun nests: In Las Alcaraveneras beach
		Southern S.	Fortifications: Castillo *de San Pedro Mártir* in *San Cristóbal* Machine gun nests: on San Cristóbal and La Laja beaches
Agriculture	Agricultural activity (local farming) also took place along two stretches of this coast (central and southern).	Northern S.	-
		Central S.	The banana crop was cultivated between the former Guanarteme dune field and *Vegueta (pre-XX century)*
		Southern S.	*In Las Tenerías, San Cristóbal* and *La Cardosa*, was located the San José valley: Local farming included bananas and tomatoes, potatoes, corn, coriander, parsley, lettuce, cabbage, beans, radish, etc. An experimental farm was also set up in this area by the Regional Government: its purpose was to support other farmers and perform agriculture experiments to determine which crops were best adapted to the local environmental conditions (climate, soil, water) (Alcaraz, 1993).
Port	Two places: northern and central sectors. Puerto de La Luz, which gave rise to La Isleta neighborhood, the development of the shoreline from Las Palmas to Santa Catalina and the establishment of a new population (Martín Galán, 2001).	Northern S.	*Puerto de La Luz* was constructed on the beaches of La Luz and El Refugio in 1883. Numerous charcoal companies, shipyards and shipping agencies were set up. Most were foreign-owned (Elder, Miller, Grand Canary Coaling, Cory Brothers, Wilson, Blandy Brothers Woermann etc.)
		Central S.	*Puerto de Las Palmas* (the first city port) was established at Triana beach (carpentries, warehouses, shipyards, caulking workshops and dry docks).
		Southern S.	-
Industrial	Several industrial activities were also developed along this stretch of coast, in 7 areas in particular.	Northern S.	La Luz and Refugio beach: factories and industries related to coal companies.
		Central S.	At El Caletón and Venegas: carpentries, workshops, warehouses, factories and small food industries (windmills, bakeries, ice cream, etc. (Florido, 1998)).
		Southern S.	Las Tenerias was devoted to tanning and carpentry activities. Two plants were established in Bajo de La Laja and La Laja in the middle of the XX century. One extracted rock from the hillside for the manufacture of bricks and blocks. The other made pieces of artificial granite for pavements.
Commercial	Commercial activity was concentrated in stores situated at ground level of the buildings, and involved mainly the supply of food, recreational and textile products.	Northern S.	Barter that took place here between the local population and the crews of the ships was a recognized practice known as *cambullón.*
		Central S.	Local shops which mainly sold food, recreational and textile products (especially in Triana). In Caleta de San Agustín there was a market (since the 18th century), butcher’s and fishmonger’s (1876).
		Southern S.	San Cristóbal beach: fish factory (1940s and 1950s) that exported its products to the UK, a tomato packing factory and a bottled water distribution company.
Residential	After construction of Puerto de La Luz, the shoreline between La Isleta and Vegueta gradually came to be occupied by buildings. *San Cristóbal* is the only neighborhood that still exists today, with a morphology similar to its original one.	Northern S.	The dwellings were low-rise constructions with a maximum of three floors.
		Central S.	The dwellings were low-rise constructions with a maximum of three floors. Access to them was generally landward-facing. Access to the beach was possible through a back door or via small passageways that separated the buildings.
		Southern S.	The dwellings were self-constructed with local materials (soil, loose material, sand and stone blocks) (Machín et al., 2005). Further south were relatively unpopulated sectors.
Recreational	The first recreational use was for health tourism (the first tourist activity in the island) at the end of the XIX century. From this time onwards and with the introduction of foreign customs, sea bathing began to acquire some popularity among the local population and the value of this environment became more appreciated (Martín Galán, 2009). In the mid-XX century the coast became a recreational area for walks, contemplation of the maritime landscape, sports, games etc. The children of the poorest families would construct their own toys from waste materials that arrived at the beaches.	Northern S.	Near to the port the departure and arrivals of the ships constituted an attraction for the local population.
		Central S.	Santa Catalina beach (Las Alcaravaneras): different hotels and other tourist facilities were concentrated here at the end of the XIX century. In the 1950s, it was one of the best prepared beaches for family activities. A spa, restaurant, bar and small boats for short sea trips could be found here. Another attraction of this beach was the sight of hydroplanes landing on the sea (Cossío, 2014). Triana beach had a promenade and San Telmo park was nearby (Martín Galán, 2008).
		Southern S.	*Playa de Las Angustias:* Camping with tents often made by the locals from old blankets, sheets or flour and sugar bags. *La Laja* beach: people went there to rest and snack. Summer houses of families from *Triana* and *Vegueta* could be found there.

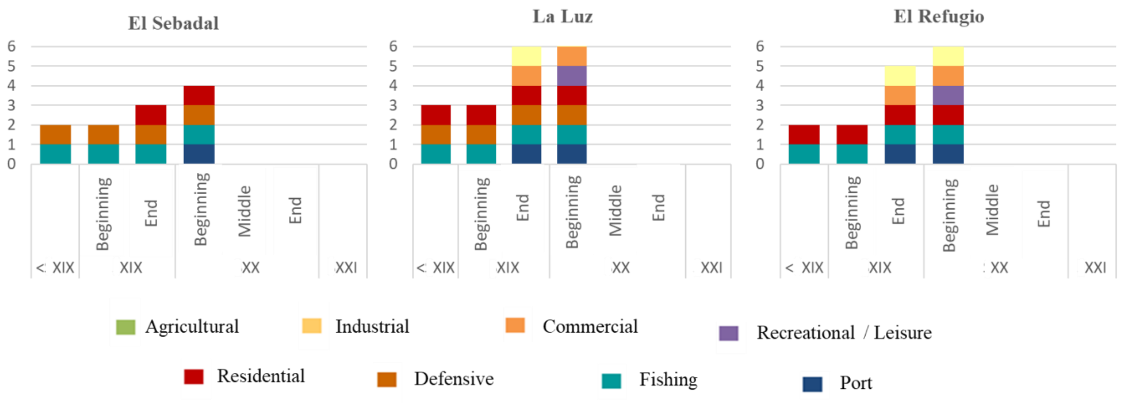


Figure 5. Distribution of land use by century (pre-XIX century, XIX century, XX century and XXI century) in the northern sector.

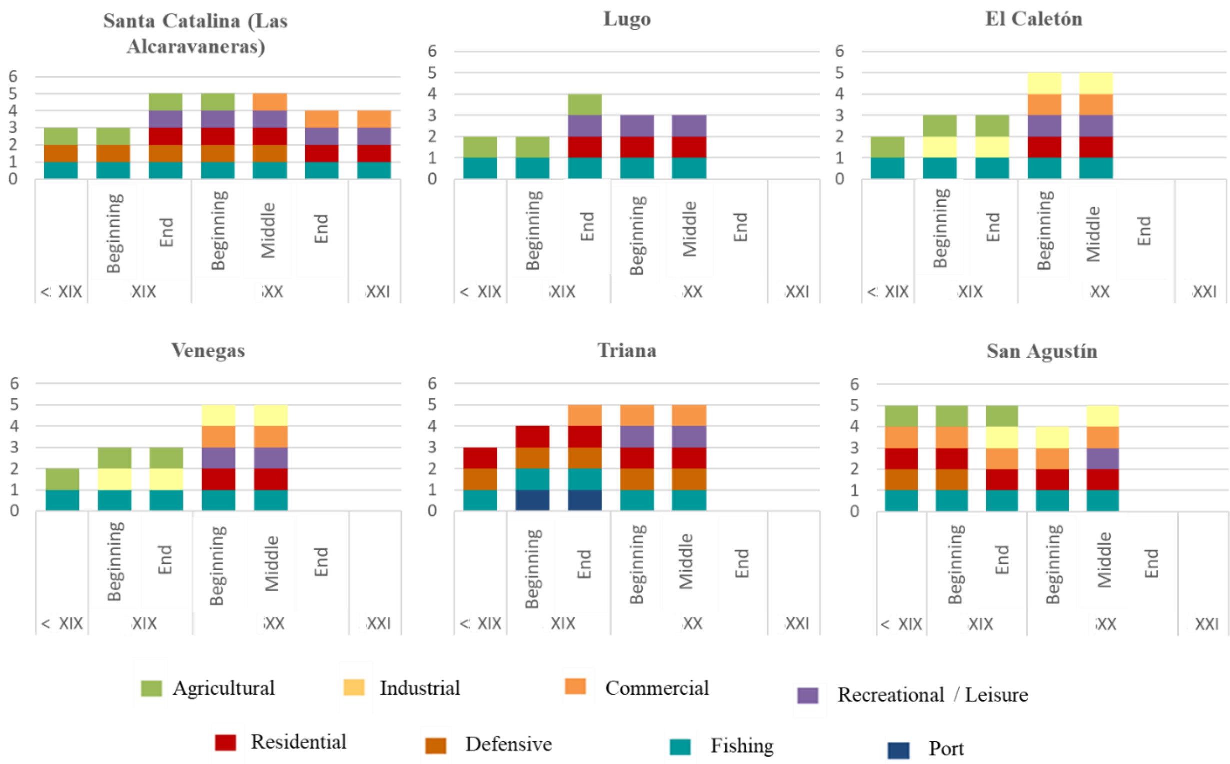


Figure 6. Distribution of land use by century (pre-XIX century, XIX century, XX century and XXI century) in the central sector.

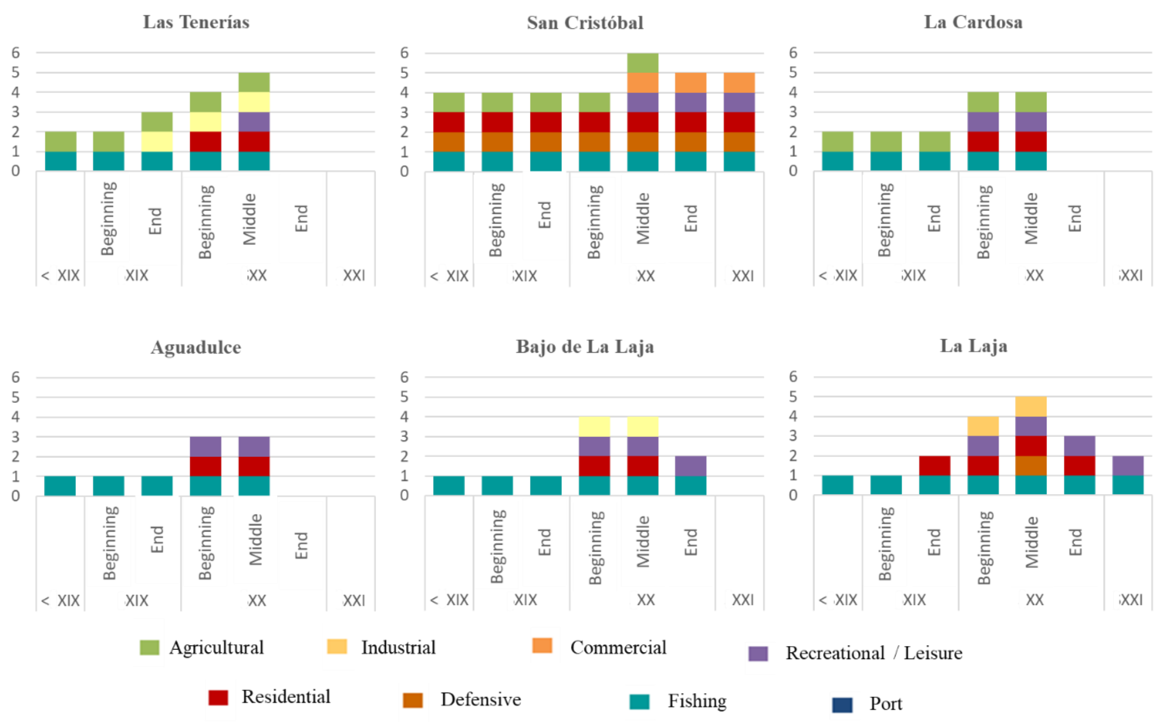


Figure 7. Distribution of land use by century (pre-XIX century, XIX century, XX century and XXI century) in the southern sector.

It can be seen how the northern and central beaches had more varied uses than those of the southern sector which tended to focus on fishing. Land uses were (high to low frequency): fishing, residential, recreational, agriculture, industrial, commercial, defensive and port. Some of these uses were no longer functional over time. Such is the case of the defensive elements located in San Cristóbal and Triana (*Torreón de San Pedro Mártir* and *Cubelo de Santa Ana*, respectively), which lost their use after the beginning of the 19th century.

4.3. Lost surface area

In terms of surface area, 13.19 ha of beaches have been lost. Currently, the only beaches that remain are *Las Alcaravaneras*, *San Cristóbal*, *La Laja* and *Bajo de La Laja* (Pérez Hernández and Hernández Calvento, 2017) (Table 5).

Table 5. Beaches and their surface area (ha).

Beaches	Area (ha) 1954	Area (ha) today
El Sebadal	Unknown*	0
La Luz	Unknown*	0
El Refugio	Unknown*	0
Santa Catalina (Las Alcaravaneras and Lugo)	6.85	3.07
El Caletón	0.77	0
Venegas (Playa Bonita)	0.42	0
Triana	0.91	0
San Agustín	1.13	0
Las Tenerías	1.59	0
San Cristóbal	3.83	1.77
La Cardosa (El Cardoso)	0.68	0
Aguadulce	0.97	0
Bajo de La Laja	0.71	0.02
La Laja	3.57	3.39

* Note that El Sebadal, La Luz and El Refugio beaches cannot be mapped (nor therefore their areas measured) from the 1954 aerial photograph, because at the time they did not exist. These beaches were identified from historical maps and oral sources.

Of these, *Las Alcaravaneras* has been the most affected, losing 3.78 ha due to the development of port infrastructures. Currently, this beach is located within the port area. The beach of *San Cristóbal* has lost 2.06 ha as the result of construction of the promenade and the small port area in this neighborhood. *Bajo de La Laja* has almost completely disappeared (0.69 ha lost), whereas *La Laja* has not experienced major loss (only 0.18 ha). Although *San Cristóbal* and *La Laja* have experienced changes, their morphologies have remained more or less unaltered.

The rest of the coast (including the beaches that formed it) disappeared in the mid-XX century due to the extension of the city towards the sea (Figure 8) and the need to acquire more land for the population. Thus, 100% of the territory of these beaches was lost.

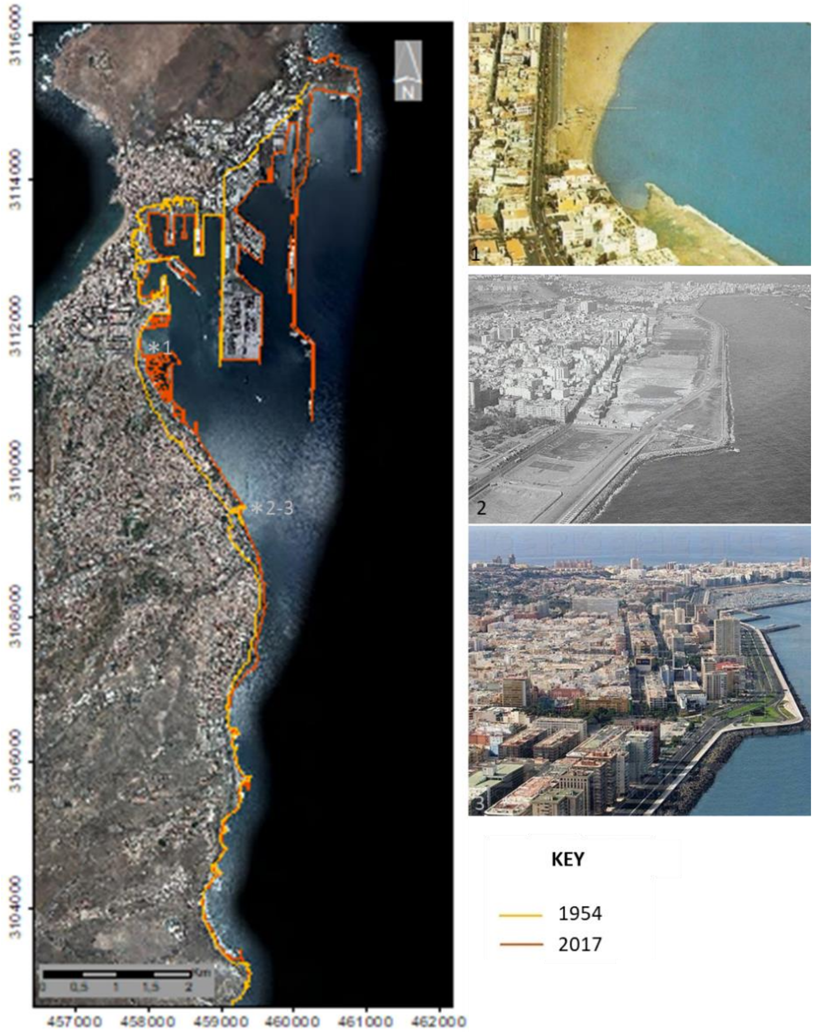


Figure 8. Comparison of the shoreline in 1954 and in 2017. Photos*: IDECanarias, Las Palmas Ayer* y *Hoy* and *Recuerdos de GC.*

4.4. Overview

In terms of land use, the occupation of the eastern coast of LPGC generally speaking followed three pathways depending on the sector: (1) buildings and infrastructures were located near to the shoreline, but did not significantly affect its characteristics: this was the case in *San Cristóbal* and *La Laja*; (2) port infrastructures and buildings altered the morphology of the original shoreline: this was the case in *Las Alcaravaneras*; and (3) the infrastructures and buildings totally changed the coast: this was the case in *El Sebadal, La Luz, El Refugio, Lugo, El Caletón, Venegas, Triana, San Agustín, Las Tenerías, La Cardosa*, *Aguadulce* and *Bajo de La Laja.*

In general, the northern beaches were occupied by port, commercial and industrial facilities. The growth of the city of LPGC occupied the central sector of this coastal stretch, from *Las Alcaravaneras* to *Vegueta*, invading the former Guanarteme dune system (Santana-Cordero et al., 2014, 2016, 2017). The southern coast was occupied by road and health infrastructures, residential zones and green spaces.

Bearing in mind these three modalities of occupation, the characteristics of each stretch of the coast are presented in Tables 6, 7 and 8.

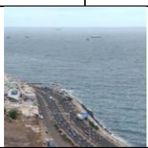
Table 6. Natural and cultural characteristics, land use and lost area of the beaches of the northern sector of the eastern coast of LPGC.

	DESCRIPTION				GEOLOGY	ECOLOGY	CULTURE	LAND USES	LOST AREA
EL SEBADAL	**Location**	**Coordinates**	**Length**	**Beach**	Basanite lava platform of the post-Roque Nublo lower cycle (2.8 Ma.)	Sparse and scarce vegetation, with the most significant being *Cymodocea nodosa.* Varied and rich in marine fauna species	Area practically uninhabited with some fishermen's houses and military buildings nearby	Fishing Defensive Residential Port	100%
	Northeast coast	28º09'06.08"N 15º25'01.25"W 28º09'53.43"N 15º24'11.57"W	2.7 km approx.	Pebble					
	-								
LA LUZ	**Location**	**Coordinates**	**Length**	**Beach**	Basanite lava platform of the post-Roque Nublo lower cycle (2.8 Ma.)	Scarce or minimal value due to construction of the port	Port area of Puerto de La Luz (at the end of the 19th century) Coal companies, ship repair and shipping agencies "cambullón" (unregulated barter)	Fishing Defensive Residential Port Industrial Commercial Recreational	100%
	Northeast coast	28º08'50.50"N 15º25'43.18"W 28º08'57.19"N 15º25'12.59"W	790 m approx.	Mixed					
									
EL REFUGIO	**Location**	**Coordinates**	**Length**	**Beach**	Part of the seaward outlet of the extinct dune fields of Guanarteme Mixed composition (organogenic-volcanic) and fine grain size	Scarce or minimal value due to construction of the port	Port area of Puerto de La Luz (at the end of the 19th century) Coal companies, ship repair and shipping agencies "cambullón" (unregulated barter)	Fishing Residential Port Commercial Industrial Recreational	100%
	Northeast coast	28º08'51.50"N 15º25'43.18"W 28º08'25.65"N 15º25'45.77"W	795 m approx.	Sand					
									

Table 7. Natural and cultural characteristics, land use and lost area of the central sector of the eastern coast of LPGC.

	DESCRIPTION				GEOLOGY	ECOLOGY	CULTURE	LAND USES	LOST AREA
	Location	**Coordinates**	**Length**	**Beach**					
SANTA CATALINA (LAS ALCARAVANERAS)	East coast 	28º08'09.12"N 15º25'44.40"W 28º07'07.77"N 15º25'27.38"W	1.9 km approx.. 	Sand	Part of the seaward outlet of the extinct dune fields of Guanarteme Mixed composition (organogenic-volcanic) and fine grain size	Sparse and scarce vegetation (halophile, psammophile and xerophile species), with the most significant being Traganum moquinii. Varied and rich in marine fauna species	Health tourism due to the beneficial properties of the water and climatic and environmental qualities Hotels (Santa Catalina, Metropol, British Club)	Agricultural Defensive Fishing Residential Commercial Recreational	55.2%
LUGO	East coast 	28º07'25.27"N 15º25'39.26"W 28º07'07.61"N 15º25'25.35"W	700 m approx. 	Mixed	Phonolite base with fossil marine deposits from the Pleistocene *Strombus bubonius* and *Thais haemastoma* (Linné) fossils Conglomerates of rounded basaltic pebbles (upper level)	Sparse and scarce vegetation (halophile, psammophile and xerophile species), with the most significant being Traganum moquinii. Varied and rich in marine fauna species	Residential and commercial area	Fishing Agricultural Residential Recreational	100%
EL CALETÓN	East coast 	28º07'07.77"N 15º25'27.38"W 28º07'07.77"N 15º25'27.38"W	600 m approx. 	Mixed	Phonolite base with fossil marine deposits from the Pleistocene. *Strombus bubonius* and *Thais haemastoma* (Linné) fossils Conglomerates of rounded basaltic pebbles (upper level)	Sparse and scarce vegetation (halophile, psammophile and xerophile species), with the most significant being Traganum moquinii. Varied and rich in marine fauna species	Carpentries, warehouses and food industries Windmills for the production of breadmaking flour and gofio (toasted cornmeal)	Fishing Agricultural Industrial Residential Commercial Recreational	100%
VENEGAS	East coast 	28º07'07.77"N 15º25'27.38"W 28º07'07.77"N 15º25'27.38"W	600 m approx. 	Mixed	Phonolite base with fossil marine deposits from Pleistocene *Strombus bubonius* and *Thais haemastoma* (Linné) fossils Conglomerates of rounded basaltic pebbles (upper level)	Sparse and scarce vegetation (halophile, psammophile and xerophile species), with the most significant being Traganum moquinii. Varied and rich in marine fauna species	Carpentries, warehouses and food industries Buildings for recreational and social use	Fishing Agricultural Industrial Residential Commercial Recreational	100%
TRIANA	East coast 	28º06'35.13"N 15º24'59.92"W 28º06'12.19"N 15º24'47.96"W	740 m approx.. 	Mixed	Phonolite base with fossil marine deposits from Pleistocene *Strombus bubonius* and *Thais haemastoma* (Linné) fossils Conglomerates of rounded basaltic pebbles (upper level)	Sparse and scarce vegetation (halophile, psammophile and xerophile species) Varied and rich in marine fauna species	The first port of the city (1811) Santa Ana tower (1574) located at the end of the Las Palmas wall at the northern end of the city	Fishing Port Defensive Residential Commercial Recreational	100%
SAN AGUSTÍN	East coast 	28º06'10.34"N 15º24'47.39"W 28º05'40.65"N 15º24'45.09"W	963 m approx. 	Pebbles	Phonolite base with fossil marine deposits from Pleistocene *Strombus bubonius* and *Thais haemastoma* (Linné) fossils Conglomerates of rounded basaltic pebbles (upper level)	Sparse and scarce vegetation (halophile, psammophile and xerophile species) Varied and rich in marine fauna species	Commercial facilities including a market, fishmonger's, butcher's, etc., and public buildings	Fishing Defensive Residential Commercial Industrial Agricultural	100%

Table 8. Natural and cultural characteristics, land use and lost area of the southern sector of the eastern coast of LPGC.

	DESCRIPTION: Location	Coordinates	Length	Beach	GEOLOGY	ECOLOGY	CULTURE	USES	LOST AREA
LAS TENERÍAS	Southeast coast	28º05'40.65"N 15º24'45.09"W 28º05'01.33"N 15º24'59.38"W	1.22 km approx.	Pebble	Phonolite base with fossil marine deposits from Pleistocene *Strombus bubonius* and *Thais haemastoma* (Linné) fossils Conglomerates of rounded basaltic pebbles (upper level)	Sparse and scarce vegetation (halophile, psammophile and xerophile species), with the most significant being *Cymodocea nodosa*. Varied and rich in marine fauna species	A large fertile plain near the beach (locally called "Vega de San José") Industrial activities, such as leather tanning or carpentry	Fishing Agricultural Industrial Residential Recreational	100%
									
SAN CRISTÓBAL	Southeast coast	28º05'01.33"N 15º24'59.38"W 28º04'26.19"N 15º24'53.12"W	1.3 km approx.	Pebble	Phonolite base with fossil marine deposits from Pleistocene *Strombus bubonius* and *Thais haemastoma* (Linné) fossils Conglomerates of rounded basaltic pebbles (upper level)	Sparse and scarce vegetation (halophile, psammophile and xerophile species) Varied and rich in marine fauna species	Traditional fishing activities, including local technique of "chinchorro" (trawl fishing from the shore) A large fertile plain near the beach (locally called "Vega de San José")	Fishing Defensive Residential Agricultural Recreational Commercial	53.8%
									
LA CARDOSA	Southeast coast	28º04'26.19"N 15º24'53.12"W 28º04'12.52"N 15º25'01.01"W	468 m approx.	Pebble	Phonolite formation (Cycle I, Upper Miocene)	Sparse and scarce vegetation (halophile, psammophile and xerophile species) Varied and rich in marine fauna species	Traditional fishing activities, including local technique of "chinchorro" (trawl fishing from the shore) Agricultural facilities	Fishing Residential Agricultural Recreational	100%
									
AGUADULCE	Southeast coast	28º04'12.52"N 15º25'01.01"W 28º04'02.40"N 15º25'01.81"W	350 m approx.	Pebbles	Phonolite formation (Cycle I, Upper Miocene)	Sparse and scarce vegetation (halophile, psammophile and xerophile species) Varied and rich in marine fauna species	Traditional fishing activities	Fishing Residential Recreational	100%
	-								
BAJO DE LA LAJA	Southeast coast	28º04'02.40"N 15º25'01.81"W 28º03'52.87"N 15º25'05.97"W	374 m approx.	Pebbles	Phonolite formation (Cycle I, Upper Miocene)	Sparse and scarce vegetation (halophile, psammophile and xerophile species) Varied and rich in marine fauna species	Traditional fishing activities	Fishing Industrial Residential Recreational	98.6%
	-								
LA LAJA	Southeast coast	28º03'52.87"N 15º25'05.97"W 28º03'12.92"N 15º24'51.67"W	1600 m approx.	Mixed	Two magmatic cycles: Phonolite formation (Cycle I, Upper Miocene) Basaltic and tetritic lavas belonging to the 2nd volcanic cycle of the island ("Roque Nublo", Pliocene)	Sparse and scarce vegetation (halophile, psammophile and xerophile species), with the most important being Cymodocea nodosa and Lotus kunkelii. Varied and rich in marine fauna species	Traditional fishing activities, including local technique of "chinchorro" (trawl fishing from the shore) Mining industries Summer residences	Fishing Recreational Residential Industrial Defensive	5%
									

5. DISCUSSION

Coastal areas have become places of growing interest in the scientific literature (Gormsen, 1997; Martínez et al., 2007). As has been demonstrated, they are areas which are highly susceptible to change in terms of their morphological dynamics, with significant natural losses occurring as a result of human activities (Jackson and Nordstrom, 2011; García Romero et al., 2016). It is widely accepted that such consequences can derive from the processes involved in changes to land use. This has been the case of our study area. The present work has shown not only the evolution and transformations experienced by this coast, but also the territorial and functional losses that it has undergone by linking disappeared beaches with those existing in the present. Additionally, this research provides quantitative data with which the natural losses can be calculated.

The study area has undergone major changes, especially in relation to land use and the natural landscape. The results show that most of the eastern coast of LPGC has been lost, with only some sections of three beaches remaining intact: Las Alcaravaneras, San Cristóbal and La Laja. We consider that exogenous socio-economic factors (Lambin and Meyfroidt, 2010), above all with respect to the influence of the port and the investments it has attracted, are the main cause of land change and transformation in this general area. Other factors include the rush to 'modernize' the city, urbanistic/political motives driven by the needs of a growing population, and the substantially lower environmental awareness that existed in the past. By way of example, a City Project document from 1894 (Archivo Histórico Nacional, 1894) explains how the plan to gain land from the sea along the Santa Catalina beaches was a viable and cheap option given that other land was being used at the time for crops and, as the document claims, "the coast has no value for society". Consequently, important resources, from a social and land use point of view, have been lost to the city. The local establishment of a given land use is usually linked to cultural traits that characterizes the area. In this line, traditional human practices, such as *el chinchorro* (land-based trawler fishing practice) and *el cambullón* (commercial exchange between small local boats and foreign ships) can be considered intangible human goods. Thus, the beaches studied represented a connection between land and culture for centuries. The loss of a large part of the coastal features has thus resulted in part of the natural history of the island also being lost.

The idea of gaining land from the sea has been put into practice in numerous places and in many countries, including the Netherlands, Monaco, Dubai (Dubai Marina or Palm Island), Japan, New Zealand, Gibraltar, Chile (Valparaíso), Turkey (Istanbul), Indonesia and Singapore, among others. Similar studies to the present one have been conducted on some of these places in terms of quantifying urban growth in their coastal areas (Marfai et al., 2008, Smit et al., 2008; Kurt et al., 2010; Nassar et al., 2014). Zhang et al. (2019) found that in Ningbo (a coastal city in China) construction land, i.e. urban/rural residential land, industrial and commercial areas, as well as other facilities, dominated in the period 1990-2005. However, this trend changed for 2005-2016, when agricultural use became dominant. Comber et al. (2016) analyzed land use changes on the coasts of England, Wales and Northern Ireland between 1965-2014, detecting a decline in defense land uses and an increase in urban and leisure land use, as well as woodland. On the other hand, Thanh Thoai et al. (2019) studied the evolution over a 20 year period (1990-2010) of a coastline in the south of Vietnam. During this period, 2206 ha of coastal zone were lost to erosion, in which both natural and human factors intervened. Erosive losses were also observed by Aymara and Benseny (2016) in Miramar (Argentina) from 1888-2015 associated with urban-tourism development. In Spain, other similar investigations have been carried out, such as the work of Sanjosé et al. (2016) on the coastal evolution of the

Cantabrian coast (northern Spain) in the period 1988-2014, in which they observed the retreat of the coastline. Manno et al. (2016) studied the evolution of coastline armouring along Spain's Andalusian coast during the period 1956-2010 when ports and coastal defense infrastructures (breakwaters, etc.) were created to avoid erosive losses and to expand the dry beach to benefit tourist and urban development at the expense of natural sedimentary transport. A general view of all these studies proves that changes in land use are dynamic in terms of adopting different trends.

The historical reconstruction of coastal areas can be used to understand their spatial variation over time and can provide keys to understand their function and current state (Douglas and Crowell, 2000; Botequilha and Ahern, 2002). Studies of this type should be considered when management, protection or regional planning projects are being undertaken in order to develop a more sustainable urban fabric. In this regard, it should be taken into account that, in the period in which the transformation of the eastern coast of LPGC city took place (1960), the regulation of the coastal areas in Spain depended on the Port Laws (from 1880 and 1928), whose main objective was to meet the needs of navigation and shelter conditions for vessels and which paid no attention to non-port coastal areas (Torres, 2010). Spain's Law on Centers and Areas of National Tourist Interest of 1963 promoted tourism development on the Spanish coasts (Ariza et al., 2016), but had no impact on our area of study, since it was not an area of tourist attraction. It is only since promulgation of the Coastal Law of 1969 (and more directly the Coastal Law of 1988) that these spaces are considered areas to be preserved, through conservation of their ecosystems and stabilization of the coastlines (Ariza, 2011). Thus, prior to enactment of the first Coastal Law of 1969. there were no legal limits to urban plans that promoted the seaward urban growth of the city of LPGC. The three remaining beaches at that time (Alcaravaneras, San Cristóbal and La Laja) have been protected since then by that and later Coastal Laws and by municipal regulations based on that legislation. In accordance with these and the current municipal regulations on coasts and beaches (in force since 2013), in these three remaining beaches, conservation and improvement work has been carried out for public use and to guarantee the rational use of public space. Previously in this regard, in the 1990s, the Ministry of Environment carried out a regeneration action on La Laja beach, building a submerged dike and providing sand from nearby seabed (Ministry of Agriculture and Fisheries. Food and Environment, 2019). At present, through the City Council's 'Pacto por el Mar' (Ciudad de Mar, 2014) initiative for the sustainable development of the LPGC coast, actions are underway aimed at sustainable coastline development ('Territorios Azules' project), promotion of the city's southernmost coastal area ('Cono Sur' project) and regeneration of the port isthmus area ('Sanapú–Istmo' project). The general goals of this wide-ranging initiative include improving water quality, reducing waste discharges at sea, and promoting sea-based renewable energies as well as marine and nautical sports tourism.

While many coastal areas of the planet have been considerably transformed and some may even have disappeared (as in our study area), it is clear that their restoration is, today, unfeasible, especially from the socio-economic point of view. Nonetheless, they retain an importance in their ability to sensitize society, hopefully making it more aware of the need to preserve and limit the damage that can be done and, especially, to avoid further negative environmental impacts in the future.

Likewise, this kind of study can be used to retrieve the environmental memory of a place enabling a knowledge and understanding of the relationship between the people that inhabited that place and its natural area (Hughes, 2006), as well as of the characteristics of the natural system (Santana-Cordero et al., 2014).

Finally, this line of study can be the basis for the undertaking of new projects in which cultural activities are developed to help promote interest in natural heritage. Studies of this type can continuously be enriched with newly found materials and data.

6. CONCLUSIONS

This work is concerned with the reconstruction of the natural characteristics, cover and use of coastal land, and the rediscovery of traditions intrinsically associated with the territory in spaces that have disappeared as the result of recent human intervention. To achieve these objectives, a methodology was used which was based on historical, geographic and bibliographic sources.

The results of the study show that the vast majority of the natural and manmade elements which used to characterise the eastern coastline of Las Palmas de Gran Canaria city have progressively disappeared over the last 70 years. The analysis of the sources revealed the extension and previous use of lost beaches along the eastern coast of the city Las Palmas de Gran Canaria. In addition, the changes that have happened in recent decades were quantified.

Land use change has many implications, some of them related to the loss of human and natural assets. Such losses can disconnect a place from its past. Knowing an area's past by retrieving its historical characteristics is essential for planning its future development in a sustainable way. The integration of historical (natural and cultural) features can be extremely useful for future land change planning.

Working on the concept of lost natural heritage can open up new perspectives in historic reconstruction research, development and strategies. Through these, lessons from the past can be learned and applied to land management issues today. The results obtained from this type of study can also be used to develop original cultural strategies, educate new generations and provide visitors to the area with interesting and relevant information.

ACKNOWLEDGMENTS

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5.2. Lost and preserved coastal landforms after urban growth. The case of Las Palmas de Gran Canaria city (Canary Islands, Spain)

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*Istmo de Guanarteme, 1895-1900. (FEDAC, 2019).

Abstract

Coastal geomorphological systems have undergone major changes in recent decades as a result of both natural and anthropic phenomena, with the growth of urban tourism having one of the biggest impacts. This has been the case of Las Palmas de Gran Canaria city (Canary Islands, Spain), which has expanded considerably since the late 19th century. The objective of this work is to identify the coastal landforms that existed in the city environment before 1879 and evaluate the extent to which they have been preserved or lost because of urban expansion on five dates (1879, 1954, 1966, 1981 and 2018). This evaluation was made possible through the integration, in a geographic information system, of information from historical and current documents, both cartographic and photographic, and from oral sources and field data. The results of the study reveal that 848.1 ha of the initial coastal landforms have been lost, with only 16.7% of the area they occupied remaining. The landforms that have experienced the most losses have been the aeolian sedimentary systems, which have totally disappeared since 1981. The least altered have been calcarenitic reefs, coastal active cliffs and sandy beaches. The land uses of the occupied coastal landforms, from highest to lowest, are: residential and tourist, road infrastructure, public spaces and green areas, port, facilities and industrial. The academic, social, educational and urban planning interests of this research are addressed in the discussion.

Keywords: Coastal geomorphology, urban sprawl, lost surfaces, preservation, geo-conservation.

1. INTRODUCTION

More than half of the world's population is currently concentrated in the coastal areas of the planet (Mimura et al., 2007; Reynard et al., 2017). This strong litoralization (Bajocco et al., 2012) exerts great pressure and has important impacts on natural resources, a problem which has been extensively studied by the scientific community (Nordstrom, 1994; Dawson and Smithers, 2010; Kurt et al., 2010; Faggi and Dadon, 2011; Roig Munar et al., 2012; Ponte et al., 2016; Ferrer-Valero et al., 2017; among others). Geological-geomorphological resources have not been exempted from the effects of litoralization, and in many cases have undergone important transformations and/or degradations, or have even disappeared completely as the result of human activities (Hudson and Inbar, 2012; Ilić et al., 2016; Reynard et al., 2017).

The interactions that occur between coastal geomorphological processes and urban expansion have become an important area of academic interest in recent decades (Reynard et al., 2017), and specific methodologies for their analysis have been developed and applied (Mohapatra et al., 2014; Cristiano et al., 2018a, b). These are usually based on geohistorical reconstructions, that is, on the evaluation and quantification of changes induced by urban growth in landforms at different dates (Shimizu and Fuse, 2003; Douglas, 2005; Lucchesi and Giardino, 2015; Ilić et al., 2016; Santana-Cordero et al., 2014, 2017; Tičar et al., 2017, among others). In this approach, historical, geographical and bibliographic sources are key to reconstructing and understanding the particularities of lost geomorphological systems. However, this approach faces the problem that buildings may hide or may have destroyed many environmental enclaves, which makes it difficult to find information about them, especially when there is no written or graphic evidence available. In such cases, oral sources may be essential to complement the information that can be found in other sources (Benadiba, 2007). In addition to these various sources, field work is commonly employed to verify and/or uncover new findings and, increasingly, the benefits of new technologies are being exploited. Among these, geographic information systems (GIS) are a very useful tool for the spatial analysis and quantification of coastal landscape changes due to urban growth. Digital photogrammetry, 3D reconstructions and interpretive images (Cayla, 2014; Scarelli et al., 2016, 2017; Pica et al., 2017) can also be used to facilitate the interpretation of geomorphological systems.

An example of the loss of coastal landforms due to urban expansion can be seen in Las Palmas de Gran Canaria city (Canary Islands, Spain). The growth experienced by this city between 1879 and the decade of the 1980s has led to important processes of changes in land occupation, which in turn have had significant consequences for the landforms. From the point of view of coastal geomorphology, the growth experienced in the isthmus of the Guanarteme area and, in general, along the eastern coastal stretch has been especially significant.

Considering this background, the objective of this work is to evaluate the degree of loss or preservation of coastal landforms in Las Palmas de Gran Canaria (LPGC) since 1879. For this purpose, it is proposed to reconstruct the geomorphological characteristics of the coastal strip of LPGC prior to its expansion (1879), quantify the landforms lost in the urban expansion process and evaluate the degree of preservation of the current coastal landforms. In doing so, a geohistorical approach is adopted, since most of these landforms do not exist today. The purpose of this document is to provide a tool to recover geomorphological memory in cities that have suffered a significant loss of geological-geomorphological values, and in this way allow present-day society and, equally importantly, future generations to have a greater appreciation and understanding of the importance and wealth of these natural landforms. In this context, we believe that integrating coastal geomorphology in this type of historical reconstruction is necessary due to the vulnerability of these areas to the incessant litoralization that is occurring globally. We also consider that the information generated in this type of research is essential for future urban planning purposes.

2. STUDY AREA

The city of LPGC is located in the NE of Gran Canaria island (Fig. 1). This study focuses on the coastal stretch of the city (2229.7ha), along the west coast from El Lloret (in the south) to El Confital (in the north), and along the east coast from El Sebadal (in the north) to La Laja (in the south).

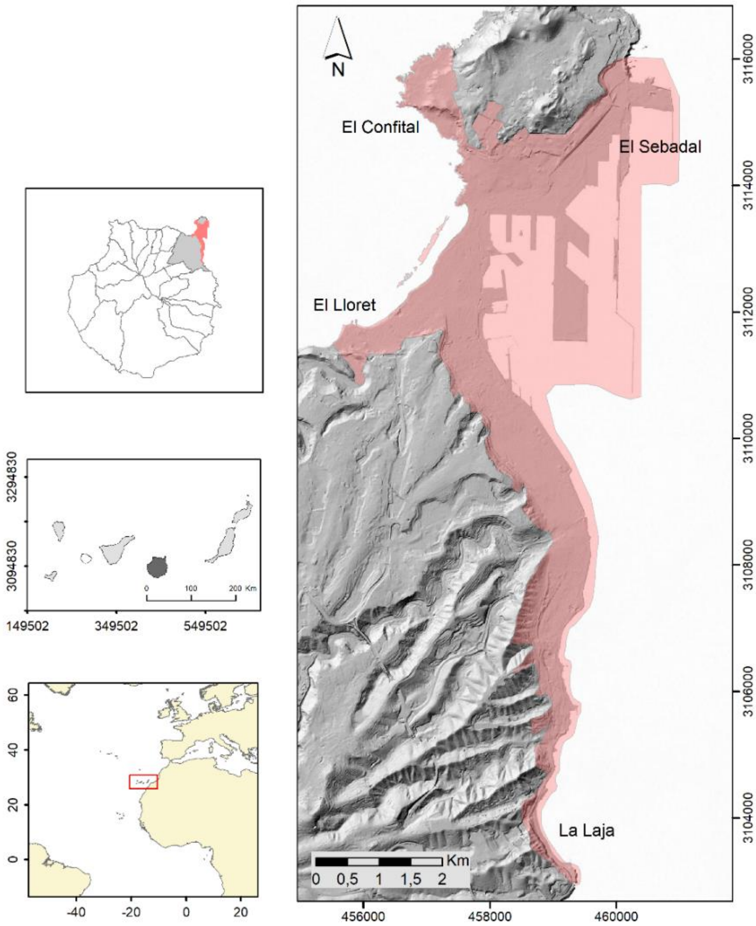

Figure 1. Study area (in red) on a hill shadows model, for appreciating the general features of the relief. The base hill shadows model was obtained from the spatial data infrastructure (SDI) of the Canary Islands Government (SDI Canary Islands).

The landforms of LPGC need first to be considered in the geological context of Gran Canaria island, which is about 14.5 Ma (Pérez Torrado, 2000). The geological history of the island is comprised of 3 major volcanic periods (Cycle I, which took place during the Miocene, Cycle II during the Pliocene, and Cycle III during the Quaternary), separated in time by gaps of volcanic activity and dominated by erosive processes (IGME, 1990).

LPGC stands mostly on a two-level sedimentary platform. The upper level, where what is known locally as *the upper city* sits, is composed of the Las Palmas Detrital Formation (FDLP, in Spanish), which is the result of the erosion of the island during long periods of volcanic inactivity during the upper Miocene and Pliocene (from ~9 Ma to ~2.8 Ma). Subsequently, there would have been a significant isostatic elevation of the coast to its current level. The lower level, where what is known locally as *the lower city* sits, is composed of the Jandiense terrace, otherwise known as the Lower Terrace of Las Palmas, whose formation is attributed to a marine transgression approximately 110,000 years ago. This level is characterized by the presence, at 8-14m above sea level, of marine deposits with *Strombus bubonius* and *Thais haemastoma (Linné)*, fauna typically found in warmer waters. Between these two episodes (from ~1 Ma to ~37,000 years), the volcanic complex of La Isleta developed. The position of this complex with respect to the prevailing winds and sea currents favoured sedimentary accumulation and the formation of a tombolo, the isthmus of Guanarteme, which connects La Isleta with the rest of the island.

The city of LPGC grew slowly and only slightly between its foundation, at the end of the 15th century, and the end of the 19th century. As the result of population growth, the city expanded steadily occupying coastal landforms between 1879 and the 1980s decade.

3. MATERIALS AND METHODS

In order to respond to the objectives of the study, various sources have been used in this work (Fig. 2a):

Historical maps. The Map of the Bay of Las Palmas (1879), and three maps of different dates (plans by Fernando Navarro and Benito Chías Carbó) contained in the map collection of Tous and Herrera (1995) were used as initial references. This mapping allowed an estimation of the position of the eastern coastline and a reconstruction of its geomorphological characteristics in relation to the sedimentary dynamics of the isthmus (Fig. 2b).

Aerial photographs and orthophotos. The aerial photographs from 1954 and 1981 were acquired, respectively, from the Cartographic and Photographic Centre of the Spanish Air Force (CECAF, 1954) and the spatial data infrastructure (SDI) managed by the Gran Canaria Government (SDI Gran Canaria, 2019). Four orthophotos (from 1966, 2002, 2006 and 2018) were obtained from the SDI of the Autonomous Government of the Canary Island (SDI Canary Islands, 2019). The aerial photographs (1954 and 1981) and the orthophoto of 1966 were used to digitize the urban spaces and buildings and also facilitated the reconstruction of the coastal landforms (Fig. 2b). The orthophotos of 2002, 2006 and 2018 allowed detailed mapping of the coastal landforms that are preserved today, as well as determination of the current state of urban development.

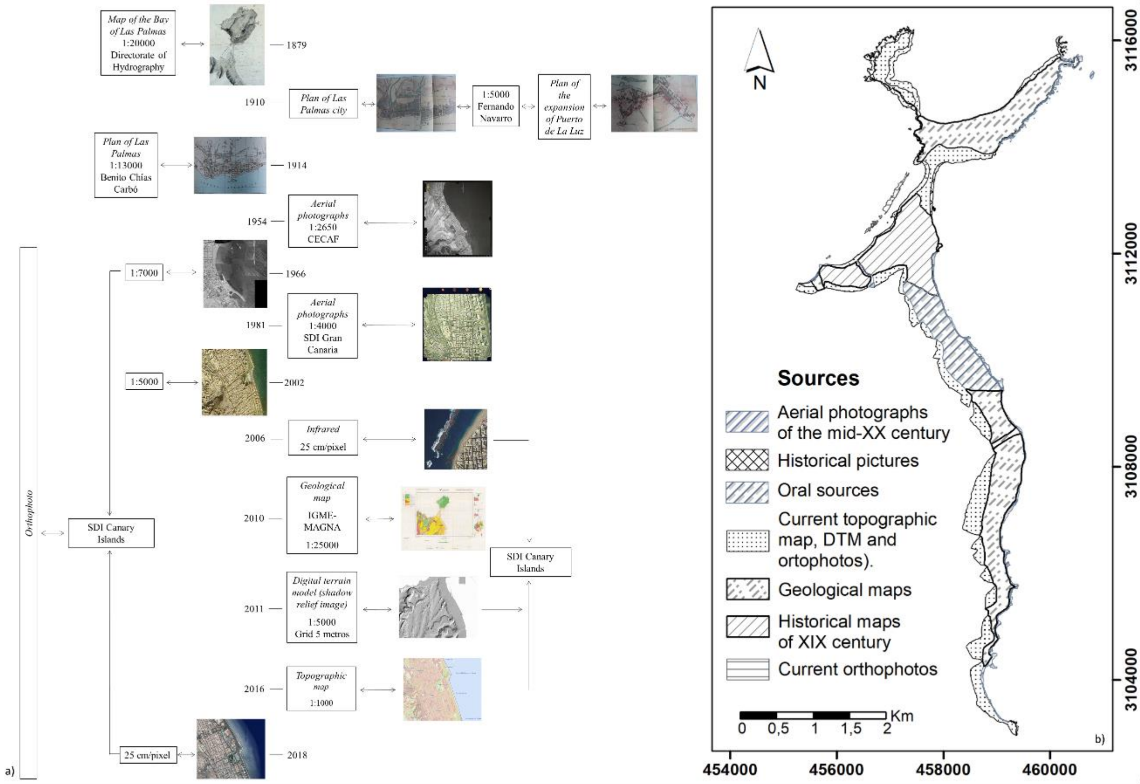

Figure 2. **a)** and **b)** Sources used to delimit and reconstruct the coastal landforms and the urban areas.

Current maps. The topographic map and digital terrain model (DTM) were consulted through the SDI of the Autonomous Government of the Canary Island (SDI Canary Islands, 2019). The geological map of LPGC (2010), from the Geological and Mining Institute of Spain (IGME, 2019), was also used. All these documents served to identify the general structure of the relief, differentiate erosive levels and steep surfaces and interpret the morphostructural units of the study area (Fig. 2b).

Images from the catalogue of the Foundation for the Ethnography and Development of Canary Crafts (FEDAC, 2019) were also consulted, as well other images available on websites such as “Las Palmas ayer y hoy” (2019), “Recuerdos de Gran Canaria” (2019) and “Gran Canaria: imágenes del ayer” (2018) (unpublished images). These images facilitated the reconstruction of the geomorphology of the south-eastern and north-eastern coastal stretches (Fig. 2b) since the end of the 19th century.

Oral sources. Nine people born between 1919 and 1953 who lived near the eastern coast of Las Palmas de Gran Canaria were located and interviewed. These interviews allowed information derived from documentary sources to be verified and compared, and also contributed to the reconstruction of the geomorphology of the south-eastern and north-eastern coastal stretches (Fig. 2b).

Field work. Three field campaigns were carried out between July 2018 and April 2019. These served to verify and compare the information derived from other sources, take current photographs and refine the cartography.

The information obtained through the documentary and oral sources was integrated into a GIS, generating three initial maps:

Geomorphological map: the classification system used for the representation of the coastal landforms was based on the work developed by Ferrer-Valero (2018) and Ferrer-Valero et al. (2017; 2018) for Gran Canaria island. The cartographic base of these maps is a hill shadows model (derived from a DTM). The main contour lines, as well as bathymetric curves, were added to facilitate the understanding of the relief.

Urban plot map: urban plot maps were drawn up for five dates (1879, 1954, 1966, 1981 and 2018). For their elaboration, the map of 1879 and the aerial photographs of 1954 and 1981 had to be scanned and geometrically corrected in order to generate georeferenced mosaics. Orthophotos were used for 1966 and 2018.

Land use map: this was based on the mapping of the Spanish National Geographic Institute (IGN, 2019) and fieldwork.

The overlaying of maps (landforms-urban areas and landforms-land uses) allowed quantification of the degree of loss vs. preserved landforms, as well as the types of uses that have affected them. Finally, a map of the state of landform preservation was generated and numerical data, which are presented in graph form, were obtained.

4. RESULTS

4.1. Geomorphological reconstruction

A total of 13 mesoscale coastal geomorphological units were identified (Fig. 3):

- *Coastal active cliffs.* Defined as a pronounced coastline of volcanic origin, whose base is in the field of action of the waves or on a rocky platform. This term would correspond to the following classes defined and published in the literature: sea cliffs (Bird, 2008); plunging cliffs (Sunamura, 1992); bluffs (Davidson Arnott, 2010); hard-soft cliffs (Davidson Arnott, 2010); simple-composite cliffs (Emery and Kuhn, 1982); and coastal slopes (Bird, 2008).
- *Coastal palaeo-cliffs.* Defined as coastal cliffs originally eroded by the sea when suffering from isostatic and eustatic movements and coastal programming processes. This term would correspond to the palaeo-cliffs class (Zazo, 1999).
- *Lava plains.* Plains or subhorizontal platforms composed of lava flows that extend along the coast. This term would correspond to the lava-deltas class (Mattox and Mangan, 1997).
- *Shore platforms.* Horizontal intertidal rocky surfaces or with gentle slopes towards the sea, with or without backing of coastal cliffs and subject to marine cycles. This term would correspond to the following classes defined and published in the literature: type A-type B shore platforms (Sunamura, 1992); low tide-high tide shore platforms (Bird, 2008); ledges (Bird, 2008);

benches (Kennedy, 2014); incipient-dissected shore platforms (Bird, 2008); and cemented pavements (Brocx and Semeniuk, 2010).

- *Calcarenitic reefs.* Coastal bar consisting of calcarenitic and conglomerate layers that generates a shallow water zone (coastal lagoon) that separates it from the open sea. This term would correspond to the following classes: rocky reefs (Bird, 2008); stumps; biogenic reefs (Brocx and Semeniuk 2010); *barras, lajas, bajas, bajíos* (local names).
- *Marine terraces.* Coastal abrasion platform with fossil marine deposits. This term would correspond to the following classes: marine terraces (Zazo, 1999); and raised platforms (Stephenson, 2000).
- *Alluvial mouth.* Plain where the sediments of a ravine are deposited. This term would correspond to the following classes: salt marshes (Bird, 2008); alluvial plains (McGill, 1958); fan-deltas (Shipman, 2008); and *saladares* (local name).
- *Nearshore rocks and stacks.* Isolated rock remains in the area near the coast, some above the sea (stacks) or others below, which may arise at low tides (rocky reefs) due to marine erosion. This term would correspond to the following classes: sea stacks, fringing platforms (Pethick, 1984); pinnacles (Bird, 2008); islets (Bird, 2008); *roques* and *peñas* (local names).
- *Aeolian sand sheets.* Mobile sands that form sand plains on an abrasion platform formed by light cream sandstones, with algae, shells and spherical algae concretions, usually having, at the top, a conglomerate of basic, rounded edges. This term would correspond to the following classes: sand sheets, nebkhas and stabilized dunes (Hesp and Walker, 2013).

- *Coastal dune systems.* Mobile, semi-mobile and stabilized sands that form dune fields (case of the 200 m wide sandy isthmus in its narrowest part that joins La Isleta with the rest of Gran Canaria). This term would correspond to the following classes: foredunes, nebkhas, barchans, parabolic dunes, transverse dunes, sand sheets, climbing dunes, falling dunes and cliff-top dunes (Hesp and Walker, 2013).
- *Sandy beaches.* Deposits of unconsolidated and loose sediments formed by fine “golden” sand from the Guanarteme dune system. This term would correspond to the following classes defined and published in the literature: sandy beaches (Bird, 2008); mixed and composite beaches (Jennings and Shulmeister, 2002); and sand barriers (Alexander, 1966).
- *Pebble-boulder beaches.* Deposits of unconsolidated and loose sediments formed by boulders and gravel. This term would correspond to the following classes: shingle, pebble and boulder beaches (Bird, 2008); bouldery shores (Bird, 2008); and storm ridges (Hall et al., 2006).
- *Stone and sand mixed beaches.* Deposits of unconsolidated and loose sediments formed by boulders and sand or gravel when the tide falls. This term would correspond to the following classes: sandy beaches (Bird, 2008); mixed and composite beaches (Jennings and Shulmeister, 2002); and sand barriers (Alexander, 1966).

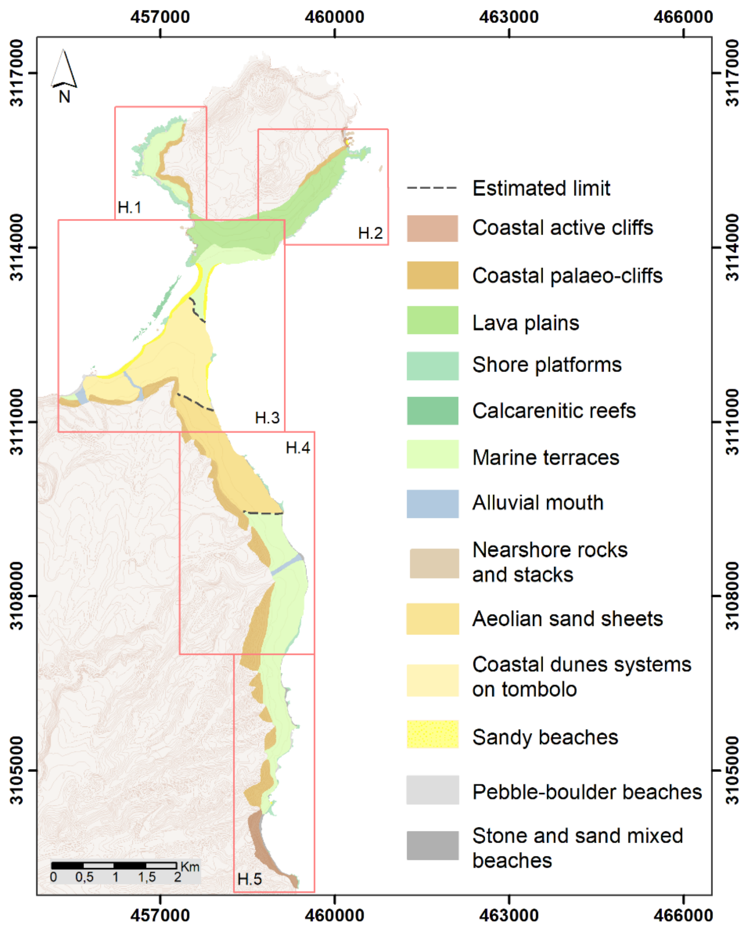

Figure 3. Geomorphological reconstruction of the coastline of LPGC city. The base images (topographic map and hill shadows model) were obtained from the SDI Canary Islands.

The presence of each type of landform depends on the zones in the study area (Figs. 4 [H.1, H.2 and H.3] and 5 [H.4, H.5]). The coastal active cliffs are mainly composed of volcanic materials from the Pleistocene in the north and from the Miocene and Pliocene in the south, presenting a medium-low height. With an area of 26.3ha, they are located in the areas of Sebadal (Fig. 4 [H.2]) and La Laja (Fig. 5 [H.5]). The coastal palaeo-cliffs (170.4ha) are escarpments of sedimentary composition (both marine and continental) of the FDLP. They are the ones with the greatest presence in the area and are far from the action of the waves as they are in the north-western sector, specifically El Confital (Fig. 4 [H.1]), and throughout the central and southern sector (Figs. 4 [H.3] and 5 [H.4 and H.5]).

The lava plains belong to the recent cycle and penetrate in the form of a lavas *aa* or *malpaís* fan in the north-eastern coast of La Isleta, specifically in Sebadal (Fig. 4 [H.2]) with an area of 160.0ha. The shore platforms have, in general, an igneous composition of different periods, are punctually calcarenitic and are supported by palaeo-cliffs. Their 41.93ha are distributed intermittently along the coastal front.

The calcarenitic reefs are a rocky set of calcarenites and conglomerates, known locally as the *Barra de Las Canteras*, that formed in a submerged beach environment approximately 110,000 years ago, covering a substrate of volcanic nature composed of gaps of the Roque Nublo Cycle with an area of 6.6ha. They emerge in the western area, opposite Las Canteras beach. The marine terraces are fossil marine deposits of the upper Pleistocene. Their 262.5ha are situated in El Confital (the north-western area of La Isleta) and in the eastern and south-eastern sector. In El Confital (Fig. 4 [H.1]), the terraces have been subjected to the intensive erosive action of the sea and the materials are more compacted, while in the eastern and south-eastern sector (Fig. 5 [H.4]) they are composed of sandstones and conglomerates with the presence of *Strombus bubonius* and *Thais haemastoma (Linné)*.

The three alluvial mouths (12.8ha) correspond to the Guiniguada, Tamaraceite and La Ballena ravines. Only the first had, in the past, a permanent flow. These flat and wide-bottom plains had sands and heterometric rocks of diverse nature.

The nearshore rocks and stacks are associated with the rapid recoil of basaltic castings of different periods, due to marine erosion. Occupying 1.7ha, they are mostly located around the coast of La Isleta (Fig. 4 [H.1 and H.2]).

The aeolian sand sheets of the Upper Pleistocene (with 117.9ha) were part of the coastal dune systems on the tombolo. Sandy sediments were transported by the trade winds to the east coast and then advanced several kilometres south (Fig. 5 [H.5]) through the south-eastern sea terraces. The coastal dune systems on the tombolo of the Upper Pleistocene was originated by marine circulation dynamics, which transported sands from the western coast of the Guanarteme isthmus towards the eastern coast. The system located in the north of the study area (Fig. 3 [H.3]) had an area of 174.2ha.

The beaches are distributed with heterogeneous morphologies throughout the coastline. The sandy beaches associated with the coastal dune systems dominated in the area of the isthmus, occupying 23.4ha, in the form of long beaches of white sand (Las Canteras and Las Alcaravaneras). The stone/sand mixed beaches, the result of the disintegration of surrounding materials, corresponded to 14.1ha, forming long ridges of black sand at low tide that dominated the eastern and south-eastern coast (Fig. 5 [H.4 and H.5]). The pebble/boulder beaches were composed of materials that came from pyroclastic type deposits, with some influence of fossil conglomerates, and from deposits of the surrounding ravines. Covering 6.4ha, they predominated to the north (La Isleta, figure 4 [H.1 and 2]), embedded at the foot of small escarpments and cliffs, as well as to the southeast (San Cristóbal beach).

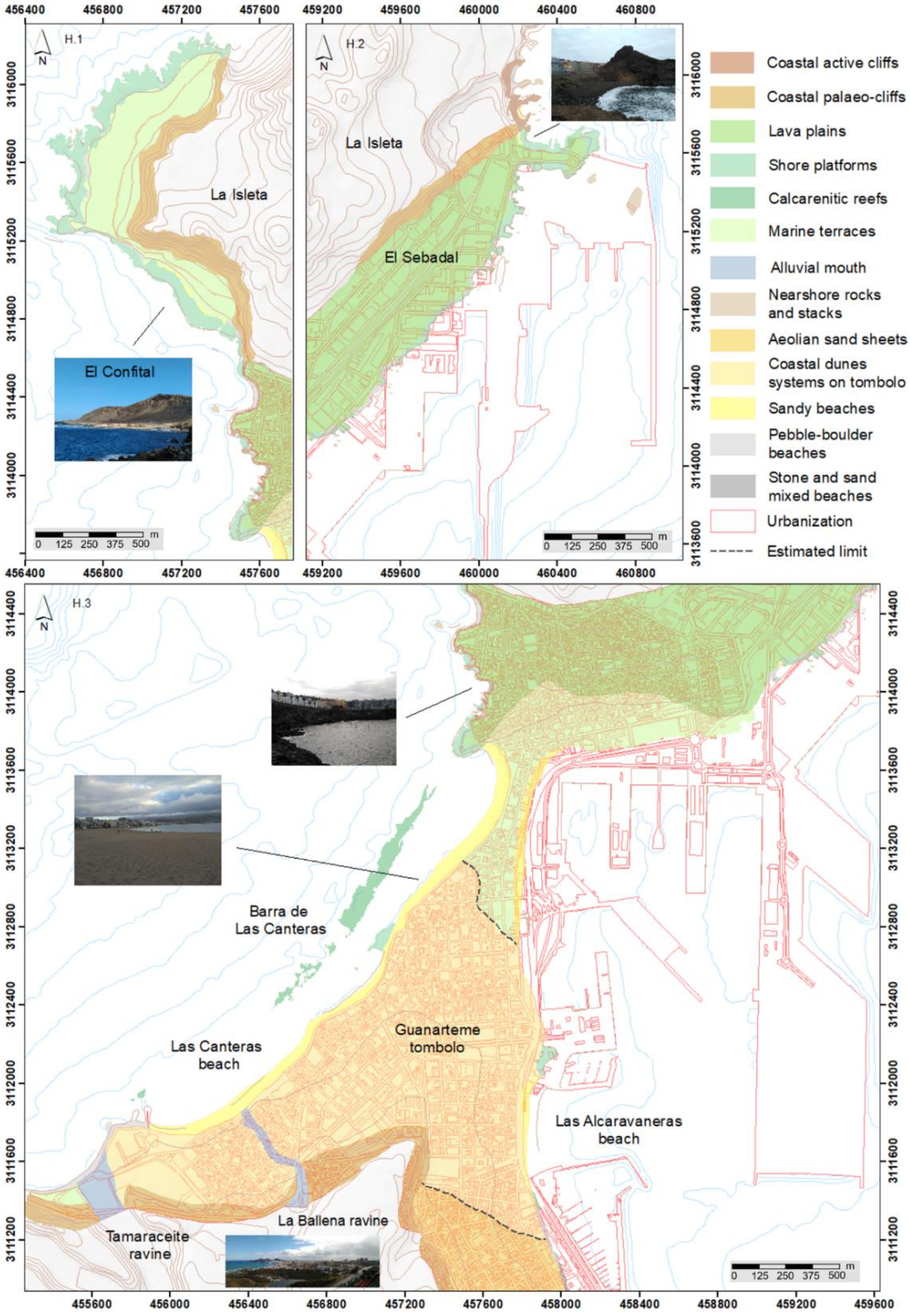

Figure 4. Geomorphological maps (H.1; H.2; H.3) of the northern sector. The base images (topographic map and hill shadows model) were obtained from the SDI Canary Islands. The images that illustrate the maps were captured by the first author of the work.

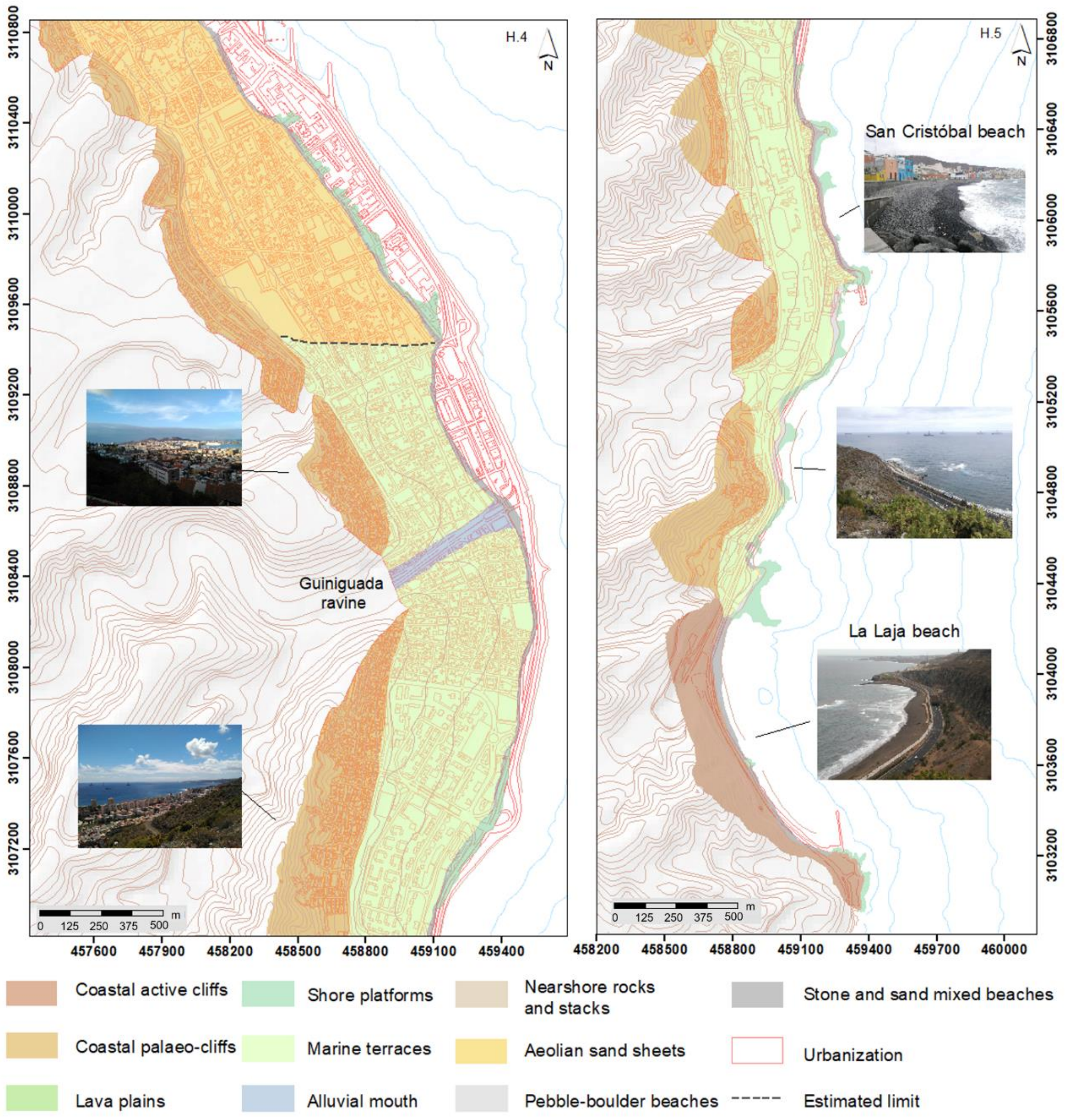

Figure 5. Geomorphological map of the central (H.4) and southern sector (H.5). The base images (topographic map and hill shadows model) were obtained from the SDI Canary Islands. The images that illustrate the maps were captured by the first author of the work.

4.2. Urban growth and land uses

4.2.1. Urban sprawl

The urban expansion of LPGC city (Fig. 6) that took place between 1879 and 2018 resulted in major landscape changes. This expansion took place on the coastal landforms (Table 1), with the 137.8ha of these landforms that were already occupied in 1879 increasing to 560.7ha by 1954, 652.4ha by 1966, 810.6ha by 1981, and 846.8ha by 2018. If we also take into account the area gained from the sea, this occupation increases to 139.2ha in 1879, 598.0ha in 1954, 731.7ha in 1966; 1028.3ha in 1981 and 1201.8ha in 2018.

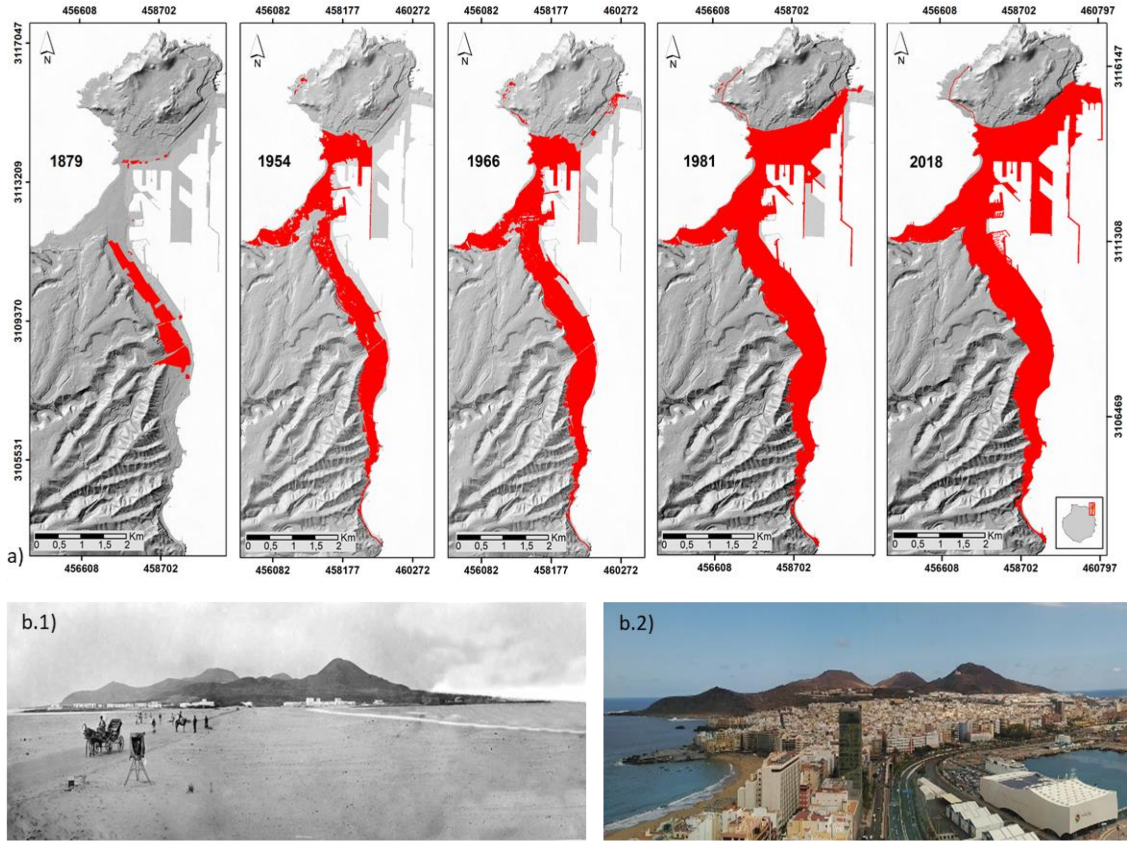

Figure 6. a) Evolution of the urbanization of Las Palmas de Gran Canaria city in 1879, 1954, 1966, 1981 and 2018. The base hill shadows model was obtained from the SDI Canary Islands. **b)** Guanarteme isthmus in 1880 (1) and in 2019 (2). The 1880 image was obtained from FEDAC, and the 2019 image was captured by the first author.

Table 1. Occupation of costal landforms by urbanization

Geomorphological categories	Urban area 1879		Urban area 1954		Urban area 1966		Urban area 1981		Urban area 2018	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Coastal active cliffs	0	0.0	3.9	14.7	4.2	15.8	7.1	27.1	10.8	41.2
Coastal paleo-cliffs	4.9	2.9	38.9	22.8	54.7	32.1	91.8	53.9	106.5	62.5
Lava plains	0.4	0.2	57.1	35.7	69.1	43.2	148.0	92.5	158.1	98.8
Shore platforms	0.0	0.0	1.2	2.8	4.4	10.6	11.6	27.8	14.4	34.3
Calcarenitic reefs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Marine terraces	59.0	22.5	215.4	82.1	234.6	89.4	230.6	87.9	231.3	88.1
Alluvial mouth	2.3	17.5	8.4	65.6	9.1	71.1	11.6	90.6	12.6	98.5
Nearshore rocks and stacks	0.0	0.0	0.1	3.6	0.1	6.7	0.4	20.8	1.2	69.9
Aeolian sand sheets	65.1	55.2	103.9	88.1	115.1	97.6	117.5	99.6	117.5	100
Tombolo coastal dune systems	4.0	2.3	122.8	70.5	148.2	85.1	172.7	99.1	174.1	100
Sandy beaches	0.2	0.8	3.9	16.5	4.8	20.7	6.4	27.4	6.5	27.7
Pebble-boulder beaches	0.0	0.3	0.5	8.3	0.8	12.4	2.0	31.8	2.4	37.5
Stone and sand mixed beaches	2.0	14.0	4.7	33.0	7.3	51.9	10.8	76.4	11.3	80.5
Sea	1.4	-	37.4	-	79.2	-	217.7	-	355.0	-
TOTAL OCCUPATION AREA OF LANDFORMS	137.8	13.5	560.7	55.1	652.4	64.1	810.6	79.6	846.8	83.2
TOTAL OCCUPATION AREA OF LANDFORMS+SEA	139.2	-	598.0	-	731.7	-	1028.3	-	1201.8	-

4.2.2. Land uses

The land uses that are currently observed on the coastal landforms (Figs. 7a and 7b) are, from greater to lesser surface area, the following: residential and tourist (25%), road infrastructure (23%), public spaces and green areas (22%), port (21%), facilities (5%), and industrial (4%). On the other hand, the uses that have been developed on land gained from the sea (Fig. 7c) are the following: 72% port, 16% road infrastructure, 4% industrial, 3% residential and tourist and facilities and 2% public spaces and green areas.

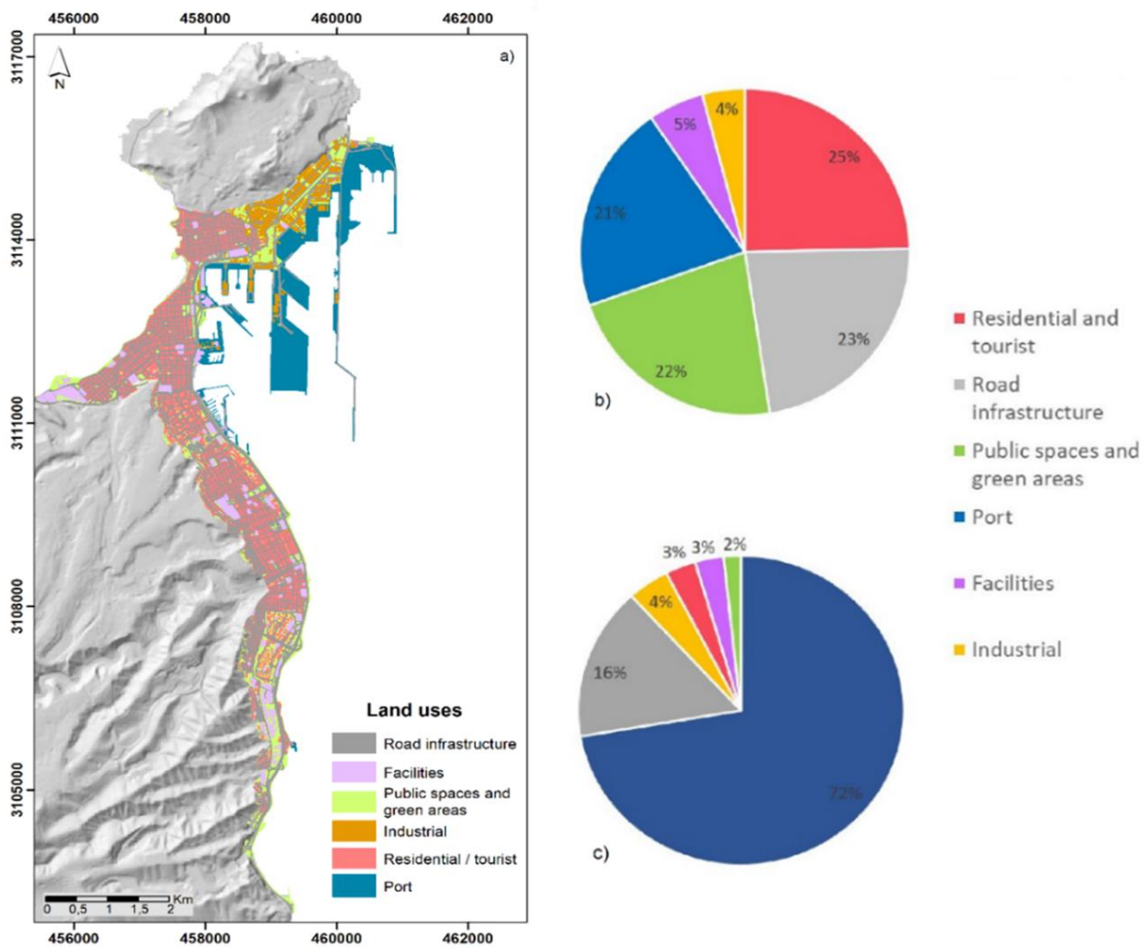

Figure 7. a) Land uses map; **b)** % land uses on coastal landforms; **c)** % land uses on land gained from the sea. The base hill shadows model was obtained from the SDI Canary Islands.

4.3. Urban growth vs. landform preservation

4.3.1. Degree of occupancy of landforms by urbanization

The occupation of coastal landforms occurred gradually (Fig. 8). In 1879, the first settlements mostly occupied aeolian sand sheets (47.3% of the occupation) and marine terraces (42.8%). By 1954 and 1966, the occupation of these two landforms continued to dominate (aeolian sand sheets [18.5%; 17.6%] and marine terraces [38.4%; 36.0%]), but by 1966 the occupation of coastal dune systems on the tombolo now stood at 22%, of lava plains at 10.2%, and of coastal palaeo-cliffs at 6.9%. By 1981, further increases in the urban occupation of lava plains (18.3%) and coastal palaeo-cliffs (11.3%) had taken place, a process that continued until 2018. In this evolution (Table 1), it should be noted that the degree of occupancy of aeolian sand sheets and coastal dune systems on the tombolo is now 100%, a level that was reached around 1981. This was due to the growth of LPGC northwards from its original centre due to the 'pull' effect of the increasingly influential Port of Las Palmas. In the case of shore platforms, the increase in their occupation between 1966 and 1981 was due to the execution of three urban projects ("Ciudad del Mar", "Plan Parcial del Paseo Marítimo" and the highway between the city and the south of the island), whose objective was to gain land from the sea for buildings and communications, given the clogging of the lower city that had occurred in previous years. At present, seawards expansion continues to take place, although basically in the port facilities. In this same period, there has been a slight decrease in the occupation of marine terraces as a result of the elimination of a shanty area that had been located in El Confital (northwest of La Isleta).

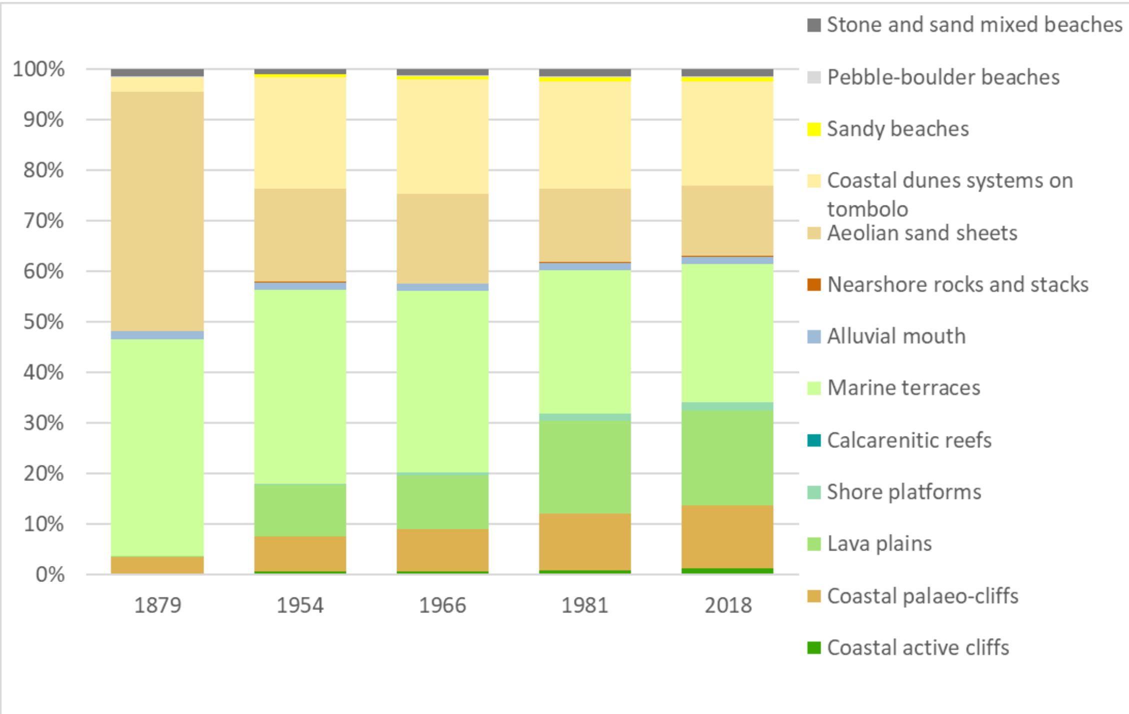

Figure 8. Landforms occupied throughout the LPGC urbanization process.

4.3.2. Occupation of landforms by land uses

Regarding the distribution of uses by coastal landform (Fig. 9), facilities are mainly concentrated in marine terraces (39%), followed by tombolo coastal dune systems (22%). Public spaces and green areas are concentrated in marine terraces (32%) and lava plains (21%). Industrial use is concentrated in lava plains (95%) and road infrastructure in marine terraces (25%) and tombolo coastal dune systems (24%). Port use is concentrated in shore platforms (52%). Finally, residential and tourist use is mostly concentrated in tombolo coastal dune systems (29%) and marine terraces (27%).

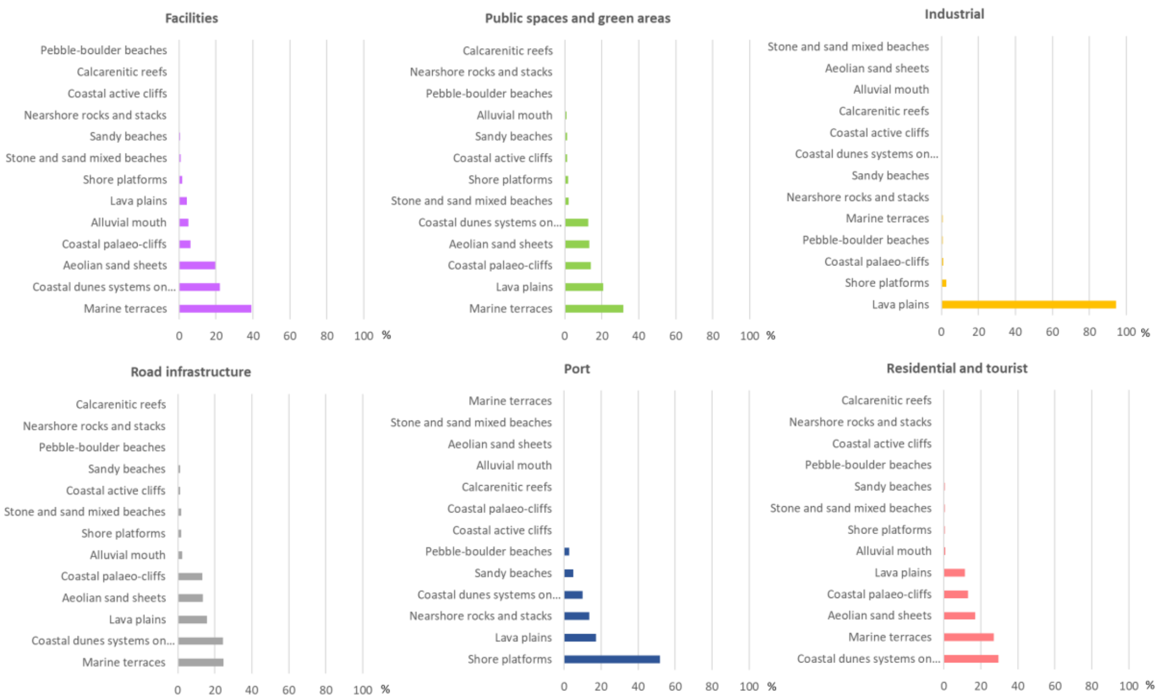

Figure 9. Representation of the distribution of the different uses for each landform.

4.3.3. Landforms lost vs. preserved.

4.3.3.1. Landforms lost.

In terms of area, a total of 848.1ha of natural coastal landforms have been lost (Table 2). The landforms with the greatest losses are: marine terraces (230.9ha), tombolo coastal dune systems (174.0ha), lava plains (158.1ha), aeolian sand sheets (117.9ha) and coastal palaeo-cliffs (106.4ha). Of these, the most affected have been the tombolo coastal dune systems and the aeolian sand sheets, which have been completely lost during the urban expansion process. The rest of the natural landforms have a lower degree of lost area: shore platforms (14.4ha), alluvial mouths (12.7ha), stone and sand mixed beaches (11.3ha), coastal active cliffs (10.9ha), sandy beaches (6.5ha), pebble-boulder beaches (2.4ha), calcaranitic reefs (1.4ha), and nearshore rocks and stacks (1.2ha). Taking into account actual surface area, the most affected are the alluvial mouths and the stone and sand mixed beaches, which have lost 98.6% and 80.5% of their areas, respectively.

Table 2. Original and current area of the coastal landforms (in ha) and lost surface (in ha and %)

Geomorphological categories	**Original area of the coastal landforms (ha)**	**Current area of the coastal landforms (ha)**	**Lost surface (ha –left- and % -right-)**	
Marine terraces	262.5	31.5	230.9	88.0
Tombolo coastal dune systems	174.2	0	174.0	100
Lava plains	160.0	1.9	158.1	98.8
Aeolian sand sheets	117.9	0	117.9	100
Coastal palaeo-cliffs	170.4	64.0	106.4	62.4
Shore platforms	41.9	27.5	14.4	34.3
Alluvial mouth	12.8	0.2	12.7	98.6
Stone and sand mixed beaches	14.1	2.8	11.3	80.5
Sandy beaches	23.4	16.9	6.5	27.7
Coastal active cliffs	26.3	15.4	10.9	41.3
Pebble-boulder beaches	6.4	4.0	2.4	37.5
Calcarenitic reefs	6.6	5.2	1.4	21.0
Nearshore rocks and stacks	1.7	0.5	1.2	69.9
TOTAL	**1018.3**	**170.2**	**848.1**	**83.3**

4.3.3.2. Landforms preserved.

At present, only 16.7% of the natural geomorphological surfaces of LPGC have been preserved (Fig. 10). The degree of preservation is variable, depending on the type of landform (Fig. 11-left and 12): calcarenitic reefs (79%), sandy beaches (72%), shore platforms (66%), pebble-boulder beaches (63%), coastal active cliffs (59%), coastal palaeo-cliffs (38%), nearshore rocks and stacks (30%), stone and sand mixed beaches

(20%) and marine terraces (12%). The tombolo coastal dune systems and aeolian sand sheets have disappeared completely, as well as practically all the alluvial mouths and lava plains areas (of which only about 1% remain in both cases).

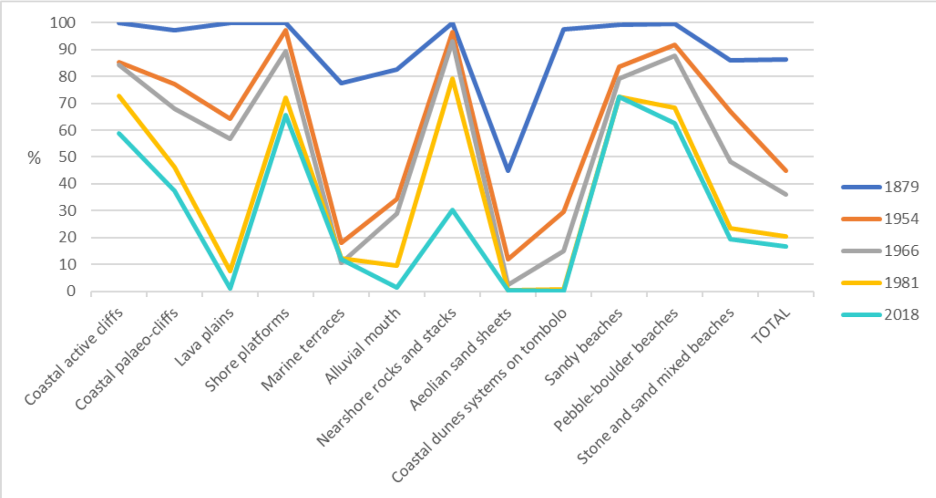

Figure 10. Temporal evolution of the degree of preservation of coastal geomorphology between 1879 and 2018.

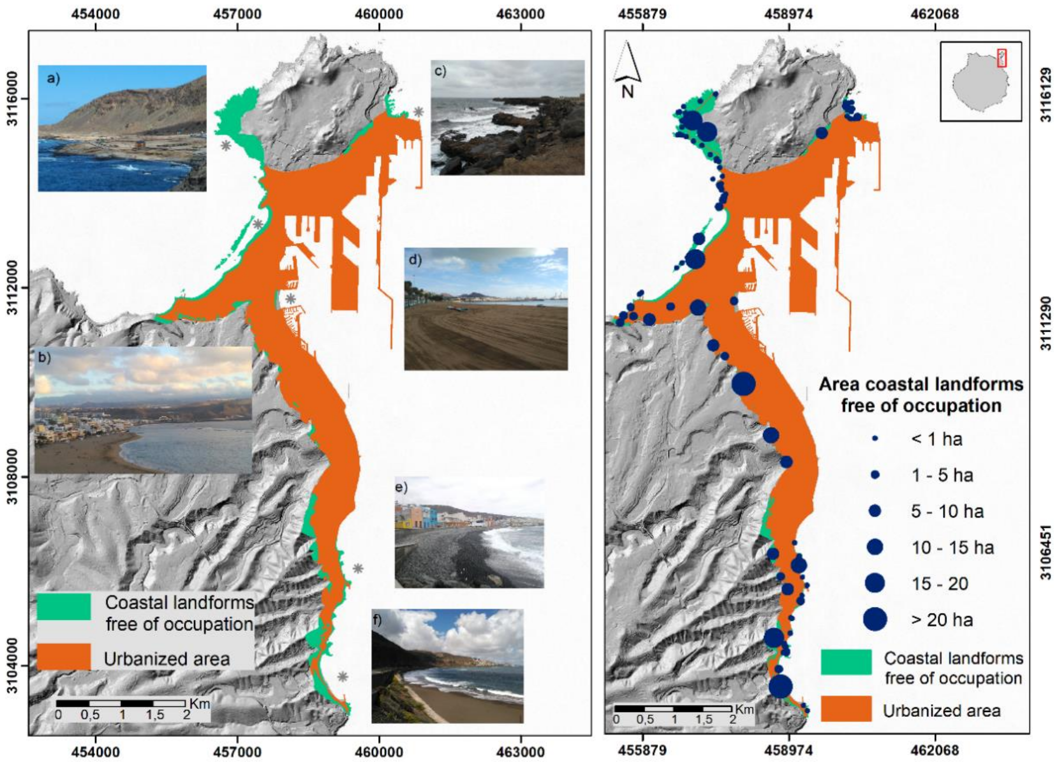

Figure 11. Map of the degree of preservation of coastal geomorphology in 2018 (left) and map of the surface of occupation-free landforms (right). The map on the left shows images of landforms preserved today, whose location is marked with an asterisk (*): a) marine terraces and coastal palaeo-cliffs (El Confital); b) sandy beaches and calcarenitic reefs (Las Canteras); c) shore platforms (El Sebadal); d) sandy beaches (Las Alcaravaneras); e) pebble-boulder beaches (San Cristóbal); f) coastal active cliffs and stone and sand mixed beaches (La Laja). The base hill shadows models were obtained from the SDI Canary Islands. The photos were captured by the first author in 2019.

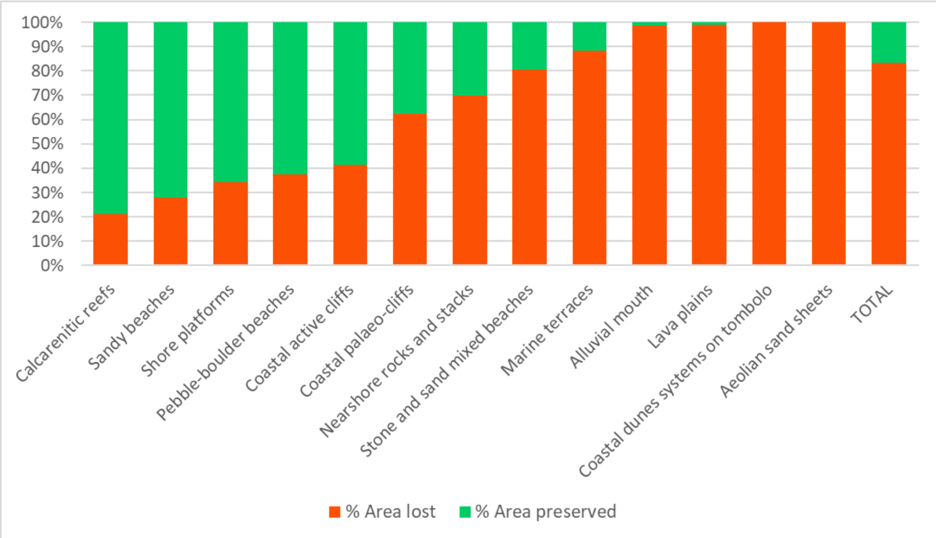

Figure 12. Coastal landforms preserved in 2018, according to their area.

The preserved geomorphological enclaves (Fig. 11, right) are generally located in the north-western and south-eastern sector of the study area. These have, for the most part, areas smaller than 1ha, although, exceptionally, we find areas larger than 15ha for sandy beaches (15ha), rocky platforms (17ha), active cliffs and palaeo-cliffs (18ha) and marine terraces (31ha).

5. DISCUSSION

Coastal geomorphological systems have undergone major changes in recent decades at global level. Although these landforms can be altered by different phenomena, natural or anthropic (Kurt et al., 2010; Ponte et al., 2016), urban growth (and the activities that this entails: land use changes, infrastructure, recreation, etc.) is its most serious threat (Ilić et al., 2016). This has been the case of our study area. This paper tackles the identification and mapping of the areas of lost and preserved coastal landforms experienced by a city. Although the methodology employed in this work has been applied here to one specific case, it can be of interest for coastal cities around the world who are having to deal with similar transformations (Graham et al., 2017). Additionally, this research mapped the extent of urban sprawl for five different dates (1879, 1954, 1966, 1981 and 2018), as well as current land uses, which were also combined with the map of the original landforms.

The results obtained reveal the high impact that the growth of LPGC city has had on natural coastal landforms, represented by a loss of 843.76ha. This high value indicates the lack of harmony that has existed during the study period between economic activities and urban interests and the conservation of nature. In this regard, two aspects must be taken into account. On the one hand, at the time the transformation of the eastern coast of the city was beginning to take place (1960 onwards), the regulation of land-sea space in Spain still depended on Port Laws (of 1880 and 1928) which disregarded non-port coastal spaces (Torres, 2010). At that time, only the 1963 Law on Centres and Areas of National Tourism -which promoted the development of tourism on Spanish coasts- was applicable (Ariza et al., 2016), but only affected Las Canteras beach. It was not until the introduction of the Coastal Law of April 1969, Law 22/1988, of July 28 (on coasts) and Law 2/2013, of May 29 on the protection and sustainable use of the coast, that these spaces were finally considered in terms of preservation, ecosystem protection and coastline stabilization (Ariza, 2011). On the other hand, very few environmental conservation policies had been established in Spain by the 1960s for the protection of natural spaces at landscape, ecological and aesthetic levels (National Parks Law (1916); Montes Law (1957)). Even so, numerous other factors have contributed to the disappearance of the geomorphological systems considered in this study. These include, amongst others, the inefficient evaluation of natural areas discarded because they were not considered relevant or worthy of protection and conservation (especially in urban environments), the lack of geoheritage methodologies, the desire for modernisation, urban or political interests, and the considerably lower environmental and cultural awareness in the past. As a result, no interest was paid to these natural systems, except in terms of their value as land for construction purposes, something common in the societies of the time. It was not really until the 1970s and, most importantly, the 1972 Convention on the Protection of the World Cultural and Natural Heritage (1972), that society finally began to show an interest in protecting natural and cultural systems and in preserving spaces of geological-geomorphological interest. At state level, more effective legal protections were gradually established (Law 15/1975 on Protected Natural Areas; Law 4/89, of March 27, on the Conservation of Natural Spaces and Wild Flora and Fauna; Law 42/2007, of December 13, on Natural Heritage and Biodiversity). Similar political changes have taken place with specific reference to the Canary Archipelago. Law 12/1987, of July 19, on the Protection of the Natural Spaces of the Canary Islands, assessed the natural geomorphological systems of the islands and granted the north-western sector of our study area (specifically, the volcanic landscape of La Isleta and part of El Confital) protected status. However, the coastal and environmental protection laws generally came into force too late to affect the process of urban growth of LPGC city and its invasion of these coastal geomorphological enclaves and the sea.

In line with the above, at present about 17% of the natural coastal landforms area that existed before the urban expansion of LPGC are conserved, including calcarenitic reefs, coastal active cliffs and sandy beaches, among others. However, these areas have only been partially preserved and/or have been subjected to considerable alterations. Their "survival", it should be noted, has been due perhaps less to the legal protection afforded to the north-western sector of the study area, but more to the fact that these are spaces that did not have optimal conditions to accommodate urban growth.

In this context, one of the questions that can be asked is whether cities that respect geodiversity can be built. It cannot be argued that geodiversity can only be preserved or improved without human presence; but at the same time the impacts of urbanization do not always have to necessarily entail a complete loss of geodiversity (Santos et al., 2017). According to Brilha (2005), it is impossible to conserve all geodiversity and, therefore, priority places and landforms that should be conserved need to be selected and defined. In such a process, it is essential to carry out rigorous inventories, the development of legal frameworks and plans for conservation, and evaluation and dissemination strategies, so that the relevant spaces from the point of view of geodiversity are recognized and included in territorial management plans (Rodrigues and Silva, 2012; Cristiano et al., 2018b). At the same time, plans have to be made to protect the population and material assets from the negative effects and consequences of various geological hazards, such as landslides or floods, among others. Gray (1997) points out that the intensity of the factors that cause adverse effects depends on the ability of the landscape to absorb morphological changes.

Precisely in our study area, there have been some problems in this regard. In the coastal palaeo-cliff area of the eastern sector of LPGC (Fig. 5 [H.4]) problems have arisen as the terrain has been unable to withstand the load of the buildings. During the winter seasons of 2005/6 and 2018/9, landslides took place on the slopes after 2 or 3 days of rainfall. This shows the inefficiency of the original measures taken through the construction of retaining walls. To avoid such issues, a balance needs to be found between the exploitation of these resources and their protection against excessive or improper use through sustainable planning and management processes (Ilić et al., 2017).

In the case of geomorphological systems that have been covered by urban infrastructure, these types of problems are difficult to detect until a process like the one described above is generated. Therefore, conventional evaluations are difficult to implement (Reynard et al., 2017). In recent years, studies similar to the one described here have been developed to assess the geodiversity of urban environments in different countries, such as Brazil, Slovenia, Switzerland and Australia (Brock and Semeniuk, 2010; Tičar et al., 2017; Santos et al., 2017; Reynard et al., 2017), among others. This type of research, which reconstructs the geomorphological characteristics of cities and shows current conflicts, can have different applications: i) at management and planning level, these studies can help prevent or redesign future urban development actions, promoting the integration and conservation of valuable geomorphological elements in urban environments; ii) at a scientific and academic level, they can help to know and interpret the geological and geomorphological context in which cities are inserted; iii) finally, at social and educational levels, these studies can help increase the level of awareness and knowledge of the natural elements of the city. An understanding of the interconnection between landforms and urbanization can help to explain the development of cities, to limit natural hazards, to adapt cities to natural processes, and to better comprehend the relationships between geomorphological and cultural heritage (Ruban, 2010; Ticar et al., 2017). In this respect, the importance should be noted of studies of this type in terms of fostering geotourism proposals. Urban areas provide interesting contextual conditions for the development of geotourism products (Reynard et al. 2017; Pica et al. 2017). Although geotourism initiatives are more developed in rural and natural contexts, in recent years they have also been carried out in urban environments of countries such as Brazil (Curitiba and Sao Paulo), Portugal (Lisbon), Serbia (Belgrade), Poland, Czech Republic and Hong Kong (Ng, 2014; Del Lama, 2015; Petrović et al., 2017; Górska and Zabielski, 2018; Chylińska, and Kołodziejczyk, 2018).

At local level, these types of measures could be taken into account when reconstructing lost coastal landforms and assessing, protecting or making known the most emblematic sites preserved in a study area.

Finally, this study could always be enriched with new contributions to learn more about the operation and geomorphological characteristics of the city. Likewise, the procedure used could be of interest for urban and tourist planning in urban settings, facilitating the preservation of geoheritage for future generations and avoiding conflicts of interest.

6. CONCLUSIONS

This work addresses the identification of the natural coastal geomorphological systems of a city, as well as its loss and/or preservation as the result of urban expansion.

The results have shown the high impact that the growth of the city studied (Las Palmas de Gran Canaria) has had on the natural morphology of a coastal space of great geomorphological diversity. Much of the geomorphological diversity has been completely destroyed (dune fields, aeolian sand sheets), while the rest has been only partially preserved and/or subjected to important alterations.

The identification of the disappeared coastal geomorphology (covered by urban sprawl) required the application of a combination of historical and geographical techniques, as well as a comparison of sources, based on a geohistorical methodology.

This type of research can help to diversify a city's tourism offer and prevent detrimental future urban development actions by increasing geoheritage awareness.

ACKNOWLEDGMENTS

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5.3. Assessing lost cultural heritage. A case study of the eastern coast of Las Palmas de Gran Canaria city (Spain).

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*Playa de Venegas, 1950-1960. Gran Canaria. Imágenes del ayer (2018)

Abstract

Land use changes have caused important losses of cultural elements around the world. While sometimes due to the impact of natural disasters, in recent decades urban sprawl invading coastal areas has intensified these losses. This process is one of the main factors responsible for the globalization of urban spaces worldwide, which implies a loss of cultural elements with heritage value. This is the case of the eastern coast of Las Palmas de Gran Canaria city (Canary Islands, Spain), which underwent major transformations from the late XIX century to the 1960s. This study evaluates the historical and cultural heritage lost along this stretch of coast. Historical sources were used to identify lost heritage elements, which were divided into four categories (military, industrial, commercial/services, and public infrastructure) and evaluated by 56 experts for six clearly defined intrinsic variables: uniqueness, identity, scientific, historical-cultural, aesthetic and social. Overall, the lost elements were given a medium heritage value score, with the highest valued elements tending to be associated with commerce/services. A link was also established between elements with the highest heritage value and the willingness to pay for them. The results of this work are of academic, social and educational interest, and can have a positive effect on the cultural sustainability of future urban planning.

Keywords: Lost heritage, coastal development, sustainability, urban planning.

1. INTRODUCTION

The disappearance of natural and cultural heritage can be observed in many parts of the world. According to Unesco (1972), the main threats that can provoke its disappearance are natural disasters and human activity. Lost heritage has important consequences for the disappearance of historical, ethnographic and natural values because of the irreparable nature of the damage caused (Rogo and Oguge, 2000).

For coastal areas, the expansion of cities, often for purposes of tourism, is one of the processes which most endangered and damages heritage (Nordstrom, 1994). Such areas also face the additional and growing risk of the disappearance of heritage assets as the result of climate change, with grave endangerment to the protection, preservation and transmission of non-renewable heritage assets for future generations (Durán et al., 2015; Reeder, 2015; Fatoric and Seekamp, 2017). This tourism/climate combination not only provokes degradation of the coast (Bajocco et al., 2012), it also impacts on the disappearance of a community's tangible cultural heritage assets and, in consequence, on the transformation of social and community practices which form part of its intangible cultural heritage assets (Durán et al., 2015). According to Markham et al. (2016), 62 World Heritage sites are presently at risk because of the impacts of tourism and/or climate change. To these can be added the 54 sites which the World Heritage Committee has declared are in danger (http://whc.unesco.org/en/danger).

1.1. State of the Art

Historical reconstruction is commonly used when studying the disappearance of cultural elements. In this approach, historical, geographical and bibliographic sources are key to knowing and understanding the particularities of lost heritage assets. Documentary evidence enables analyses of the changes that have occurred and studies of the evolution of different aspects of a specific territorial environment (Santana-Cordero et al., 2014; Pérez-Hernández et al., 2020). However, such a historically based approach faces the difficulty of finding information about a particular element or event as in some cases there is no written or graphic evidence available. For this reason, oral sources can be essential to complement the information that can be found from other sources (Fogerty, 2005; Benadiba, 2007; Gimmi and Bürgi, 2007).

In recent years, this type of investigation has been enhanced by the use of new technologies. These include, among others, geographical information systems (GIS), which are useful tools for the integration of georeferenced spatial information (Santana-Cordero, 2016a, 2016b), and digital photogrammetry, used in the field of archaeology, the documentation of monuments and for museums exhibitions (Guidi and Russo, 2011; Vaudetti et al., 2012; Caro, 2012; Ramírez-Sánchez et al., 2014; Fraile, 2015; Stathopoulou et al., 2015; Vincent et al., 2015; Bitelli et al., 2017). In this respect, new technologies have played a fundamental role in giving other perspectives to lost heritage elements through 3D modelling, virtual reality, etc. However, few studies have used these techniques to evaluate lost heritage assets (Tuan and Navrud, 2007). In fact, while it may be true that some studies can be found in the literature which have focused on assessing the vulnerability and quality of cultural heritage elements in coastal areas transformed by urban sprawl or the development of urban-tourism projects (Pinder, 2003; Howard and Pinder, 2003; Daire et al., 2012; Reeder, 2015; Mattei et al., 2019).

Most cultural heritage evaluation studies are based on the economic value of the asset, which can be associated especially with heritage management and expert assessments. The most commonly used methods have been based on the contingent valuation (CV) method (Bille, 2002; Navrud and Ready, 2002; Navrud and Strand, 2002; Windle and Rolfe, 2003; Brown, 2004; Tuan and Navrud, 2007) and on the choice modelling (CM) approach (Adamowicz et al., 1998b; Rolfe et al., 2000; Bennett and Blamey, 2001; Morey et al., 2002). Both models employ citizen surveys to determine how much they would pay for the preservation of such an asset or their willingness to accept some sort of compensation for its loss. The main purpose of these analyses is to calculate the economic benefits that might accrue if these assets were to be preserved, conserved or restored, and to contribute to the decision-making process when determining the best options to maximize social benefits (Tuan and Navrud, 2007; Windle and Rolfe, 2003). This economic assessment can evaluate the cultural heritage in utilitarian and non-utilitarian terms: in the first, the utility of the heritage is measured, and in the second its sociocultural qualities (non-utilitarian value) (Claesson, 2011). Other approaches have attempted to analyse both use and non-use values, and for the latter suggest the existence of cultural values associated with benefits other than economic ones (Durán et al., 2015; Windle and Rolfe 2003). Finally, other studies have undertaken a description and evaluation of the methodologies for economic valuations, considering the advantages, drawbacks and applications of the various techniques they employ (Claesson, 2011; Navrud and Ready, 2002; Throsby, 2001).

In view of all the above, this study aims to identify and evaluate lost cultural heritage elements that existed along the eastern coast of Las Palmas de Gran Canaria city before the expansion of the city in the 1960s that occupied this stretch of coast. A historical approach is employed for this purpose, as the majority of these elements no longer exist. The expert evaluation that is undertaken of lost heritage elements also provides information about the cultural and economic-related values that have been lost with the disappearance of these heritage elements. The purpose of this paper is to provide a tool to recover the historical memory in cities which have suffered an important loss of cultural values and to generate information that could be incorporated into future urban planning. The evaluation of lost heritage elements is a way of bringing the existing historical-cultural wealth closer to society, in particular to future generations.

2. STUDY AREA

Las Palmas de Gran Canaria (Canary Islands, Spain) is a municipality located in the NE of Gran Canaria island (Figure 1). It is delimited by the coastline to the north and east. This study focuses on the 19.74 km long eastern coastline, from El Sebadal (in the north) to La Laja (in the south) covering a total area of 16.35 ha, which was heavily transformed between the late 19th century and the 1960s by urban sprawl.

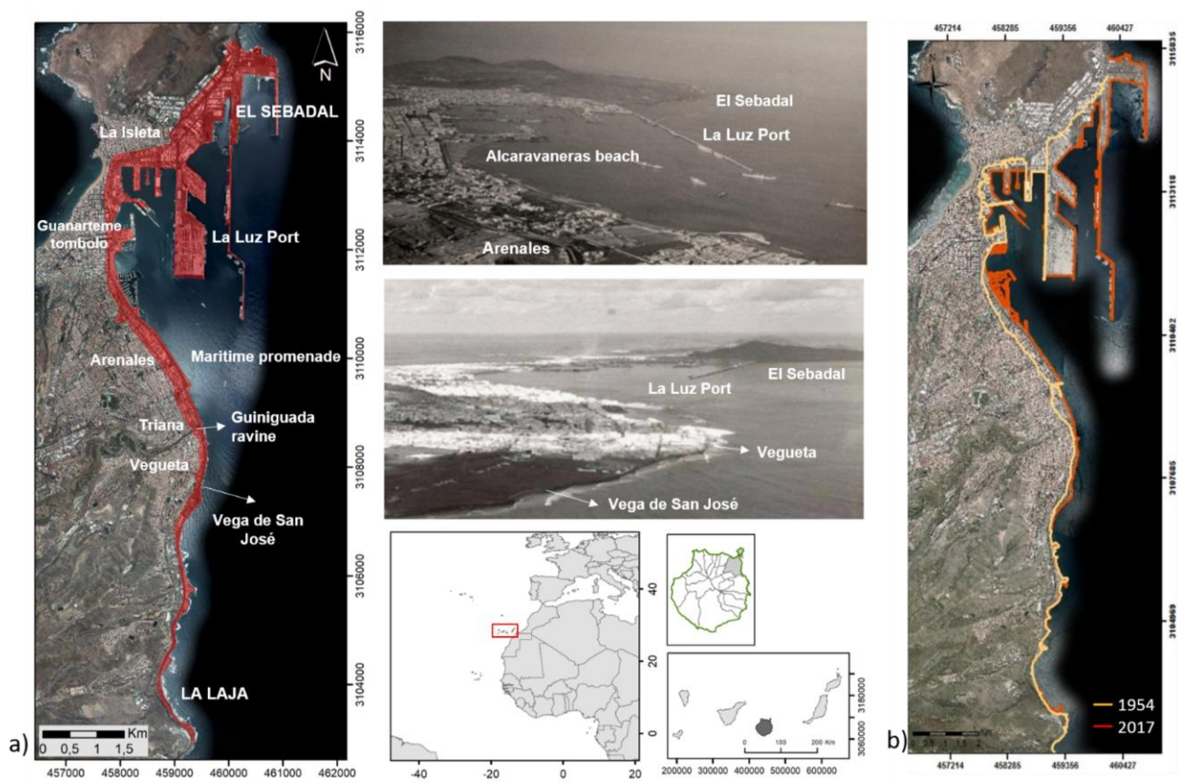

Figure 1. a) Study area; **b)** Coastline in 1954 and in 2017. Photographs reproduced from the Facebook pages of "Recuerdos de Gran Canaria" and "Las Palmas Ayer y Hoy".

Since the time of the occupation and conquest of the Canary Islands by the Spanish towards the end of the 15th century, its socioeconomic base has evolved from what was initially an agricultural based system to a service based one (Santana-Cordero et al., 2017), as indeed has also been the case in most European cities (Van de Laar, 2016). The growth of Las Palmas de Gran Canaria was practically non-existent from its establishment around the beginning of the 16th century until the middle of the 19th century. The city, comprised of two districts (Vegueta and Triana) and surrounded by walls, remained virtually unchanged over this period (Machín, 2006). The eastern coast was practically uninhabited, a space that was undervalued, of secondary importance and unsafe, where port, manufacturing and defensive infrastructures were set up (Martín, 2008).

At the end of the 19th century, with the extraordinary worldwide growth of maritime trade (facilitated by the development of steam engines and stimulated by industrial capitalism and the empire-building of the heavyweight European powers), the strategic intercontinental location of the Canary Islands led to them becoming a reference point for transoceanic routes (Herrera et al., 2008). The ports of the Canary archipelago, especially those in Las Palmas de Gran Canaria, benefitted enormously from these internationalisation processes as a stopover point for European vessels in their journeys to the African, Asian and Latin American colonies (Davies, 1984; Suárez, 2004, 2013).

The initiation of the construction works of Puerto del Refugio (La Luz Port), in 1883, was a milestone in the urban, economic, demographic, social and political evolution of the city (Martín, 2001), a 'modernisation' which gradually transformed it into a cosmopolitan city. This process fostered, on the one hand, the creation of numerous port-based businesses, activities and jobs and, on the other, the arrival of the first tourists to the Canary Islands. Coexisting with people from foreign lands would induce a change in the mindset of the local inhabitants and their customs, as well as initiating a re-evaluation of the coast as an area for recreation and leisure (Santana-Cordero et al., 2014; Pérez-Hernández et al., 2020). The city thus underwent a transformation and began to grow northwards, parallel to the sea (Ramón and González, 2019). From the start of the 20th century, town planning ordinances were approved and expansions undertaken which were to result in major migrations of the population from other urban and rural settlements inland the island (Machín, 2006).

Around the middle of the 20th century, tourism became a new driver of economic growth for the islands. As occurred in other coastal regions of the south of Europe, like the Mediterranean (Boyer, 2002), the Canary Islands, with its superlative climate and pristine sun-blessed beaches, were 'discovered' by the incipient mass tourism sector. This new tourism was centred particularly on the southern coasts of the islands of Tenerife and Gran Canaria (Martín Galán, 2008). In the case of Gran Canaria, the need to connect these tourist areas in the south of the island with the capital city in the north and the with air and port infrastructures generated major changes along the eastern coast of LPGC city. New connection roads were needed, but at the same time disruption to the urban fabric existing at the time was undesirable. Consequently, new plans for expansion operations that were designed to gain land from the sea were drawn up (Pérez-Hernández et al., 2020). Some of the most important transformations took place between the beginning of the 1950s and the middle of the 1960s with the development of a dual carriageway which linked the city with the south of the island (Avenida de Canarias – GC-1), and the construction of new buildings and a promenade along the eastern coast (Machín and Ruiz, 2006). The new coastline was thus extended seawards by some 250 m. The evolution that the city experienced generated new means of communication and gained buildable land, but also resulted in the loss of heritage assets.

3. MATERIALS AND METHODS

A 4-stage methodology was used to evaluate the lost cultural heritage of this stretch of coast: 1) identification of lost heritage elements and land uses; 2) inventory; 3) selection; and 4) expert evaluation of the lost heritage elements.

1st stage: Identification of lost heritage elements and land use

The identification of lost elements was undertaken using four different sources (Table 1): i) bibliographic references; ii) aerial photograph and orthophotos; iii) old photographs; and iv) oral sources. An exhaustive search was conducted in scientific and informational publications as well as archive-based sources for information about the heritage elements identified. Their position was digitalized onto the 1954 aerial photograph and, when possible, onto the 2017 orthophoto by sectors (northern, central and southern). These sectors were differentiated according to the urbanization process and the development of economic activities in the city throughout its history. Thus, as previously mentioned, the historical center is located in the central part of the city; the port, industrial and defense infrastructures, together with the urban fabric, have been situated towards the north since the end of the 19th century; and traditional uses (agriculture and fishing) were located towards the south until the mid-twentieth century, when the urban process started. The land uses around these three sectors were also digitalized in order to proportionally calculate land use losses. Finally, data about heritage elements and land uses were integrated in a GIS, grouping them by functionality.

Table 1. Characteristics and descriptions of the sources used.

<table>
<tr><th colspan="2">Source type</th><th colspan="3">Description</th><th>Date</th><th>Source</th></tr>
<tr><td rowspan="5">Bibliographic references</td><td>Scientific papers and local publications</td><td colspan="3">These publications provide historical and contextual information about the heritage elements.</td><td>1980 - 2016</td><td>Martín (1980, 2001, 2007, 2008, 2009)</td></tr>
<tr><td rowspan="4">Historical maps</td><td rowspan="4">The four historical maps served to identify heritage elements from the beginning of the 20th century and to know the urban evolution of the city and the changes in land use.</td><td>Map of the Bay of Las Palmas (Directorate of Hydrography)</td><td>1:20000</td><td>1879</td><td rowspan="4">Tous J, Herrera A (1995)</td></tr>
<tr><td>Plan of the expansion of Puerto de La Luz (Fernando Navarro)</td><td rowspan="2">1:5000</td><td>1910</td></tr>
<tr><td>Plan of Las Palmas city (Fernando Navarro)</td><td>1910</td></tr>
<tr><td>Plan of Las Palmas (Benito Chías Carbó)</td><td>1:13000</td><td>1914</td></tr>
<tr><td rowspan="3">Aerial photograph and orthophotos</td><td>Aerial photograph</td><td colspan="2" rowspan="3">The aerial photograph and two orthophotos served to compare the urban growth of the city and to digitalize the located heritage elements.</td><td>1:2650</td><td>1954</td><td>Cartographic and Photographic Centre of the Spanish Air Force (CECAF). Department of Geography (ULPGC) Funds.</td></tr>
<tr><td>Orthophoto</td><td>1:7000</td><td>1966</td><td rowspan="2">IDECanarias (Spatial data infrastructure of the Canary Islands).</td></tr>
<tr><td>Orthophoto</td><td>25 cm/pixel</td><td>2017</td></tr>
<tr><td colspan="2">Pictures</td><td colspan="3">Consultation of unpublished photographs. Provided by public administrations and the general public, these were taken from the FEDAC (Gran Canary Government Foundation for the Study and Development of Canary Handicrafts) catalogue and social media ("Las Palmas Ayer y Hoy", “Gran Canaria. Imágenes del Ayer” and "Recuerdos de Gran Canaria").</td><td>Between 1879 and 1970</td><td>FEDAC
Las Palmas Ayer y hoy (2019)
Gran Canaria. Imágenes del Ayer (2018)
Recuerdos de Gran Canaria (2019)</td></tr>
<tr><td colspan="2">Oral sources</td><td colspan="3">Nine interviews were conducted with people born between 1919 and 1953 who lived in the vicinity of the eastern coast of Las Palmas de Gran Canaria.</td><td>2015</td><td>Interviews</td></tr>
<tr><td colspan="2">Data integration and analysis</td><td colspan="3">The collected data was integrated in a GIS in which the heritage elements were represented on the 1954 photograph and the present-day orthophoto.</td><td>2017</td><td>Geographic Information Systems (GIS). ArcGIS.</td></tr>
</table>

2nd stage: Inventory

The lost heritage elements that were identified in stage 1 were subdivided into tangible, intangible and mixed types. Information about the elements was stored on inventory datasheets which contain a descriptive section for each identified tangible and intangible heritage element. The tangible elements refer to cultural expression through the realization of immovable (buildings, sites, etc.) and movable (works of art, books, photographs, etc.) assets. Intangible heritage is the set of distinctive spiritual, material, intellectual and emotional features which characterize a society or social group, including value systems, traditions and beliefs.

These datasheets also show the location of the assets in the past and present, their characteristics, history and a code which correlates to the numbering used in the mapping performed for the rest of the study.

3rd stage: Selection of heritage elements

A selection was then made of the most relevant and important heritage elements that had been previously identified. This selection was based on the following criteria: a) priority was given to elements for which conventional images were available; b) elements for which insufficient information was available were excluded, and; c) intangible and mixed heritage (cultural landscape) elements were discarded due to their difficult evaluation. This process resulted in the final selection of a total of 30 heritage elements for subsequent expert evaluation. The selected elements were subdivided into military (MI), industrial (IN), commercial services (CS) and public infrastructure (PI) categories.

4th stage: Expert evaluation of lost heritage elements

A series of experts were asked to fill in a Google Form online survey. The survey was structured in two parts. The first section included an explanation of the purpose of the study and the structure of the form, and personal questions about the experts to generate a profile of the participants. The second part was comprised of three questions about each heritage element. In the first question, the experts were asked to score each selected lost heritage element for each of six intrinsic variables (Table 2): uniqueness (U), identity (I), scientific (SC), historical-cultural (HC), aesthetic (A) and social (S). The following two questions - i) What would be the most appropriate way for its reconstruction or recognition as a heritage asset? and; ii) If this patrimonial element existed, how much would you be willing to pay to visit it? - were related to the type of reconstruction (total or partial) or awareness of the heritage element (by marker, information panel or plaque) and the willingness of the participant to pay to visit (0 euros, < 5 euros, < 10 euros, and > 10 euros).

Table 2. Intrinsic variables used to evaluate the lost heritage elements.

Intrinsic variables	Definition
UNIQUENESS (U)	The quality possessed by the element that differentiates it from others with similar characteristics.
IDENTITY (I)	The bond or emotion that an individual or collective group has with respect to the element. This bond or feeling may be related to historic, symbolic, traditional, commemorative, sentimental, spiritual, religious or patriotic aspects.
SCIENTIFIC (SC)	The potential the element has to generate scientific knowledge.
HISTORICAL-CULTURAL (HC)	The capacity the element has to transmit or bear witness to historical facts, events or processes which are of importance for the cultural and educational enhancement of a community.
AESTHETIC (A)	The visual qualities of the element that give the observer pleasure and satisfaction.
SOCIAL (S)	The interaction with the population, enabling and facilitating social connections as a meeting point for the development of shared activities and a shared space.

In total, 56 experts participated in the survey (Figure 2), separated into three groups: 1) university academics (UA) working on heritage from historical, geographic, geologic and economic perspectives; 2) heritage institution (HI), experts working in public administrations including the Gran Canaria Government, museums and archaeological companies; and 3) experts from other fields (OF) working indirectly on heritage-related matters. The latter group had either a personal (because they lived or knew that environment before its transformation) or a professional connection (because of the knowledge they had from various perspectives) with the element. It was comprised of historians, heritage specialists, translators, secondary school and college teachers, and other professionals from administrative bodies.

Figure 2. Sub-groupings and fields of the experts surveyed.

The results obtained were statistically analysed using SPSS software. Firstly, a Spearman's correlation was performed between each of the variables (U, I, SC, HC, A and S) used to estimate the value of each heritage element and the willingness to pay to visit it. A Kruskal-Wallis test was then performed to determine if there were statistically significant differences between the four types of heritage element (see section 4.2) in relation to the intrinsic variables used for their evaluation.

4. RESULTS AND DISCUSSION

4.1. Identification of the lost heritage elements

In total, 61 types of lost heritage elements were identified (Table 3). Most (57) were of the tangible type, in other words architectural elements of various forms including industrial, commercial/service, military, port, transport, hydraulic and religious. Three elements were intangible heritage assets (*chinchorro* - a traditional fishing method, *cambullón* - a Canary word derived from the English 'come and buy' describing the bartering between sailors and locals in the port area, and *curtido de la piel* - local tanning methods), and one example of cultural landscape mixed heritage (farming crops).

Table 3. Types and categorisation of heritage found.

Types of heritage		**Cultural heritage category**	**Types of lost elements**	**Lost elements**
Cultural heritage	**Tangible (immovable)**	Industrial heritage	17	23
		Commercial/services heritage	17	27
		Military heritage	11	11
		Public infrastructure heritage	12	15
	Intangible	Intangible heritage	3	8
Mixed cultural/natural		Cultural landscape heritage	1	4
		TOTAL	61	88

* "Lost elements" represents the elements located on the maps (Figures 4, 5 and 6). The numbers tend to be higher than those for "Types of lost elements" (table 3) because some heritage elements are represented-digitized several times in each coastal sector.

The three sectors (northern, central and southern) had lost practically the same number of heritage elements (Figure 3), though the central sector was slightly more affected with the loss of 31 elements; 30 elements disappeared in the southern sector and 27 heritage element losses were recorded in the northern sector. Specific aspects of each sector are discussed below.

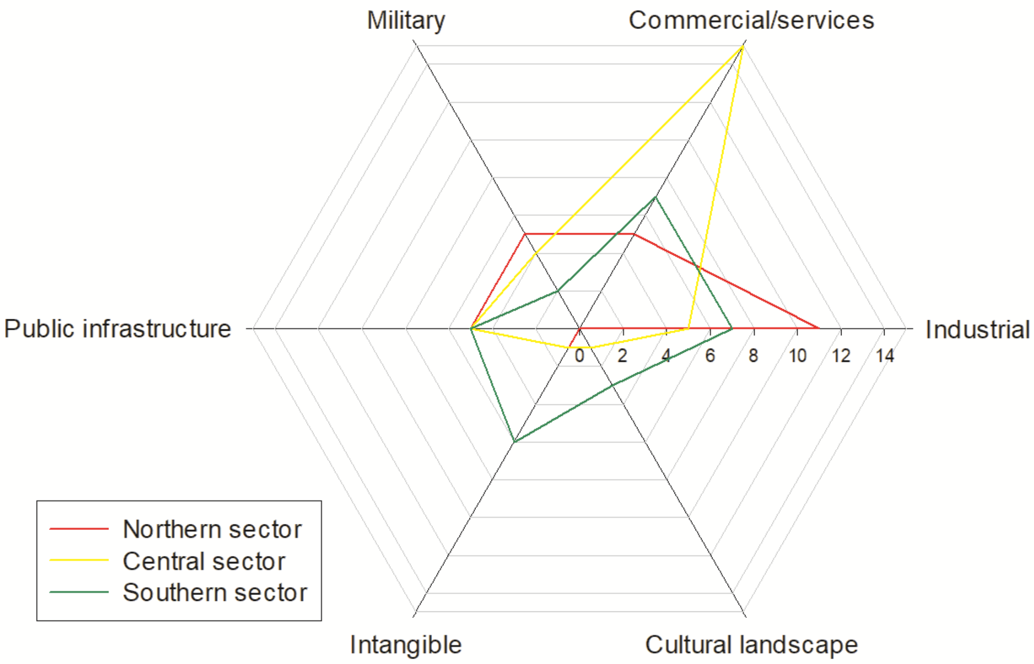

Figure 3. Distribution of the lost heritage elements by sector. Intangible and tangible heritage elements located on the maps (Figures 4, 5 y 6) are included.

Northern sector

This sector corresponds to the beaches (areas) of El Sebadal, La Luz and El Refugio (Figure 4). This sector is characterized (Figure 3) by losses in its industrial heritage (11 elements) and its notable military heritage (5 elements). Commercial/services elements, as well as those related to public infrastructure, also represent significant losses (5 each). In the middle of the 19th century, this sector was practically uninhabited as the city was essentially comprised of the Vegueta and Triana districts (central sector). The termination of the Las Palmas road joining the Vegueta-Triana district to the port area in 1881 and the commencement of the works on El Refugio port in 1883 saw more settlements of the population along this seafront (Martín, 2001). This pattern can also be seen during this period, or even in previous years, in other European port cities including, among others, Lisbon, Rotterdam and Liverpool (Van de Laar, 2016; Pinheiro, 2018). Numerous coal, ship repair and shipping agency companies were established in this area which were mostly foreign-owned (Herrera, 1984).

In this sector there is also the loss of an element of intangible heritage. The *cambullón* practice of bartering that took place between the local population and the crews of visiting vessels became widespread. This practice was developed throughout the Canary Islands, although it was most commonly seen in Gran Canaria and Tenerife. Its importance lies in the fact that, through this practice, it was possible to acquire products and goods, for example penicillin, that were scarce or non-existent at the time in the local market (Herrera et al., 2008). This activity, however, was not exclusive to the Canary ports, but rose spontaneously in various places against the backdrop of port activities (Cubas et al., 1992). A similar activity can be found, for example, in Madeira, and its "*bomboteiros*" (Vieira, 2017; Faria and Alves, 2017).

El Sebadal, which had been previously used only by waterfront fishermen, was converted into a military zone as its strategic location in a high area allowed a panoramic viewpoint and hence control over the approach of any vessel to the city (Martín Galán, 2001).

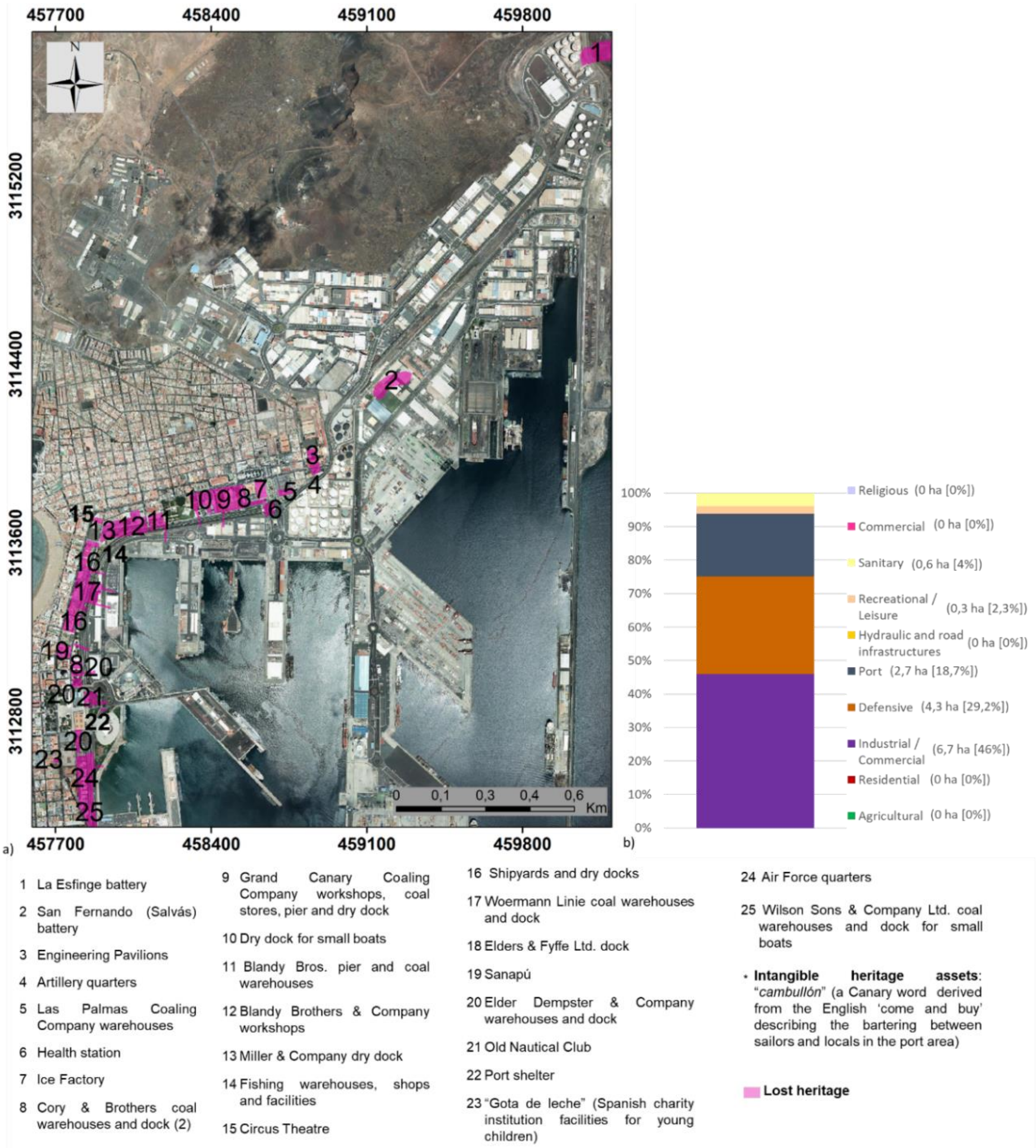

Figure 4. a) Heritage elements in the northern sector (El Sebadal, La Luz and El Refugio) in 2017. *Some heritage elements may be represented-digitized several times in the same coastal sector, or the same element type located in more than one of the three coastal sectors. For this reason, some of the numbered elements are repeated in the figure (e.g. shipyards and dry docks -16-). To avoid statistical reiteration, they are counted just once in each coastal sector. The number of elements identified is indicated in brackets when the number is more than one. **b)** Lost land use in % (and surface area) in central sector.

Central sector

This sector is comprised of the beaches of Santa Catalina (in the present day only one part of this beach remains, named "Las Alcaravaneras"), Lugo, El Caletón, Venegas, Triana and San Agustín (Figure 5). This sector is characterized (Figure 3) by significant losses in its commercial/services heritage (15 elements) and its notable industrial heritage and public infrastructure (5 elements each). However, military elements (4) also represent important losses. Though lower in number, losses are also found in intangible heritage and cultural landscape (1 element in each case).

In the middle of the 19th century, Santa Catalina was uninhabited with only some fortifications along the coast for the defence of the city (Figure 5). At the start of the 20th century, as in other coastal cities (Boyer, 2002; Benseny, 2011), the construction of housing began along the coast and the first hotels and other tourist infrastructures were constructed in response to the arrival of foreign visitors, which in turn accelerated after the construction of El Refugio port (González, 2007; Martín, 2009).

The district of Lugo (Figure 5) was a residential, commercial and recreational area. El Caletón and Venegas was a productive area inhabited by the working classes since the end of the 19th century. This distribution pattern of residential areas alongside areas of production has also been observed in other European and Asian countries (Chandavarkar, 2003; Tomba, 2009; Petrovici, 2011). The buildings for the most part were carpentries, workshops, or small food industries (Florido, 1998). In addition, various buildings were located in Venegas designed for recreational, social use and journalism. The Triana stretch of coast was occupied by port facilities, workshops and shipyards (because the first dock of the city built in 1811 was there). In the middle of the 20th century, it was converted a residential and recreational area with a promenade. In Caleta de San Agustín were installed municipal facilitiesand public buildings.

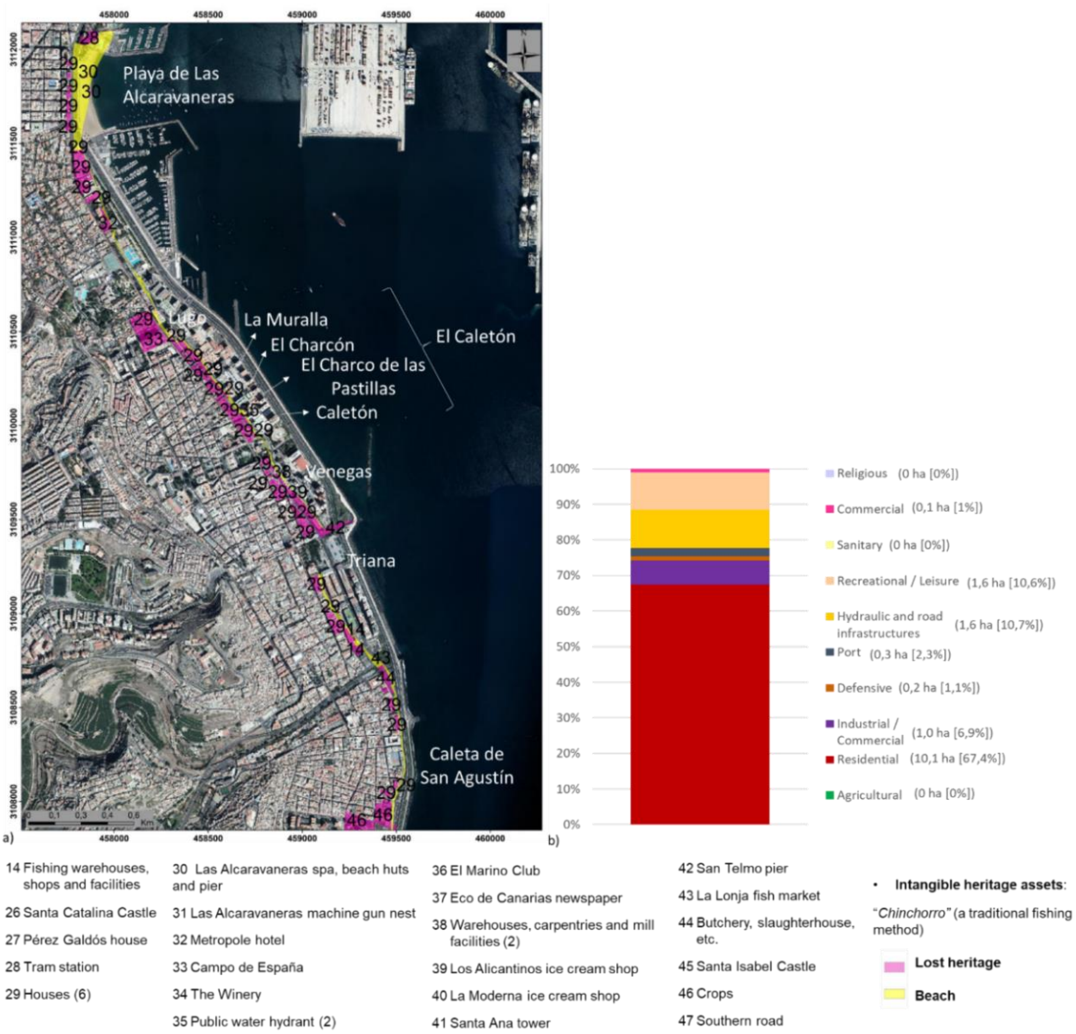

Figure 5. a) Heritage elements of the central sector (Santa Catalina / Las Alcaravaneras; Lugo; El Caletón; Venegas; Triana and Caleta de San Agustín) in 2017. *Some heritage elements may be represented-digitized several times in the same coastal sector, or the same element type located in more than one of the three coastal sectors. For this reason, some of the numbered elements are repeated in the figure (e.g. houses -29-). To avoid statistical reiteration, they are counted just once in each beach of coastal sector. The number of elements identified is indicated in brackets when the number is more than one. **b)** Lost land use in % (and surface area) in central sector

Southern sector

This was comprised of the beaches of Las Tenerías, San Cristóbal, La Cardosa, Aguadulce, Bajo de La Laja and La Laja (Figure 6). This sector is characterized (Figure 3) by important losses in its commercial/services and industrial heritage (7 elements each), intangible heritage (6 elements) and public infrastructure (5 elements). Military elements (2), as well as those related to cultural landscape, also represent important losses (3).

There was an extensive and fertile meadow in this area known locally as *La Vega de San José* (Figure 6). The expansion of international maritime trade brought with it, after the end of the 19th century, the intensification, at different coastal enclaves of the Canary Islands, of agricultural crop production for export, particularly in the islands of Gran Canaria and Tenerife (Bianchi, 2004). For this purpose, bananas and tomatoes were grown here along with various other crops, especially in Las Tenerías and San Cristóbal.

The coast continues southward with some isolated fishermen houses and agricultural warehouses and the continuous housing constructions of Las Tenerías, San Cristóbal and La Laja. Industrial activities were established in Las Tenerías, including tanning and carpentry, while San Cristóbal was primarily a residential area associated with fishing activities although in the 1940s and 1950s it was also home to a fish factory which exported its products to the UK, a tomato packing factory and a mineral water distributor.

On La Laja beach (Figure 6), there was a line of higher architectural quality dwellings than the other fishermen houses. These were the summer residences of well-to-do families from the districts of Triana and Vegueta. There were also two factories in this area at the mid-point of the 20th century. Also found in this area was the *Fielato* building, a tax collection office for the entrance of consumables into Las Palmas city (Doreste, 2014). Finally, one of the most important activities that took place both in this area and Las Alcaravaneras was the now in disuse *chinchorro*, a shoreline-based trawler fishing practice.

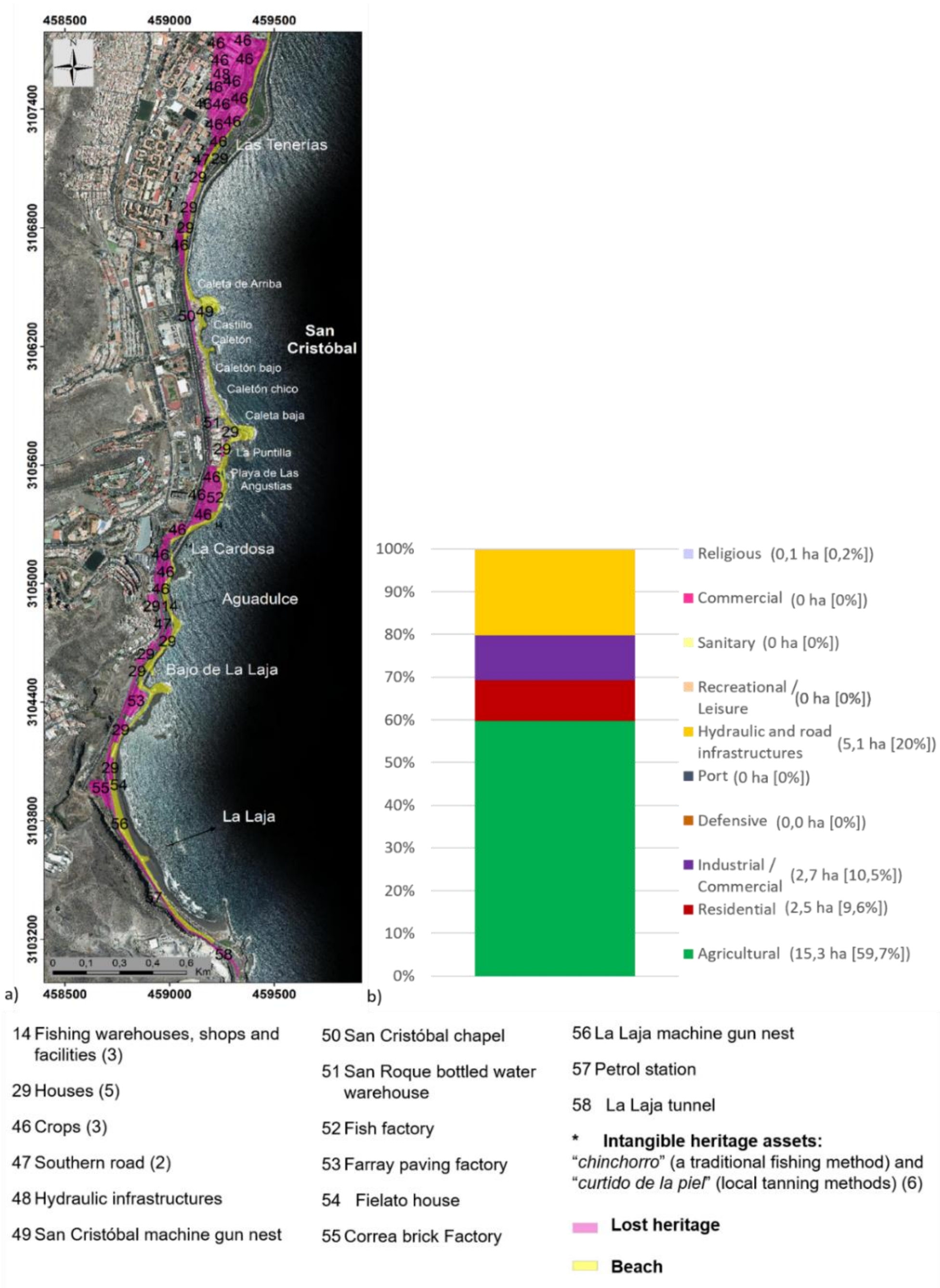

Figure 6. Heritage elements of the southern sector (Las Tenerías, San Cristóbal, La Cardosa Aguadulce, Bajo de La Laja and La Laja) in 2017. *Some heritage elements may be represented-digitized several times in the same coastal sector, or the same element type located in more than one of the three coastal sectors. For this reason, some of the numbered elements are repeated in the figure (e.g. houses -29-). To avoid statistical reiteration, they are counted just once in each beach of coastal sector. The number of elements identified is indicated in brackets when the number is more than one. **b)** Lost land use in % (and surface area) in southern sector.

Parallel to this loss of heritage there was an important loss of land uses and social and community practices associated with them. Ten types of land use, associated with the functionality of the heritage elements, diminished along this stretch of coast: agricultural, residential, industrial/commercial, military or defensive, port, infrastructure (transportation and hydraulic), recreational, sanitary, commercial and religious.

The most affected land uses, as they occupied the largest surface areas, were agricultural (28.2%), residential (23.2%) and industrial/commercial (19.3%). Some spatial differences, depending on the coastal section in question, have been observed in these losses (Figures 3b, 4b and 5b). Thus, whereas in the northern sector the three most affected land uses were industrial (46%), defensive (29.2%) and port (18.7%), by far the most affected in the central sector was residential use (67.4%), followed by infrastructure (10.7%) and recreational/leisure (10.6%). Meanwhile, in the southern sector, the highest losses were in agriculture use (59.7%), followed by infrastructure (20%) and industrial (10.5%). The transformation of the coast gave rise to new uses, which include most notably residential and infrastructure.

4.2. Inventory and expert evaluation

A total of 30 elements were selected according to the criteria explained in the Material and Methods section and grouped according to typology and functionality (Appendices A, B): 1) commercial/service heritage (CS); 2) military heritage (MI); 3) industrial heritage (IN); and 4) public infrastructure heritage (PI).

The results obtained from the surveys (Table 4; Appendix C) indicate that overall, the experts awarded a medium value to the heritage elements. Some of the most notable elements, however, which were given high values include the Circus Theatre, Old Nautical Club, Metropole Hotel and La Lonja fish market.

Table 4. For each lost heritage element and in each of the 6 intrinsic variables, the highest scoring category (very low, low, medium, high or very high) is shown with the % of experts who voted in that category.

	Heritage elements	U	I	SC	HC	A	S
Commercial and services heritage	**EP3.** Health station	54	38	36	39	48	43
	EP8. Circus Theatre	48	46	30 / 30	48	38	43
	EP9. Old Nautical Club	55	38	34	46	48	38
	EP13. Pérez Galdós house	39	32	46	52	41	32
	EP15. Las Alcaravaneras spa, beach huts and pier	52	45	45	46	45	36
	EP17. Metropole Hotel	48	41	30	34 / 34	52	43
	EP22. La Lonja fish market	36 / 36	39	41	46	48	43
	EP25. San Cristóbal chapel	39	39	34	43	41	38
Military heritage	**EP1.** La Esfinge battery	43	39	36	38	48	30
	EP2. San Fernando (Salvás) battery	50	41	36	45	48	39
	EP12. Santa Catalina Castle	45	46	38	39 / 39	43	41
	EP16. Las Alcaravaneras machine gun nest	52	39	39	41	46	46
	EP20. Santa Ana Tower	36	34	29	39	41	34
	EP23. Santa Isabel Castle	39	41	32	52	36	38
	EP24. San Cristóbal machine gun nest	50	39	36	41	46	32 / 32
	EP29. La Laja machine gun nest	48	41	39	41	50	34 / 34
Industrial heritage	**EP4.** Ice factory	41	43	41	43	46	39
	EP5. Cory & Brothers coal warehouses and dock	48	45	48	43	46	41
	EP6. Grand Canary Coaling Company workshops, coal stores, pier and dry dock	50	32	41	43	36	36
	EP7. Blandy Bros. pier and coal warehouses	39	34 / 34	38	39	50	39
	EP10. Woermann Linie coal warehouses and dock	38	38	39	46	38	38
	EP19. Mill facilities	57	55	39	45	36	39
	EP26. San Roque bottled water warehouse	45	34 / 34	38	32	39	30 / 30
	EP28. Correa brick factory	45	41	39	61	52	45
Public infrastructures	**EP11.** Port shelter	50	43	36	41	39	45
	EP14. Tram station	38	39	27	39	36	38
	EP18. Public water hydrant	45	43	34 / 34	41	43	38
	EP21. Las Palmas pier	39	32	29	39	36	34 / 34
	EP27. *Fielato* house	38	36	32	43	34	36
	EP30. La Laja tunnel	36	34	38	38	39	34

Key	**Very low**	**Low**	**Medium**	**High**	**Very high**

*Abbreviations of the intrinsic variables: (U) Uniqueness; (I) Identity; (SC) Scientific; (HC) Historical – Cultural; (A) Aesthetic; (S) Social. The elements EP8, EP17, EP22, EP12, EP24, EP29, EP7, EP26, EP18, EP21 have, in some intrinsic variables, two values as they were placed in two of the categories (very low, low, medium, high and very high) by the same number of experts.

4.2.1. Heritage category evaluation

The results reveal that the CS heritage category (Figure 7) had the elements with the highest values (4), with the most highly valued being the Circus Theatre, Old Nautical

Club, Metropole Hotel and La Lonja fish market. This category of elements tends to present high heritage values associated to their architectural and historical features, an aspect which has also been noted by other authors in other cities of the Americas or Australia, among others (Laing et al., 2014; Kling et al., 2004). This may explain why the uniqueness, historical/cultural and aesthetic intrinsic variables had the highest values in the CS heritage category. However, there was greater disparity in the evaluation of the identity and social variables. Finally, the scientific variable had the lowest evaluations in this category.

The most highly valued element in the MI heritage category (Figure 7) was Santa Catalina Castle. In general, these elements were valued lowest in the aesthetic (except EP12) and scientific variables as they are specifically functional constructions for defence with little social attraction. There was also higher disparity in the evaluations of the I and SC variables.

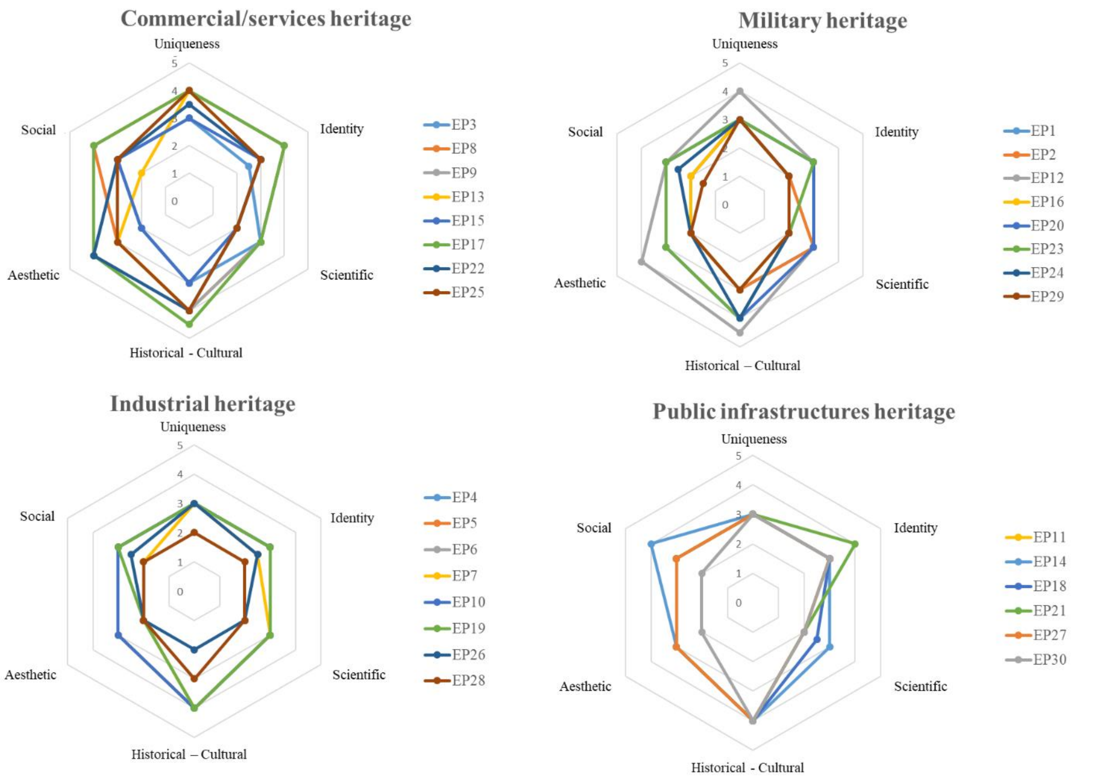

Figure 7. Evaluation of the intrinsic variables by heritage category. Explanation of the intrinsic variable values: (1) very low (2) low; (3) medium; (4) high; (5) very high.

In the IN category (Figure 7) the elements with the highest values were the Ice factory, Cory & Brothers coal warehouses and dock, Grand Canary Coaling Company workshops, coal stores, pier and dry dock, Woermann Linie coal warehouses and dock and mill facilities. The historical/cultural intrinsic variable had the highest values in this category. This could be due to the importance that these industries had in the economic and social development of the city. In general, these elements presented a medium value in the other variables, except San Roque bottled water warehouse and Correa brick factory which had the lowest evaluation. However, there was greater disparity in the evaluation of the aesthetic variable, with predomination of the lowest value.

In the PI category (Figure 7), the highest value was awarded to EP14, the electric tram station. This category of elements also tends to have significant importance in terms of heritage, associated with their architectural and artistic characteristics, as has also been noted by other authors in diverse places including Istanbul, Singapore, China, Saudi Arabia and Portugal, among others (Orbaşli and Woodward, 2008; Henderson, 2011; Gholitabar, 2018; Güzelci et al., 2019; Jiang et al., 2019). All these authors studied different railway stations and tracks in which they observed how the architectural characteristics, together with the objects and the surrounding landscape, increase the appreciation and importance of these elements at heritage level, as happens in the cases evaluated in this study. In the uniqueness and historical/cultural variables, all the elements were given medium (3) and high (4) values. While this could be due to the importance they had in terms of economic and social development via modernization of the city's services and connections, it should also be taken into account that the type of research carried out can enhance the original value. In the identity variable, Las Palmas pier was given a high value in contrast to the other elements in this group. This could be related to the fact it was the first pier in the city generating a feeling of attachment to this element, making it a commemorative symbol. In the scientific variable, the elements of this group were predominantly given low (2) values. This could be related to the absence or scarcity of local scientific studies on these heritage elements. Medium (3) values are common in the aesthetic variable, except for La Laja tunnel which had the lowest evaluation possibly because it is an underground passage with a functional structure that does not capture the attention of individuals. In the social variable, there is more disparity between the values given to the six elements, with the electric tram station having a high value and the others medium or low. All the elements that make up the PI category were points of concentration (as is the case with most of the elements in the CS category) and interaction of people with recreational/leisure uses. This is because these are public spaces which, as happens in other places like Lithuania, China, Australia, Iran or Istanbul, among others, are extensively used by their inhabitants as areas of transit or for routine activities of daily life (Grazuleviciute-Vileniske and Matijosaitiene, 2010; Lee, 2011; Harandi and De Vries, 2014; Güzelci et al., 2019). This functionality may explain why the heritage elements in the CS and PI categories were given by all the experts lower evaluations in the scientific variable than the elements in the other two categories (MI and IN), in that these elements are not sufficiently relevant for research purposes or that this type of construction has little relation with research. However, it was also observed that the CS and PI categories were the highest valued in both the uniqueness and identity variables. This may be due to the closer link and interaction which the experts would have with these elements compared to the MI and IN categories which do not have such a direct connection with society.

When evaluating the elements, the experts gave the most importance to the historical/cultural variable with 35%. The elements with the highest evaluation in this variable were Pérez Galdós house, Santa Isabel Castle, Circus Theatre, Old Nautical Club and Woermann Linie coal warehouses and dock. The social variable was also valued highly (with 20%). In this case, the elements with the highest evaluation were the Circus Theatre, Metropole Hotel, Tram station and Las Palmas pier.

The uniqueness variable was also positively valued (with 19%). In this case, the most notable elements were (from high to low) the Old Nautical Club, Circus Theatre, Metropole Hotel, Santa Catalina Castle, Pérez Galdós house and San Cristóbal chapel. The differences in this ranking could be due to the fact that the qualities, characteristics or features of the first assets are not as common as those of the subsequent ones.

The aesthetic variable was the fourth highest valued (with 11%). The most valued elements were the Metropole Hotel, Old Nautical Club, La Lonja fish market and Santa Catalina Castle. In this ranking, the first elements could have obtained a higher score than the other elements as they present an architectural style marked by the time (post-romantic and colonial, respectively), which have been able to increase the aesthetic singularity and visual characteristics of both elements.

The scientific variable was valued at 10%, with the medium value (3) the most awarded. The highest valued elements were the Cory & Brothers coal warehouses and dock, Ice factory, Grand Canary Coaling Company workshops, coal stores, dock and dry dock, Woermann Linie coal warehouses and dock, Mill facilities, and Blandy Bros. pier and coal warehouses. The differences at scientific level shown in this ranking could be due to the fact that there have been more studies and local publications about the first assets than the subsequent ones.

For the experts surveyed, the identity variable had little importance when evaluating the heritage elements. This could be due to the subjectivity that this variable can generate as the results of feelings of attachment or connection to a particular heritage element

(Zukin, 2012; Bhati et al., 2014). If this is the case, this variable would only be useful for local environments evaluated on the basis of local social perceptions.

4.2.2. Assessment of intrinsic variables and expert category

The degree of importance of certain qualities as intrinsic variables (e.g. spiritual, symbolic, historical and cultural values) cannot be easily measured as it will depend on the narratives of the specific training and field of expertise of the experts (their profile) and the number of experts in each group (university academics, professionals from heritage institutions and professionals from other fields) (Garnåsjordet et al., 2012) (figure 8). These narratives mark the conceptual development and perception of the heritage values being able to create some statistical bias. This was observed in a number of variables. Generally, the heritage institution experts gave higher evaluations in all the variables (figure 8). The greatest similarity between the evaluations of the three groups of experts was in the historical/cultural variable, with high values given in the CS and PI categories. This could be due to two reasons: 1) that the historical-cultural variable is the most understandable or feasible for all groups; and 2) that the elements of both categories (CS and PI) are more everyday and familiar elements, and so more people are able to know if they have a value or not. With respect to the variable of uniqueness, the heritage institutions experts gave high values to the CS and PI categories. All three groups of experts gave medium values to the MI and IN categories. In the scientific variable, experts with training and specific expertise closely linked to heritage evaluations (university academics and historical cultural experts) generally gave higher scores than those experts who, despite being knowledgeable about the heritage under evaluation, did not have this specific training and expertise.

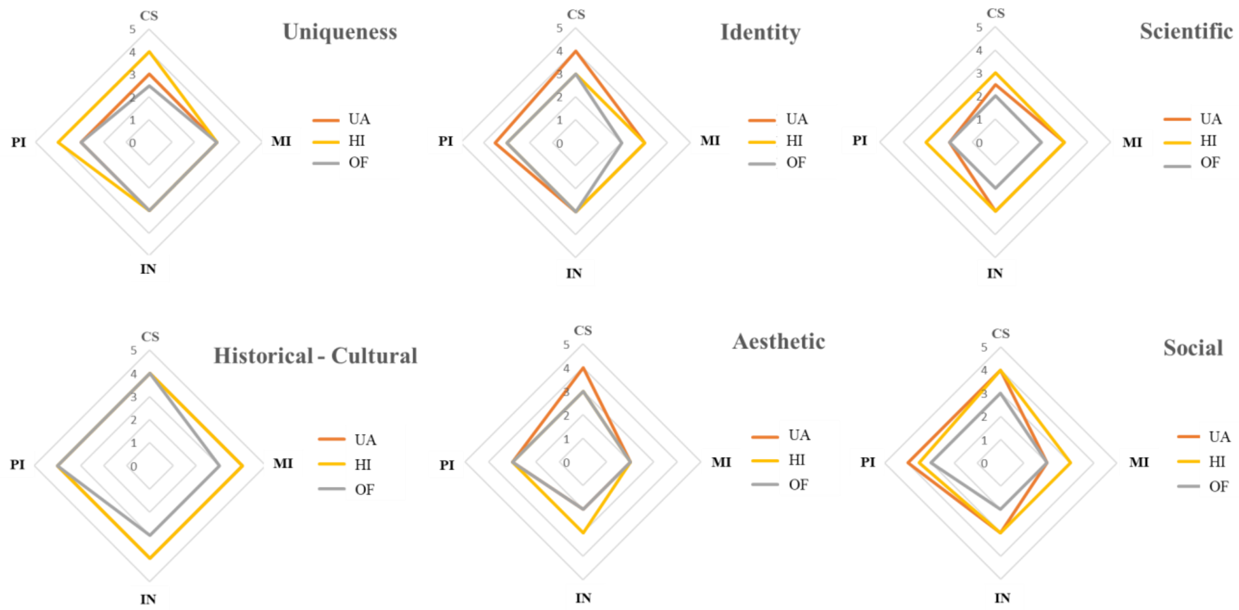

Figure 8. Representation of the intrinsic variable modal value according to expert group (UA – University academics; HI – Professionals from heritage institutions and OF – Professionals from other fields). Definition of intrinsic values: (1) very low value (2) low value; (3) medium value; (4) high value; (5) very high value. Abbreviations of heritage category: commercial/services (CS); military (MI); industrial (IN); public infrastructures (PI).

Likewise, these 'other field' experts gave lower values in the aesthetic variable to elements in the MI and IN categories, as they are functional constructions with pragmatic/utilitarian aspects with little architectural interest. This pattern was also observed by Jevremovic et al. (2012) in different European and American cities. They noted how the aesthetic variable has often been more admired by architects and artists than the public at large. The low valuation by this group of experts of the same elements in the social, identity and historical/cultural variables may be due to the fact that these constructions were not open to the public and hence there was no interaction with the local population. Bhati et al. (2014) also observed this aspect in Asian and European cities. They detected how the identity variable had less value when people are not involved or related to assets and vice versa. This would explain why the PI and CS categories were the most highly valued in social variable by the three groups of experts, whereas the identity variable was given high values in the CS and PI categories by the university academics. In the identity and aesthetic variables, the heritage institutions experts and 'other field' experts tended to coincide in their evaluations. Nonetheless, the low value given by the 'other field' experts to the elements in the MI and IN categories may also be related to a lack of awareness of the heritage value associated with them. If this is the case at a general level, then it would be of interest to make better information available and thus allow the public a better opportunity to appreciate their value. In addition, it should be borne in mind that the MI and PI categories can be difficult to evaluate. Elements in the MI category have more value when they are part of a defensive system than when they are isolated. Likewise, the value given to public infrastructures can depend on other associated structures or buildings (e.g. roads, water hydrants, pipelines, etc) (Rivieiro et. al., 2001; Pinder, 2003; Orbaşli and Woodward, 2008; Ruiz et. al., 2014).

4.2.3. Relationship between heritage elements and willingness to pay to visit.

The results indicate a clear relationship between the value awarded to the heritage element and the willingness to pay to visit it (Table 5). The results show positive and statistically highly significant correlations in all cases ($P<0.001$). This positive correlation means that the higher the value awarded by the experts to the heritage element the greater the willingness to pay to visit it. This pattern was also observed by Iacob et al. (2012), who noted that when heritage assets are desired and appreciated by people, they are willing to pay the corresponding price. The elements which the experts preferred to be given only partial reconstruction in the form of a plaque/marker/information panel were correlated with the willingness to pay 0 euros to visit, evidently because people would not pay to see such objects. In this respect, according to the opinions of the experts, the prior existence of 87% of the elements considered should be acknowledged through the installation of a marker, information panel or plaque, while consideration should be given to the reconstruction of 13% of them (Circus Theatre, Old Nautical Club, Santa Catalina Castle and Water hydrant). The experts also considered that the price should not only reflect the site being visited but also the facilities provided there (museum-type exhibitions, interpretation centres, heritage sightseeing routes, etc).

Table 5. Spearman's correlation

Correlations (N: 1624)		
Spearman's rho		**Willingness to pay**
Uniqueness	Correlation coefficient	0.311**
	Two-sided significance	0.000
Identity	Correlation coefficient	0.300**
	Two-sided significance	0.000
Scientific	Correlation coefficient	0.298**
	Two-sided significance	0.000
Historical - Cultural	Correlation coefficient	0.304**
	Two-sided significance	0.000
Aesthetic	Correlation coefficient	0.330**
	Two-sided significance	0.000
Social	Correlation coefficient	0.309**
	Two-sided significance	0.000
**	**The correlation is significant at 0.01 level (bilateral).**	

The results of the Kruskal-Wallis H test (Table 6) indicate there were statistically significant differences between the 4 categories of heritage elements (MI, CS, IN and PI) in relation to their intrinsic variables, with the exception of the aesthetic (A) variable. In the case of this variable (aesthetic), there were no statistically significant differences between the value given by the experts to the elements in the different heritage categories. This may be because of the complication of evaluating this variable and hence generating differences in opinions between the categories of heritage when dealing with lost elements that cannot be appreciated. It can thus be seen how the university academics gave higher values to the elements in the commercial/services category, whereas the heritage institutions experts gave higher values to the IN category elements.

Table 6. Kruskal-Wallis test

Contrast statistics (a, b)						
	Uniqueness	**Identity**	**Scientific**	**Historical - Cultural**	**Aesthetic**	**Social**
Chi-squared	44.214	52.368	78.300	70.298	1.747	15.526
Asymptotic significance *	0.000	0.000	0.000	0.000	0.418	0.000

* P value >0.005 = normal value; P value <0.005 = not normal value.

It should also be noted that the values can change over time. That is, elements with a certain value today would not necessarily have had the same value in the past and will not necessarily do so in the future. An element can acquire new significance, perhaps becoming a symbol for that particular time, or re-acquire its original significance, or acquire arbitrary significance (Claesson, 2011; Moreno 2002). In this respect, it should be borne in mind that, in the period in which the transformation of the east coast of Las Palmas de Gran Canaria city took place (1960s), there were already some decrees, regulations and laws in force in Spain protecting relevant heritage elements (Decree of the Ministry of National Education on the Protection of Spanish Castles in 1949; Law of December 22, 1955, on the Conservation of Historical/Artistic Heritage; Decree of July 22, 1958, on the Creation of the Category of Provincial and Local Monuments; Decree 1938/1961 of 22 September on the Creation of the National Artistic, Archaeological and Ethnological Information Service; Decree 1864/1963 of July 11, modifying the 1958 Decree on the Creation of the Category of Provincial and Local Monuments; Decree of February 22, 1973, on Bibliographic and Documentary Heritage, among others). However, it was not until the introduction of the Spanish Historical Heritage Law of April 1985 and the Canary Historical Heritage Law of 1999 that a more effective protection could be afforded to heritage elements and indeed to more types of such elements (such as intangible heritage). There were numerous factors that contributed to the disappearance of the heritage elements considered in this study. These include the inefficient evaluation of elements discarded as not being relevant or worthy of protection and conservation, the non-compliance with or laxity in the application of legislation prior to 1985, the non-application of methodologies for the evaluation of heritage, the excessive eagerness to modernise the city, the need for urban development, political interests, and the lower environmental and cultural awareness that existed in the middle of the 20th century. Although these aspects may have improved considerably since then, this does not mean that irregularities are not still being committed in terms of the preservation of heritage elements.

5. GENERAL DISCUSSION

Heritage elements located in coastal environments have been the object of analysis in diverse studies at global level (Daire et al., 2012; Reeder 2015; Fowler, 2017; Guerrini 2018). It has been possible to verify that these elements are susceptible to suffering damage as the result of different threats generated by both natural and anthropic global phenomena (Durán et al., 2015; Graham et al., 2017). These impacts are greater in places where the globalization process has had a strong impact (Armitage and Johnson, 2006) or where the economy is tourism based, as is the case of the Canary Islands, which can lead to the restructuring or disappearance of heritage elements (O'Brien and Leichenko, 2000). This reflection is the opening argument in the debate between development and heritage conservation (Williams and Micallef, 2009; Peña-Alonso et al., 2018). The lack of a specific heritage evaluation methodology, along with disagreements and conflicts about heritage management, directly affect heritage assets (Taboroff, 2000).

This paper tackles the problem of evaluating or assessing heritage elements lost as the result of the growth of urban sprawl experienced by a city. Although the methodology has been applied to this specific case, coastal communities around the world can find themselves having to deal with these same challenges (Graham et al., 2017). If appropriate historical sources are available (maps, old conventional photographs, etc.), we consider that it can be replicated in other situations in which a considerable transformation of the landscape has taken place along with the disappearance of a significant number of heritage elements. At detail level, the procedure employed enabled the reconstruction of the cultural characteristics of the study area.

When the aim is to analyse lost heritage, a multidisciplinary methodology is required which is capable of revealing the different dimensions that constitute its value from a social perspective. In spite of abundant literature on expert evaluation in heritage studies (Fry 1997), as also observed by other authors (Ballart, 1997; Moreno, 2002; Claesson, 2011; Allen Consulting Group, 2006), we found that no single methodological approach exists for the calculation of the value of heritage elements. The originality of the research presented in this paper lies in the fact it is based on quantitative data, through the calculations of cultural and land use losses, and in the undertaking of an evaluation of the interest of each heritage element. As far as we are aware, and although we acknowledge there are some methodologically relevant works (Pinder, 2003; Rivieiro et.al., 2011; Ruiz et.al, 2014; Khakzad and Van Balen, 2015; among others), there have been no published evaluation studies of lost heritage elements.

The use of a methodology based on the integration of sources and techniques from various scientific disciplines is of particular interest, as it is key to the development of this type of work (Bürgi and Gimmi, 2007; Mkadem et al., 2018). In addition, a combination of analysis tools from the specific fields of geography and history was required for the development of the study presented here.

However, the evaluation of lost elements entails one particular major difficulty, especially when this evaluation is undertaken through surveys. While the carrying out of surveys allows a value, or degree of importance, to be given to the different elements being analysed (Moreno, 2002), it should be noted that opinions on no longer existing elements will have a lower range of perception than elements that are still in existence and well-known. For this reason, a photograph and a historical explanation of each element was included in the online survey. In the knowledge that this could potentially condition the evaluation carried out by experts by providing higher scores to those photos with more quality (Sánchez, 2012; Robledano et al., 2016; Quezada and Tusa, 2018), the best image that was available of each heritage element was chosen for the purposes of the survey.

While any object can in principle become an element of cultural heritage, this will only happen to elements which meet certain criteria associated with their nature, history and originality or which are chosen because of their formal and symbolic use value (Claesson, 2011). An object may become a heritage element once it has been: 1) identified and characterised in an attempt to clarify its use and original function and to understand and reconstruct its past; 2) protected; 3) recovered; 4) interpreted; and 5) disseminated. The results obtained allowed a value to be given to the lost historical and cultural heritage elements, along with an awareness of the transformation that has taken place in recent decades. These results are to some extent related to the management measures which are being undertaken in the study area with a view to the preservation of heritage elements still found there. The prior existence of some of the elements (such as the Port shelter or Las Palmas pier) is being acknowledged by means of the installation of plaques or, on occasions, by reconstruction, although such cases are very few. However, the elements which were awarded the highest evaluations (Circus Theatre, Old Nautical Club, Metropole Hotel and La Lonja fish market) have received no such recognition. The study also revealed the correlation between the most highly valued elements and the willingness to pay to visit them.

The contributions of this study are numerous. One the main ones, from an academic perspective, is that it can be used to contribute to the development of a research line in the recovery and historical reconstruction of lost heritage, with a strong historic memory basis. This would include, among other things, a detailed written or taped recording of the memories of people of advanced age.

In line with this, but from a social perspective, this type of study also helps to prevent further heritage losses taking place (Shipley and Reyburn, 2003). Such studies not only allow the local population to recreate, recover, get to know or simply gain awareness of the historical and cultural heritage element, but they also increase society's appreciation of, and sensitivity to, heritage values. Similarly, from an educational perspective this type of study can be used as a resource to foster reflection among students about heritage-related attitudes, values or regulations (Feliu and Hernández, 2011), thereby contributing to the development of autonomous, reflexive and critical thinking (Ávila, 2003) and encouraging new generations to collaborate in the defence and preservation of their heritage. These ideas are currently being developed by some public and private institutions, through educational and cultural programs, such as *enSeñas*, *Butterfly. Transforming Arts into Education*, *CultureScape*, *Europa Creativa - Patrimonio Cultural* or the *Herit-Data project* which aims to reduce the impact of tourism activities on cultural heritage through innovative solutions.

In terms of management, heritage reconstruction research studies serve to understand the past and to strive for the sustainability of communities (Durán et al., 2015). This means that cultural resources should be administered in such a way that the preservation of heritage is guaranteed for current generations without having to sacrifice access to, and appreciation of, these resources for future generations (Claesson, 2011). Therefore, it is of fundamental importance that cultural resources be taken into account in urban planning through the development of specific plans addressed from integrated and multidisciplinary perspectives. From this point of view, coastal cultural heritage should be evaluated considering global changes in natural, socioeconomic and geopolitical systems (Pinder, 2003) with the aim of integrating it as a capital resource in holistic management plans (Vallega, 2003; Pinder and Vallega, 2003). These ideas are currently being developed in several places in Portugal, Italy, Spain, United Kingdom, Netherlands, Germany, Belgium, USA and Australia, among others, using integrated and multidisciplinary methods to establish control mechanisms to ensure sustainable development and preserve the landscape and cultural heritage (Janssen and Knippenberg, 2008; Zhao and Jia, 2008; Rivieiro et al., 2011). Coastal management is being improved in the case of European countries through the implementation of various schemes including, amongst others, integrated coastal zone management (ICZM) and marine spatial planning (MSP) (Khakzad et al., 2015). The ICZM has also been implemented in American and Asian countries, in addition to other programs or projects such as the US Coastal Zone Management Program (CZMP) established under the Coastal Zone Management Act (CZMA), the Broad-based Coastal Management Training Program (BCMTP), or the Cooperative Research Centre for Coastal Zone Estuary and Waterway Management (Coastal CRC), among others (Vallega, 2003; Hills et al., 2006; Campuzano et al., 2013). By taking into account natural, cultural and social aspects, planners, administrators and specialists in cultural heritage can better understand the links between sea, land and people.

Finally, different studies show that cultural heritage, as well as the activities related to it, can directly and indirectly provide socio-economic benefits to people living on coastal areas (Khakzad et al., 2015). For example, different projects for the rehabilitation or reuse of coastal heritage elements (Conejos et al., 2011; Galland, 2013; Cho and Shin, 2014; Blagojevic and Tufegdzic, 2016) can be presented as appropriate and useful actions, serving to preserve them with their original use or provide them with new uses (recreational, artistic, cultural, endowment, etc.) that allow them to be adapted to reflect present day needs. Such actions could be the first step towards the recovery of valuable heritage assets before their disappearance.

Initiatives to avoid losing the memory of a heritage element could, according to experts in the field, involve other types of action (with new technologies, planned heritage sightseeing routes, exhibitions, museum-based projects, audio-visual presentations, press releases, written documents, etc.) which would provide information about the past existence of the element and its geographic and historical context. Not only would this keep the memory of the past alive, it would also have positive implications at academic, social, educational and management levels. Such types of intervention are being undertaken already through the creation of open-air museums (Middelheim Museum; Pompey; Sharlot Hall Museum; Inhotin; Katzrin ancient village and synagogue; Hakone Open-Air Museum; Open-Air Museum of Old Japanese Farm Houses; Kyōdo-no-Mori; Alcalá de Henares, etc.), cultural and educational museum-based projects (including the Louvre; Metropolitan Museum of Art; British Museum; El Prado; the Guggenheim in Bilbao; or the National Gallery of Victoria), cultural-educational projects, historical recreations or theatre-based representations, and living museums (Freilichtmuseum

Ballenberg; Mystic Seaport; Nazareth Village; Rock Ledge Ranch Historic Site; Kfar Kedem; Polynesian Cultural Center; Korean Folk Village), among others.

Finally, this study can be further enriched by new contributions and more interviews of older generations recounting their experiences. In this way, a more in-depth knowledge of the operation and historical features and characteristics of this area of the city can be acquired.

6. CONCLUSIONS

This work establishes a method for the identification and evaluation of lost cultural elements as the result of human activity and actions. The general scarcity of studies in the literature which tackle the evaluation of lost heritage elements can be considered a gap in the body of knowledge which this work helps to cover.

The objective of the approach employed was to establish a value, via a panel of experts, for a selection of 30 lost heritage elements. For this purpose, this methodology required the application of a mixture of historical and geographic techniques, as well as a comparison of sources. In addition, as this is a cross-disciplinary study, it can be used from different perspectives, enhancing its contribution.

The results show that, in a short period of time (around 80 years), numerous cultural elements with a medium or high heritage value have been lost along the eastern coast of Las Palmas de Gran Canaria city (Spain). The evaluations made by experts who participated in the study survey and who were equipped with knowledge of the historical attributes of the heritage elements reveal that these elements did in fact have a great value. These losses have taken place as the result of the accumulation of a number of circumstances: deficiencies in the evaluation processes of heritage elements, non-compliance with the diverse heritage-centred legislation of that period that could have protected such elements, the lower awareness of and sensitivity to questions of heritage of the local society at the time of the disappearance of these elements, and the fact that the overriding goal of the public administrations of the time was the rapid modernization of the city. Nonetheless, this is not an isolated case and other cities face the same challenges. Given that heritage elements are faced with continuous and ongoing changes as the result of diverse global processes, the methodology used in this study can be applied to other places throughout the world that have suffered and are presently suffering important heritage losses.

Nowadays, the evaluation of heritage has numerous implications: 1) Knowing the past history of an area and the true value of its lost heritage elements opens the door to the recovery of historical memory and, with it, the recovery of symbols of identity; 2) For these reasons, the procedure developed in this work can be of interest in terms of urban land planning for the expansion of coastal environments with a view to preserving historical and cultural heritage for future generations. Lessons can be learned from past examples of lost heritage elements and applied to new and emerging heritage management issues, as for example the rising sea level. This study can thus serve as a methodological approach for the evaluation of heritage elements in danger of being lost as it facilitates a knowledge of exactly which elements are the most important and who they are important to. In this respect, the public in general are better able to understand such problems and are made more aware of the need to preserve heritage elements when these problems are seen at a local level; and 3) This type of study can be used to prevent similar losses in the future by increasing heritage awareness and sensitivity and providing visitors to the area with interesting and relevant information that can be incorporated in the cultural and tourism offer.

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5.4. Assessing the scenic quality of transgressive dune systems on volcanic islands. The case of Corralejo (Fuerteventura island, Spain).

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[En revisión].

* Dunas de Corralejo (Fuerteventura). (Fuente: Elaboración propia, 2020).

ASSESSING THE SCENIC QUALITY OF TRANSGRESSIVE DUNE SYSTEMS ON VOLCANIC ISLANDS. THE CASE OF CORRALEJO (FUERTEVENTURA ISLAND, SPAIN)

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Abstract

The formation of transgressive aeolian sedimentary systems on hot-spot volcanic islands results in globally singular conditions. The natural attractions and landscape features of these spaces can result in the concentration of urban-tourist developments in their surroundings, altering their physical integrity and their ecological and scenic functionality. This has been the case of the Corralejo dunefield in Fuerteventura (Canary Islands, Spain), where the strong pressure exerted by tourism is endangering the area's natural and landscape resources. This study aims to qualitatively assess the landscape heritage through a number of indicators, some of which are developed on the basis of user perception. Four landscape dimensions (substratum, sea, vegetation, and scenic background) were used to analyse the 24 landscape units into which the Corralejo beach-dune system was divided. The results show that this system presents a high landscape value, as do its four different dimensions. This value was found to decrease in areas bordering the urban area or where tourists were commonly present. Recommendations are proposed to improve the area based on user perceptions. This type of research is of

interest for future planning, ordinance preparation and management with a view to establishing a balance between the physical medium and anthropic pressure.

Keywords: scenic quality, indicators, scenic background, volcanic landscape, transgressive dune systems, geotourism.

1. INTRODUCTION

Among coastal geomorphological landscapes, sandy landscapes can be found on 20% of the world's coasts (Van der Maarel, 2003; Walker et al., 2003; Carboni et al., 2009), with beach-dune systems among the most highly valued natural landscapes (Shivlani et al., 2003; Brenner et al., 2010; Ariza et al., 2012). However, in the case of hot-spot volcanic islands, such natural landscapes are very scarce and non-existent in the vast majority of cases. In this type of island, which represents just 0.04% of the world's emerged land surface (Ferrer-Valero et al., 2018), coastal landscapes display tremendous complexity due to the different natural processes that they undergo (Ramalho et al., 2013). The formation of coastal aeolian sedimentary systems depends on the geological maturity of the islands and on low rates of island subsidence (Hernández Calvento et al., 2017), with long erosive periods required to generate conditions suitable for their formation. Transgressive dunefields are generated when there is an abundance of sediment in these systems that can be transported by the wind (Hesp and Walker, 2013). In arid climates, the scarcity of vegetation facilitates the existence of mobile dunes, as occurs in the dunefields of Maspalomas and Corralejo, in the Canary Islands (Spain) (Hernández Cordero et al., 2019). In summary, the exclusivity and scarcity of these dune formations on scenic volcanic backgrounds provoke globally singular and unique conditions.

Worldwide, natural landscape attractions are an important factor driving the development of urban-tourist infrastructures and leisure activities which, in turn, contributes to altering the physical integrity and ecological functions of natural spaces (Drius et al., 2013) and commonly results in their degradation (Wascher, 2001; Marin et al., 2009). In consequence, these activities derive in a reduction in landscape heritage values from a nature-based and cultural point of view (Consejo de Europa, 2000; Ergin et al., 2006; Philip et al., 2010; Kivanç, 2016), generating losses of identity and of sense of place (Pedroli, 2000; Van Eetvelde and Antrop, 2009), as well as altering the human perception of them.

The landscape is a manifestation of the preservation of biodiversity, culture and traditions (Calero et al., 2018). In recent decades, recognition of the aesthetic quality of landscapes has increased, but so too has the number of people searching for scenic spaces for their recreation activities (Bosque et al., 1997; Wascher, 2001). The European Landscape Convention (ELC) was conceived precisely because of the desire to protect and preserve attractive landscapes, understanding these as areas, as indeed the population perceives them, whose character is the result of the action and interaction of natural and/or human factors (ELC, 2000).

These socio-ecological processes are intensified on islands, given the small dimensions and limited resources of their coasts (Mimura et al., 2007; Hay, 2013; Santana-Cordero et al., 2016; Ferrer-Valero et al., 2017). If the climatic conditions are favourable compared with neighbouring territories, as occurs in the Canary Islands, the year-round presence of tourists becomes a possibility (Peña-Alonso, 2018), generating even greater pressure on coastal landscapes, especially sandy ones, which can lead to the alteration of their natural conditions (Cabrera-Vega et al., 2013, García-Romero et al., 2016, Hernández Cordero et al., 2017; Pérez-Chacón et al., 2019) and with it to a loss of environmental and scenic quality.

The interactions that take place between society and coastal landscapes can be studied from various perspectives (Silva-Terán, 2017), using diverse methods and techniques to evaluate the landscape. Some authors (Macleod et al., 2002; López – Martínez, 2017) have used direct methods to evaluate the quality of the landscape based on considering it as a totality. Others have used indirect methods, assessing the landscape through an analysis of its components (Bosque et al., 1997; Montoya et al., 2003; Otero et al., 2007; Cañas et al., 2009; Ergin et al., 2010; Philip et al., 2010; Uzun et al., 2011; Anfuso et al., 2014, 2017; Da Costa et al., 2018; Peña-Alonso et al., 2018; García Romero et al., 2019). To disaggregate the quality of the landscape, these authors used physical characteristics, such as topography, land use, the presence of water bodies, etc. Finally, other authors (Muñoz Pedreros, 2004; Loures et al., 2015; Felix et al., 2016) have used a mixture of methods, directly evaluating the landscape and then analysing its components to determine the contribution of each of the elements to the global landscape value. As this is essentially a unification of the first two methods, these mixed methods are usually considered more accurate for landscape evaluation (Silva Terán, 2017). In these evaluations, a series of indicators or quantitative or qualitative parameters are used (Nogué et al., 2009; García Romero et al., 2019) to perceptively determine the quality of the landscape and the interactions among its visual elements (Malcok et al., 2010). From this perspective, it is understood that the perceptive recognition of the relationships between society and the territory define the landscape heritage of the place in question (Montoya et al., 2003; Peña et al., 2018).

Given this background, the main aim of the present study is to evaluate the landscape heritage of the Corralejo dunefield in Fuerteventura (Canary Islands) using a series of indicators based on scenic quality assessment. The construction of these indicators has been based on a systematic search through the literature on landscape evaluation in coastal settings and combined with user perception. At the same time, this research aims to provide a tool that will allow the assessment of scenic quality in coastal aeolian sedimentary systems situated in volcanic settings. This is the case of hot-spot islands which are additionally exposed to constant littoralization, as occurs in the Canary Islands. The main contribution of this research is to generate a robust indicator-based tool. User participation is incorporated in the construction process of this tool in order to broaden the objectivity of the results and to enable the application of the methodology to similar natural settings worldwide.

2. STUDY AREA

The 1812.40 ha Corralejo beach-dune system is situated in the northeast of Fuerteventura (Fig. 1). Its landscape setting is bounded to the west and south by malpais (terrain of volcanic rock) and various volcanic edifices such as Montaña Roja, to the north by the urban-tourist Corralejo urbanization, and to the northeast and east by sandy beaches and rocky platforms.

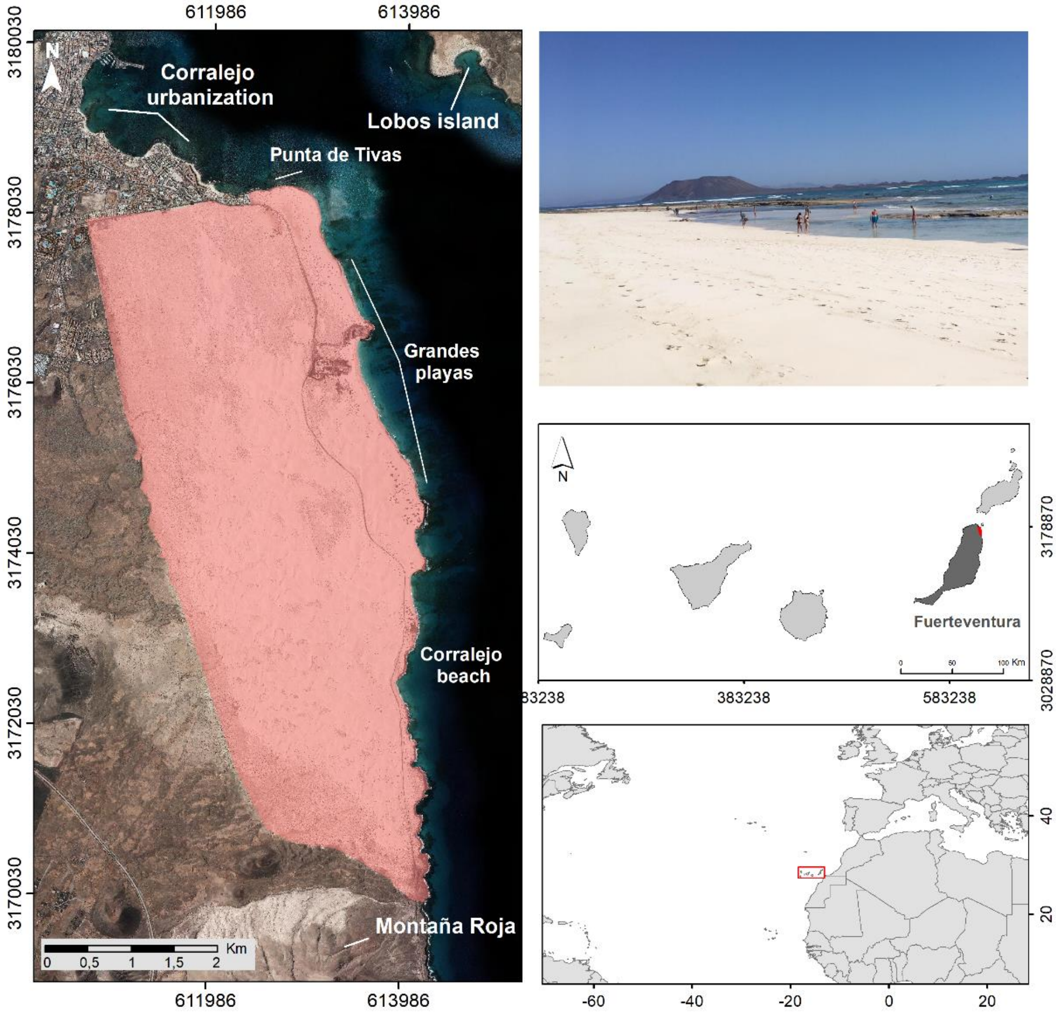


Figure 1. Study area. The top right photo was taken by the first author on the Grandes playas. Punta de Tivas (tip of Tivas) and Lobos island can be seen in the background.

Fuerteventura is the oldest island in the Canary Archipelago (20.2 million years). It has been shaped by different subaerial volcanic phases forming three independent shields (oriented NE to SW) between the Early to Mid-Miocene (to 12 Ma), by a prolonged phase of volcanic inactivity, and by a subsequent period of volcanic reactivation during the Plio-Quaternary (<5 Ma) (Ferrer-Valero et al., 2018).

Corralejo is a pre-Quaternary transgressive arid coastal dunes system (following the classification by Hesp and Walker (2013)) deposited on a lava platform. According to Criado et al. (1987; 2004), three sandy area environments (known locally as *jables*) can be differentiated in the system, an older, a clayey and a more recent *jable*. The dunes of the first two *jables* are stabilised by vegetation, with significant accumulations of firmly established reddish-brown sandstone outcrops. Whereas the older *jable* is organogenic and cemented with calcium carbonate (Fernández-Cabrera et al., 2012), in the clayey *jable* the sandstones are earthy in composition due to the high percentage of silt and mud and volcanic rocks (García-Romero et al., 2016). Finally, the more recent *jable* is comprised of mobile sand dunes, generally barchan in type, and also transversal dunes. All of them are derived from ancient marine deposits from the coastal platform of the north and northeast of Fuerteventura (Alonso et al., 2011).

These geomorphological characteristics have resulted in a singularly unique system, with a volcanic-sedimentary landscape where mixed aeolian-volcanic processes are generated that display characteristics of both environments (García-Romero et al., 2016). With respect to the vegetation, xerophytic and halophytic shrubs predominate, including *Traganum moquinii*, *Salsola vermiculata, Polycarpaea nivea, Launaea arborescens, Euphorbia paralias* and *Cyperus capitatus*, among others (Hernández-Cordero et al., 2015).

The alterations that are perceived in the dune system are due to the impact of the urban-tourism complex to the north of the area (supply zone), to the road infrastructure which crosses the dune system from north to south, and to two hotels which have been constructed in the dunefield (Pérez-Chacón et al., 2019). The impediment to sedimentary transport caused by the urbanization has, presumably, altered the aeolian sedimentary dynamics, which has had a joint impact along with the depletion of the banks of marine sediment which feed the dunefield (Hidtma-Iberinsa, 2005; Jiménez et al., 2006), decreasing the depositions and movement of the dunes (Alonso et al., 2011) and significantly transforming its littoral geomorphology (García-Romero et al., 2016).

Given this diversity of characteristics, Corralejo can be considered a highly representative hot-spot aeolian sedimentary system, characterised by settings of great attraction to tourists due to the attractiveness of its landscape.

3. METHODS AND DATA ANALYSIS

The procedure developed in Peña et al. (2018) was followed to evaluate the Corralejo dunefield landscape. The methodology was based on 5 stages (Fig. 2): 1) search for variables in literature; 2) classification and selection of appropriate indicators for study area; 3) estimation of the evaluation criteria of landscape variables through user perception; 4) estimation and assignment of landscape variables; and 5) landscape evaluation.

Stage 1. Search of variables in national and international literature.

An exhaustive data search of publications was conducted in this first stage. A total of 25 studies were identified and collected (Fig. 2) in which use was made of variables to evaluate landscapes.

Stage 2. Classification and selection of appropriate indicators for study area

The literature search conducted in Stage 1 enabled the selection of the most suitable variables for use in the study area. The selection was based on the natural and anthropic characteristics of the beach-dune system. The chosen indicators were classified into 4 dimensions, or groups of elements, which make up the volcanic coastal landscape: 1) *Substratum* (S); 2) *Sea-coastal area* (AC); 3) *Vegetation* (V); and 4) *General scenic background* (SB). These are dimensions which define the elements that form part of the landscape concept and can be extrapolated for use with other similar systems situated anywhere in the world.

The *Substratum* (S) dimension defines the basic structure of the landscape, that is to say its composition (organic and inorganic) and its properties (physical and chemical), indispensable characteristics for its proper functioning and the perception of scenic quality (Aguilo et al., 2004). A set of variables are analysed in this dimension (Table 1) which describe the natural, visual/aesthetic, and anthropic characteristics related to its nature, texture (grain), colour, cleanliness, waste on the sand, presence of windbreakers built from pebbles (known locally as *goros*) and other pebble-based structures. The *Sea-coastal area* (AC) dimension also comprises a set of variables (Table 1) which represent natural, aesthetic and anthropic variables, including transparency and colour of the water, anthropic solid waste, marine plant waste, and the presence of jellyfish and foam, tar and oil which impact on the visual quality. As an active agent of the territory, the *AC* dimension plays a decisive role in the structural organisation of the landscape (Aguilo et al., 2004). The *Vegetation* (V) dimension evaluates the natural and visual aspects (coverage, contrast, colour and pattern) of the land cover. This vegetative cover takes on a fundamental role in the characterisation of the visible landscape (Aguilo et al., 2004). The *Scenic background* (SB) dimension corresponds to the zone that is visible from a specific point of the territory (Bosque et al., 1997). For its analysis, a division was made into four different panoramic backgrounds: beach, land, marine and these three combined. Beach composition was evaluated (shape, length, width and slope), along with structural attributes (diversity, natural perception, coherence), the scenic view and the integration of natural and anthropic elements that make up the landscape.

In total, 37 variables (v) were selected (7v-substratum; 8v-sea-coastal area; 4v-vegetation; 18v-scenic background (4v/14 sub-variables)).

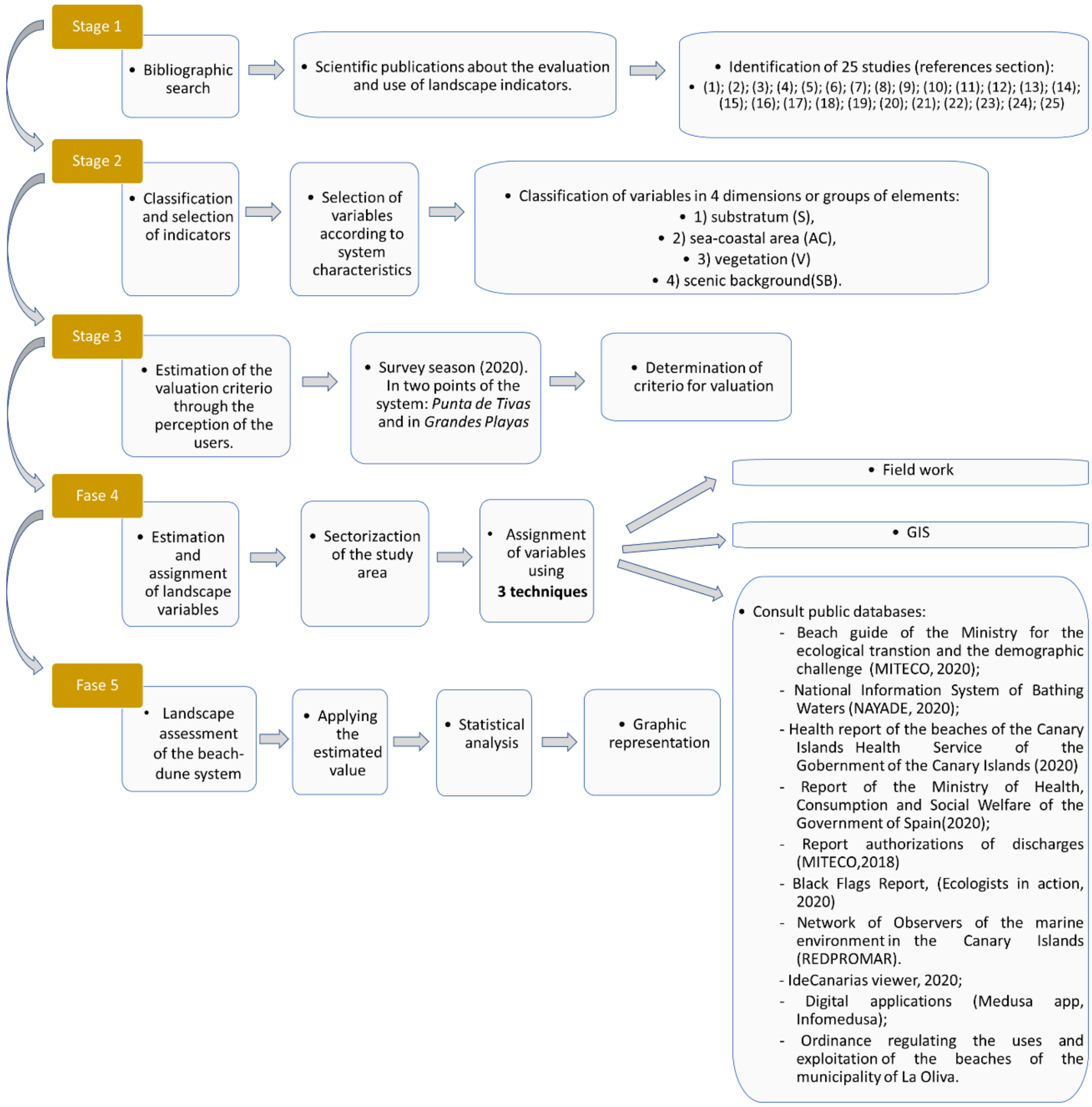


Figure 2. Schematic representation of the methodology employed. Bibliographic abbreviations: (1) Bosque et al., 1997; (2) Montoya et al., 2003; (3) Aguilo et al., 2004; (4) Muñoz Pedreros, 2004; (5) Otero et al., 2007; (6) Reynard et al., 2007; (7) Mérida et al., 2008; (8) Serrano, 2008; (9) Cañas et al., 2009; (10) Fry et al., 2009; (11) Ergin, 2010; (12) Uzun et al., 2011; (13) William and Micaleff, 2011; (14) Ariza et al., 2012; (15) Estévez 2012; (16) Geronta, 2013; (17) Sowińska-Świerkosz and Chmielewski, 2014; (18) Suárez Chaparro, 2015; (19) Bruni, 2016; (20) Peña, 2015 and 2018; (21) Silva-Terán, 2017; (22) Da Costa et al., 2018; (23) García Romero et al., 2019; (24) Nogué et al., 2019; (25) Servicio de Evaluación Ambiental, 2019.

Stage 3. Estimation of evaluation criteria through user perception

The evaluation criteria and the methods used in the references selected in Stage 1 (Table 1) were taken into account for the evaluation of each landscape variable. No evaluation criteria were found in the literature for nine of the selected variables (texture, sand colour, vegetation colour, pattern, slope, horizontal line, viewshed shape and area, and coherence), and so the decision was made to measure them via the perception of the Corralejo dunefield users. For this purpose, a field survey campaign was held in March 2020, with the establishment of two areas within the system corresponding to two user entry points: *Punta de Tivas* and *Grandes playas*. This period of the year was chosen for the survey as it is in the main peak tourist season in the Canary Islands (ISTAC, 2019).

The survey (Appendix D) was structured in three parts: the first and third parts involved presenting the purpose of the study and recording personal details to generate a profile of the survey participants. The second part formed the main body of the survey and comprised a total of 13 questions. The first 8 were used to estimate the evaluation ranges of the landscape variables for which no evaluation criteria had been found in the literature, using photographs or drawings to facilitate the process. The final 5 questions were focussed on determining the value of the type of dune and landscape in general, its attractiveness and characteristics.

In total, 70 surveys were conducted with users of different nationalities. The highest number of surveys was with English tourists (30%), followed by Dutch (12.3%), German (10%), Spanish (10%), Swedish (4.3%), Irish (4.3%), French (4.3%), Polish (4.3%), Belgian (2.9%), Italian (1.4%), Slovenian (1.4%), Rumanian (1.4%) and Portuguese (1.4%) tourists. In terms of the educational level of those surveyed, the majority had a university degree (45.7%), while 21.4% had a vocational training qualification, 14.3% were still attending school and 12.9% had completed their compulsory school education.

Based on the results of the surveys (Appendix E), the criteria for the evaluation of the variables were determined on a scale of 0 to 4 (Table 1).

Stage 4. Estimation and assignment of landscape variables

For the landscape evaluation, the study area was sectorized in two spatial scales following the methodology of Cruz et al. (2017). The starting point comprised the four landscape units of first taxonomic rank of that study (*[1] area with a high degree of anthropogenic alteration; [2] coastal influence area; [3] mobile dunes with barjanoid morphology and [4] sand area environments over malpais*). In units 1 and 2 (bordering with the coastal area and with the highest user transit rate), an in-depth analysis was conducted by crossing in a geographic information system, GIS (ArcGis 10.6), the first with the second taxonomic rank units, giving as a result 20 subunits. A total of 24 units were therefore defined in the sectorization process (4 units and 20 subunits) (Fig. 3).

After establishing the evaluation ranking system and concluding the sectorization process, a value was assigned to each of the variables (Table 1). The criteria for estimation of the variables comprised various techniques (Fig. 2): 1) *fieldwork* to contrast *in situ* the allocation of captured data and the photographic images. Evaluation of the units was made from a central point or centroid of each unit which had been previously georeferenced in GIS; 2) *geographic information systems (GIS)* for the measurement and analysis of spatial parameters such as viewsheds, slope and cover; 3) *public database searches* of guides, reports, municipal ordinances, public observers, digital applications, etc., for variables pertaining to the *Substratum* (S) and *Sea-coastal area* (AC) dimensions.

Table 1. Landscape evaluation criteria.

D	VARIABLE	0	1	2	3	4	SOURCES	METHOD
SUBSTRATUM (S)	**1-Nature (S-N)**	Pebble or rocks	Sand and pebbles	-	Coarse sand	Fine sand	7; 20	20
	2-Texture (S-T)	Pebbles		Mixed		Sand	3; 4; 5; 9; 21; 25.	Own
	3-Colour of sediment (S-ColS)	Black	Brown	-	Blonde	White	3; 4; 5; 9; 14; 20; 21; 25.	20
	4-Substratum cleaning (S-ClS)	Unavailable	-	Seasonal/occasional	-	Continuous	20	20
	5-Waste on sand (S-WtS)	>40%	25-40%	15-25%	5-15%	0-15%	14; 20	20
	6- Existence of pebble windbreakers (S-EPWB)	Absent	-	Sparse (one every 100 m)	-	Very frequent (more than one every 100 m)	20	20
	7- Existence of (other) pebble structures (S-EPS)	Absent	-	Sparse (one every 100 m)	-	Very frequent (more than one every 100 m)	20	20
COASTAL AREAS (AC)	**1- Water transparency (AC-WaT)**	Muddy	-	-	-	Transparent	14; 20, 25	20
	2-Colour of water (AC-WCo)	Muddy Brown/Grey	Milky Blue Green; Opaque	Green/Grey Blue	Clear Blue/Dark Blue	Very clear Turquoise	3; 4; 5; 9; 11; 14; 19; 21; 22;	11; 18
	3-Anthropic solid waste (AC-SlAn)	Very frequent	Frequent	Infrequent	Very rare	Absent	14	14
	4-Marine plant waste (AC-MPW)	Very frequent	Frequent	Infrequent	Very rare	Absent	14	14
	5-Presence of jellyfish (AC-PJell)	Very frequent	Frequent	Infrequent	Very rare	Absent	14	14
	6-Foam (AC-F)	Very frequent	Frequent	Infrequent	Very rare	Absent	14	14
	7-Tar (AC-T)	Very frequent	Frequent	Infrequent	Very rare	Absent	14	14
	8-Oil (AC-O)	Very frequent	Frequent	Infrequent	Very rare	Absent	14	14
VEGETATION (V)	**1-Contrast (V-VC)**	No vegetation	Low contrast	Moderate contrast	High contrast	-	4; 16; 20.	20
	2-Cover (V-Cov)	>75%	50-75%	25-50%	5-25%	<5%	5; 7; 9; 11; 21; 22; 25.	5
	3-Colour (V-Col)	Brown		Light green		Dark green	4	Own
	4-Pattern (V-P)	-	Shrubs	No vegetation	Trees	Herbs	10	Own
SCENIC BACKGROUND (SB)	**1- Structure of beach-dune system**						Own	
	1.1-Beach shape (SB-BS)	Closed (3/4)		Open (1/4)		Linear (1.5/4 - 2/4)	3; 4; 7; 9; 21; 20; 25	20
	1.2-Beach length (SB-BL)	Absent	<5m	5-25m	26-50m	>50	20	13
	1.3-Slope (SB-S)	>30%		0-15%		15-30%	2; 7; 21; 23; 25	25
	1.4-Beach width (SB-BW)	Absent	<5 - >100m	5 - <25m	25 - <50m	50-100m	7; 11; 20; 22.	11; 22
	2- Land scenic background of the system						Own	Own
	2.1- Relief of land scenic background (SB-RLSB)	Concave	-	Flat	Dunes/cliffs	-	11; 17; 20; 22;	20
	2.2- Existence of water bodies (SB-EWB)	Without water	-	-	-	With water	2; 20; 23;	20
	2.3- Landscape integration of buildings (SB-LIB)	High-rise on the front line	-	-	Stepped buildings on hillside	Low-rise/sparse buildings	20	20
	2.4- Horizontal line (SB-HL)	High or mixed buildings	-	Single-family or semi-detached	-	Without buildings	9	Own
	3- Marine scenic background of the system						Own	Own
	3.1- Kind of sea horizon (SB-KSH)	Industrial/port/shanty	Urban	Agricultural	With islands	Natural or free	20	20
	4- General scenic background						Own	Own
	4.1-Natural perception (SB-NPe)	Dunes, equipment and buildings	-	Dunes and equipment	-	Natural dunes	1; 10; 15; 16.	Own
	4.2-Viewshed (SB-V)	-	<100 ha	100-<500 ha	500-1000 ha	>1000 ha	1; 7; 15; 25;	Own
	4.3-Viewshed shape (SB-VS)	Small coves	-	Open and flat beach	-	Cove between cliffs	2; 7; 21; 25;	Own
	4.4- Landscape diversity (SB-LD)	Dunes, equipment and buildings	-	Natural dunes	-	Dunes and equipment	3; 5; 9; 10; 15; 17; 19; 25.	Own
	4.5-Coherence (SB-C)	Dunes, equipment and buildings	-	Natural dunes	-	Dunes and equipment	10	Own

Abbreviations: (1) Bosque et al., 1997; (2) Montoya et al., 2003; (3) Aguilo et al., 2004; (4) Muñoz Pedreros, 2004; (5) Otero et al., 2007; (7) Mérida et al., 2008; (9) Cañas et al., 2009; (10) Fry et al., 2009; (11) Ergin, 2010; (13) William and Micaleff, 2011; (14) Ariza et al., 2012; (15) Estévez 2012; (16) Geronta, 2013; (17) Sowińska-Świerkosz and Chmielewski, 2014; (19) Bruni, 2016; (20) Peña, 2015 and 2018; (21) Silva-Terán, 2017; (22) Da Costa et al., 2018; (23) García Romero et al., 2019; (25) Servicio de Evaluación Ambiental, 2019.

Stage 5. Landscape evaluation

The variables were evaluated on a 5-point scale ranging from 0 (minimum) to 4 (maximum) (Table 1). After the estimated value had been assigned to each variable, the information from the set of variables was aggregated in order to give a single standardised value to the corresponding subindex. The landscape indicator value (I_s) was calculated by dividing the sum of the values assigned to each variable (*Vi*) by the sum of the maximum possible values (4) of each variable (*Vp max*).

Eq.1. $I_s = Vi/Vp\ max.$

Finally, a single value was obtained, ranging from 0 to 1, for each group of variables. These results were classified as follows: <0.2 (very low); >0.2-<0.4 (low), 0.4-<0.6 (medium), 0.6-<0.8 (high) and >0.8 (very high).

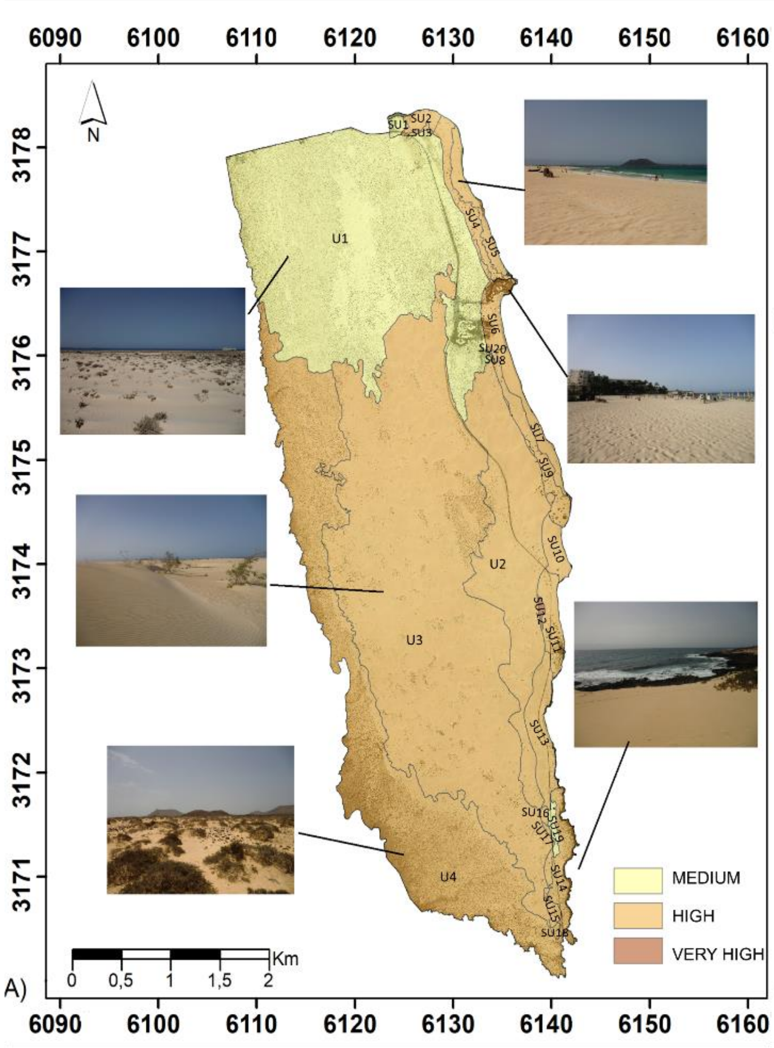
The results obtained were statistically analysed using SPSS 26.0. Firstly, the results of this analysis were represented graphically. Secondly, a Pearson bivariate correlation was made between each of the variables and sub-variables used to estimate the correlations of each dimension. Finally, the information obtained was integrated in the GIS to generate a scenic quality map.

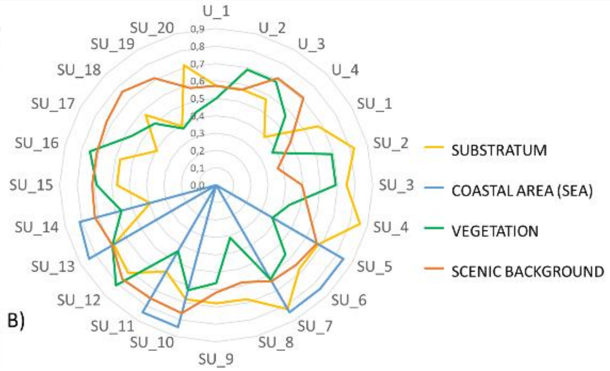
4. RESULTS AND DISCUSSION

4.1. Landscape evaluation of the Corralejo beach-dune system

According to the results obtained, the global scenic quality score of Corralejo beach-dune system is 0.7 (high) (Fig. 3). The highest valued subunit (SU12) obtained a score of 0.8 (very high). This unit is situated in the centre-west area of the system, where mobile dunes of barchan morphology and herbaceous vegetation begin to develop with a natural and open scenic background (aspects which increase its score). The following units/subunits obtained a medium score (0.5): U1, SU1, SU8 and SU19. These units/subunits border with the urban development of Corralejo or contain within them road infrastructures, parking areas or tourist complexes (aspects which lower their score). This was previously observed by Fernández-Cabrera et al. (2011) and Cruz et al. (2017), who explained how the impact of these factors, together with the intensive transit of people of in this area, had resulted in these being the most anthropogenically affected sectors of the system, with alterations to the sedimentary dynamics as well as plant growth and bird life. Areas can be found in these units with deflation surfaces where mobile dunes in their strict sense are barely perceptible, and other areas where hummock dunes develop stabilised by the vegetation.

The other units/subunits (SU7, SU10, SU13, SU6, SU16, U3, SU15, SU11, SU3, SU15, SU11, SU3, SU5, SU2, SU14, SU9, SU4, SU18, U2, SU20, SU20, SU17 and U4) obtained a high score, with values ranging between 0.6 and 0.7. These units/subunits are situated in the central and eastern areas of the system. In the interior zones, the units are characterised by the presence of mobile barchan dunes and barchan ridges interspersed with interdune depressions. The areas closest to the coast are composed of organogenic (calcareous remains of marine organisms) sand beaches and hummock dunes, some of which make up the foredune of the system (Cruz et al., 2017; García-Romero et al., 2017). Isolated crops of vegetation can also be found here, along with a natural and open scenic background.





C)

	SUBSTRATUM (S)	SEA (AC)	VEGETATION (V)	SCENIC BACKGROUND (SB)	SCENIC QUALITY
U_1	0,6	-	0,5	0,6	0,5
U_2	0,6	-	0,7	0,6	0,6
U_3	0,6	-	0,7	0,7	0,7
U_4	0,4	-	0,6	0,7	0,6
SU_1	0,7	-	0,4	0,5	0,5
SU_2	0,8	-	0,7	0,4	0,6
SU_3	0,8	-	0,7	0,5	0,6
SU_4	0,9	-	0,4	0,6	0,6
SU_5	0,7	0,8	0,4	0,7	0,6
SU_6	0,7	0,8	0,6	0,6	0,7
SU_7	0,8	0,8	0,6	0,6	0,7
SU_8	0,7	-	0,3	0,6	0,5
SU_9	0,7	-	0,6	0,6	0,6
SU_10	0,7	0,8	0,6	0,8	0,7
SU_11	0,6	0,8	0,4	0,8	0,7
SU_12	0,7	-	0,8	0,8	0,8
SU_13	0,7	0,8	0,7	0,7	0,7
SU_14	0,4	0,8	0,6	0,7	0,6
SU_15	0,6	-	0,7	0,7	0,7
SU_16	0,6	-	0,8	0,7	0,7
SU_17	0,4	-	0,6	0,7	0,6
SU_18	0,6	-	0,5	0,8	0,6
SU_19	0,4	-	0,4	0,7	0,5
SU_20	0,7	-	0,4	0,6	0,6
Mean	0,6	0,8	0,6	0,6	0,7
Standard deviation	0,13	0,01	0,14	0,10	0,1

Figure 3. A) Unit-based scenic quality map; B) and C) Scenic quality results for each dimension and unit/subunit.

At *dimension* level, AC obtained a very high scenic quality score (0.8), while the other dimensions scored high (0.6). It should be noted that in the case of AC, the same score was obtained for all the units for which this evaluation was possible as, in accordance with the information provided in the public databases, there were no observable differences between the different sectors of the coast and, therefore, this dimension was considered homogenous along the coastal border of this dune system.

4.2. Evaluation of dimensions and landscape variables

4.2.1. Value of the substratum

The highest score for the *Substratum* dimension (Fig. 3: B and C) was obtained in SU4 (0.9) and SU2, SU7 and SU3 (0.8 in all three cases). These subunits, situated in the northeast sector, are located close to the urban-tourist area (Corralejo) and the hotel complexes. Cleaning activities are carried out in these areas, and user-constructed pebble-based windbreak structures are common. These units are found over a volcanic relief and are characterised by a combination of dark volcanic sands to the north and exclusively organogenic sands to the south. The units/subunits which obtained a low scenic quality score of 0.4 (U4, SU14; SU17 and SU19) correspond to the southernmost coastal areas and the western sector of the sedimentary system. The coastal relief is more rugged as these units are situated in the malpais. For this reason, volcanic materials (different-sized and scattered volcanic debris and pebbles) mixed with aeolian deposits can be found in these units. No cleaning is undertaken, and no user-constructed pebble windbreaks or structures are found here. Likewise, no anthropic waste was detected here, and any that might have been found would have been transported here from elsewhere by the wind. The remaining units/subunits (SU12, SU20, SU1, SU5, SU6, SU8, SU9, SU10, SU13, U1, U3, U2, SU11, SU15, SU16, SU18) obtained a high score of 0.6 or 0.7. Situated in different parts of the system, these subunits display similar characteristics, though with some differences with respect to cleaning activities and the presence of pebble-based structures.

In the *Nature* variable (S-N), the sub-variable “fine sand” was reported in 10 units, “coarse sand” (composed of remains or marine or land deposits with shells, snails, etc.) and “sand and pebbles” in 7 units each. In the variable *Texture* (S-T), 18 units corresponded to “sand”, and 6 to a “mixed” structure. As for *Colour of sediment* (S-ColS), all units were white. It has been found in some studies (Peña (2015) and Ortiz (2020) among others) that clear tonalities and fine sands are more aesthetically appreciated by users of these systems than darker colours, as this is an important component of the coastal setting. In the *Substratum cleaning (S-ClS)* variable, 13 units were subjected to “continuous” cleaning, while for 11 units cleaning was “unavailable” (Fig. 4; Appendix F). The units with cleaning correspond to areas close to urban and hotel constructions, as in this type of area cleaning activities are required with greater regularity due to their recreational use (Mercadé, 2019). As for *Waste on the sand (S-WtS),* all 24 units (Fig. 4; Appendix F) were between 0% and 15%. The amount of waste, which is mostly anthropogenic (user-detected paper towels, concrete blocks and plastic), is minimal and only found in discrete points throughout the area, predominantly in areas of transit, on the roadside and in areas close to buildings. The *Existence of pebble windbreakers (S-EPWB)* was not a factor in 18 of the units but was very common in the remaining 6 (with more than one structure every 100 m) (Fig. 4; Appendix F). The *Existence of (other) pebble structures (S-EPS)* was very common in one unit, but absent in the remaining 23 units (Fig. 4; Appendix F).

4.2.2. Value of sea-coastal area

The score obtained for the *Sea-coastal area* dimension (Fig. 3: B and C) was very high and the same in all the variables as there were no significant differences between the different sectors. Thus, we find that the coastal area is characterised (Fig. 4; Appendix F) by transparent (AC-WaT) and very clear turquoise (AC-Wco) waters, with an absence of anthropic solid waste (AC-SIAn) and fatty substances such as tar (AC-T), foam (AC-F) and oils (AC-O), the very rare presence of jellyfish (AC-Plell) and the frequent presence of marine plant waste (AC-MPW). According to Anfuso et al. (2009), this variable, which refers to aesthetic aspects (colour, transparency, absence of algae and solid waste) and non-visible aspects (microbial load of the waters), is a fundamental component of the environmental, sanitary and recreational quality of tourist beaches. Users prefer turquoise and crystalline waters, free of solid waste.

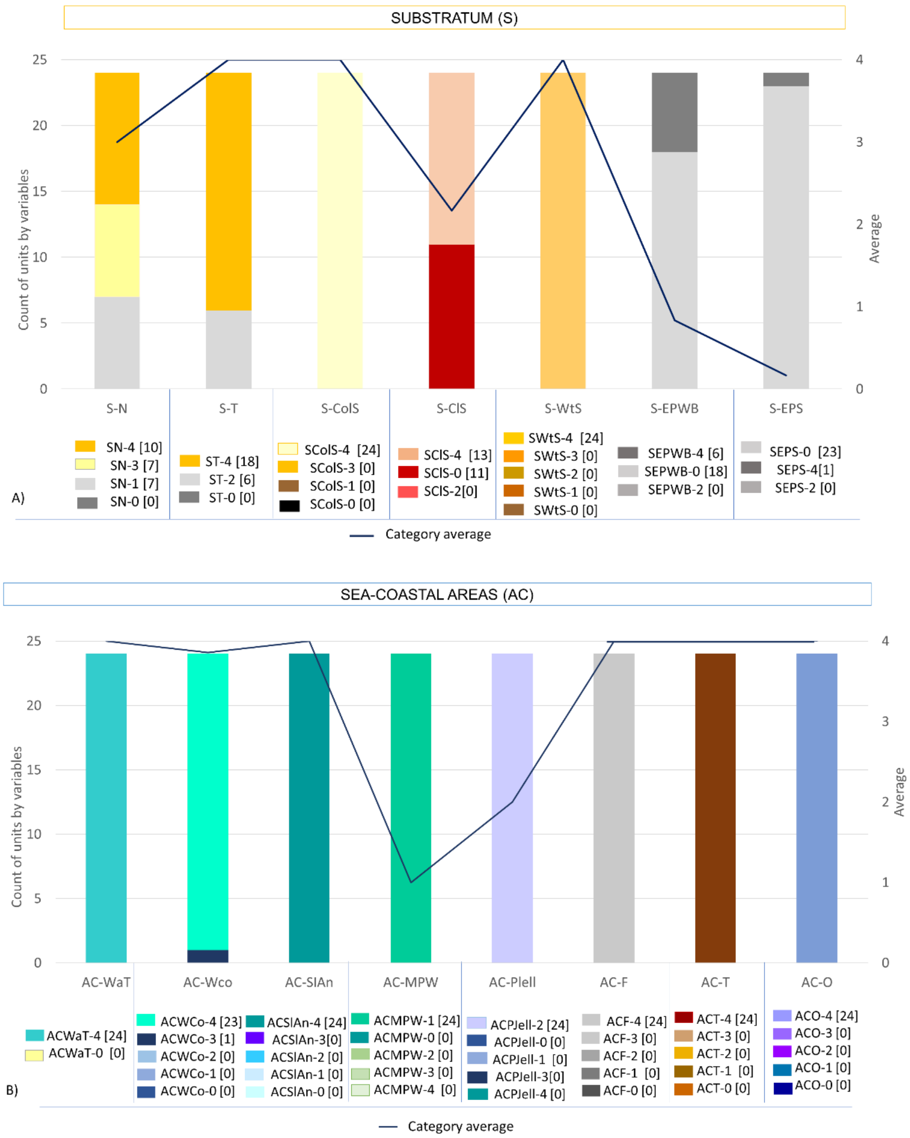


Figure 4. Abbreviations of variables: S-N (Nature); SN-0 (Pebble or rocks); SN-1 (Sand and pebbles); SN-3 (Coarse sand); SN-4 (Fine sand); S-T (Texture); ST-0 (Pebbles); ST-2 (Mixed); ST-4 (Sand); S-ColS (Colour of sediment); SColS-0 (Black); SColS-1 (Brown); SColS-3 (Blonde); SColS-4 (White); S-ClS (Substratum cleaning); SClS-0 (Unavailable); SClS-2 (Seasonal/occasional); SClS-4 (Continuous); S-WtS (Waste on sand); SWtS-0 (>40%); SWtS-1 (25-40%); SWtS-2 (15-25%); SWtS-3 (5-15%); SWtS-4 (0-15%); S-EPWB (Existence of pebble windbreakers); SEPWB-0 (Absent); SEPWB-2 (Sparse (one every 100 m)); SEPWB-4 (Very frequent (more than one every 100 m)); S-EPS (Existence of (other) pebble structures);SEPS-0 (Absent); SEPS-2 (Sparse (one every 100 m)); SEPS-4 (Very frequent (more than one every 100 m)); AC-WaT (Water transparency); ACWaT-0 (Muddy); ACWaT-4 (Transparent); AC-WCo (Colour of water) ; ACWCo-0 (Muddy Brown/Grey); ACWCo-1 (Milky Blue/Green; Opaque); ACWCo-2 (Green/Grey Blue); ACWCo-3 (Clear Blue/Dark Blue); ACWCo-4 (Very clear Turquoise); AC-SlAn (Anthropic solid waste); ACSlAn-0 (Very frequent); ACSlAn-1 (Frequent); ACSlAn-2 (Infrequent); ACSlAn-3 (Very rare); ACSlAn-4 (Absent); AC-MPW (Marine plant waste); ACMPW-0 (Very frequent); ACMPW-1 (Frequent); ACMPW-2 (Infrequent); ACMPW-3 (Very rare); ACMPW-4 (Absent); AC-PJell (Presence of jellyfish); ACPJell-0 (Very frequent); ACPJell-1 (Frequent); ACPJell-2 (Infrequent); ACPJell-3 (Very rare); ACPJell-4 (Absent); AC-F (Foam); ACF-0 (Very frequent); ACF-1 (Frequent); ACF-2 (Infrequent); ACF-3 (Very rare); ACF-4 (Absent); AC-T (Tar); ACT-0 (Very frequent); ACT-1 (Frequent); ACT-2 (Infrequent); ACT-3 (Very rare); ACT-4 (Absent); AC-O (Oil); ACO-0 (Very frequent); ACO-1 (Frequent); ACO-2 (Infrequent); ACO-3 (Very rare); ACO-4 (Absent).

4.2.3. Value of the vegetation

In the *Vegetation* dimension (Fig. 3 B and C), the subunits with very high scores were SU12 and SU16 (0.8). These units, situated in the centre-east of the system, are characterised by predominantly herbaceous vegetation, with green tonalities of low contrast and cover of below 5%. The units/subunits with high values (U3, U2, SU2, SU3, SU13, SU15, SU7, SU10, U4, SU6, SU9, SU14 SU17) were more scattered throughout the system and, unlike the very high scoring units, had vegetation which was larger in size with contrasting shrubs of moderate/low cover (<5% and 5-25%). The units situated in the northern and southern tips of the system (U1 and SU18) had medium values, with predominantly herbaceous vegetation of brown tonalities. More scattered throughout the system were the units with low scores of 0.4 in all cases (SU4, SU11, SU20, SU1, SU5 and SU19), where light green or brown shrubs predominated with moderate/low cover and contrast (<5% and 5-25%). The SU8 unit had the lowest score of all the units (0.3), with higher cover (50-75%) than the other units.

In the *Contrast* variable (V-VC), 20 units were “low contrast”, and 4 “moderate contrast” (Fig. 5; Appendix F). In *Cover* (V-Cov), there were greater differences between units, with 13 units having cover below 5%, 10 between 5% and 25%, and 1 between 50% and 75% (Fig. 5; Appendix F). The units with highest cover and moderate contrast corresponded to those situated in the interior of the system, where stabilised dunes are developed, or those close to buildings. According to Varea (2016), vegetation grows more easily in areas influenced by anthropic structures as the constructions generate aeolian shadow zones which encourage their growth. Likewise, Cruz et al. (2017) verified how anthropic structures not only lead to the introduction of gardening species but also to the greater distribution of natural vegetation. With respect to the variable *Colour* (V-Col), there is a variety of tonalities in the system, with light green predominating in 11 units, dark green in 8 and brown in 5 (Fig. 5; Appendix F). Thorpert and Busse (2014) reported how green tonalities are more appreciated than brown ones due to a greater perception of cleanliness and purity. In the *Pattern* variable (V-P) "shrubs" (15 units) predominated over "herbs" and "trees" (8 and 1 units, respectively) (Fig. 5; Appendix F). The units with herbaceous vegetation coincide with the more dynamic areas of the system, whereas the shrubs correspond to areas where the sediments are more stabilised (Cruz et al., 2017). This pattern was observed by both Hesse and Simpson (2006) and Varea (2016). They reported that vegetation gains in height and volume in areas where processes of sediment supply loss are taking place, and that in sediment entry and exit areas or in areas where the dunes are mobile, the vegetation tends to be more herbaceous or at least give that impression as the plants are more likely to be covered by dunes.

4.2.4. Value of scenic background

The highest values in the *Scenic background* dimension (Fig. 3 B and C) were obtained in the units SU10, SU12, SU18 and SU11. These units, situated in the central and eastern part of the study area, are characterised by the presence of free natural dunes and an absence of buildings. The northeast units, SU1, SU3 and SU2, had medium and low values, with the presence of diverse equipment and buildings next to the coast, as these are areas close to the urban-tourist development of Corralejo. The remaining units scored high values (SU17, SU14, U4, U3, SU15, SU16, SU19, SU13 and SU5), as they have natural dunes with the presence of some equipment, mainly sunbeds, sunshades and beach surveillance services.

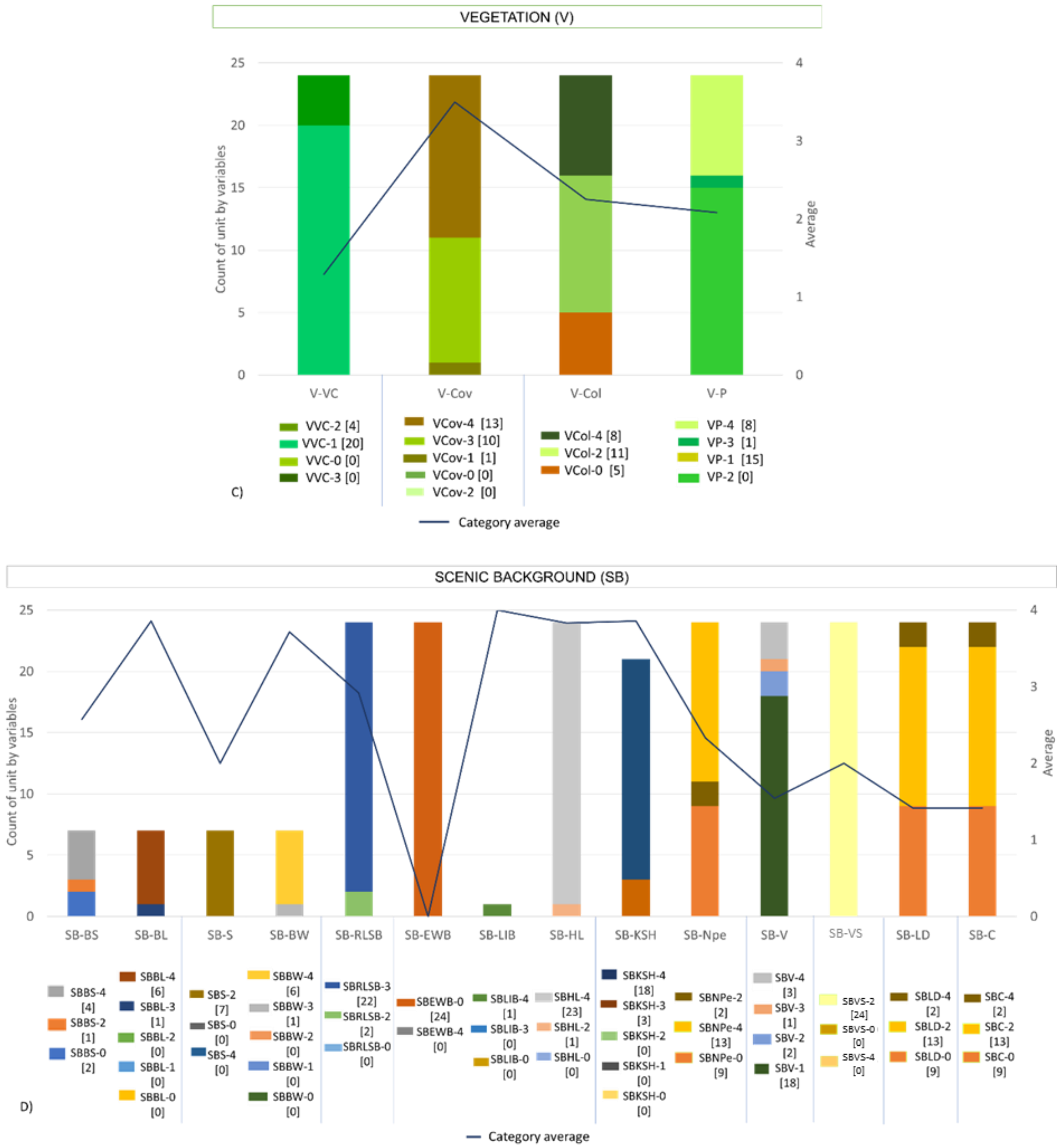


Figure 5. Abbreviations of the variables: V-VC (Contrast); VVC-0 (No vegetation); VVC-1 (Low contrast); VVC-2 (Moderate contrast); VVC-3 (High contrast); V-Cov (Cover); VCov-0 (>75%); VCov-1 (50-75%); VCov-2 (25-50%); VCov-3 (5-25%); VCov-4 (<5%); V-Col (Colour); VCol-0 (Brown); VCol-2 (Light green); VCol-4 (Dark green); V-P (Pattern); VP-1 (Shrubs); VP-2 (No vegetation); VP-3 (Trees); VP-4 (Herbs); SB-BS (Beach shape); SBBS-0 (Closed (3/4)); SBBS-2 (Open (1/4)); SBBS-4 (Linear (1.5/4 - 2/4)); SB-BL (Beach length); SBBL-0 (Absent); SBBL-1 <5m; SBBL-2 (5-25m); SBBL-3 (26-50m); SBBL-4 (>50); SB-S (Slope); SBS-0 >30º; SBS-2 (0º-15º); SBS-4 (15º-30º); SB-BW (Beach width); SBBW-0 (Absent); SBBW-1 (<5 - >100m); SBBW-2 (5 - <25m); SBBW-3 (25 - <50m); SBBW-4 (50-100m); SB-RLSB (Relief of land scenic background); SBRLSB-0 (Concave); SBRLSB-2 (Flat); SBRLSB-3 (Dunes/cliffs); SB-EWB (Existence of water bodies); SBEWB-0 (Without water); SBEWB-4 (With water); SB-LIB (Landscape integration of buildings); SBLIB-0 (High-rise on the front line); SBLIB-3 (Stepped buildings on hillside); SBLIB-4 (Low-rise/sparse buildings); SB-HL (Horizontal line); SBHL-0 (High or mixed); SBHL-2 (Single-family or semi-detached); SBHL-4 (Without buildings); SB-KSH (Kind of sea horizon); SBKSH-0 (Industrial/port/shanty); SBKSH-1 (Urban); SBKSH-2 (Agricultural); SBKSH-3 (With islands); SBKSH-4 (Natural or free); SB-NPe (Natural perception); SBNPe-0 ((Dunes, equipment and buildings); SBNPe-2 (Dunes and equipment); SBNPe-4 Dunas naturales; SB-V (Viewshed)); SBV-1 (<100 ha); SBV-2 (100-<500); SBV-3 (500-1000); SBV-4 (>1000); SB-VS (Viewshed shape); SBVS-0 (Small coves); SBVS-2 (Open and flat beach); SBVS-4 (Cove between cliffs); SB-LD (Landscape

diversity); SBLD-0 (Dunes, equipment and buildings); SBLD-2 (Dunes and equipment); SBLD-4 (Natural dunes); SB-C (Coherence); SBC-0 (Dunes, equipment and buildings); SBC-2 (Natural dunes); SBC-4 (Dunes and equipment).

With respect to the variables that make up the structure of the beach-dune system (Fig. 5; Appendix F), *Beach shape* (SB-BS) was represented as “linear” in 4 units, followed by “closed” in 2 and “open” in 1 (Fig. 5; Appendix F). In *Beach length* (SB-BL), 6 units were “>50”, followed by one unit of “26-50m”. In *Slope* (SB-S), all the units appeared in “0º-15º”. In *Beach width* (SB-BW), all units were “50-100 m”, except for one with “25<50 m”. With regard to the variables that constitute the *Land scenic background of the system* (Fig. 5; Appendix F), 22 units appeared in “dunes/cliffs” in *Relief of land scenic background* (SB-RLSB, and 2 in “flat”. No unit was represented in *Existence of water bodies* (SB-EWB). Only 1 unit appeared in *Landscape integration of buildings* (SB-LIB) in the “low-rise/sparse buildings” sub-variable, while no evaluations were possible in this category in the other units as none of them had any buildings. *Horizontal line* (SB-HL) was “without buildings” in all units except 1 where “single-family or semi-detached buildings” were observed. In *Marine scenic background of the system* (Fig. 5; Appendix F), *Kind of sea horizon* (SB-KSH) appeared in 18 units as “natural or free” and in 3 units in the northeast of the area as “with islands”, in reference to Lobos and Lanzarote. With respect to the variables that comprise the *General scenic background* (Fig. 5; Appendix F), *Viewshed* (SB-V) had 18 units in “<100ha”, 3 in “>1000ha”, 2 in “100-<500ha” and 1 in “500-1000ha). *Viewshed shape* (SB-VS) had all 24 units in “open and flat beach”. In *Natural perception* (SB-NPe), *Landscape diversity* (SB-LD) and *Coherence* (SB-C), “natural dunes” were reported in 13 units “dunes, equipment and buildings” in 9 and “dunes and equipment” in 2. The units with the presence of “natural dunes” are situated in the interior of the system or on eastern and southern coasts, where larger sized barchan-type, hummock and stabilised dunes are widespread. These types of dune are highly appreciated by users of this beach-dune system, who particularly appreciate the stabilised dunes (42.9%), barchan dunes (35.7%) and nebkha or hummock dunes (20%). In the units situated further north, close to the urban-tourist development or bordering with the sea, the dunes appear together with equipment and buildings, with hummock dunes, foredunes, sand sheets and deflation zones being developed. This has been verified by Fernández-Cabrera et al. (2011 and 2012), Varea (2016) and García-Romero et al. (2016), among others. They reported on how anthropogenic structures are affecting the dunefield processes and observed how the area covered by mobile dunes is decreasing in the north and increasing in the south, while the sand sheets are displaying the opposite pattern and the deflation zones are mainly present in the northern area.

4.3.Correlations between landscape dimensions.

The results show the existence of statistically significant and highly significant correlations ($P<0.001$ and $P<0.005$) between interdimensional variables (table 2).

In the *Substratum* dimension (S), the variables *Nature* (S-N) and *Texture* (S-T) increase respective to each other ($p<0.01$) as they present the same natural features. Both display a highly significant correlation with *Colour of water* (AC-WCo). It has been reported (Asensio et al., 2019) how the type of sea bottom (rocky or sandy), the wave characteristics, and the granulometry, composition and colour of the sediments affect the transparency and colour of the sea, giving rise to crystalline and turquoise or murky and turbid waters. In addition, *Nature* (S-N) was positively correlated with *Pattern* (V-P), as edaphic characteristics are one of the factors that affect the appearance of the plant, as well as the climate and the relief, among others (Gallego, 2004; Junta de Andalucía, 2020). As for *Substratum cleaning* (S-ClS), this increased with *Existence of pebble windbreakers* (S-EPWB) ($p<0.05$) and tended to decrease ($p<.0.05$) with *Natural* *perception* (SB-NPe). The direct correlation may be attributable to the location of these elements close to the tourist complexes, or to the influx of users and, hence, to the importance of cleaning. Contrastingly, the inverse correlation may be attributable to the fact that the type of cleaning undertaken, especially with respect to the heavy machinery used, has repercussions for the natural, ecological and geomorphological characteristics of the system, as well as for the social perception of these anthropic impacts. This problem has been analysed by several authors (Roig, 2004; Davenport and Davenport, 2006; Asensio et al., 2019; Mercadé, 2019; Zielinski et al., 2019, among others), who have observed how the maintenance and conditioning of these spaces using this type of mechanical cleaning (sieving, suction, sweeping, sifting, digging, etc.), based on extensive washing and flattening of the whole beach area in a short period of time, can cause serious problems, including sand compaction and the alteration and elimination of organic remains, coastal meiofauna and macrofauna, and result in changes to the natural profile or erosion (Nordstrom, 1994). The *Existence of pebble windbreakers* (S-EPWB) also increases with the *Existence of (other) pebble structures* (S-EPS) (and vice-versa) and decreases as *Kind of sea horizon* (SB-KSH), *Natural perception* (SB-NPe), *Landscape diversity* (SB-LD) and *Coherence* (SB-C) increase. The artificial use and movement of stones/pebbles breaks the environmental and scenic equilibrium. This has been observed by various authors, including Martínez et al. (2015) and Peña et al. (2016), in other sedimentary systems of the Canary Islands, as in Maspalomas in Gran Canaria where these modifications are affecting diverse coastal landforms, as they generate aeolian shadows which impact the foredune. The remobilization of the sedimentary structure, including palaeoreefs, affect plant species such as *Traganum moquinii*, as has been observed by Hernández-Cordero et al. (2008), as they use them as support and give them solidity. However, these pebble windbreak structures, generally circular or semicircular in appearance (Hernández-Calvento, 2006) are positively valued and much appreciated by the users as they offer refuge and protection from the constant gusts of wind, as well as a degree of comfort and intimacy. Additionally, the location of these windbreakers on the beaches and first nebkhas which make up the foredune (Peña, 2015) could explain the decrease in landscape visibility.

With respect to the *Vegetation* dimension, *Cover* (V-Cov) increases with *Landscape diversity* (SB-LD) and *Coherence* (SB-C). *Colour* (V-Col) has a moderate and positive correlation with *Horizontal line* (SB-HL). When there is an absence of buildings the presence of vegetation is more likely, and there will thus be enhanced development of a balanced landscape equilibrium that is heterogenous among the components of the landscape (Aguilo et al., 2004; Junta de Andalucía, 2020).

As for the *Scenic background* dimension, *Relief of land scenic background* (SB-RLSB) increases ($p<0.05$) with *Horizontal line* (SB-HL). This could be attributed to the fact that the visual opening of the horizontal plane is greater when no or only low-rise buildings are present, and vice-versa. *Natural perception* (SB-NPe), *Landscape diversity* (SB-LD) and *Coherence* (SB-C) show a significant correlation between each other. In other words, as one rises, so do the others, and vice-versa. This has also been observed by the Junta de Andalucía (2020), who found correlations between these variables as diversity is higher when the distribution of the elements is equitably and homogenously balanced within the space, and vice-versa.

Finally, it should be borne in mind that most of the variables of the *Sea-coastal area* dimension (AC-WaT, AC-SlAn; AC-MPW; AC-PJell; AC-F; AC-T; AC-O) could not be compared, as was the case with others in the *Substratum* dimension (S-ColS, S-WtS) and the *Scenic background* dimension (SB-S; SB-EWB; SB-LIB; SB-VA), as the variables all presented a constant score.

Table 2. Correlations between the Substratum (S), Sea-coastal area (AC), Vegetation (V), and Scenic background (SB) dimensions.

			Substratum (S)					Sea-coastal area (AC)	Vegetation (V)			Scenic background (SB)					
			S-N	**S-T**	**S-ClS**	**S-EPWB**	**S-EPS**	**AC-WCo**	**V-Cov**	**V-Col**	**V-P**	**SB-RLSB**	**SB-HL**	**SB-KSH**	**SB-NPe**	**SB-LD**	**SB-C**
Substratum (S)	**S-N**	Pearson C.	1	,849**	-0,056	-0,343	-0,307	,910**	-0,055	-0,115	,434*	-0,161	-0,161	0,390	0,094	0,100	0,100
		Sig. (2-tailed)		0,000	0,795	0,101	0,145	0,004	0,798	0,592	0,034	0,452	0,452	0,080	0,661	0,641	0,641
	S-T	Pearson C.	,849**	1	0,241	-0,178	-0,361	1,000**	-0,034	0,100	0,239	-0,174	-0,174	0,091	-0,102	0,039	0,039
		Sig. (2-tailed)	0,000		0,256	0,406	0,083	0,000	0,874	0,644	0,262	0,416	0,416	0,694	0,635	0,855	0,855
	S-ClS	Pearson C.	-0,056	0,241	1	,472*	0,192	0,645	-0,114	0,274	-0,301	-0,277	0,025	-0,389	-,636**	-0,302	-0,302
		Sig. (2-tailed)	0,795	0,256		0,020	0,369	0,117	0,597	0,195	0,153	0,189	0,907	0,081	0,001	0,151	0,151
	S-EPWB	Pearson C.	-0,343	-0,178	,472*	1	,406*	0,167	0,103	0,053	-0,176	-0,217	0,155	-,495*	-,635**	-,595**	-,595**
		Sig. (2-tailed)	0,101	0,406	0,020		0,049	0,721	0,632	0,806	0,412	0,309	0,471	0,022	0,001	0,002	0,002
	S-EPS	Pearson C.	-0,307	-0,361	0,192	,406*	1	.[b]	0,160	-0,036	0,283	0,063	0,063	.[b]	-0,258	-0,242	-0,242
		Sig. (2-tailed)	0,145	0,083	0,369	0,049		0,000	0,455	0,868	0,180	0,770	0,770	0,000	0,223	0,255	0,255
Sea (AC)	**AC-WCo**	Pearson C.	,910**	1,000**	0,645	0,167	.[b]	1	0,471	-0,320	0,167	-0,167	-0,167	-0,167	-0,420	0,000	0,000
		Sig. (2-tailed)	0,004	0,000	0,117	0,721	0,000		0,286	0,484	0,721	0,721	0,721	0,721	0,348	1,000	1,000
Vegetation (V)	**V-Cov**	Pearson C.	-0,055	-0,034	-0,114	0,103	0,160	0,471	1	0,051	0,338	-0,018	-0,018	-0,133	0,323	,407*	,407*
		Sig. (2-tailed)	0,798	0,874	0,597	0,632	0,455	0,286		0,813	0,106	0,934	0,934	0,564	0,123	0,049	0,049
	V-Col	Pearson C.	-0,115	0,100	0,274	0,053	-0,036	-0,320	0,051	1	-0,254	0,260	,468*	0,233	0,030	-0,012	-0,012
		Sig. (2-tailed)	0,592	0,644	0,195	0,806	0,868	0,484	0,813		0,230	0,220	0,021	0,309	0,888	0,957	0,957
	V-P	Pearson C.	,434*	0,239	-0,301	-0,176	0,283	0,167	0,338	-0,254	1	0,231	-0,089	0,285	0,303	0,076	0,076
		Sig. (2-tailed)	0,034	0,262	0,153	0,412	0,180	0,721	0,106	0,230		0,277	0,679	0,210	0,151	0,722	0,722
Scenic background (SB)	**SB-RLSB**	Pearson C.	-0,161	-0,174	-0,277	-0,217	0,063	-0,167	-0,018	0,260	0,231	1	,455*	0,331	0,213	-0,144	-0,144
		Sig. (2-tailed)	0,452	0,416	0,189	0,309	0,770	0,721	0,934	0,220	0,277		0,026	0,143	0,317	0,502	0,502
	SB-HL	Pearson C.	-0,161	-0,174	0,025	0,155	0,063	-0,167	-0,018	,468*	-0,089	,455*	1	0,331	0,213	-0,144	-0,144
		Sig. (2-tailed)	0,452	0,416	0,907	0,471	0,770	0,721	0,934	0,021	0,679	0,026		0,143	0,317	0,502	0,502
	SB-KSH	Pearson C.	0,390	0,091	-0,389	-,495*	.[b]	-0,167	-0,133	0,233	0,285	0,331	0,331	1	0,351	0,031	0,031
		Sig. (2-tailed)	0,080	0,694	0,081	0,022	0,000	0,721	0,564	0,309	0,210	0,143	0,143		0,118	0,894	0,894
	SB-NPe	Pearson C.	0,094	-0,102	-,636**	-,635**	-0,258	-0,420	0,323	0,030	0,303	0,213	0,213	0,351	1	,735**	,735**
		Sig. (2-tailed)	0,661	0,635	0,001	0,001	0,223	0,348	0,123	0,888	0,151	0,317	0,317	0,118		0,000	0,000
	SB-LD	Pearson C.	0,100	0,039	-0,302	-,595**	-0,242	0,000	,407*	-0,012	0,076	-0,144	-0,144	0,031	,735**	1	1,000**
		Sig. (2-tailed)	0,641	0,855	0,151	0,002	0,255	1,000	0,049	0,957	0,722	0,502	0,502	0,894	0,000		0,000
	SB-C	Pearson C.	0,100	0,039	-0,302	-,595**	-0,242	0,000	,407*	-0,012	0,076	-0,144	-0,144	0,031	,735**	1,000**	1
		Sig. (2-tailed)	0,641	0,855	0,151	0,002	0,255	1,000	0,049	0,957	0,722	0,502	0,502	0,894	0,000	0,000	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
b - Cannot be computed because at least one of the variables is constant: (S-ColS, S-WtS; AC-WaT, AC-SlAn; AC-MPW; AC-PJell; AC-F; AC-T; AC-O; SB-S; SB-EWB; SB-LIB; SB-VS)

*Abbreviations of variables: S-N (Nature); S-T (Texture); S-ClS (Substratum cleaning); S-EPWB (Existence of pebble windbreakers); S-EPS (Existence of (other) pebble structures); AC-WCo (Colour of water); V-Cov (Cover); V-Col (Colour); V-P (Pattern); SB-RLSB (Relief of land scenic background); SB-HL (Horizontal line); SB-KSH (Kind of sea horizon); SB-NPe (Natural perception); SB-LD (Landscape diversity); SB-C (Coherence).

4.4.Landscape satisfaction and management improvements

Corralejo is considered a valuable or very valuable landscape setting in the opinion of 87.2% of the users who visit it (Appendix E). In recent decades, the concept of landscape has begun to form part of an area's natural and cultural heritage, as it plays a fundamental role in the wellbeing of the people who live there or visit and in the preservation of the area's identity (Silva Terán, 2017). The extent of landscape satisfaction is influenced by the different ecological, environmental, cultural, social and even economic factors that the landscape transmits (Mercado, 2015).

Today, coastal landscapes associated to beach-dune systems are a resource with enormous potential for tourist activity (García Romero et al., 2019). However, the tourism industry has prioritized the practice of recreational activities over coastal resources (Williams and Micallef, 2009), preferring profit to the preservation of these ecosystems (Silva Terán, 2017). In the survey that was conducted the main reasons for visiting Corralejo (Appendix D) were as follows (in descending order): 1- *Take a walk and enjoy nature* (30%); 2- *Sunbathing and bathing* (22.4%); 3- *Enjoy the landscapes* (20.5%); 4- *Other*: (live there; relaxation; naturism, friends) (2.4%); 5- *To practise water sports* (1.9%) and *To practise beach/sand sports* (1.4%), and 6- *To play with my children, grandchildren…* (0.5%). Bearing in mind that factors related to the landscape and nature were among the main reasons for visiting, the users were asked if they would visit this space if the dune landscape did not exist, with 33.8% replying that they would not. This result suggests the need to ensure a balance between the development of these environments and landscape conservation, as ecologically poor conditions would negatively impact on the recreational experience of its users (Roca et al., 2009; Malcok et al., 2010; Pinto et al., 2013) and, in consequence, would have a negative impact on the local economy, as indeed has occurred in other coastal communities with strong littoralization (Graham et al., 2017).

The management of these settings must be compatible with social and economic evolution and transformation (Suárez-Chaparro et al., 2015) in order to satisfy the needs of the present without compromising future generations (Bruni, 2016). The conservation and preservation of these natural spaces requires the application of sustainable planning and management of tourism destinations (Geronta, 2013). In settings with environmental protection, as is the case of Corralejo which has been classified a Nature Park (Law 12/1994, dated December 19, on Natural Spaces in the Canary Islands), the goal should be for management that aims to reconcile access to and public enjoyment of the resources with nature preservation (Mercado, 2015). In this respect, the potential benefits of geotourism-based activities can be highlighted. This type of tourism can contribute to the scenic, environmental and social quality of the geoheritage elements of a particular space with geological-geomorphological interest as it aims to promote the conservation of its geodiversity (Dóniz-Paez and Quintero, 2016; Vegas and Díez-Herrero, 2018) and increase further the value of its attributes (Silva Terán, 2017).

Citizen participation and involvement is vital if this is to take place, as it provides a more real perspective in the design of common proposals (Funtowicz and Ravetz, 1993; Ostrom et al., 2007; Geronta, 2013; Gordon, 2018; García Romero et al., 2019). When the survey was being conducted, the interviewees reported the best and worst aspects that they had detected in the Corralejo system (Fig. 6). The positive aspects were related to the landscape and its beauty, the elements that make up the system (beaches, dunes, sand), the panoramic view of the contrast between dunes and mountains, its tranquillity, silence and the sense of relaxation (no music and few people), the preservation and conservation of the space (both abiotic and biotic), the properties of the water and the air, and the cleanliness of the surroundings. As for the negative aspects, the most notable were those related to the presence of large hotels next to the coast and in the interior of the beach, the lack of equipment, both in terms of sanitation (bathrooms, showers, footbaths) and accessibility and signposting (walkways and benches, among others), the difficulty to get from the road to the sea and the difficulty to enter the sea in areas where the coast is composed of a rocky platform, the presence of unfinished buildings and buildings in ruins, old beach furniture (sunbeds and parasols), the presence of solid waste (cigarette butts, bottles and plastic waste on the beach and in the dunes), the presence of naturist areas in some sectors of the beaches, traffic noise and road type. Considering the above aspects, the Corralejo system meets the so-called "big five" preference criteria (Ergin et al., 2004, Williams, 2011, Anfuso et al., 2018), with approval in landscape, safety and water quality aspects, but improvements required in the quality of the services offered and in cleaning up the solid waste.

Taking into account all these considerations, it is possible to guarantee a better landscape quality of the systems by tackling in an integrated manner the elements that make up the landscape. For this, this type of evaluation study promotes management of the coastal system as a tool that ensures its preservation and the wellbeing of its users.

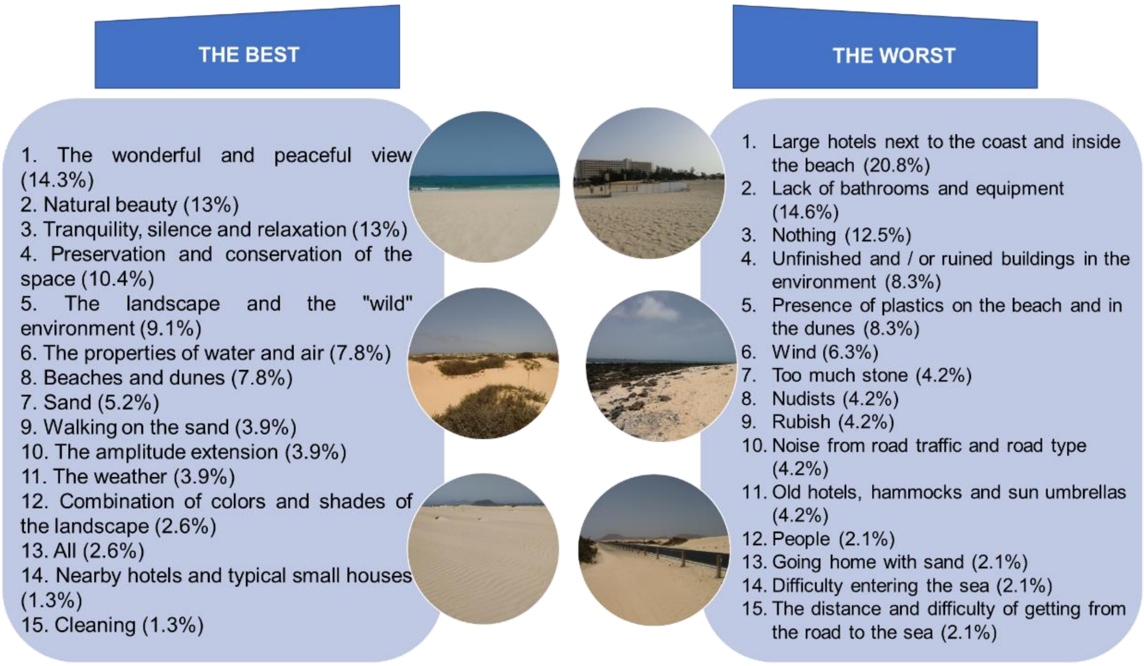


Figure 6. Positive and negative aspects of the Corralejo system according to user perception.

The methodology that has been applied is based on a variety of procedures used by different authors, as to date there is no universally accepted method for the landscape evaluation of coastal systems of these characteristics despite their worldwide social importance. Likewise, there are no studies based on lists of systematically integrated, structured and applied landscape indicators (Sala, 2009; Cervantes et al., 2018; García Romero et al., 2019). A series of considerations were taken into account when applying the methodology. Firstly, user surveys can be conditioned by a degree of implicit subjectivity (Bosque et al., 1997), as the personality (age, gender, education, etc.) and perception (sensitivity mechanisms, state of mind, etc.) of the observer can be influential (Uçar et al., 2004; Ergin et al., 2004, 2006; Boullón, 2006; Silva-Terán, 2017). Secondly, photography was used in the survey as a complement and reference for the visual elements that the users were being asked to evaluate and analyse. The use of a mixed technique (photography-fieldwork) contributed to avoiding some of the limitations or drawbacks that are reflected in the literature with respect to the use of photographs in questionnaires, as some authors (Oku and Fukamachi, 2006; Cañas et al., 2009; Ode et al., 2009; Povilanskas et al., 2016; López-Martínez, 2017, among others) consider that the images may not be able to completely transmit the complex reality of the landscape as they only contemplate the visual aspects of the scene, whereas in fieldwork all the senses (sight, hearing, smell, etc.) provide information that influences the final result. Thirdly, the inclusion was taken into account of indicators applicable to other environments and more generally understandable to society (Nogué, 2009), as survey participants are more likely to be willing to participate (Sala, 2009).

Finally, the procedure employed in this study could be of interest for planning, territorial ordinance, and future management purposes in types of setting. Furthermore, these studies could set up projects and activities that incentivise an equilibrium between the physical medium and anthropogenic pressure.

5. CONCLUSIONS

This work proposes a method for the evaluation of the landscape quality of coastal areas situated in singular volcanic settings, as is the case of hot-spot islands, which are additionally exposed to constant littoralization. As far as we are aware, very little has been published in the literature on the evaluation of landscapes structured by organogenic beaches and mobile dunefields in volcanic settings, and even less in relation to hot-spot volcanic islands.

The aim of the study was to evaluate the scenic quality of the aeolian sedimentary system of Corralejo on the island of Fuerteventura (Canary Islands), as a site with heritage landscape, through the use of a series of user perception-based indicators. User participation in this type of perceptual approach allows the construction of robust and objective tools that are applicable to other settings of the same nature. This study focussed on indicators for four different landscape dimensions (substratum, sea-coastal area, vegetation and scenic background), which were used to analyse the total of 24 landscape units into which the Corralejo beach-dune system was divided.

The results show that the Corralejo beach-dune system has a high landscape value. The image of a field of white mobile dunes over a scenic background of volcanoes, dark ridges, an open sea, and even other islands, is a highly exotic one. The creation of procedures for its evaluation offers the potential to enhance our understanding of it and to establish measures that will allow improved interactions between biodiversity and human activities.

Research into landscape evaluation currently has several possible applications: i) at a scientific and academic level, this type of study helps to better understand the landscape elements that make up beach-dune systems and to interpret how geomorphology is regulating the transformations and how it will do so in the future; ii) at social and didactic level, this type of study helps to increase the level of sensitivity to and awareness, recognition, respect and knowledge of the elements that make up the landscape, both as far as the local population and the tourists who visit the area are concerned, as it promotes interest in disseminating and interpreting this geoheritage and incentivises geotourism-based activities; and iii) at management level, this type of study can help towards the protection, planning and ordinance preparation of coastal areas as it can be used to better understand the natural resources and the heritage that they represent. For all of the above reasons, this type of study, in which user perception and perspective is emphasised, in combination with their relationship with these spaces, is both useful and necessary.

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6. DISCUSIÓN GENERAL

* (Fuente: Elaboración propia, 2019).

En el siguiente apartado se discuten los resultados obtenidos en la Tesis, teniendo en cuenta los objetivos y la hipótesis de partida.

El objetivo general de la investigación se planteaba "identificar, reconstruir y valorar el patrimonio natural y cultural perdido o en riesgo de desaparecer en dos tramos costeros de las islas Canarias, así como aportar recursos turísticos y didácticos que fomenten el respeto, la protección y la preservación hacia los espacios costeros insulares". Desde el punto de vista académico-científico entendemos que el objetivo se ha cumplido de forma satisfactoria.

El trabajo desarrollado ha estado apoyado en estudios precedentes, pero también supone una aportación frente a éstos, por cuanto ha permitido ampliar los conocimientos que hasta ahora se tenían sobre el patrimonio natural, cultural y paisajístico de las áreas de estudio. En el caso del litoral oriental de Las Palmas de Gran Canaria, se ha partido del Trabajo Final de Máster (TFM) de Pérez-Hernández (2015), así como de diversos trabajos de Martín Galán (1980, 2001, 2007, 2008 y 2009). También, para la definición de la geomorfología costera de esta ciudad y del sistema de Corralejo, se partió de distintos trabajos desarrollados por miembros del Grupo *Geografía Física y Medio Ambiente* del IOCAG-ULPGC. La implementación de una metodología basada en fuentes y técnicas de análisis históricas y geográficas ha permitido recomponer, evaluar y valorar el patrimonio natural y cultural costeros de LPGC desde finales del siglo XIX. También han permitido valorar la calidad paisajística del sistema playa-dunas de Corralejo.

El objetivo general se dividía en otros cuatro, de carácter específico:

El primero de ellos proponía "Reconstruir las características patrimoniales naturales, históricas y culturales". Este se ha desarrollado a través de tres objetivos planteados en los artículos 1 y 2 (dos del primero [1.1. identificar y describir las playas naturales que existían a lo largo de la costa oriental de LPGC antes de la expansión de la ciudad sobre este tramo de costa; 1.2. identificar y caracterizar la naturaleza, usos del suelo, funciones y rasgos culturales de las playas naturales de la costa oriental de LPGC y sus cambios a lo largo del tiempo] y uno del segundo [1.3. reconstruir las características geomorfológicas de la franja costera de LPGC previas a su expansión (1879)]). Estos objetivos han consumido una gran cantidad de tiempo en la elaboración de la Tesis, pues la información consultada para identificar los elementos patrimoniales ha sido muy diversa, a través de la integración de fuentes geográficas e históricas y técnicas mixtas. En ambos casos, se procedió, en primer lugar, a la consulta de una cantidad relevante de fuentes bibliográficas dispersas, que permitieron componer la geomorfología costera de la ciudad desde finales del siglo XIX. La fotografía convencional histórica fue una de las piezas claves en esta tarea, al igual que las fuentes cartográficas, tanto históricas como actuales, la fotografía aérea de 1954 y la ortofoto de 1966. Sobre ellas se cartografiaron los distintos elementos naturales y culturales costeros mediante SIG, transformando, por lo tanto, dicha información, en digital y temática. También estas tecnologías permitieron comparar las fotografías aéreas históricas, una vez rectificadas, con las ortofotos actuales, confrontar la geomorfología costera y la línea de costa y comprobar los cambios experimentados.

Para el caso del litoral oriental de LPGC, también ha sido fundamental la labor realizada en la recopilación de fuentes históricas (a través de métodos propios de la Historia oral). Los testimonios recopilados han permitido contrastar y corroborar información obtenida por otros medios, así como deducir información desconocida hasta ahora. Gracias a la información adquirida en las entrevistas realizadas a personas mayores, se han podido caracterizar una serie de elementos no observables en detalle, como las vivencias, los estilos de vida o los usos que se desarrollaron en las áreas objeto de análisis. Desde esta investigación se entiende, no obstante, que este aspecto siempre podría enriquecerse con nuevas aportaciones y vivencias, que permitirían conocer más profundamente el funcionamiento y las características naturales y culturales de estos espacios.

En el segundo objetivo se propuso "conocer en profundidad los aspectos naturales costeros del pasado". Su desarrollo se ha basado en la evaluación y cuantificación de la geomorfología costera de la ciudad de LPGC, por medio de cuatro objetivos de los artículos 1 y 2 (uno del primero [2.1. cuantificar el área de playa perdida y la cubierta terrestre ahora desaparecida en LPGC] y tres del segundo [2.2. cuantificar las formas del relieve perdidas en el proceso de expansión urbana de LPGC; 2.3. evaluar la pérdida, frente a la preservación, de superficies caracterizadas por presentar formas del relieve costeras en LPGC antes de 1879; 2.4. evaluar la preservación de las formas del relieve costeras actuales en LPGC]). El peso en este objetivo estuvo en los SIG, que facilitaron la localización de los elementos de la geomorfología costera y de los elementos culturales, así como recopilar, integrar y sintetizar la información en una base de datos. Parte de esta información fue exportada a herramientas de análisis estadístico, a través de las cuáles se analizaron los datos, para cuantificar las pérdidas y los procesos de cambios, además de realizar comparaciones en diferentes fechas.

El tercer objetivo, "identificar y valorar los elementos patrimoniales costeros culturales y paisajísticos" fue desarrollado por dos objetivos de los artículos 3 y 4 (3.1. identificar, describir y valorar los elementos del patrimonio cultural que existían a lo largo de la costa oriental de LPGC antes de la expansión de la ciudad sobre este tramo de costa, en la década de los sesenta del siglo XX; 3.2. valorar el patrimonio paisajístico del sistema playa-dunas de Corralejo mediante una serie de indicadores y a través de la percepción de los usuarios de estos sistemas). En la fase de identificación, también la fotografía convencional histórica fue una pieza clave, al igual que las fuentes cartográficas y la fotografía aérea de 1954. Sobre esta última, se identificaron y cartografiaron los diferentes elementos del patrimonio cultural, a través de un SIG. Esta tarea, que tiene un claro antecedente en el citado TFM (Pérez-Hernández, 2015), añade, como fuentes de información claves, los planos de la ciudad de Las Palmas de Fernando Navarro, de 1910, y el plano de Benito Chías Carbó, de 1914. De este modo, esta Tesis Doctoral ha ampliado la información de aquel TFM, introduciendo nuevos elementos informativos. En cuanto a la información de cada elemento patrimonial desaparecido en el litoral oriental de LPGC, ésta fue compilada de diferentes estudios, así como de páginas web. Para recopilar todos estos datos se han utilizado unas fichas de inventario, en las cuales se ha recogido la información existente de cada uno de ellos. Esta herramienta ha sido necesaria para localizar y sintetizar la información de cada elemento, con el fin de mejorar la accesibilidad y la transmisión a la población.

Uno de los aspectos que más tiempo ha ocupado ha sido la realización de encuestas para valorar el patrimonio. En primer lugar, llevó mucho tiempo la elección de los parámetros culturales y paisajísticos, tarea que se desarrolló mediante la consulta de diferentes referencias y el contraste de información. Al no existir un enfoque metodológico único para calcular el valor de los elementos patrimoniales (y del paisaje, en general) fue necesario establecer, para cada estudio (cultural y paisajístico), variables/indicadores que se adaptaran a las características de cada área y del trabajo en sí. Además, se tuvo especial cuidado en conseguir que tales variables/indicadores fueran claras y comprensibles, no solo para expertos, sino para la población en general. En segundo lugar, el método utilizado para valorar estos elementos fue la elaboración de encuestas. En el caso del litoral oriental de LPGC, al tratarse de elementos desaparecidos, se optó por realizar las encuestas de manera online, eligiendo cuidadosamente a los expertos encuestados, tanto en cuanto a su número, como en cuanto a su especialidad, de forma que abarcaban tanto a académicos, como a miembros de instituciones patrimoniales o a profesionales diversos relacionados indirectamente con el patrimonio. El desarrollo de las encuestas tuvo la dificultad añadida de que las opiniones sobre elementos desaparecidos tienen un menor rango de percepción que sobre elementos existentes o conocidos. Entendemos que esta Tesis añade también como resultado novedoso la valoración de elementos patrimoniales desaparecidos. En el caso de las encuestas desarrolladas en Corralejo, parte de la valoración se realizó de manera presencial, a través de la percepción de los usuarios de estos sistemas. Cabe citar, al respecto, que, durante la realización de este trabajo, surgieron una serie de inconvenientes, pues las campañas de campo se vieron inmersas en el comienzo de la crisis sanitaria por la Covid-19. Ello supuso el traslado de las últimas campañas a fechas posteriores al estado de alarma decretado por el Gobierno de España. Sin embargo, las condiciones posteriores no eran suficientemente óptimas para continuarlas, principalmente por la poca afluencia de turistas extranjeros, por la repercusión de la crisis en la sociedad a la hora de participar, la dificultad en su realización presencial por las labores de limpieza o desinfección y por el tiempo limitado en los plazos para la presentación de esta Tesis Doctoral. Todas estas circunstancias supusieron que se optara por utilizar únicamente las encuestas realizadas en la primera campaña para realizar un estudio preliminar.

El cuarto y último objetivo de este trabajo se plantea “establecer propuestas de recuperación y gestión, de cara a su posible explotación turística, didáctica y cultural”. A lo largo de la investigación se propone una serie de recomendaciones e ideas para recobrar el patrimonio perdido, y se plantean sugerencias y utilidades para el patrimonio preservado. De igual forma se plantea, en el apartado de “perspectivas” de esta investigación, una ruta interactiva para promover e incentivar un patrimonio desaparecido que ya no es posible recuperar, salvo a través de este tipo de herramientas. De este modo, se pretende que estas ideas sean la base para la elaboración de nuevos proyectos, donde se desarrollen actividades educativas y culturales que ayuden a divulgar y fomentar el interés por el patrimonio de estos espacios costeros insulares.

La consideración conjunta de los objetivos logrados permite admitir, como válida, la hipótesis de partida ("la investigación, a través de fuentes y métodos geográficos e históricos, permite identificar y valorar las características patrimoniales naturales, históricas y culturales perdidas y actuales de áreas costeras de islas, de cara a favorecer la gestión de sus elementos patrimoniales"). Así, queda en evidencia que en el desarrollo de esta investigación ha sido necesaria la utilización de un enfoque metodológico multidisciplinar, basado en la aplicación de diversas herramientas y técnicas mixtas, históricas y geográficas, para abarcar y analizar los diferentes ámbitos de estudio desde las diversas perspectivas patrimoniales analizadas. Este enfoque mixto ha aportado resultados muy interesantes acerca de los valores, las características, prácticas y funcionalidades de los elementos estudiados. Estos resultados pueden contribuir de manera importante a la concienciación, sensibilización, preservación, planificación y gestión futura del patrimonio de los espacios costeros insulares analizados. Sin lugar a duda, de no haberse optado por los procedimientos mixtos anteriormente mencionados, no habría sido posible alcanzar tales resultados.

7. CONCLUSIONES GENERALES

* Playa de Es Trenc (Mallorca). (Fuente: Elaboración propia, 2019).

Las conclusiones generales que se derivan de esta Tesis Doctoral son las siguientes:

1. Esta investigación estableció un método para la identificación, reconstrucción y evaluación de elementos del patrimonio natural y cultural perdidos y del paisaje alterado como resultado de las actividades humanas. Este método se aplica, en la Tesis, en dos líneas: una que abarca los elementos patrimoniales, culturales y mixtos desaparecidos (comprendido por los tres primeros artículos que conforman la Tesis); y otra, que engloba el patrimonio preservado con un alto valor natural (desarrollado a través del cuarto artículo y parte del segundo).

2. La utilización de un enfoque geohistórico basado en la utilización de fuentes históricas (documentales, gráficas, cartográficas y orales) y sistemas de información geográfica (SIG) permitió la reconstrucción, identificación y cuantificación de las características naturales y culturales del litoral oriental y la geomorfología costera de la ciudad de Las Palmas de Gran Canaria.

3. Se aplicó un enfoque novedoso en la valoración de elementos perdidos, que permitió establecer un valor, a través de un panel de 56 expertos, para una selección de 30 elementos patrimoniales perdidos divididos en cuatro categorías (militar, industrial, comercial / de servicios e infraestructura pública) mediante seis variables intrínsecas (singularidad, identidad, científica, histórico-cultural, estético y social).

4. Por lo que respecta a la valoración paisajística, el patrimonio se evalúa en términos de calidad a través de indicadores, algunos de ellos construidos a través de la percepción de los usuarios. La creación de estos procedimientos ha ofrecido un potencial para mejorar su comprensión, así como para establecer medidas que permitan mejorar las interacciones entre la biodiversidad y las actividades humanas.

5. Los trabajos enfocados en el patrimonio perdido han mostrado que la gran mayoría de los elementos naturales y culturales que caracterizaron la franja costera oriental de la ciudad de Las Palmas de Gran Canaria, han desaparecido progresivamente en los últimos 80 años.

6. El primer artículo (Pérez-Hernández et al., 2020a) ha mostrado no solo la evolución y las transformaciones experimentadas en la costa oriental, sino también las pérdidas territoriales y funcionales que ésta ha experimentado, al vincular las playas desaparecidas con las aún existentes. Los resultados revelan que gran parte de ese litoral se ha perdido, concretamente once playas, con una extensión de 13,19 ha, conservándose solamente tres sectores: las Alcaravaneras, San Cristóbal y La Laja.

7. El segundo artículo (Pérez-Hernández et al., 2020b) constató el alto impacto que el crecimiento de la ciudad de Las Palmas de Gran Canaria ha tenido en la morfología natural costera, al haberse perdido, por ocupación, 848,1 ha. Los accidentes costeros más afectados han sido los propios de los sistemas sedimentarios (campos de dunas y mantos eólicos) que desaparecieron totalmente desde 1981, mientras que el 17% de las geoformas costeras naturales han sido preservadas, de manera residual o fuertemente alteradas, debido a acciones de protección o por no presentar condiciones óptimas para el asentamiento.

8. El artículo 3 (Pérez-Hernández et al., 2020c) reveló como numerosos elementos culturales con un valor patrimonial medio y alto se han perdido en el litoral oriental de esta ciudad. Se demostró como los elementos más valorados tendían a estar asociados con el comercio / servicios, además de existir un vínculo entre los elementos de mayor valor patrimonial y la disposición a pagar por ellos.

9. Con estos tres artículos se demostró como la pérdida de elementos naturales y culturales ha ocasionado la desaparición de una serie de usos de suelo y recursos sociales, como pueden ser las tradiciones y las costumbres populares intrínsicamente vinculadas a estos espacios costeros insulares. Así, se identificaron ocho usos del suelo: pesquero, defensivo, agrícola, portuario, industrial, comercial, residencial y recreativo. Estos mostraron como las playas de los sectores norte y centro tenían usos más variados que las del sector sur, que tendían a ser utilizadas principalmente para la pesca.

10. El estudio dedicado al patrimonio preservado mostró que el campo de dunas de Corralejo presenta un valor paisajístico alto, al igual que sus distintas dimensiones (sustrato, mar, vegetación y fondo escénico). Se identificó como en zonas limítrofes al área urbana o con afluencia turística la valoración disminuye por la fuerte presión que ejercen este tipo de actividades sobre ellas.

Considerando estas conclusiones generales de forma conjunta, se plantean dos conclusiones finales: i) el enfoque metodológico seguido en esta investigación puede servir de cara a establecer estrategias para la reconstrucción histórica o para la evaluación de elementos del patrimonio en peligro de pérdida, ya que facilita conocer qué elementos son importantes y para quiénes; y ii) las lecciones del pasado, especialmente en cuanto a la gestión de los elementos del patrimonio natural, cultural e histórico, pueden ser de utilidad para aprender y aplicar a los problemas de gestión patrimonial actuales.

8. PERSPECTIVAS

*Playa de Es Trenc (Mallorca). (Fuente: Elaboración propia, 2019).

De esta Tesis Doctoral surgen una serie de perspectivas futuras de investigación, pero también de recomendaciones de cara a la gestión.

Por lo que respecta a las primeras, se plantean las siguientes:

- Ampliar el estudio de reconstrucción y valoración patrimonial a otras áreas costeras de Canarias con características semejantes.

- Realizar un análisis comparado de aspectos humanos relacionados con los sistemas dunares de las islas Canarias y Baleares, así como de cambios inducidos en sus líneas de costa por procesos de artificialización. Como primer paso, se plantea aplicar los métodos de valoración del patrimonio paisajístico desarrollado para el sistema playa-duna de Corralejo a las áreas de Es Trenc (Campos), Parque Natural de Es Trenc y Es Comú (Muro) dentro del Parque Natural de s`Albufera de Mallorca. La elección de estos sistemas se ha hecho en colaboración con investigadores de la Universitat de les Illes Balears, teniendo en cuenta que se trata de sistemas de naturaleza y problemática semejantes a los sistemas canarios. En la aplicación del método se deberán realizar ajustes, con el fin de cubrir aquellos elementos en los que ambos grupos de sistemas puedan mostrar mayores diferencias, principalmente por ser los de Canarias áridos, y templados los de Baleares.

- Seguir progresando en los métodos de valoración patrimonial para avanzar hacia un enfoque metodológico global que garantice un sistema eficaz y homogéneo para evaluar los elementos patrimoniales culturales.

- Desarrollar y extender el estudio de valoración paisajística al sistema playa-dunas de Maspalomas. En un principio, el cuarto trabajo que compone esta investigación incorporaba ambos sistemas para valorarlos y compararlos. Debido a que las campañas de campo se vieron inmersas en el comienzo de la crisis sanitaria por la Covid-19 y que las condiciones posteriores no eran suficientemente óptimas para continuarlas, no fue posible incorporar dicha área en el estudio de valoración.

- La valoración paisajística se ha analizado teniendo en cuenta la percepción social a través de un conjunto de indicadores. Sería interesante seguir profundizando en ello y realizar un estudio que preste atención al valor que perciben los residentes de las localidades localizadas en el entorno del sistema playa-dunas de Maspalomas, como San Fernando, El Tablero o Lomo Gordo, entre otros, frente a la imagen idílica que muestran las postales o web turísticas, con el fin de contrastar la imagen idílica, percibida por los turistas y los residentes de otros municipios de la isla, frente a la imagen cotidiana que pudieran tener los residentes locales.

- De forma general, entendemos que tendría interés, desde el punto de vista académico, favorecer el desarrollo de una línea de investigación de reconstrucción del patrimonio natural, cultural e histórico perdido. En paralelo, sería interesante apoyar una línea de investigación, sobre memoria histórica, que permita recoger los recuerdos que guardan muchas personas mayores sobre el entorno en el que han desarrollado sus vidas, así como sobre el aprovechamiento de los recursos.

Por lo que respecta a las sugerencias y propuestas de gestión, las dividimos en dos ámbitos, según el tipo de patrimonio: actual o perdido.

- Con respecto al primero, durante el estudio se han identificado y valorado elementos naturales y culturales que se preservan con el fin de hacer visible la riqueza patrimonial existente a la sociedad, en particular de cara a las generaciones futuras. Entendemos que el siguiente paso sería que estos resultados se tengan en cuenta en futuras actuaciones urbanísticas, donde se fomente la integración y conservación de los elementos patrimoniales preservados en los entornos urbanos, con la finalidad de contribuir en el desarrollo de un tejido urbano costero más sostenible.

- Con respecto al patrimonio perdido, se plantean una serie de ideas para recuperar la memoria de los elementos de mayor valor. En este sentido, proponemos una ruta patrimonial interactiva por el litoral oriental de Las Palmas de Gran Canaria para promover e incentivar este tipo de patrimonio, cuya presencia sería imposible recuperar sin la ayuda de las herramientas digitales. Esta ruta podría ser la base para la elaboración de nuevos proyectos donde se desarrollen actividades culturales que ayuden a divulgar y fomentar el interés por nuestro patrimonio, a la vez que contribuirían a impulsar la investigación sobre esta área de estudio. Una propuesta de ruta patrimonial se presenta en el anexo G de la Tesis.

- Asimismo, y relacionado con la idea anterior, tendría interés la puesta en marcha de un museo virtual sobre el patrimonio perdido, con el fin de acercar el patrimonio desconocido tanto por la población local como por los visitantes. La aplicación de tecnologías de recreación podría ser adecuada, con el fin de revivir el patrimonio desde un punto de vista más realista. Esta iniciativa no sólo permitiría conocer y acercar a la población local con el patrimonio histórico, cultural y natural de este entorno de la ciudad siendo un conocimiento escaso en la actualidad, sino, además, incrementaría la apreciación y sensibilización hacia los valores patrimoniales por parte de la sociedad.

- En relación con esta idea, este estudio sienta las bases de una futura propuesta de protección y valoración del geopatrimonio litoral en el entorno de LPGC a través de itinerarios, paneles de interpretación y nuevas tecnologías (con dispositivos móviles u otros) dirigidos tanto a escolares como al público en general. Estos promoverían el desarrollo de aplicaciones de realidad aumentada, reconstrucciones 3D de paisajes antiguos insertados en actuales o imágenes interpretativas dedicadas al descubrimiento de la geología urbana y la geomorfología (Cayla, 2014; Pica et al. 2017).

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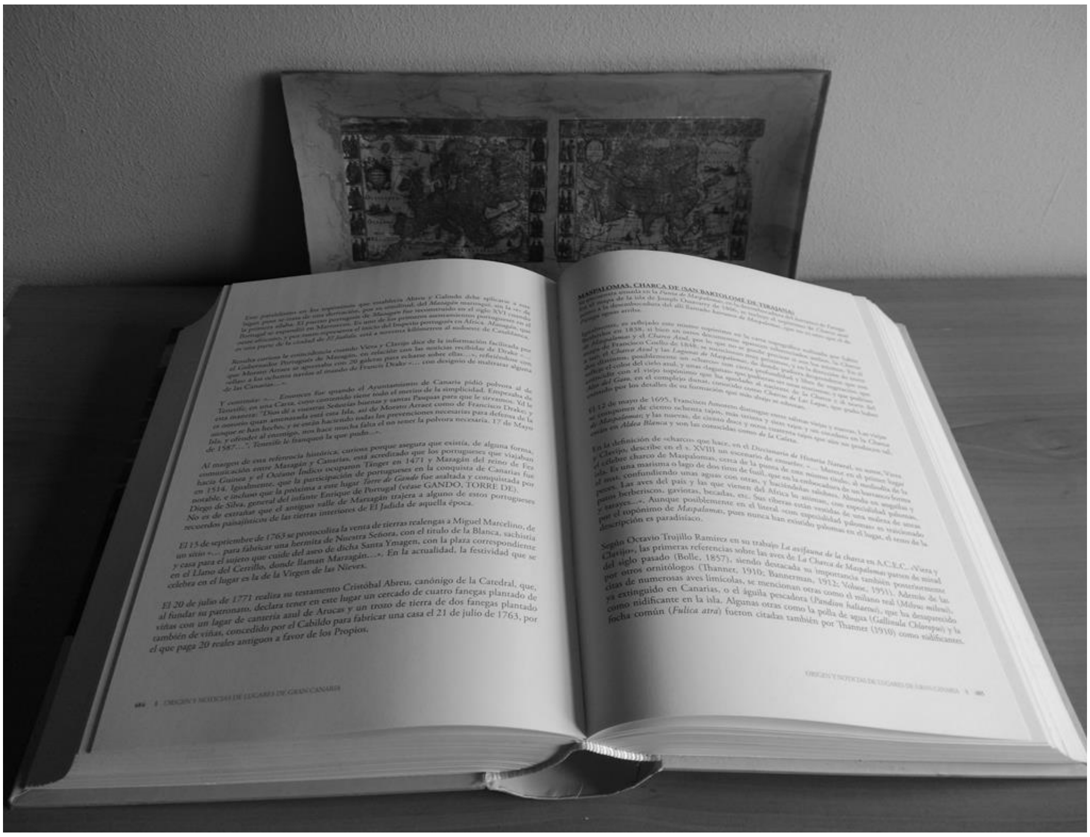

* Fuente: Elaboración propia, 2020.

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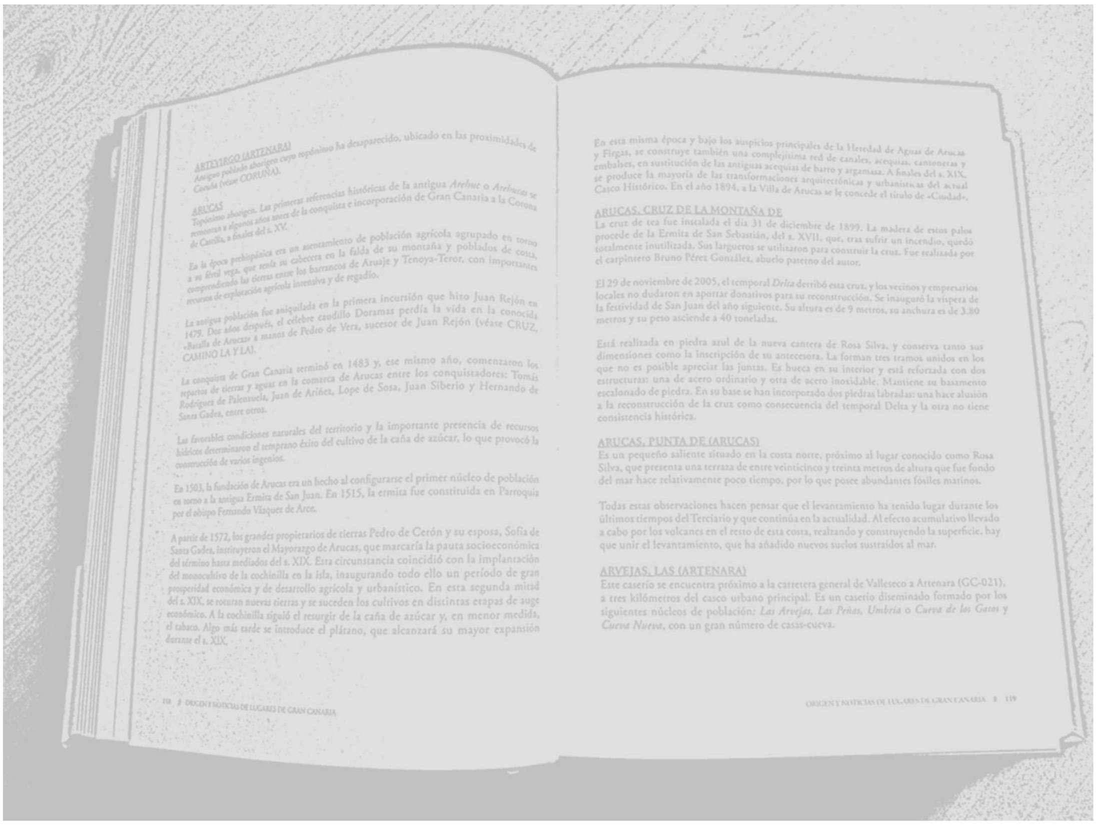
10. ANEXOS



* Fuente: Elaboración propia, 2020).

Anexo A (Appendix A). Elementos seleccionados para el proceso de evaluación.

Military heritage

La Esfinge battery	**Date of construction:** 1914	**Date of disappearance:** -	Its purpose was to watch over, defend and protect the coast from possible attacks from the sea. (Medina, 1996).
San Fernando (Salvás) battery	**Date of construction:** 1899	**Date of disappearance:** -	Their purpose was to watch over, defend and protect the coast in this area during the two World Wars and the Spanish Civil War (Medina, 1996).
Santa Catalina Castle	**Date of construction:** -	**Date of disappearance:** In the 1940s	It was designed by the military engineer Próspero Cazorla with the intention of providing reinforcement and additional support to Castillo de la Luz. (Sanabria, 1996; Pérez, 2010).
Las Alcaravaneras machine gun nest	**Date of construction:** 1943	**Date of disappearance:** In the 1960s	This machine gun nest was constructed during World War II (1943) to help defend this stretch of coast in the event of a hypothetical attack by Great Britain or the United States.
Santa Ana tower	**Date of construction:** 1554	**Date of disappearance:** In the 1960s	Santa Ana Tower was conceived as the northern endpoint of the Las Palmas city wall (Pérez, 2010).
Santa Isabel Castle	**Date of construction:** -	**Date of disappearance:** -	Santa Isabel Castle was the southern endpoint of the Las Palmas city wall, which protected the city along the coast (Pérez, 2010).
San Cristóbal machine gun nest	**Date of construction:** 1943	**Date of disappearance:** In the 1960s	This machine gun nest was built during World War II (1943) to help defend this stretch of coast in the event of a hypothetical attack by Great Britain or the United States.
La Laja machine gun nest	**Date of construction:** 1943	**Date of disappearance:** In the 1960s	This machine gun nest was built during World War II (1943) to help defend this stretch of coast in the event of a hypothetical attack by Great Britain or the United States.

Commercial and services heritage

Health station	**Date of construction:** Between 1900 and 1905	**Date of disappearance:** -	It played an important, necessary and decisive role in the social and economic maritime development of the island, ensuring correct hygiene standards in the port and impeding the entrance into the city of external health concerns (Martín-Castillo, 1997).
Circus Theatre	**Date of construction:** 1916	**Date of disappearance:** 1987	This new cultural space was called the Circus Theatre because during the intermissions of theatrical plays, or while the reels were being changed during the screening of a film, the audience would be entertained by short circus-type acts. (López, 2016; Gran Canaria Island Government, 2015).
Old Nautical Club	**Date of construction:** 1908	**Date of disappearance:** -	The Old Nautical Club was built in post-romantic style on columns in the sea. From the day of its inauguration, it became the symbolic entrance point to the island where the visitors were effusively welcomed and lavishly treated (Valcarce, 2013).
Pérez Galdós house	**Date of construction:** -	**Date of disappearance:** In the 1940s.	Home of the family of the renowned novelist, Benito Pérez Galdós.
Las Alcaravaneras spa, beach huts and pier	**Date of construction:** Midway through the 20th century	**Date of disappearance:** -	These public facilities constituted a major change for the beach, fostering its use a recreational space.
Metropole Hotel	**Date of construction:** 1889	**Date of disappearance:** -	It was initially conceived as a space for recreational activities but subsequently was converted into a hotel due to the large number of visitors arriving to the island during this period.
La Lonja fish market	**Date of construction:** 1876	**Date of disappearance:** the 1960s	La Lonja fish market was the first public point-of-sale for fish in the city to offer proper hygienic conditions.
San Cristóbal chapel	**Date of construction:** around 1559 or 1580	**Date of disappearance:** the 1950s	This chapel was built in an east-to-west direction following Christian tradition of the times.

Anexo B (Appendix B). Elementos seleccionados para el proceso de evaluación.

Industrial heritage			
Ice Factory	**Date of construction:** 1948	**Date of disappearance:** 2017	Its purpose was to supply the high demand for ice to preserve freshly caught fish (Coronet, 2015).
Cory & Brothers coal warehouses and dock	**Date of construction:** 1904	**Date of disappearance:** -	The biggest coal export company in the south of Wales, they began operating in Gran Canaria. Coal was brought form the mines they owned in Cardiff to fuel the vessels of the Admiralty at various ports in the Atlantic (Quintana, 1983; Herrera, 1984).
Grand Canary Coaling Company' s shops, coal stores, dock and dry dock	**Date of construction:** 1884	**Date of disappearance:** -	The company employed a strategy of diversification of activities, which included the company's own dry dock and ship repair facilities as well as offering a variety of services for the small vessels (falúas) which transported people to and from the larger seagoing vessels (Quintana, 1983; Herrera, 1984).
Blandy Bros. pier and coal warehouses	**Date of construction:** 1885	Date of disappearance: -	Blandy made a major contribution to the development of the supply of coal and the exportation of fruit produce (Quintana, 1983; Herrera, 1984).
Woermann Linie coal warehouses and dock	**Date of construction:** 1906	**Date of disappearance:** In the 1960s	It was the only coal company without a British connection. Its headquarters were in Hamburg (Germany) and the company was heavily backed by the Reichstag in its policy of penetration of the African continent (Quintana, 1983; Herrera, 1984).
Mill industries	**Date of construction: -**	**Date of disappearance:** -	The wind and mechanical (powered by gas, steam or crude oil) mill facilities, with their wheels or blades positioned on building roofs tops of buildings, were used to grind grains, especially corn, to make bread flour and the local product of gofio, which was and remains a staple part of the Canary diet (Florido, 1998).
San Roque bottled water warehouse	**Date of construction: -**	**Date of disappearance:** 2017	The company had several warehouses distributed throughout the island for its naturally sparkling water. The San Cristóbal site was used for distribution in the city of Las Palmas.
Correa brick factory	**Date of construction: -**	**Date of disappearance:** In the 1970s	Materials were extracted from the mountainside to make different sized gravel for concrete and the manufacture of bricks and blocks (Doreste, 2014).

Public infrastructures heritage			
Port shelter	**Date of construction:** 1915	**Date of disappearance:** 1965	Its function was to shelter people who were waiting for the small vessels (falúas) which transported people to and from the larger seagoing vessels (González, 2009).
Tram station	Date of construction: 1890	**Date of disappearance:** in the 1960s	It connected the port with the city. The tam (initially steam and subsequently electric) ran along the 7 km of road that connected the two areas, with various pick-up and put-down points along the way for both passengers and cargo 1960s (Medina, 1996).
Water hydrant	**Date of construction: -**	**Date of disappearance: -**	Direct water supply to houses was not available in Las Palmas de Gran Canaria until the first decade of the 20th century. Until that time, the local population had to go to springs or hydrants like the one located in Venegas street (Arroyo et al., 2008).
Las Palmas pier	**Date of construction:** 1811	Date of disappearance: In the 1960s.	It was the city's first pier (Martín, 1983).
Fielato house	**Date of construction:** -	**Date of disappearance:** -	The Fielato house was a tax collection office for the entrance of consumables and their sale in Las Palmas city (Doreste, 2014).
La Laja tunnel	**Date of construction: -**	**Date of disappearance:** In the 1960s.	This 111 m long, 4.5 high and 5 m wide stone tunnel was the only means of access for the city inhabitants to the south of the island (Doreste, 2014).

Anexo C (Appendix C). Results (in %, mean and standard deviation) of the responses of all the experts surveyed for each element and their corresponding intrinsic values (IV).

		%							M	SD
	IV	Very low	Low	Medium	High	Very High	NR/DK	TOTAL		
EP1	U	3	29	43	20	3	2	100	2.7	1.0
	I	27	28	40	2	3	0	100		
	SC	16	23	36	16	7	2	100		
	HC	0	12	38	30	20	0	100		
	A	20	48	25	7	0	0	100		
	S	19	30	29	18	4	0	100		
EP2	U	5	21	50	20	2	2	100	2.6	1.0
	I	21	41	34	2	2	0	100		
	SC	11	36	34	12	5	2	100		
	HC	0	9	45	37	9	0	100		
	A	23	48	23	6	0	0	100		
	S	22	39	30	7	2	0	100		
EP3	U	2	18	54	19	5	2	100	2.9	1.0
	I	9	36	38	14	3	0	100		
	SC	4	27	36	21	12	0	100		
	HC	0	11	39	30	20	0	100		
	A	16	48	30	2	2	2	100		
	S	9	21	43	20	7	0	100		
EP4	U	2	16	41	36	5	0	100	3.1	1.0
	I	5	14	43	29	9	0	100		
	SC	11	28	41	14	4	2	100		
	HC	2	11	37	43	7	0	100		
	A	2	23	46	25	4	0	100		
	S	5	20	39	23	13	0	100		
EP5	U	0	3	48	36	11	2	100	3.2	0.9
	I	7	18	45	21	9	0	100		
	SC	2	21	48	16	11	2	100		
	HC	0	4	37	43	16	0	100		
	A	4	29	46	14	7	0	100		
	S	6	25	41	21	7	0	100		
EP6	U	4	14	50	25	7	0	100	3.0	1.0
	I	9	28	32	27	4	0	100		
	SC	7	25	41	21	4	2	100		
	HC	2	9	35	43	10	0	100		
	A	7	34	36	18	3	2	100		
	S	9	28	36	23	4	0	100		
EP7	U	2	28	39	20	9	2	100	2.9	1.1
	I	9	34	34	12	11	0	100		
	SC	9	30	38	16	5	2	100		
	HC	2	16	30	39	13	0	100		
	A	11	50	23	12	4	0	100		
	S	9	39	25	18	9	0	100		
EP8	U	0	4	34	48	14	0	100	3.6	1.0
	I	0	9	29	46	14	2	100		
	SC	11	30	30	18	9	2	100		
	HC	0	4	25	48	23	0	100		
	A	2	16	38	34	10	0	100		
	S	0	2	27	43	27	1	100		
EP9	U	2	2	18	55	23	0	100	3.8	1.0
	I	2	2	30	38	26	2	100		
	SC	5	30	34	18	11	2	100		
	HC	2	2	20	46	30	0	100		
	A	2	5	16	48	29	0	100		
	S	2	2	38	35	23	0	100		
EP10	U	4	12	38	32	14	0	100	3.1	1.0
	I	9	25	38	21	7	0	100		
	SC	4	30	39	18	7	2	100		
	HC	2	9	27	46	16	0	100		
	A	5	27	38	19	11	0	100		
	S	7	29	38	21	3	2	100		
EP11	U	4	5	50	29	12	0	100	3.2	1.1
	I	5	18	43	20	14	0	100		
	SC	23	36	23	11	5	2	100		
	HC	5	11	34	41	9	0	100		
	A	4	9	39	36	12	0	100		
	S	5	16	45	27	5	2	100		

		%							M	SD
	IV	Very low	Low	Medium	High	Very High	NR/DK	TOTAL		
EP12	U	2	0	25	45	28	0	100	3.7	1.0
	I	7	7	46	18	22	0	100		
	SC	9	10	38	25	16	2	100		
	HC	0	2	20	39	39	0	100		
	A	2	2	28	43	25	0	100		
	S	7	16	41	21	13	2	100		
EP13	U	2	11	37	39	9	2	100	3.2	1.0
	I	5	23	32	29	11	0	100		
	SC	7	46	25	13	7	2	100		
	HC	2	7	23	52	16	0	100		
	A	2	25	41	25	7	0	100		
	S	7	32	30	22	9	0	100		
EP14	U	3	0	38	30	29	0	100	3.5	1.1
	I	4	4	39	27	27	0	100		
	SC	12	25	27	23	11	2	100		
	HC	4	0	27	39	30	0	100		
	A	4	18	36	30	12	0	100		
	S	5	12	25	38	18	2	100		
EP15	U	4	23	52	18	4	0	100	2.8	1.0
	I	5	21	45	23	4	2	100		
	SC	25	45	18	7	3	2	100		
	HC	5	22	46	20	7	0	100		
	A	9	45	32	11	3	0	100		
	S	2	16	36	30	14	2	100		
EP16	U	5	32	52	9	0	2	100	2.5	1.0
	I	22	39	32	5	2	0	100		
	SC	16	39	25	14	4	2	100		
	HC	3	20	41	29	7	0	100		
	A	27	46	23	4	0	0	100		
	S	18	46	27	5	4	0	100		
EP17	U	0	9	25	48	18	0	100	3.6	1.0
	I	4	9	32	41	14	0	100		
	SC	13	27	30	21	7	2	100		
	HC	0	7	25	34	34	0	100		
	A	0	7	18	52	21	2	100		
	S	3	12	29	43	11	2	100		
EP18	U	2	12	45	30	11	0	100	3.3	1.0
	I	0	10	43	27	18	2	100		
	SC	12	34	34	9	9	2	100		
	HC	0	5	36	41	18	0	100		
	A	2	30	43	18	7	0	100		
	S	0	9	36	29	25	2	100		
EP19	U	0	11	57	27	5	0	100	3.1	0.9
	I	4	13	55	23	5	0	100		
	SC	9	30	39	13	7	2	100		
	HC	2	3	41	45	9	0	100		
	A	9	36	34	16	5	0	100		
	S	4	21	39	29	5	2	100		
EP20	U	0	9	36	34	18	3	100	3.2	1.1
	I	9	25	34	16	14	2	100		
	SC	11	25	29	18	14	3	100		
	HC	0	9	25	39	25	2	100		
	A	4	19	41	27	5	4	100		
	S	11	25	34	18	9	3	100		
EP21	U	0	22	39	23	16	0	100	3.3	1.1
	I	0	21	29	32	18	0	100		
	SC	12	29	19	27	11	2	100		
	HC	0	14	20	39	27	0	100		
	A	7	32	36	20	5	0	100		
	S	4	14	34	34	14	0	100		
EP22	U	2	5	36	36	21	0	100	3.5	1.0
	I	2	11	39	34	12	2	100		
	SC	9	41	18	21	11	0	100		
	HC	2	7	25	46	20	0	100		
	A	2	5	27	48	16	2	100		
	S	0	7	43	36	12	2	100		

		%							M	SD
	IV	**Very low**	**Low**	**Medium**	**High**	**Very High**	**NR/DK**	**TOTAL**		
EP23	**U**	0	16	39	34	9	2	100	3.1	1
	I	4	23	41	23	7	2	100		
	SC	11	32	29	14	12	2	100		
	HC	0	12	20	52	16	0	100		
	A	5	30	36	23	2	4	100		
	S	12	23	38	23	4	0	100		
EP24	**U**	9	23	50	12	4	2	100	2.6	1.1
	I	16	39	25	14	5	0	100		
	SC	18	36	29	12	3	2	100		
	HC	4	16	34	41	5	0	100		
	A	16	46	27	7	4	0	100		
	S	21	32	32	9	5	0	100		
EP25	**U**	2	11	36	39	12	0	100	3.3	1.0
	I	2	12	39	32	12	2	100		
	SC	10	34	29	18	7	2	100		
	HC	2	7	23	43	25	0	100		
	A	2	20	41	32	4	2	100		
	S	3	16	38	25	16	2	100		
EP26	**U**	9	34	45	10	2	0	100	2.5	1.0
	I	9	34	34	16	5	2	100		
	SC	25	38	29	3	3	2	100		
	HC	5	32	30	29	4	0	100		
	A	23	39	34	2	2	0	100		
	S	18	30	30	16	4	2	100		

		%							M	SD
	IV	**Very low**	**Low**	**Medium**	**High**	**Very High**	**NR/DK**	**TOTAL**		
EP27	**U**	5	18	38	36	3	0	100	2.9	1.1
	I	9	29	36	23	3	0	100		
	SC	14	32	25	21	5	2	100		
	HC	9	5	29	43	14	0	100		
	A	16	30	34	14	2	4	100		
	S	11	29	36	21	3	0	100		
EP28	**U**	11	45	41	3	0	0	100	2.3	0.8
	I	18	41	39	2	0	0	100		
	SC	21	39	36	2	0	2	100		
	HC	9	21	61	9	0	0	100		
	A	26	52	20	0	0	2	100		
	S	19.64	45	30	5	0	0	100		
EP29	**U**	14	36	48	2	0	0	100	2.3	0.9
	I	25	41	29	3	2	0	100		
	SC	23	39	27	7	2	2	100		
	HC	11	18	41	28	2	0	100		
	A	29	50	21	0	0	0	100		
	S	34	34	27	2	3	0	100		
EP30	**U**	7	27	36	23	5	2	100	2.7	1.1
	I	11	23	34	29	3	0	100		
	SC	23	38	23	11	2	3	100		
	HC	7	14	34	38	5	2	100		
	A	20	39	23	16	2	0	100		
	S	9	34	32	23	0	2	100		

***** Appendix C. Abbreviations of the intrinsic variables: (U) Uniqueness; (I) Identity; (SC) Scientific; (HC) Historical – Cultural; (A) Aesthetic; (S) Social. Abbreviation NR/DK: No response/Don't know; M: Mean; SD: Standard deviation. * Percentages shaded in yellow indicate the values most voted by experts for each variable. * The mean and standard deviation are based on the raw data that experts have given to each variable. Its value range is minimum 1 and maximum 5.

Anexo D. (Appendix D). Users survey.

Playa: ____________ Fecha: __________

Zona: ___________________________

This survey is part of the process of preparing a doctoral thesis at the University of Las Palmas de Gran Canaria. The objective is to evaluate landscape parameters of the beaches and dunes of the Canary Islands through the perception of the users.

Thank you for its participation.

IMPORTANT: THIS SURVEY IS ANONYMOUS AND CONFIDENTIAL AND WILL BE USED ONLY FOR SCIENTIFIC RESEARCH PURPOSES.

1) When you decide to visit a sandy beach, is the colour of the sand important to you?

(1) ☐ Yes (2) ☐ No (3) ☐ No response/Don't know

In the case that you answer "Yes", value the following sand colours according to your preferences. *(Please check ONLY one box for each colour).*

SAND COLOUR						NR/DK
A) Black	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐
B) Brown	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐
C) Blonde	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐
D) White	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐
E) Other colour:______	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐

2) In respect of vegetation. What colours do you find most attractive? *(Please check ONLY one box for each factor).*

						NR/DK
A) Brown	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐
B) Light green	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐
C) Dark green	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐

3) Which of the following landscapes values more? *(Please check ONLY one box).*

			
☐	☐	☐	☐

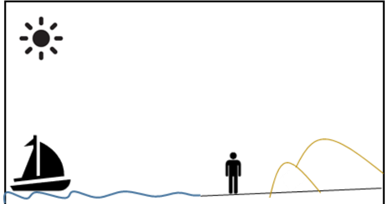
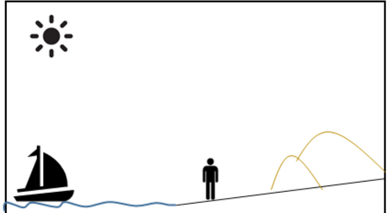
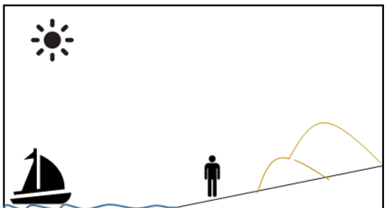
4) What type of substratum do you find most attractive when you visit a beach? *(Please check ONLY one box).*

		
☐	☐	☐

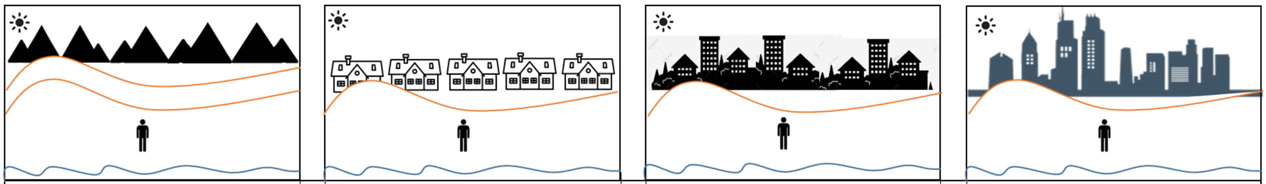
5) Of the beaches shown below, which do you prefer? *(Please check ONLY one box).*

		
☐	☐	☐

6) Imagine you are in the beach. Indicate which of the following images you like best. *(Please check ONLY one box).*

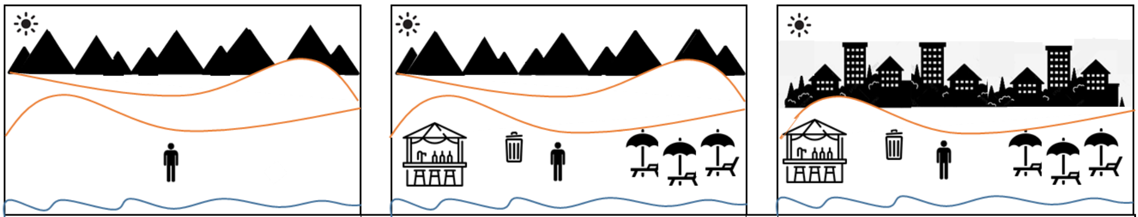
		
☐	☐	☐

7) Imagine that you are on a beach with your back to the sea looking at the interior landscape. Indicate which of the following images you consider most attractive. *(Please check ONLY one box).*



☐ ☐ ☐ ☐

8) ***Of those three images, which one do you consider most representative of the environment in which you now find yourself?*** *(Please check ONLY one box).*



☐ ☐ ☐

9) The following images represent different types of dunes. Which one do you like or value more? *(Please check ONLY one box).*

☐ ☐ ☐

10) In your opinion, what landscape value / importance would you attribute to this dune landscape? *(1 Insignificant - 5 Very important).*

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11) If this dune landscape did not exist, would you have visited this place?

☐ Yes ☐ No ☐ No response/Don't know

12) What are the main reasons to come to this environment? *(Please check <u>ONLY</u> three boxes).*

☐ Sunbathing and bathing	☐ To practice water sports
☐ Take a walk and enjoy nature	☐ To play with my children, grandchildren …
☐ Enjoy the landscapes	☐ To practice beach / sand sports
☐ Other reasons (specify):________________	☐ No response/Don't know

13) What is the best and worst of this dune landscape?

THE BEST	THE WORST

PERSONAL DATA

Age	Sex	City of residence	Country of residence
	☐ Male ☐ Female ☐ Other		

Academic education	
(1) ☐ Without study	(5) ☐ Middle professional training (PT1, oficial industrial)
(2) ☐ Primary incomplete	(6) ☐ Higher professional training (PT2, maestría industrial master's degree)
(3) ☐ Graduate (primary, CSE)	(7) ☐ 1st cycle university studies (degree, certificate of advanced study …)
(4) ☐ High School (a level)	(8) ☐ 2nd and 3rd cycle university studies (bachelor's degree, Master's degree, Doctorate-PHD…)
(9) ☐ No response/Don't know	

ANEXO E. (Appendix E). Results of the responses to the survey.

DIMENSION	VARIABLE	ANSWER OPTIONS	ANSWER QUESTION	QUESTION	HIERARCHY
SUBSTRATUM	COLOUR	**YES**	**(64.9%)**	P.1	-
		NO	(22.10%)	P.2	-
		NR/DK	(3.9%)	P.3	-
		Black	**Not nice [20.0%]** Very unpleasant [12.9%] Not very unpleasant [14.3%] Pleasant [4.3%] Very nice [7.1%] NR/DK [41.4%]	P.1.A	0
		Brown	Not nice [14.3%] **Very unpleasant [20.0%]** Not very unpleasant [14.3%] Pleasant [7.1%] Very nice [4.3%] NR/DK [40.0%]	P.1.B	1
		Blonde	Not nice [-] Very unpleasant [-] Not very unpleasant [5.7%] Pleasant [20.0%] **Very nice [34.3%]** NR/DK [40.0%]	P.1.C	3
		White	Not nice [2.9%] Very unpleasant [-] Not very unpleasant [1.4%] Pleasant [2.9%] **Very nice [54.3%]** NR/DK [38.6%]	P.1.D	4
		Others	**NR/DK [88.3%]** YES (2.6) [red, multicolour] NO [9.1%]	P.1.E	-
	TEXTURE	Pebbles	(2.9%)	P.4	0
		Mixed	(4.3%)	P.4	2
		Sand	**(91.4%)**	P.4	4
VEGETATION	COLOUR	Brown	Not nice [10.0%] Very unpleasant [24.3%] **Not very unpleasant [28.6%]** Pleasant [10.0%] Very nice [4.3%] NR/DK [22.9%]	P.2	0
		Light green	Not nice [-%] Very unpleasant [-] Not very unpleasant [7.1%] Pleasant [31.4%] **Very nice [44.3%]** NR/DK [17.1%]	P.2	2
		Dark green	Not nice [2.9%] Very unpleasant [2.9%] Not very unpleasant [8.6%] Pleasant [18.6%] **Very nice [54.3%]** NR/DK [12.9%]	P.2	4
	PATTERN	Shrubs	4.3%	P.3	1
		No vegetation	11.4%	P.3	2
		Trees	38.6%	P.3	3
		Herbs	**44.3%**	P.3	4
SCENIC BACKGROUND	VIEWSHED SHAPE AND AREA	Small coves	10.0%	P.5	0
		Open and flat beach	32.9%	P.5	2
		Cove between cliffs	**55.7%**	P.5	4
	SLOPE	>30º	11.4%	P.6	0
		0-15º	28.6%	P.6	2
		15-30º	**55.7%**	P.6	4
	HORIZONTAL LINE	High-rise or mixed buildings	0%	P.7	0
		Single-family or semi-detached	5.7%	P.7	2
		Without buildings	**91.4%**	P.7	4
	COHERENCE	Dunes, equipment and buildings	2.9%	P.8	0
		Natural dunes	41.4%	P.8	2
		Dunes and equipment	**51.4%**	P.8	4

	ANSWER OPTIONS	ANSWER QUESTION	QUESTION
Dune types	**Stabilized dunes**	42.9%.	P.9
	Nebkhas or hummock dunes	20.0%	P.9
	Barchan dunes	35.7%	P.9
	NR/DK	1.4%	P.9
Landscape satisfaction	Insignificant	0%	P.10
	Nothing important	1.4%	P.10
	Less important	8.6%	P.10
	Important	**44.3%**	P.10
	Very important	42.9%	P.10
Attraction of the place	**YES**	**37.7%**	P.12
	NO	33.8%	P.12
	NR/DK	28.6%.	P.12

ANEXO F (Appendix F). Results of gross value of variables per unit.

		U1	U2	U3	U4	SU 1	SU 2	SU 3	SU 4	SU 5	SU 6	SU 7	SU 8	SU 9	SU 10	SU 11	SU 12	SU 13	SU 14	SU 15	SU 16	SU 17	SU 18	SU 19	SU 20
SUBSTRATUM (S)	**S-N**	4	4	4	1	1	1	1	4	3	3	3	3	3	3	4	4	3	1	4	4	1	4	1	4
	S-T	4	4	4	2	2	2	4	4	4	4	4	4	4	4	4	4	4	2	4	4	2	4	2	4
	S-ColS	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	S-ClS	0	0	0	0	4	4	4	4	4	4	4	4	4	4	0	4	4	0	0	0	0	0	0	4
	S-WtS	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	S-EPWB	0	0	0	0	4	4	4	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
	S-EPS	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean	2.3	1.6	2.3	2.3	2.7	3.3	3.0	3.4	2.7	2.7	3.3	2.7	2.7	2.7	2.3	2.9	2.7	1.6	2.3	2.3	1.6	2.3	1.6	2.9
	SD	2.1	1.8	2.1	2.1	1.7	1.3	1.7	1.5	1.9	1.9	1.5	1.9	1.9	1.9	2.1	2.0	1.9	1.8	2.1	2.1	1.8	2.1	1.8	2.0
COASTAL AREAS (AC)	**AC-WaT**	-	-	-	-	-	-	-	-	4	4	4	-	-	4	4	-	4	4	-	-	-	-	-	-
	AC-WCo	-	-	-	-	-	-	-	-	4	4	4	-	-	4	4	-	4	3	-	-	-	-	-	-
	AC-SlAn	-	-	-	-	-	-	-	-	4	4	4	-	-	4	4	-	4	4	-	-	-	-	-	-
	AC-MPW	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	-	1	1	-	-	-	-	-	-
	AC-PJell	-	-	-	-	-	-	-	-	2	2	2	-	-	2	2	-	2	2	-	-	-	-	-	-
	AC-F	-	-	-	-	-	-	-	-	4	4	4	-	-	4	4	-	4	4	-	-	-	-	-	-
	AC-T	-	-	-	-	-	-	-	-	4	4	4	-	-	4	4	-	4	4	-	-	-	-	-	-
	AC-O	-	-	-	-	-	-	-	-	4	4	4	-	-	4	4	-	4	4	-	-	-	-	-	-
	Mean	-	-	-	-	-	-	-	-	3.4	3.4	3.4	-	-	3.4	3.4	-	3.4	3.3	-	-	-	-	-	-
	SD	-	-	-	-	-	-	-	-	1.8	1.8	1.8	-	-	1.8	1.8	-	1.8	1.2	-	-	-	-	-	-
VEGETATION (V)	**V- VC**	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	4	1	2	2	1	1	1
	V-Cov	3	4	4	3	4	4	4	3	4	3	4	1	3	4	3	4	4	3	4	4	4	3	4	3
	V-Col	0	2	2	4	0	2	4	2	0	4	4	2	4	4	2	4	2	4	2	2	2	0	0	2
	V-P	4	4	3	1	1	4	1	1	1	1	1	1	1	1	1	4	4	1	4	4	1	4	1	1
	Mean	2.0	2.3	2.8	2.8	1.5	2.8	2.8	1.8	1.5	2.3	2.5	1.3	2.3	2.5	1.8	3.3	2.8	3.0	2.8	3.0	2.3	2.0	1.5	1.8
	SD	1.8	1.5	1.0	1.5	1.7	1.5	1.5	1.0	1.7	1.5	1.7	0.5	1.5	1.7	1.0	1.5	1.5	1.4	1.5	1.2	1.3	1.8	1.7	1.0
SCENIC BACKGROUND (SB)	**SB-BS**	-	-	-	-	-	-	-	-	0	4	4	-	-	4	4	-	0	2	-	-	-	-	-	-
	SB-BL	-	-	-	-	-	-	-	-	4	3	4	-	-	4	4	-	4	4	-	-	-	-	-	-
	SB-S	-	-	-	-	-	-	-	-	2	2	2	-	-	2	2	-	2	2	-	-	-	-	-	-
	SB-BW	-	-	-	-	-	-	-	-	4	4	3	-	-	3	4	-	4	4	-	-	-	-	-	-
	SB-RLSB	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	SB-EWB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SB-LIB	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB-HL	2	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	SB-KSH	4	-	4	4	3	-	3	4	3	4	4	4	-	4	4	4	4	4	4	4	4	4	4	4
	SB-NPe	0	4	4	4	0	0	0	0	2	0	0	0	4	2	4	4	4	4	4	4	4	4	4	0
	SB-V	1	1	1	1	1	1	1	1	4	2	1	1	3	1	1	4	1	1	1	1	2	4	1	1
	SB-VS	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SB-LD	0	2	2	2	0	0	0	0	4	0	0	0	2	4	2	2	2	2	2	2	2	2	2	0
	SB-C	0	2	2	2	0	0	0	0	4	0	0	0	2	4	2	2	2	2	2	2	2	2	2	0
	Mean	1.6	2.4	2.4	2.3	1.4	1.3	1.4	1.4	2.6	2.2	2.1	1.6	2.5	2.8	2.8	2.8	2.5	2.6	2.4	2.4	2.6	2.8	2.4	1.3
	SD	1.6	1.4	1.4	1.4	1.6	1.6	1.6	1.7	1.4	1.7	1.7	1.7	1.3	1.3	1.4	1.4	1.5	1.3	1.4	1.4	1.3	1.4	1.4	1.7

Anexo G. (Appendix G). Ruta patrimonial del litoral oriental de LPGC.

1. OBJETIVOS

El objetivo general de este proyecto ha sido “divulgar, recrear, recuperar y acercar hacia la población el patrimonio perdido, mediante propuestas, como una ruta interactiva y fomentar la investigación sobre los bienes patrimoniales”. Para ello, se ha planteado los siguientes objetivos específicos:

1. Identificar puntos de interés para la instalación de paneles informativos, según la importancia que tienen los hitos históricos que persisten en la actualidad, los accesos de los usuarios al paseo marítimo y el valor natural e histórico que tenían los elementos desaparecidos.

2. Desarrollar y diseñar los contenidos informativos de los paneles, por medio de la selección de los gráficos a utilizar (fotografías, dibujos, mapas o esquemas) y el resumen de la información.

3. Explorar las posibilidades de difusión por medios digitales, entre los que encontrarían las nuevas tecnologías de reconstrucción y visualización tridimensional mediante modelos 3D, gafas interactivas o rutas dinámicas descargadas en dispositivos móviles donde se muestren, de manera virtual, los tramos de costa y los bienes patrimoniales perdidos.

2. METODOLOGÍA

La elaboración de este trabajo se ha desarrollado a través de cuatro fases metodológicas (Fig. III). La primera fase se ha realizado a través de los resultados de esta

Tesis, publicadas en Pérez Hernández et al., 2020a y 2020c. Las otras tres son las que componen este trabajo.

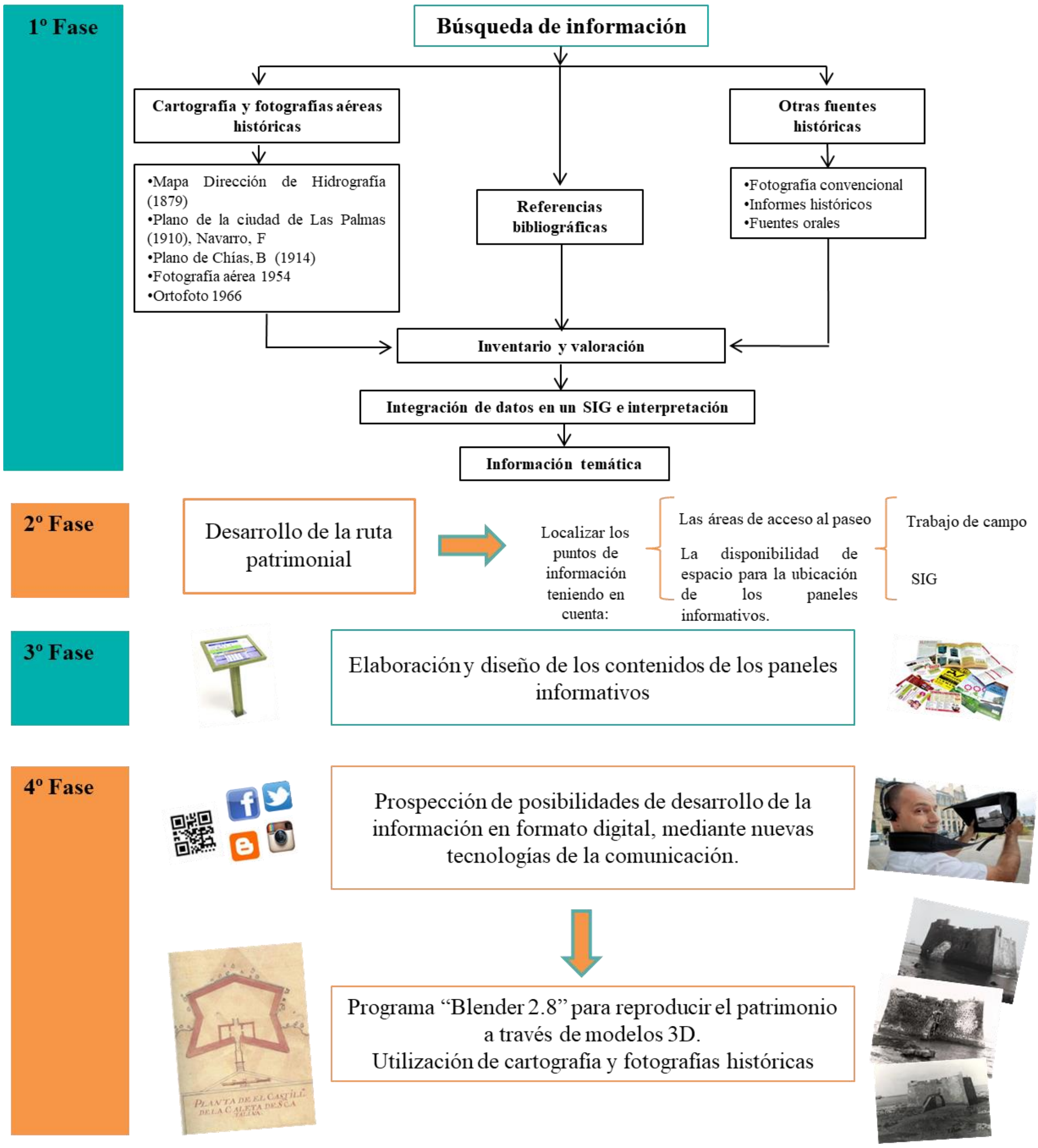


Figura III. Fuentes y metodología seguida en este trabajo. Imágenes y logos procedentes de Google imágenes.

En la segunda fase, se partió de la idea inicial de itinerario desarrollada en el TFM (Pérez-Hernández, 2015), a partir del cual, se definieron y reestructuraron los límites y el recorrido de la ruta patrimonial, y se procedió a localizar los puntos de información. Para ello se tuvo en cuenta distintos aspectos, como las áreas de acceso al paseo o disponibilidad de espacio para la ubicación de los paneles informativos. Esa comprobación se realizó a través de trabajo de campo. En la tercera fase se ha abordado el desarrollo de los contenidos de los paneles informativos, adaptando la información de las fichas de inventario a los puntos de información de la ruta. Además, se ha realizado el diseño de los paneles informativos. El diseño de los paneles consta de dos partes: una parte dedicada al patrimonio natural y otra para el cultural. En ellos se mostrarán la ubicación en el pasado y en la actualidad de los elementos patrimoniales de cada zona, sus características principales, su historia y toda aquella información que pueda ser de interés para la sociedad. Toda esta información se acompañará a través de mapas e imágenes. En paralelo a esta última fase, en la cuarta se ha prospectado las posibilidades de desarrollo de la información en formato digital, mediante nuevas tecnologías de la comunicación. Como demostración y verificación de estas herramientas, se ha utilizado el programa de modelado tridimensional y animación denominado “Blender 2.8” para reproducir el patrimonio (en este caso el castillo de Santa Catalina) a través de modelos 3D. Para su levantamiento se ha utilizado la planta del castillo de 1686 de Pedro Agustín del Castillo y tres fotografías convencionales de diferentes fechas (1890-1900; 1920, 1925) proporcionadas de la FEDAC (2019).

3. RESULTADOS

3.1.Ruta del patrimonio perdido del litoral oriental de Las Palmas de Gran Canaria.

3.1.1. Perfil del Usuario.

La ruta del patrimonio perdido del litoral oriental de Las Palmas de Gran Canaria se traza con fines turísticos, educativos y de ocio donde la población local fuera partícipe y, además, sea un complemento en la visita de los turistas a la ciudad. De esta manera, el perfil del usuario puede abarcar toda clase de edades desde niños hasta personas mayores.

Una de las cuestiones planteadas es el interés que puede tener estos elementos para los diferentes tipos de usuarios. Partiendo de la metodología empleada en Pérez-Hernández et al., (2020c) se ha observado como, en cuanto a la diferencia de grupos de edad (Fig. IV), los elementos tienen más valor Histórico – Cultural y Singularidad. Los mayores de 60 años han dado más valor a los elementos, pudiendo deberse a dos cuestiones 1) coinciden con que gran parte son Expertos Universitarios y 2) algunos de estos elementos pueden recordarlos o les hacen rememorar como fue su infancia y juventud y les dan más valor. Los encuestados entre 20 - 40 años destacan el valor Histórico – Cultural. En el estético y Social hay mayor diversidad de respuestas junto con el Científico que coinciden y es al que le dan menos valor (el máximo es medio 3). Mientras, los grupos de 41 – 50 años con los de 51 – 60 años muestran muchas similitudes ya que de forma general valoran a los elementos con niveles medios. Sin embargo, los primeros suelen dar mayor puntuación a algunos elementos como EP4, EP14 o EP20 entre otros.

3.1.2. Selección de los elementos de interés

Siguiendo la metodología de Pérez-Hernández et al., 2020b, se han identificado 61 elementos de interés siendo 30 los más representativos (Anexo G.1. [G.1.1; G.1.2; G.1.3; G.1.4])

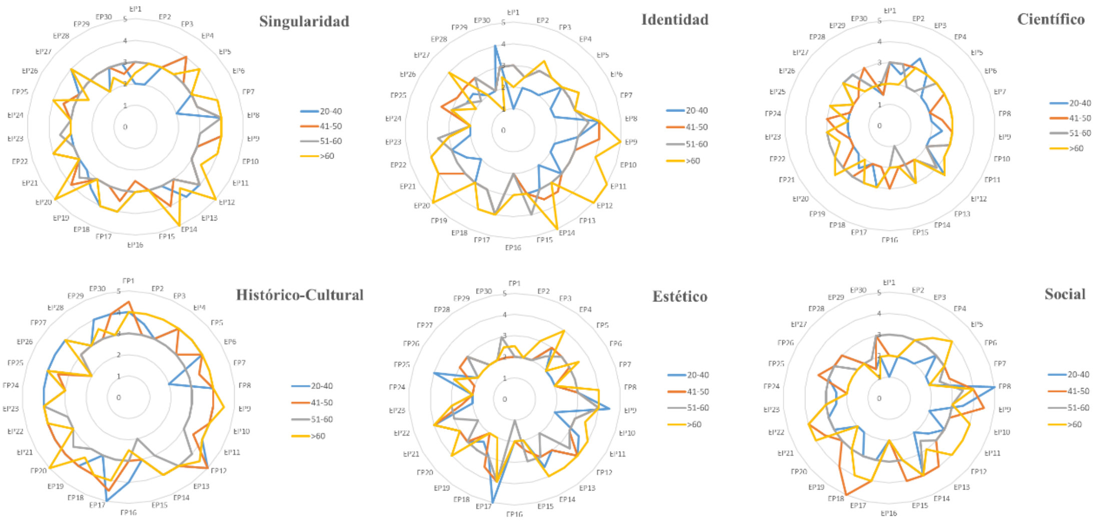


Figura IV. Representación de los valores intrínsecos según los grupos de edad de los encuestados (20-40; 41-50; 51-60; >60 años). Abreviaturas de los Valores Intrínsecos: (1) Valor Muy Bajo (2) Valor Bajo; (3) Valor Medio; (4) Valor Alto; (5) Valor Muy alto. Abreviaturas de los elementos patrimoniales: EP1. Batería de La Esfinge; EP2. Batería de San Fernando (Salvás); EP3. Estación sanitaria; EP4. Fábrica de hielo; EP5. Almacenes de carbón y muelle Cory & Brothers; EP6. Talleres, almacenes de carbón, muelle y Varadero de Grand Canary Coaling Company; EP7. Blandy Bross. Embarcadero y almacenes de carbón; EP8. Teatro Circo; EP9. Antiguo Club Náutico; EP10. Oficinas, almacenes de carbón y muelle de Woermann Linnie; EP11. Marquesina; EP12. Castillo de Santa Catalina; EP13. Casa de Pérez Galdós; EP14. Estación de tranvía; EP15. Caseta, balneario y muelle de Las Alcaravaneras; EP16. Casamata (nido de ametralladoras) de Las Alcaravaneras; EP17. Hotel Metropole; EP18. Pilar de agua; EP19. Almacenes, carpinterías e industrias molineras; EP20. Cubelo de Santa Ana; EP21. Muelle de Las Palmas (San Telmo); EP22. Pescadería La Lonja; EP23. Castillo de Santa Isabel; EP24. Casamata (nido de ametralladoras) de San Cristóbal; EP25. Ermita de San Cristóbal; EP26. Almacenes de la embotelladora del agua de San Roque; EP27. Caseta del Fielato; EP28. Fábrica de ladrillos de Correa; EP29. Casamata (nido de ametralladoras) de La Laja; EP30. Túnel de La Laja. Abreviaturas de los Valores Intrínsecos: (1) valor muy bajo (2) valor bajo; (3) valor medio; (4) valor alto; (5) valor muy alto.

3.1.3. Itinerario del patrimonio perdido.

La ruta patrimonial por el litoral oriental de LPGC tendría una longitud de 13,24 kilómetros con una duración de 6 horas. La ruta se ha dividido en cuatro tramos temáticos (tabla III) basados según las características de los elementos patrimoniales localizados en ellos. Ésta se ha trazado desde la playa de La Laja hasta el Castillo de la Luz mediante 14 paradas. Se puede empezar en ambos extremos o desde cualquier punto según los elementos que sean del interés de cada persona, al igual que las actividades complementarias que serían opcionales.

Tabla III. Características de los tramos de la ruta costera patrimonial (Pérez-Hernández, 2015).

	NOMBRE/TEMÁTICA DE LOS TRAMOS	LOCALIZACIÓN	LONGITUD (Km)	ACCESIBILIDAD
	TRAMO 1_BARRIO DE PESCADORES	Litoral sureste de la ciudad de Las Palmas de Gran Canaria	5,48	En vehículo por la GC-1 y caminando por el paseo marítimo desde San Cristóbal
	TRAMO 2_CASCO ANTIGUO	Litoral este de la ciudad de Las Palmas de Gran Canaria	2,21	Acceso caminando por el paseo marítimo desde San Cristóbal o por túneles que conectan la ciudad con la avenida (uno en el mercado de Vegueta y el otro en la estación de San Telmo)
	TRAMO 3_ CRECIMIENTO DE LA CIUDAD Y BARRIO DE LOS HOTELES (TURISMO DE SALUD)	Litoral este de la ciudad de Las Palmas de Gran Canaria	3,02	Acceso caminando por túneles que conectan la ciudad con la avenida (uno en la estación de San Telmo otro en el muelle deportivo) y a través de la calle Juan XXIII.
	TRAMO 4_EL PUERTO Y LOS CAMBULLONEROS	Litoral noreste de la ciudad de Las Palmas de Gran Canaria	2,53	Acceso en vehículo por la GC-1 y por las calles Eduardo Benot, López Socas y Poeta Agustín Millares Sall. Caminando a través del puente localizado delante del Club Náutico, por el parque Santa Catalina
	Temporalización: 6 h		TOTAL: 13,24	

Se trata de una ruta de dificultad baja, ya que el trayecto discurrirá por el paseo marítimo de la GC-1 y de la Avenida de Canarias y por las siguientes calles: Rafael Cabrera, Francisco Gourié, Muelle Las Palmas, Eduardo Benot, Poeta Agustín Millares Sall y Plaza de Ntra. Señora de La Luz. De este modo, el itinerario sería de fácil acceso puesto que se puede ir caminando sin ningún problema a todos los elementos patrimoniales; siendo el camino de forma continua, sin interrupciones y sin barreras (Pérez-Hernández, 2015). Se puede realizar en cualquier época del año, debido a las buenas condiciones climáticas que posee la ciudad de LPGC durante todo el año. No es necesario un equipamiento especializado para la realización del mismo, ya que al trayecto discurrirá por un paseo adoquinado y por calles asfaltadas. No obstante, si es recomendable llevar consigo al menos una botella de agua, un gorro, crema solar, paraguas (según las condiciones meteorológicas) durante el recorrido, ya que solo se podrá encontrar algún establecimiento de restauración en el barrio de San Cristóbal (tramo 1), Triana (tramo 2) y en el Puerto (tramo 4) y existen muy pocos puntos para resguardarse ante la lluvia o sol.

A continuación, se presentan las características de cada tramo temático:

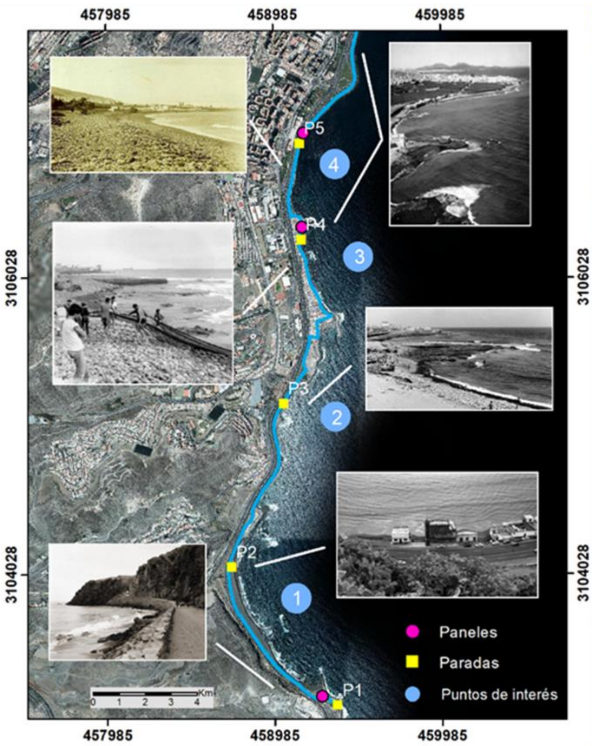
Tramo 1. Barrio de Pescadores

El tramo 1 (figura V) se encuentra enmarcado en el litoral sureste de la ciudad entre el mirador de La Laja y el Cementerio de Las Palmas. Este tramo se caracteriza por haberse dedicado principalmente a actividades pesqueras y agrarias. Por tanto, el patrimonio localizado en esta área estará vinculado a estas funciones.

Durante el recorrido, se podrá descubrir cómo era el patrimonio natural formado por diferentes playas de bolos, callaos y arena oscura localizados sobre una plataforma de abrasión rocosa. Así, in situ se podrá apreciar tres playas preservadas de este litoral como son La Laja (parada 1 [P.1]), Bajo de La Laja y San Cristóbal (P.4) y conocer las mareas desaparecidas (de sur a norte) de Aguadulce, La Cardosa (P.3) y Las Tenerías (P.5).

Además, se podrá conocer distintos elementos culturales que lo conformaban. De esta forma, al principio del itinerario, en la playa de La Laja (P.1 y P.2) se observará como existieron viviendas terreras, dos fábricas de ladrillos y pavimentos, la caseta del Fielato (oficina de recaudación de impuestos de productos) y el túnel de La Laja entre otros.

En la Cardosa (P.3), se podrá observar como esa zona no tenía un tramado urbano continuo, con viviendas de pescadores aisladas y, algunos almacenes relacionados con los cultivos, en paralelo a la carretera del Sur.



TRAMO I. BARRIO DE LOS PESCADORES			
Paradas: 5		Puntos de interés: 4	
P.1_Playa de La Laja (mirador Exordio del Tritón). P.2_Playa de La Laja (Torre del Viento). P.3_Playa de La Cardosa (Hoya la Plata) P.4_Playa de San Cristóbal (Torreón de San Pedro Mártir) P.5_Playa de Las Tenerías (Barrio de San José)		P.1_Playa de La Laja. P.2_Playa de La Cardosa (Hoya la Plata) P.3_Playa de San Cristóbal P.4_Playa de Las Tenerías	
Paneles: 3	Inicio:	Mirador de La Laja (Exordio del Tritón). [28.052056,-15.413753]	
Temporalización: 2 h	Fin:	Paseo marítimo a la altura del Cementerio de Las Palmas [28.094481,-15.412316]	
Elementos perdidos: 35	Naturales: 5	Culturales: 30	
	Las Tenerías Caleta de Arriba (San Cristóbal Playa de las Angustias (San Cristóbal) La Cardosa Aguadulce	Cultivos [3] Almacenes, talleres y equipamientos pesqueros [3] Viviendas [5] Carretera del Sur [2] Infraestructuras hidráulicas Casamata de San Cristóbal Ermita de San Cristóbal Almacenes del agua de San Roque	Factoría de Pescado Fábrica de Pavimentos de Farray Caseta del Fielato Fábrica de Ladrillos de Correa Casamata de La Laja Gasolinera Túnel de La Laja El Chinchorro [5] Curtido de piel
Elementos conservados: 6	Naturales: 3	Culturales: 3	
	Playa San Cristóbal Bajo de La Laja Playa de La Laja	Torreón de San Pedro Mártir Viviendas de San Cristóbal Torre del Viento (La Laja)	
Atractivos de apoyo	- 1 mirador con vistas a la ciudad. - Comenzar el recorrido paseando junto a la orilla - Ver el amanecer - Representaciones de actividades tradicionales como el chinchorro, vela latina, juegos etc. - Gastronomía - Sensaciones: Olor a mar		

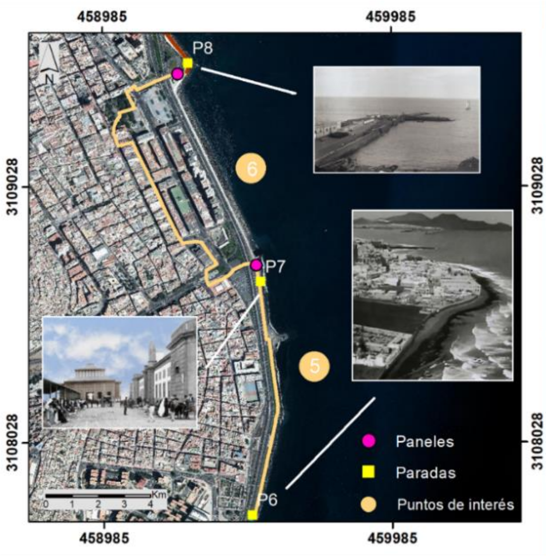
Figura V. Localización y características del tramo 1.

Más hacia el norte, nos encontraremos con los barrios de San Cristóbal y Las Tenerías compuestos por viviendas autoconstruidas con los materiales del entorno. El primero era un barrio prácticamente residencial, asociado principalmente al desarrollo de actividades pesqueras (P.4) como por ejemplo la práctica desaparecida del “chinchorro”. En este, también existieron, una factoría de pescado y una empaquetadora de tomates entre otros. San Cristóbal es el único barrio que subsiste en la actualidad con una morfología semejante a la original. Y en el segundo (P.5) se desarrollaron actividades industriales, como el curtido de piel o carpintería y En esta zona se extendía una gran vega fértil, denominada localmente como "la vega de San José" donde se practicaba la agricultura a nivel local y la Granja del Cabildo en los años cuarenta.

Tramo 2. Casco Antiguo

El tramo 2 (Figura VI) se encuentra enmarcado en el litoral oriental de la ciudad entre el Cementerio de Las Palmas y el parque San Telmo (c/ Muelle Las Palmas). Este tramo se caracteriza por ser el asentamiento original de la ciudad de Las Palmas (1478). Así, su frente litoral estará dedicado al uso residencial, edificios públicos y comercios con sus fachadas de espaldas al mar debido al poco prestigio que presentaba la costa con anterioridad al siglo XX. Por tanto, el patrimonio localizado en esta área estará vinculado a estas funciones.

Durante el recorrido, se podrá descubrir cómo era el patrimonio natural formado por diferentes playas de bolos, callaos y arena oscura localizados sobre una plataforma de abrasión rocosa. Así, podremos conocer las mareas desaparecidas de San Agustín (P.6) y Triana (P.7).



TRAMO II. CASCO ANTIGUO			
Paradas: 3		Puntos de interés: 2	
P.6_Castillo de Santa Isabel (Cementerio de Las Palmas) P.7_Mercado de Las Palmas (Desembocadura b. Guiniguada). P.8_Muelle de Las Palmas (Parque San Telmo).		P.5_Caleta de San Agustín P.6_Playa de Triana	
Paneles: 2	Inicio:	Paseo marítimo a la altura del Cementerio de Las Palmas [28.094481,-15.412316]	
Temporalización: 1:30 h	Fin:	Paseo marítimo a la altura del Parque San Telmo [28.110113,-15.414910].	
Elementos perdidos: 12	Naturales: 2	Culturales: 10	
	Playa de Triana Caleta de San Agustín	Cubelo de Santa Ana Muelle de San Telmo Viviendas [2] Almacenes, talleres y equipamientos pesqueros [2]	Pescadería La Lonja Carnicería, matadero etc Castillo de Santa Isabel Cultivos
Elementos conservados: 12	Naturales: 0	Culturales: 12	
	-	Casa de Don Bruno (Hotel Parque) Parque de San Telmo Ermita de San Telmo Calle La Marina Teatro Pérez Galdós Mercado de Vegueta Pescadería Municipal	Centro Parroquial San Agustín Palacio de la Justicia Colegio San Ignacio de Loyola Cementerio de Las Palmas Viviendas
Atractivos de apoyo	Visita castillo de Mata, Iglesia de San Telmo Gastronomía: Mercado de Vegueta		

Figura VI. Localización y características del tramo 2.

Además, se podrá conocer distintos elementos culturales que lo conformaban. De esta forma, al principio del itinerario, en la playa de San Agustín (P.6) se observará como existieron: el torreón de Santa Isabel (remate sur de la muralla de Las Palmas), viviendas y edificios públicos (muchos de ellos continúan en la actualidad) y junto a la desembocadura del barranco Guiniguada, equipamientos municipales de carnicería, mercado, pescadería y matadero. En Triana (P.7), contemplaremos el primer muelle de la ciudad (1811) junto al torreón de Santa Ana (en 1574) como remate de la muralla de Las

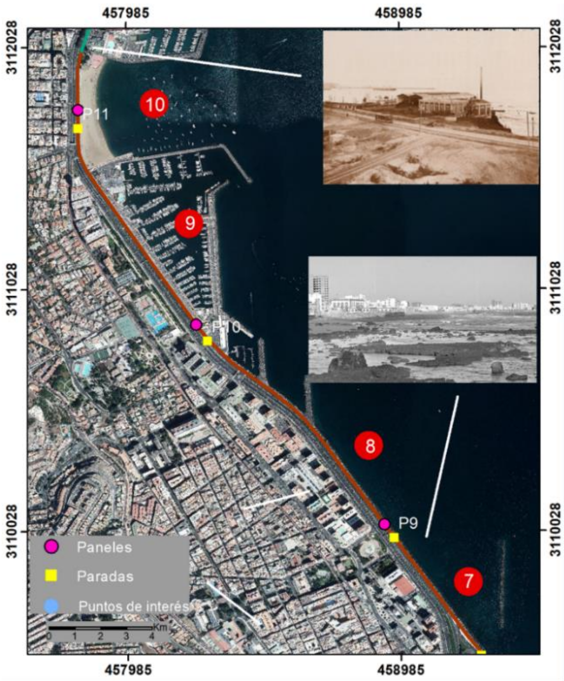
Palmas por el norte de la ciudad. Además, se observará como este litoral pasó de estar compuesto por carpinterías de ribera, almacenes y astilleros a finales del siglo XIX a ser un espacio recreativo formado por un borde residencial marítimo y un paseo a mediados del siglo XX.

Tramo 3. Crecimiento de la ciudad y barrio de los hoteles.

El tramo 3 (Figura VII) se encuentra enmarcado en el litoral oriental de la ciudad entre el parque San Telmo (c/ Muelle Las Palmas) y el Real Club Náutico. Este tramo se caracteriza por haberse dedicado por un lado a actividades industriales y de producción, a uso residencial y, por otro, a equipamientos turísticos. Por tanto, el patrimonio localizado en esta área es más diverso y estará vinculado a estas funciones.

Durante el recorrido, se podrá descubrir cómo era el patrimonio natural formado por diferentes playas de bolos, callaos y arena oscura localizados sobre una plataforma de abrasión rocosa. Así, podremos conocer las mareas desaparecidas de Venegas (P.6), El Caletón y Lugo (P.7) y donde podremos apreciar otra playa preservada de este litoral como es Las Alcaravaneras (Santa Catalina).

Además, se podrá conocer distintos elementos culturales que lo conformaban. De esta forma, al principio del itinerario, en las playas de Venegas y el Caletón (P.9) se observará como desde finales del siglo XIX, el litoral fue residencia de las clases obreras siendo ésta, una zona más productiva y de trabajo, cuyas edificaciones, en su mayor parte, fueron carpinterías, talleres, almacenes o pequeñas industrias alimenticias (destacando las industrias molineras). Además, en Venegas se ubicaron edificaciones con uso recreativo, sociales y periodísticos. Mientras, Lugo (P.10) fue, un barrio residencial y comercial de viviendas terreras.



<table>
<tr><th colspan="4">TRAMO III. CRECIMIENTO DE LA CIUDAD. BARRIO DE LOS HOTELES</th></tr>
<tr><th colspan="2">Paradas: 3</th><th colspan="2">Puntos de interés: 4</th></tr>
<tr><td colspan="2">P.9_Industrias molineras (Fuente Luminosa)
P.10_Hotel Santa Catalina (Enfrente al Club Natación Metropol)
P.11_Playa de Las Alcaravaneras</td><td colspan="2">P.7_Playa de Venegas (Bonita)
P.8_Playa del Caletón
P.9_Playa de Lugo
P.10_Playa de Las Alcaravaneras (Santa Catalina)</td></tr>
<tr><td>Paneles: 3</td><td>Inicio:</td><td colspan="2">Paseo marítimo a la altura del Parque San Telmo [28.110113,-15.414910].</td></tr>
<tr><td>Temporalización: 1 h</td><td>Fin:</td><td colspan="2">Paseo marítimo junto al Real Club Náutico [28.133111,-15.429561]</td></tr>
<tr><td rowspan="2">Elementos perdidos: 24</td><td>Naturales: 3</td><td colspan="2">Culturales: 21</td></tr>
<tr><td>Playa de Venegas (Bonita)
Playa del Caletón
Playa de Lugo</td><td>Castillo de Santa Catalina
Casa Pérez Galdós
Estación de tranvía
Viviendas [4]
Caseta, balneario y muelle de Las Alcaravaneras
Casamata de Las Alcaravaneras
Hotel Metropol
Campo de España</td><td>La Bodega
Pilar de agua [2]
Club el Marino
Periódico Eco de Canarias
Almacenes, carpinterías y molineras [2]
Heladería Los Alicantinos
Heladería La Moderna
El Chinchorro</td></tr>
<tr><td rowspan="2">Elementos conservados: 7</td><td>Naturales: 1</td><td colspan="2">Culturales: 6</td></tr>
<tr><td>Playa de Las Alcaravaneras</td><td>Viviendas
Club Inglés
Paseo Alonso Quesada</td><td>Colegio Salesianos
Hotel Santa Catalina
Comandancia Marina</td></tr>
<tr><td>Atractivos de apoyo</td><td colspan="3">Visitar el Hotel Santa Catalina y el muelle deportivo
Actividades o representaciones de vela latina u otras actividades acuáticas múltiples restaurantes, cafeterías ubicadas en torno al muelle.
“mirador del faro” en donde se ve una magnífica vista de la bahía y del litoral.</td></tr>
</table>

Figura VII. Localización y características del tramo 3.

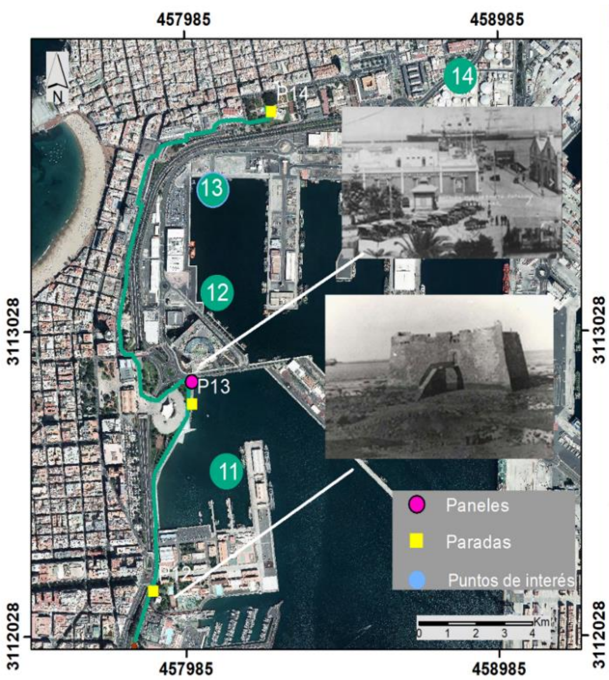
En la desaparecida playa de Santa Catalina (P.10) veremos cómo tras la creación del puerto del Refugio comienza el “despegue” de la ciudad en lo referente al comercio y empiezan a llegar los primeros turistas. La necesidad de acoger a los trabajadores de empresas extranjeras que trabajaban en la isla; a familiares de los aventureros británicos residentes en el continente africano y turistas atraídos por las propiedades climáticas para reponer su salud (enfermedades pulmonares y reumáticas) provocó que se concentraran en este espacio diversos hoteles y otras infraestructuras turísticas. Ya, en la actual playa de Las Alcaravaneras (P.11), veremos distintos equipamientos públicos que supusieron un gran cambio en la playa al incentivar su uso recreativo y también un nido de ametralladoras entre otros. Y para finalizar, en el sector norte de esta playa se localizaban a finales del siglo XIX el Castillo de Santa Catalina y una estación del tranvía eléctrico.

Tramo 4. El Puerto y los Cambulloneros

El tramo 4 (Figura VIII) se encuentra enmarcado en el litoral noreste de la ciudad entre el Real Club Náutico y el Castillo de La Luz. Este tramo se caracteriza por haberse dedicado principalmente a actividades pesqueras y portuarias. Por tanto, el patrimonio localizado en esta área estará vinculado a estas funciones.

Durante el recorrido, se podrá descubrir cómo era el patrimonio natural formado por diferentes playas. Así, podremos conocer las mareas desaparecidas del Refugio, La Luz y el Sebadal (P.7). Además, se podrá descubrir distintos elementos culturales que lo conformaban. De esta forma, durante el paseo se observará como a mediados del siglo XIX, esta zona se encontraba prácticamente deshabitada y con la terminación de la carretera de Las Palmas al Puerto (1881) y el comienzo de las obras del Puerto del Refugio (1883) empezó a poblarse. Así, en este tramo y especialmente en el Refugio (P.13) se establecieron, equipamientos orientados a las actividades que el Puerto demandaba como numerosas empresas carboneras, de reparación naval y consignación de buques que en su mayor parte pertenecían a compañías extranjeras (Elder, Miller, Grand Canary Coaling, Cory Brothers, Wilson, Blandy Brothers y Woermann). Asimismo, fue importante el trueque que tuvo lugar en esta zona entre la población local y las tripulaciones de los barcos (práctica conocida en la isla como cambullón).

Y para finalizar la ruta, desde el castillo de La Luz (P.14) se contemplará como el Sebadal pasó de ser aprovechado por pescadores de ribera y marineros, a zona de militares y, en la actualidad, a empresas portuarias, depósitos de gasolina y gasoil y naves industriales.



TRAMO IV. EL PUERTO Y LOS CAMBULLONEROS			
Paradas: 3		**Puntos de interés: 4**	
P.12_Castillo de Santa Catalina (Base Naval) P.13_Plaza de Canarias P.14_Castillo de La Luz		P.11_El Puerto P.12_Playa del Refugio P.13_Playa de La Luz P.14_Playa del Sebadal	
Paneles: 1	**Inicio:**	Paseo marítimo junto al Real Club Náutico [28.133111,-15.429561]	
Temporalización: 1:30	**Fin:**	Castillo de La Luz [28.148527,-15.424792	
Elementos perdidos: 30	**Naturales: 3**	**Culturales: 27**	
	Playa del Refugio Playa de La Luz Playa del Sebadal	Batería La Esfinge Batería de San Fernando (Salvás) Pabellones de ingenieros Cuartel de artillería Depósitos y almacenes de carbón Las Palmas Coaling. C Estación sanitaria Fábrica de Hielo Almacenes de carbón y muelle Cory & Brothers [2] Talleres, almacenes de carbón, muelle y varadero Grand Canary Coaling C Varadero para embarcaciones menores Blandy Bross. Embarcadero y almacenes de carbón Talleres de Blandy Brothers & Cº Varadero de Miller & Cº	Almacenes, talleres y equipamientos pesqueros Teatro Circo Astilleros y varaderos Oficinas almacenes de carbón y muelle de Woermann Linnie Muelle de Elders & Fyffe Ltd Sanapú Almacenes y muelle de Elder Dempster & Cº Antiguo Club Náutico Marquesina Gota de leche Cuartel de Aviación Almacenes de carbón y dique para embarcaciones menores Wilson Sons & Cº Ltd Cambullón
Elementos conservados: 11	**Naturales: 0**	**Culturales: 11**	
	-	Muelle de abrigo Juntas obras del Puerto Castillo La Luz Ermita La Luz Mercado del Puerto Muelle Santa Catalina	Edificio Miller Edificio Elder Carretera del Puerto Almacenes Cory Brothers Base Naval (Muelle frutero)
Atractivos de apoyo:	Mirador hotel AC con vistas a la ciudad. Gastronomía en el Mercado del Puerto Visitas al museo Elder, Miller, Iglesia y Castillo de la Luz		

Figura VIII. Localización y características del tramo 4.

3.1.4. Elaboración y diseño de los contenidos de los paneles informativos.

El itinerario patrimonial estaría vinculado y apoyado con nueve paneles informativos (Anexo G.2. [G.2.1; G.2.2; G.2.3; G.2.3; G.2.4; G.2.5; G.2.6; G.2.7; G.2.8; G.2.9]), folletos informativos (Apéndice G.3.) y representaciones o explicaciones de actividades tradicionales como el chinchorro en San Cristóbal y el curtido de piel en las Tenerías (actualmente la Vega de San José) por medio de la población local etc.

3.1.5. Prospección de posibilidades de desarrollo de la información en formato digital, mediante nuevas tecnologías de la comunicación u otros.

Como ya se ha ido observado durante esta investigación, las zonas costeras estudiadas constaban de un valor patrimonial natural, cultural y paisajístico, muy importante. A pesar de que esté de moda reproducir elementos patrimoniales, que por diferentes motivos fueron destruidos, sería imposible recuperar, todo ese patrimonio, sobre todo el natural.

En los últimos años, las nuevas tecnologías han tenido un papel primordial dándole otra visión al patrimonio mejorando la divulgación y promoción de los elementos patrimoniales perdidos a través de modelos 3D, realidad virtual etc. Este tipo de tecnologías se viene aplicando desde hace unos cuantos años en algunos países, como en Francia, o también en algunas ciudades españolas, como Sevilla o Barcelona (Pérez-Hernández, 2015).

Por ello, es conveniente que esta ruta estuviera ligada a las nuevas tecnologías de reconstrucción y visualización tridimensional mediante modelos 3D, gafas interactivas o rutas dinámicas descargadas en los dispositivos móviles donde se muestre el litoral de antes y los bienes patrimoniales perdidos de manera virtual. Como ejemplo, se presenta un boceto de un modelo 3D (Figura IX) del Castillo de Santa Catalina (Tramo 4).

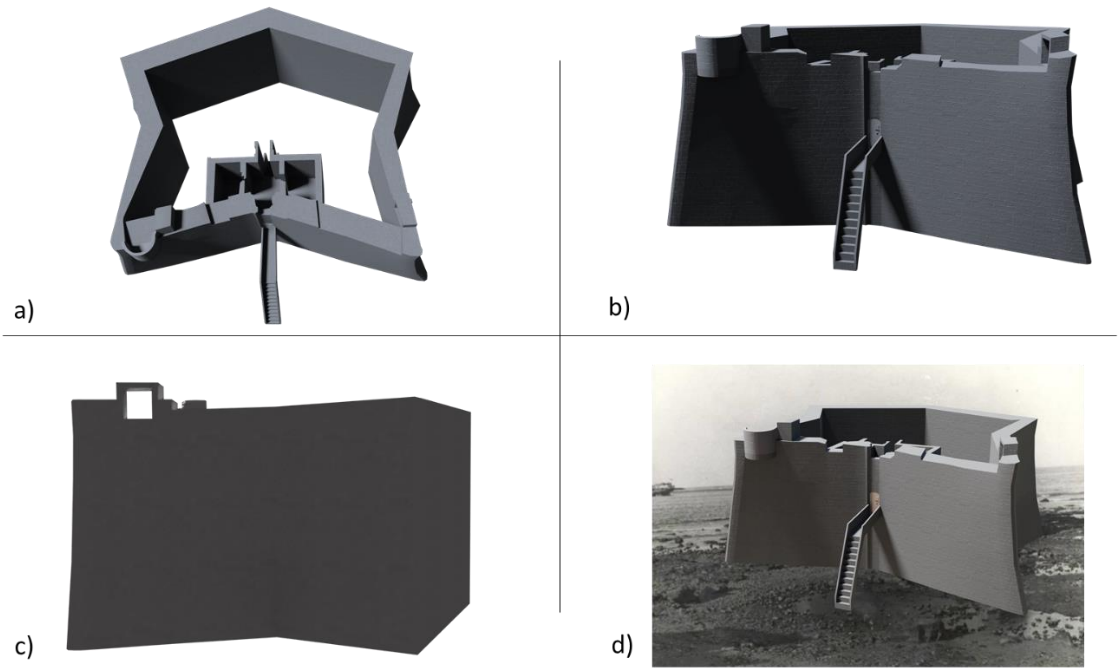


Figura IX. Boceto de modelo 3D del castillo de Santa Catalina. a) vista de la planta; b) vista frontal; c) vista lateral del castillo; d) montaje modelo 3D con fotografía de la playa de Santa Catalina.

3.1.6. Aportación favorable a la comunidad.

La necesidad de crear un itinerario turístico es importante como herramienta para la recopilación, recuperación, divulgación de todos los elementos patrimoniales. De este modo, es un trabajo abierto en el que se podrían incorporar nuevos datos y materiales de apoyo, enriqueciéndose continuamente con esas nuevas aportaciones.

Los resultados de esta iniciativa no sólo permitirían recrear, recuperar, conocer y acercar hacia la población local el patrimonio histórico, cultural y natural de este entorno de la ciudad (siendo un conocimiento escaso en la actualidad) sino, además, incrementaría la apreciación y sensibilización hacia los valores patrimoniales por parte de la sociedad.

Asimismo, aportaría promoción turística, como oferta complementaria y original al turista que viene a pasar unos días a la ciudad puesto que podría incentivar actividades turísticas sobre el patrimonio perdido (Pérez-Hernández, 2015). En los últimos años, la actividad turística en la ciudad ha aumentado considerablemente. Los turistas buscan conocer los lugares emblemáticos, las actividades de ocio, la gastronomía y la oferta cultural (museos, lugares de interés histórico, etc). Además, los visitantes demandan mapas de la ciudad y folletos informativos sobre rutas o excursiones que se pueden completar en la ciudad o en la Isla. De esta forma, se impulsaría, por un lado, la difusión del patrimonio desde otro punto de vista y la demanda y el interés de los visitantes.

Por último, la iniciativa permitiría aportar amabilidad al contacto entre la ciudad y el mar, en un enclave peatonal, muy utilizado por viandantes y deportistas, pero constreñido a un estrecho paseo entre la vía motorizada y el mar. El hecho de aportar amabilidad a este enclave, por medio de la cultura, no sólo tiene interés turístico, sino también para la educación de la ciudadanía, pudiéndose incentivar otras iniciativas complementarias, como punto de reunión de los mayores para enseñar a los jóvenes la historia de nuestra ciudad. También se podrían realizar representaciones de actividades tradicionales como el chinchorro en San Cristóbal y el cultivo de piel en las Tenerías (actualmente la Vega de San José) etc. Estas gestiones, permitiría de nuevo la unificación de la ciudad y el mar puesto que desde la creación de la avenida marítima se encuentran distanciados y las conexiones son mínimas. Además, conectaría las actividades desarrolladas en este litoral con la memoria histórica de ese espacio atrayendo así, a un público diverso (Pérez-Hernández, 2015).

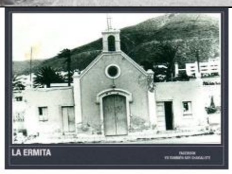
Anexo G.1. Elementos patrimoniales destacados que fueron seleccionados para la ruta patrimonial

G.1.1. Elementos patrimoniales de tipo militar.

	Patrimonio Militar	
Batería de La Esfinge		La batería de La Esfinge se comenzó a construir en 1914, con el fin de vigilar, defender y proteger el litoral de posibles ataques por mar. Presentaba originariamente 6 cañones Munaiz-Arguelles de 150 mm y modelo 1903, configuración que mantuvo hasta después de finalizar la Guerra Civil Española. Además, disponía de buenas instalaciones para personal, repuestos y depósitos de municiones, talleres de reparación de vainas y confección de cargas (Medina, 1996).
Batería San Fernando (Salvás)		La Batería de San Fernando se comenzó a construir en 1899 según el proyecto de los ingenieros militares D. Francisco Lapierre y D. Antonio de la Rivera como apoyo a otra batería con la misma denominación (denominada desde 1903 Salvás de la Plaza) que fue construida en 1742 y se encontraba en esa época en estado ruinoso. Se caracterizaba por presentar 4 cañones H. E. de 254 mm. Ordóñez, de planta semicircular con el fin de vigilar, defender y proteger el litoral de esta zona durante las Guerras Mundiales y la Guerra Civil Española (Medina, 1996).
Castillo Santa Catalina		El Castillo de Santa Catalina estaba situado en la costa este de la ciudad de Las Palmas de Gran Canaria. Fue diseñado por el ingeniero militar Próspero Cazorla con la intención de reforzar y apoyar al Castillo de la Luz. Era una fortaleza abaluartada con entrada a media altura por medio de una escalera con puente levadizo. Presentaba cañoneras en su parte superior. Era de fábrica de sillería en el zócalo y en las esquinas; el resto de mampostería. Los ángulos de las esquinas hacían curvatura para repeler mejor los impactos de la artillería. El castillo se alzaba sobre un arrecife que durante la bajamar quedaba al descubierto y permitía llegar hasta él caminando. Desapareció por la construcción de la actual Base Naval (años 40) (Sanabria, 1996; Pérez, 2010).
Nido de ametralladoras de Las Alcaravaneras		Este nido de ametralladoras se encontraba al sur de la playa de Las Alcaravaneras. Fue construido durante la Segunda Guerra Mundial (1943) como defensa de la franja costera de Gran Canaria ante un hipotético ataque por parte de Gran Bretaña o EE. UU. Se caracterizaba por ser un nido de dos frentes con fusil ametrallador y construido con materiales de la propia costa o de lugares cercanos, como callaos, arena etc.
Cubelo de Santa Ana		El Cubelo de Santa Ana se concibió en 1554 como remate de la Muralla de Las Palmas por el norte de la ciudad (Pérez, 2010).
Castillo de Santa Isabel		El castillo de Santa Isabel correspondía al fuerte sur de la muralla, que protegía la ciudad en la costa (Pérez, 2010).
Nido de ametralladora de San Cristóbal		Este nido de ametralladoras se encontraba junto al Castillo de San Cristóbal. Fue construido durante la Segunda Guerra Mundial (1943) como defensa de la franja costera de Gran Canaria ante un hipotético ataque por parte de Gran Bretaña o EE. UU. Se caracterizaba por ser un nido de dos frentes y construido con materiales de la propia costa o de lugares cercanos, como callaos, arena etc.
Nido de ametrallador a de La Laja		Este nido de ametralladoras se encontraba en la playa de La Laja. Fue construido durante la Segunda Guerra Mundial (1943) como defensa de la franja costera de Gran Canaria ante un hipotético ataque por parte de Gran Bretaña o EE.UU. Se caracterizaba por ser un nido de un frente y construido con materiales de la propia costa o de lugares cercanos, como callaos, arena etc.

* Fotografías adquiridas de las páginas del Facebook "Recuerdos de Gran Canaria" (2019); "Las Palmas Ayer y Hoy" (2019) y la FEDAC (2019).

G.1.2. Elementos patrimoniales de tipo Comercial y de servicios.

Patrimonio comercial y de servicios		
Estación sanitaria		La Estación Sanitaria fue construida entre 1900 y 1905 por Laureano Arroyo, junto al muelle de abrigo (concretamente en su lado izquierdo). Era un organismo independiente en el examen de la carta de salud de los buques arribados a puerto. El servicio estaba compuesto por un reducido grupo de personas, aptas para el ejercicio médico y preventivo, como un inspector, un médico, un celador y algún administrativo. Tuvo un papel importante, necesario y decisivo en el desarrollo social y económico marítimo de la isla al mantener una correcta higiene del puerto y la ciudad libre de preocupaciones externas (Martín-Castillo, 1997)
Teatro Circo		El Teatro Circo del Puerto de La Luz fue fundado en 1916 por un colectivo cultural denominado "Primero de Mayo" que realizaban obras de teatro y recitales en viviendas y en la calle. Este espacio se convirtió en una nueva empresa de Cinematógrafo. El nuevo espacio cultural se denominó de esta manera debido a que entre obra y obra teatral o mientras cambiaban las bobinas de las películas, ofrecían espectáculos circenses. Con el tiempo, pasó a llamarse Teatro Cine y posteriormente, cine viejo. En 1987 se cerró el teatro (López, 2016; Cabildo de Gran Canaria, 2015).
Antiguo Club Náutico		El Antiguo Club Náutico fue construido en 1908 con un estilo post-romántico, sobre pilares en el mar. Desde su inauguración se convirtió en la puerta de entrada a la isla, donde se recibieron y agasajaron a todas las personalidades que la visitaron. El Club se constituyó en una entidad defensora del Puerto en múltiples proyectos y, en especial, en la creación de la Estación Radiotelegráfica del Puerto de la Luz y del Instituto General Técnico (Valcarce, 2013)
Casa de Pérez Galdós		Vivienda residencial de la familia de D. Benito Pérez Galdós. Desapareció por la construcción la actual Base Naval (en los años 40).
Caseta, balneario y muelle de Las Alcaravaneras	 	A mediados del siglo XX se construyó, en el interior de la playa de Las Alcaravaneras, un balneario junto al paseo marítimo, así como un bar-restaurante. También existió un chiringuito en el centro de esta y un pequeño muelle desde donde salían los botes. Estos equipamientos públicos constituyeron un gran cambio en la playa, incentivando el uso recreativo.
Hotel Metropole	 	El Hotel Metropole se construyó en 1889 por Laureano Arroyo. En un principio, su finalidad fue una casa de recreo, pero posteriormente se convirtió en hotel, debido a la afluencia de personas que en esa época llegaban a la isla. El edificio presentaba una arquitectura tradicional colonial, formado por tres pisos con dos torres cuadradas en la que ambas fachadas contaban con ventanales y balcones. Desde su construcción, el hotel Metropole ha estado expuesto a sucesivas reformas, restauraciones y ampliaciones. Entre sus ilustres huéspedes destacan la famosa escritora Agatha Christie, que se hospedó en él en los años veinte. En los años cuarenta, el Ayuntamiento adquiere el hotel y lo reconstruye. En la actualidad su arquitectura nada tiene que ver con el estilo y planos originales. En él se encuentran las oficinas municipales (González, 2009).
Pescadería La Lonja		La Pescadería La Lonja se localizaba en la desembocadura del barranco Guiniguada. Construida en 1876 por el arquitecto José A. López Echegarreta, fue la primera pescadería pública que ofreció condiciones higiénicas para la venta del pescado (ya que las existentes hasta ese momento en la ciudad no presentaban tales requisitos). La pescadería estuvo prestando servicio hasta los años sesenta del siglo XX, cuando fue demolida por la construcción de la avenida marítima y la carretera del centro (Martín, 2001)
Ermita San Cristóbal		Esta ermita se localizaba en San Cristóbal. Algunos autores sitúan su construcción hacia 1580, aunque en algunos documentos se menciona que ya existía en 1559. Esta primera ermita se encontraba orientada de este a oeste, siguiendo la tradición cristiana. La ermita fue derruida sobre los años cincuenta del siglo XX debido a la construcción de la autopista del sur (Pérez, 2010).

* Fotografías adquiridas de las páginas del Facebook "Recuerdos de Gran Canaria" (2019); "Las Palmas Ayer y Hoy" (2019) y la FEDAC (2019).

G.1.3. Elementos patrimoniales de tipo industrial

Patrimonio industrial		
Fábrica de Hielo		La Fábrica de Hielo se construyó en 1948 por los empresarios Lloret y Linares. Se edificó por la alta demanda de hielo para conservar el pescado recién capturado de finales de los años 40 y principios de los 50 del siglo XX. El inmueble de planta rectangular y de grandes dimensiones, presenta una entrada que forma un vano de cantería con puerta metálica, rematado en su parte superior por un frontón triangular. En el interior encontramos varias naves con techos a dos aguas y un gran patio. La fábrica estuvo en activo hasta 1982 y se convirtió en almacén y oficinas. Finalmente, en 2017 fue destruida para convertirse en un centro de día para personas sin hogar (Coronet, 2015)
Almacenes de carbón y muelle Cory & Brothers		Tras la construcción del Puerto de Refugio, en 1883, se establecieron en esta zona equipamientos orientados a las actividades que el Puerto demandaba, como numerosas empresas carboneras, de reparación naval y consignación de buques que en su mayor parte pertenecían a compañías extranjeras. Cory Brothers era una de estas empresas. Fue la mayor compañía exportadora de carbón del sur de Gales. En Gran Canaria se inicia en el negocio en 1904. Poseía minas en Cardiff, desde donde traían el carbón que alimentaba a los buques del Almirantazgos en varios puertos del Atlántico (Quintana, 1983; Herrera, 1984)
Talleres, almacenes de carbón, muelle y varadero Grand Canary Coaling Company' s		Tras la construcción del Puerto de Refugio, en 1883, se establecieron en esta zona, equipamientos orientados a las actividades que el Puerto demandaba, como numerosas empresas carboneras, de reparación naval y consignación de buques que en su mayor parte pertenecían a compañías extranjeras. Grand Canary Coaling Cº era una de ellas. Esta se estableció desde 1884 en el Puerto de Las Palmas. Empleaba la estrategia de diversificar actividades como el poseer su propio varadero o astillero, así como los servicios de falúas (Quintana, 1983; Herrera, 1984).
Blandy Bros. Embarcadero y almacenes de carbón		Tras la construcción del Puerto de Refugio, en 1883, se establecieron en esta zona, equipamientos orientados a las actividades que el Puerto demandaba, como numerosas empresas carboneras, de reparación naval y consignación de buques que en su mayor parte pertenecían a compañías extranjeras. Blandy obtiene su concesión en el puerto de Las Palmas en 1885 y contribuyó mucho en el desarrollo del abastecimiento de carbón y embarque de frutos (Quintana, 1983; Herrera, 1984).
Oficinas, almacenes de carbón y muelle de Woermann Linie		Tras la construcción del Puerto de Refugio, en 1883, se establecieron en esta zona, equipamientos orientados a las actividades que el Puerto demandaba, como numerosas empresas carboneras, de reparación naval y consignación de buques que en su mayor parte pertenecían a compañías extranjeras, como Woermann Linie. Se estableció en 1906 y fue la única empresa carbonera que estaba fuera de la conexión inglesa. Su casa matriz en Hamburgo, estuvo fuertemente apoyada por el Reichstag en su política de penetración en África (Quintana, 1983; Herrera, 1984).
Almacenes, carpinterías e industrias molineras	 	Las industrias molineras estaban integradas en edificios o viviendas ya construidos. Las instalaciones de molinos eólicos y mecánicos (accionados por motores de gas, vapor o aceite crudo), con sus ruedas de paletas o aspas ubicados sobre las azoteas de las viviendas o de los locales, constituían la molturación del grano, sobre todo maíz, para la elaboración de harina panificable y gofio que abasteció a gran parte de la población local. Estas pequeñas instalaciones desaparecieron por las importaciones de productos desde Europa, que tenían precios más económicos que los que se producían aquí, la inexistencia de espíritu industrial y la creación de grandes fábricas (Florido, 1998)
Almacenes de la embotelladora del agua de San Roque		El almacén del agua San Roque se encontraba en el barrio de San Cristóbal. El agua mineral carbónica y natural de San Roque tenía diferentes almacenes repartidos en la isla, siendo éste de San Roque el destinado a la distribución en la ciudad. La fábrica cerró a finales de los noventa. El inmueble desapareció en 2017, quedando actualmente un solar con función de aparcamientos (García, 2011)
Fábrica de ladrillos de Correa		La fábrica de ladrillos de Correa se localizaba en la playa de Laja. Esta hacía extracciones en la ladera para hacer gravas de diferentes tamaños y utilizarlos como áridos de hormigón y fabricación de ladrillos y bloques. La fábrica desapareció en los años setenta por la ampliación de la autopista (Doreste, 2014).

* Fotografías adquiridas de las páginas del Facebook "Recuerdos de Gran Canaria" (2019); "Las Palmas Ayer y Hoy" (2019) y la FEDAC (2019).

G.1.4. Elementos patrimoniales de infraestructuras públicas.

Patrimonio de infraestructuras públicas		
Marquesina		La marquesina, construida en 1915 por Jaime Ramón Ramonell, se encontraba sobre el muelle de Santa Catalina. Tenía doce metros de largo por ocho de ancho y contaba con una escalera. La marquesina tenía como función resguardar a las personas ante la espera de las falúas (barco pequeño que llevaba a la gente de los barcos grandes a la marquesina y viceversa). Fue derruida en 1965 con motivo de la ampliación y modernización de las instalaciones portuarias (González, 2009)
Estación de tranvía		La estación del tranvía se localizaba al norte de la playa de Las Alcaravaneras. Se construyó en 1890 por la necesidad de enlazar la ciudad con el Puerto. De esta forma, el tranvía (al principio de vapor y después eléctrico) recorría los 7 kilómetros de la carretera que unía ambas zonas. En la estación se instalaron los carriles, paradas intermedias para recoger y dejar a los pasajeros y la carga. El tranvía estuvo en servicio hasta principios de 1937, en que se canceló la concesión por la escasez de energía eléctrica derivada de la Guerra Civil, siendo sustituido por las Jardineras Guaguas. En la época de escasez de combustibles y repuestos provocada por la Segunda Guerra Mundial, a partir de 1940, las Autoridades reactivaron el servicio del tranvía (conocido como "La Pepa"), desapareciendo de forma definitiva en la década de los sesenta (Medina, 1996).
Pilar de agua		En las Palmas de Gran Canaria el abastecimiento de agua directo a las viviendas no se instaló hasta la primera década del siglo XX. Antes de esa fecha era necesario ir a buscarla a fuentes y pilares, como el que estaba localizado en la calle Venegas junto a la Comandancia de Marina (Plaza de la Feria). Un buen número de mujeres y niños se dedicaban a transportar agua (en barriles sobre mulas o sobre sus cabezas) desde las fuentes públicas a la mayoría de las casas particulares. Únicamente las familias de mayores recursos económicos, con casa en Vegueta y Triana, disponían de pozos de escasa profundidad (Arroyo et al., 2008)
Muelle de Las Palmas		El muelle de Las Palmas, construido en 1811 según un proyecto del ingeniero León y Castillo, se ubicaba al norte del actual parque de San Telmo. Fue el primer muelle de la ciudad. Su exposición a constantes rachas de viento y fuerte oleaje originaban destrozos y su inutilización. Por esta razón, así como por la insuficiente asignación económica para nuevas obras, propiciaron la construcción del muelle de La Luz, quedando inutilizado el de Las Palmas para las faenas portuarias. El viejo muelle quedó a la merced del embate marino, usándose a mediados del siglo XX de manera recreativa (paseos, juegos etc.). Desapareció definitivamente en la década de los años sesenta por el ensanche de "Ciudad del Mar" (Martín, 1983).
Casa del Fielato		La casa del Fielato era una oficina de recaudación en donde se cobraban los impuestos por la entrada de productos de consumo para su venta en la ciudad. Aparte de su función recaudatoria, servía para ejercer un cierto control sanitario sobre los alimentos que entraba en la ciudad (Doreste, 2014).
Túnel de La Laja		El túnel de La Laja se ubicaba al sur de la playa. Este túnel de piedra, con una longitud de 111 metros, 4,5 metros de alto y 5 de ancho, era el único acceso de los habitantes del norte de la isla hacia el sur. Desapareció en los años setenta por la ampliación de la autopista (Doreste, 2014).

* Fotografías adquiridas de las páginas del Facebook "Recuerdos de Gran Canaria" (2019); "Las Palmas Ayer y Hoy" (2019) y la FEDAC (2019).

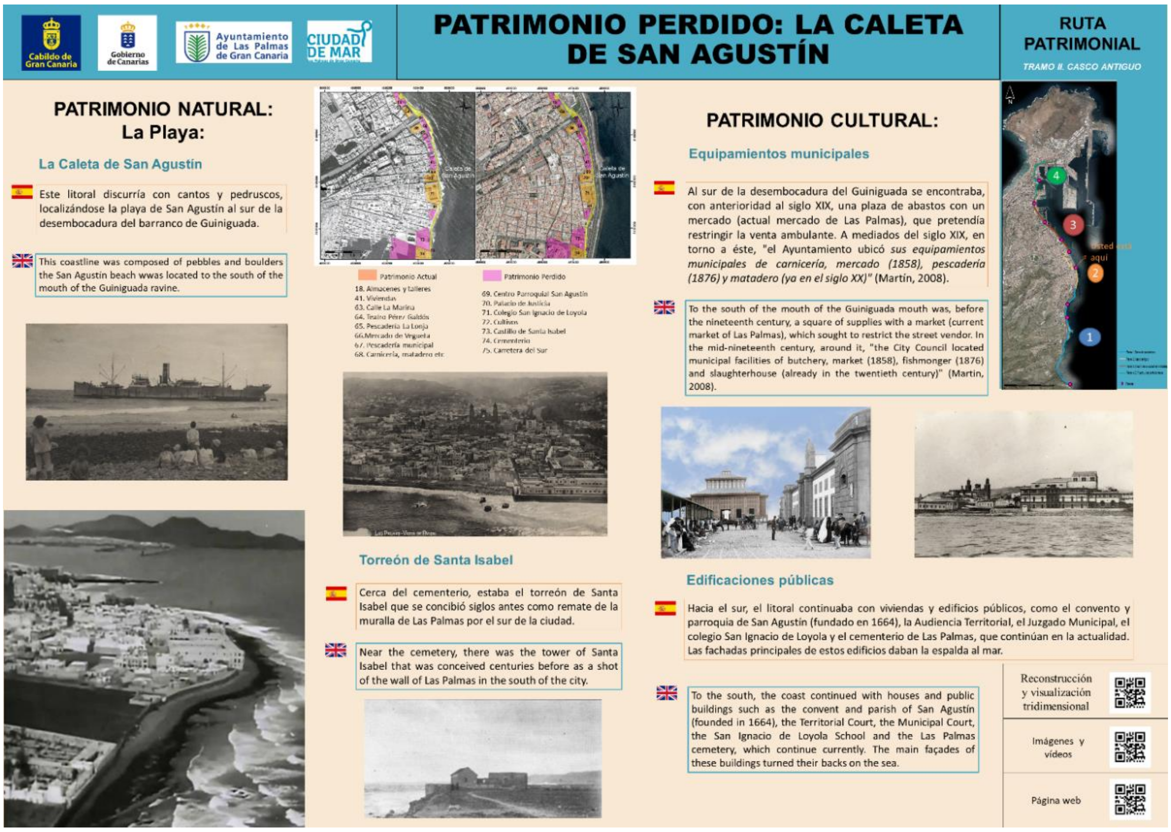
Anexo G.2. Paneles informativos

G.2.1. Panel 1. La Laja

G.2.2. Panel 2. San Cristóbal

G.2.3. Panel 3. Las Tenerías

G.2.4. Panel 4. La Caleta de San Agustín



G.2.5. Panel 5. Triana

G.2.6. Panel 6. El Caletón y Venegas

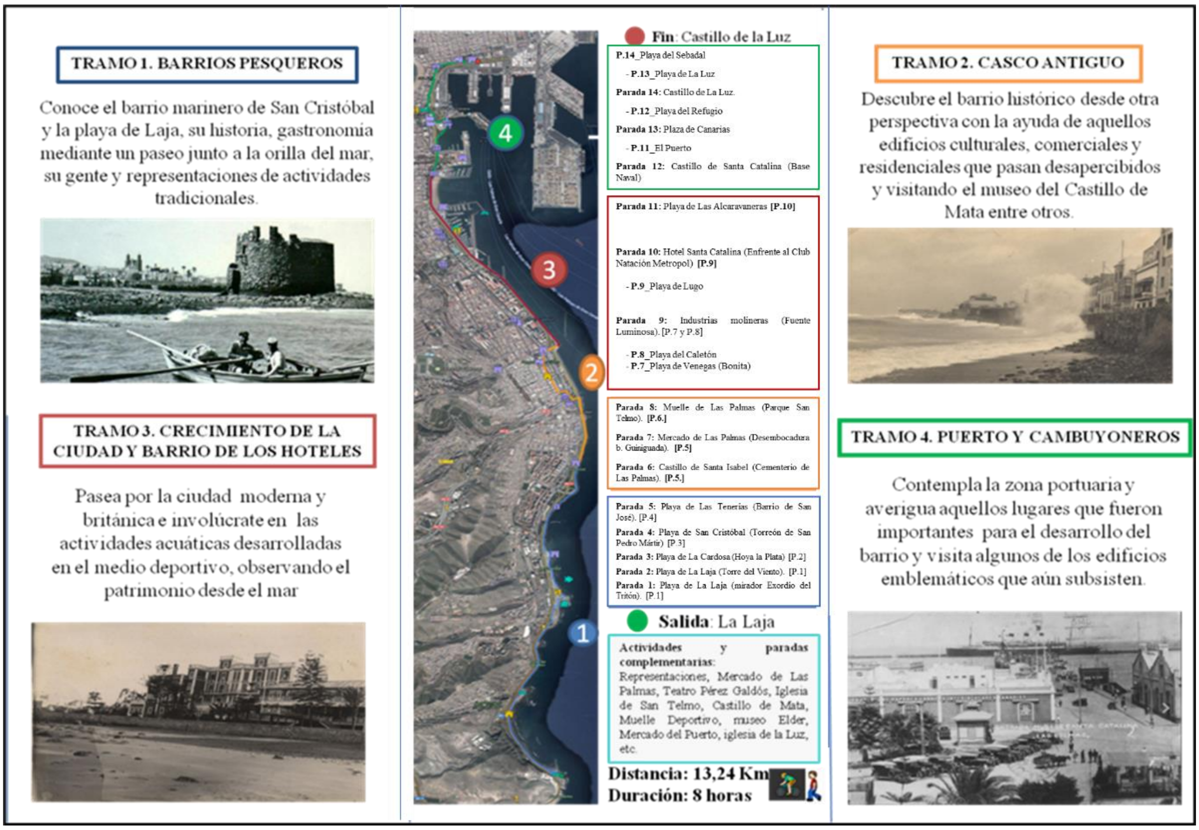
G.2.7. Panel 7. Lugo

G.2.8. Panel 8. Las Alcaravaneras

G.2.9. Panel 9. El Puerto

* Fotografías adquiridas de las páginas del Facebook "Recuerdos de Gran Canaria" (2019); "Las Palmas Ayer y Hoy" (2019) "Gran Canaria, imágenes del ayer" (2018) y la FEDAC (2019).

Anexo G.3. Folletos



* Fotografías adquiridas de las páginas del Facebook "Recuerdos de Gran Canaria" (2019); "Las Palmas Ayer y Hoy" (2019) "Gran Canaria, imágenes del ayer" (2018), la FEDAC (2019).

Sueña

Con un mañana

Un mundo nuevo

Debe llegar

(Luis Miguel. 1996. Canción “Sueña” [extracto])