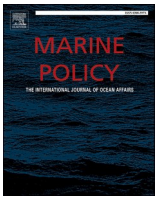
Marine Policy 144 (2022) 105226

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol



Beach management policy analysis concerning safety flag systems in Northern Spain

Imanol Basterretxea-Iribar [a,*], Iranzu Sotés [a], Javier Sanchez-Beaskoetxea [a], María de las Mercedes Maruri [b,c]

[a] Dpt. of Nautical Sciences and Marine Systems Engineering, University of the Basque Country, UPV/EHU, Portugalete, Bizkaia, Spain
[b] Tecnalia Research & Innovation, Meteorology Unit, Euskalm et, Basque Agency of Meteorology, Spain
[c] Dpt. of Applied Mathematics, University of the Basque Country, UPV/EHU, Bilbao, Bizkaia, Spain

ARTICLE INFO

Keywords:
Beach management
Beach warnings
Beach signage
Beach flags

ABSTRACT

The aim of this paper is to analyse the meaning of beach safety flags and their management along the Northern Spanish coast. There are more than 1000 small beaches, which are often in high demand by tourism during the summer season. To carry out the research, most of main beaches have been visited to observe and analyse the meaning of all the safety flags and their correct use depending on the oceanographic and meteorological conditions. The influence of the beach safety management and regulations on the use of beach safety signage has been also analysed. The results show that safety flag systems differ even between very close beaches where safety management is in the hands of different local governments. Outdated and local legal framework and the absence of an agreed system between the different organizations that provide lifeguarding services seem to be behind this lack of uniformity. A specific guide for beach safety flags and signage within a national safety beach plan agreed by all the autonomic or provincial governments may be a solution.

1. Introduction

Drownings in Spain during the period 2015–19 have not decreased and more than 50 % of them have taken place on the beaches, 16 % of the total in beaches without surveillance. In particular, 233 drownings occurred in 2015, 306 in 2016, 349 in 2017, 276 in 2018 and 335 in 2019 [66]. That means 5.02 drownings per million citizens in 2015, 6.59 in 2016, 7.51 in 2017, 5.93 in 2018 and 7.20 in 2019. Bathers' care should be a priority for institutions to prevent accidents, as it occurs in Australia where the ratio drowning/bathers has decreased in the last years [86]. In order to achieve this aim, global and understandable tools based on, among others, a proper signage, must support the lifeguard services. Beach safety flags are one of the proactive ways to protect the beachgoers from the beaches' risks and provide users with information concerning safety conditions for bathing. Their intention is to keep the bathers far away from dangers as well as the spatial distribution of the bath zone for different activities. Flags are only used in patrolled beaches where the lifeguards are in charge of beach safety. Hazards, sea condition, wind and beach features are the main factors that influence the choice of flag.

In respect of the beach flags, the research differentiates between general and coastal flags. General flags are those static ones, placed at the entrance to the beach, indicating the safe conditions for the whole of beach. On the other hand, coastal flags are those easily moved and posted along the seashore to define a dangerous zone or particular area where some specific activities (swimming, surfing, etc.) are permitted or not.

Concerning the hazards, the rip currents are the main cause of death on the beach and are related to more than 50% of rescues and drowning deaths on Australian and American beaches [10-12]. In Biscay province, for instance, first year university students knowledge of rip currents is very low [79]. The waves and tides have a direct influence on the rip currents [21] [13], [17]. Tides may also generate dangerous currents on beaches located in estuaries [51]. The break-waves in the surf zone are also related to death and serious injuries [16]. In the same way, the interaction between waves and rocks and the changes in depth pose also serious risks on the beaches and on the adjacent rocky coast [44] [43]. The water strength at swash areas in high waters may also cause injuries on people walking on the shoreline and it is even related to many drowning incidents caused by swash rips [16,23,37]. Other basic

* Corresponding author.
E-mail address: imanol.basterrechea@ehu.eus (I. Basterretxea-Iribar).

https://doi.org/10.1016/j.marpol.2022.105226
Received 5 January 2022; Received in revised form 18 March 2022; Accepted 18 July 2022
Available online 1 August 2022

parameter to evaluate safety on the beach is the wind [24] that may affect directly the inflate objects on recreational waters [42].

On the other hand, overcrowded areas have the highest drowning records and fatalities [76]. In addition, overcrowding may create a bad atmosphere among beach users [83]. Basterretxea-Iribar et al. [4] studied particularity a pair of Biscay beaches where the overcrowding and surf activities together with other hazards as rocks and rip currents were present, and noticed that the coastal flags should be used to keep safety and spatial distribution. Special mention should be made regarding watercrafts such as surfboards or kayaks the use of which can cause accidents in crowded bathing areas and, consequently, lifeguards tend to designate specific zones for aquatic activities and/or safe swimming by means of coastal beach flags [2].

Another hazard that beachgoers may find in the seawater is the presence of dangerous marine species and the contamination of the water. Sharks are a real danger in Australian and South African beaches, among others, but are rarely found in Northern Spain [26,55]. However, other species such as jellyfish or lesser weevers are usually found in Spanish beaches [6] [58]. Beach water quality is examined frequently to proceed to take control measures such as signage or beach closure when contamination is detected [14].

Other factors related to the signage by means of flags are the size, location and morphodynamics of the beach. For instance, flags along the endless beaches in the South-west of France are intended to designate patrolled and bathing areas, whereas they are used for a spatial distribution separating surfers from other bathers on the small beaches at Northeast of Spain [4]. Beach grain size together with the wave climate and the absence or presence of dunes are related to morphodynamic type of beach [88]. The morphology of the beach together with the action of the waves may also cause travelling and flash rip currents reaching 0.8 m/s [15,73] and, consequently, there may be alterations in the condition of currents and depth in a short period of time. Beachgoers, therefore, have to pay attention to those potential alterations and, in the same way, lifeguards should be objective when it comes to changing beach flags. Recent research shows greater underestimation of sea conditions in lifeguards facing high waves than in those patrolling calm beaches [60]. Nevertheless, these changes of location of coastal flags may be a way of interaction with the beachgoers and help frequent users to notice the warning [87].

Concerning the effectiveness of beach flags, Sanders and McCormick [71] suggested a safety hierarchy with a set of priorities for dealing with hazards: first, the design; second, the guard and third, the warning. In this way, designing safe beaches would be the best way to reduce risks. For instance, the installations of drainage channels and submerged breakwaters enable for the control the rip currents [29]. Nevertheless, the modifications are costly and the results may not be as expected due the beach morphodynamism. Therefore, lifeguarding is the current means to make the beach safer and it should be enhanced with the use of proper tools as jet-ski, surfboards or warning system. The reasons why warnings come third in the hierarchy are various: difficulties to notice, lack of understanding or lack of motivation to comply [45] For example, warning signs and flags alone have limited effectiveness and they should be supported by an educational plan to change users' behaviour towards beach risks such as rip currents [39]. An educational plan should be a more effective tool than warning strategies [30,53,7]. Education also includes television shows [19,2,84] and other methods to raise awareness of beach hazards [8]. Meanwhile, new methods are designed to provide an automated systems to detect high profile of drowning, and warning systems that support lifeguarding [47].

The effectiveness of beach flags as safety communication will depend on a three-stage model. The three stages are attention, knowledge and compliance behaviour. Therefore, the flags, in addition catching beachgoer's attention, have to provide them with comprehension, memory, beliefs, compliance intent, motivation, some compliance decision-making, and behaviour [46]. As an example of lack of comprehension, a research carried out on three public beaches in Texas shows that many beach users will respond to a warning sign showing the hazard from the perspective of the place where they are sitting, rather than the aerial view representing the ocean as space [9]. Therefore, the design will be important for the efficiency of the warnings in general and the beach flags in particular. The place where the flag is located, its size, colour/contrast, signal word and format are factors related to its effectiveness. Additionally, other non-design factors such as the effects of target audience and situational factors should be taken into account [46]. On the other hand, bather compliance with beach flags is questionable and, for example, beachgoers aged from 30 to 49 years in Australia are less likely to choose to swim between the flags than other bathers [74].

Worldwide standardization of beach flags is in the hands of two organizations: the International Standardization Organization (ISO) and the International Life Saving Federation (ILS). ISO started to study the design of labour warning signs at the end of last century and provide specifications for beach safety flags (colour, shape, meaning and performance) in 2007 . Later, a guidance for the use of water safety signs and beach safety flags was published in 2008 and modified in 2014 . ILS adopted a range of beach safety flags in 2002, and in 2010 issued a position statement concerning the current beach safety and information flags [42]. There are differences between both systems in the number of flags and the meaning of some of them but they concur in the essentials. A comparison of both systems is shown in Table 1. Even though the existence of these worldwide standards, the local and national flag systems, that existed prior ILS/ISO standards, still remain on the beaches of many countries.

Safety beach flags are one of most useful and adaptable tool for lifeguards, who must be trained and skilled properly in handling them to mark the areas where the users can swim safer or, on the contrary, dangerous zones where they have to take care. However, what happens when a wrong flag is flying? Then, the users may trust that they are swimming in a safe and patrolled area when the reality is very different and consequence would be an increase of the number of rescues [39]. On the other hand, a proper beach safety signage may mitigate risk with respect to civil liability [68] and reduce the likelihood of public liability for injuries sustained by a user of a patrolled and flagged beach [22].

According to [62], risk assessment, stakeholders' involvement and signage design and positioning are considered best practices to reduce accidents in the use of the coastal area. For instance, significant results are achieved in Australia where drowning cases have been stopped in the last years through a widespread stakeholders' sensitization [86].

In addition, beach safety education is necessary to raise awareness among beach users to understand signage and hazards [38,85] and the community should be educated before they visit the beach and from nursery school if possible [3,82].

2. Methodology

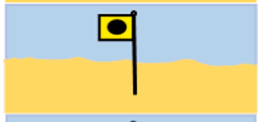
2.1. Study method

The study follows a qualitative-descriptive method based on the observation of beach flags and their relation with the environment and people behaviour. The steps used are as follows:

2.1.1. Selection of beaches

Only patrolled beaches were chosen since the presence of safety flags does not exist on unpatrolled beaches. The selection of beaches was based on their length, proximity between beaches, hazards, activities, carrying capacity, occupancy, province, rescue organization and management system. The data were collected from the Councils' websites and the Spanish Environment Ministry website [40]. Taking into account that safety flags are related to the hazards, beaches were previously evaluated for their swell and overcrowding at least three levels (high, medium and low). In addition, the presence or absence of surfers, as well as the composition of the beach sediments, were weighted.

Table 1
ILS and ISO standard beach safety flags and their summarised meaning.

		ILS	ISO
Yellow general flag		Medium hazard	General warning
Red general flag		High hazard	Do not enter the water
Double red general flag		Beach closed	-
Purple flag		Marine pests (no shark present)	-
Yellow with central black ball flag		Surfboards and other non-powered watercraft prohibited	-
Orange windshock		Unsafe for inflatable objects	No inflatable to be used
Red-white (quartered) flag		Emergency evacuation (including shark present)	
Two Red-yellow (halved) flags		Swimming/body surfing area under supervision between flags	
One Red-yellow (halved) flag		Swimming/body surfing area under supervision in front of the flag	
Two Black-white (quartered) flags		Non-powered Watercraft area between flags	

Pebble beaches were refused due to the lack of lifeguards and low occupancy, and the sand beaches were classified into white, golden and dark sand. The grain size of the beach sand is medium ($0.25 < d50 < 0.5$), being finer on white sand beaches typical of estuaries.

2.1.2. Time of visiting beaches

Selected beaches were visited at the beginning of July and at the end of August since lifeguard services were not operating on all beaches in June and September. Using two observations far apart in time, the research group would gain insight into possible changes in beach profile shape and occupancy would affect flags and other signs. The observations were performed on different occasions throughout the day to analyse the beach flags and hazards in different oceanographic and meteorological conditions.

2.1.3. Data

The group of researchers collected input and output data from each beach to be analysed globally in the study area. Input data are the beach hazards and the beach safety management and regulations that influence the output data related to the beach signage. Fig. 1 shows the basic variables taken into account in the investigation. Culture and politics do not affect the characteristics of the beach flags since there are not radical differences in cultural terms along the study area, although some different political ideas may exist in the Basque Country.

2.1.4. Tools

Basic guidelines were prepared previously to collect information on the company providing lifeguard services, the existence of an integrated safety management plan, poster signage informing of flag meaning, overcrowding, aquatic activities and surf schools. The environment variables such as tides, wind direction and intensity, sea swell direction and wave height were foreseen from local oceanographic and meteorological web sites. The group surfed in situ and used universal current metres to obtain other parameters, such as rip current location and intensity. Hazards observed together with on-site photos of signage and beach conditions were collected and classified as observation results. All input and output data were sorted for comparative study.

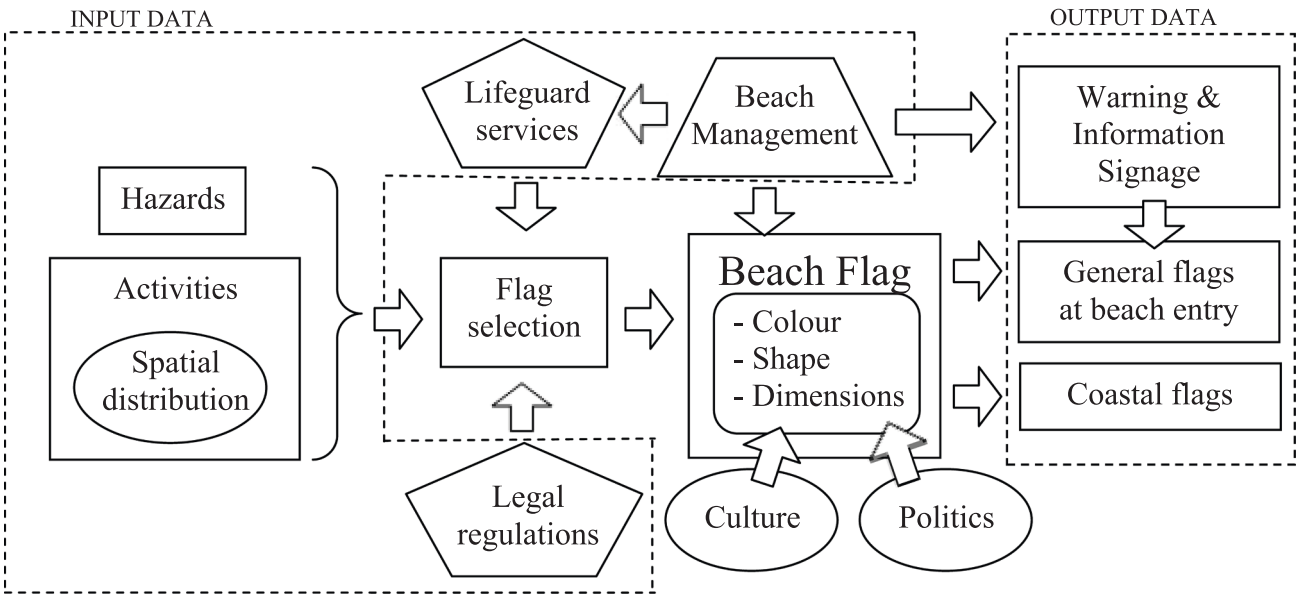


Fig. 1. Flowchart of variables regarding the investigation methodology.

2.2. Study area

The study focuses on the Spanish coast of the Bay of Biscay (from Higuer Cape to Estaca de Bares Cape) where the beaches are an attraction for surf lovers and for a large number of local people and tourists looking for relaxing and pleasure. Beach safety flags are only used during summer time when lifeguards patrol the beaches.Fig. 2.

2.2.1. Administrative map

The ultimate power of Spain is in hands of the central government that delegates some powers to the autonomous communities and these, in turn, delegate powers to provincial and municipal governments. The autonomous communities involved in the study are made up from West to East of Galicia, Asturias, Cantabria and the Basque Country. The western coast of Galicia is not included in the research. The North of Galicia includes two provinces (Corunna and Lugo) just as the Basque Country (Biscay and Gipuzkoa). The North Corunna coastline only includes one local council and is delimited by Estaca de Bares Cape and the border with Lugo. Table 2 provides the coast length of every province covered by the research, the number of coastal municipalities belonging to every province and the number of coastal municipalities visited by researchers [41].

2.2.2. Coast morphology

The study area is located at the south of the Bay of Biscay facing north. The Northern Spanish coast is broken and abrupt which favours the appearance of narrow inlets where the beaches are embayed [59]. Consequently, the beaches are usually not longer than one kilometre except in cases of a wide estuary inlet as Laredo in Cantabria which reaches four kilometres long [40]. Many beaches are often very small (for instance, Hondartzape in Urdaibai estuary is only 27 m long and 24 m wide) and the access is difficult in many of them due to the presence of rocky cliffs. Their plan shape is varied (quasi-rectilinear, semi-circular and estuary) because of the steep coastline. The morphodynamism of beaches is high due to wind, swell and the medium sand grain. In some cases, the severe succession of winter storms may result in the almost disappearance of the supratidal beach [51]. Because of the morphologic changes that occur in winter, rocks that were previously buried in the sand can reappear the following summer, changing the location of permanent rip currents.

2.2.3. Oceanic meteorological conditions

Air and seawater temperature in the Northern coast of Spain is suitable for bathing only during the summer and, consequently, beaches are patrolled only during this time. This area is meso-tidal and the range of tides may be higher than 4 m during equinoctial springs in September reaching tidal currents at the estuaries higher than 2 m/s [51,70]. The high tide range and the presence of semi-diurnal tides cause the change of safety conditions over six hour. The tide may also generate dangerous currents on beaches located in estuaries where the velocity of the tidal

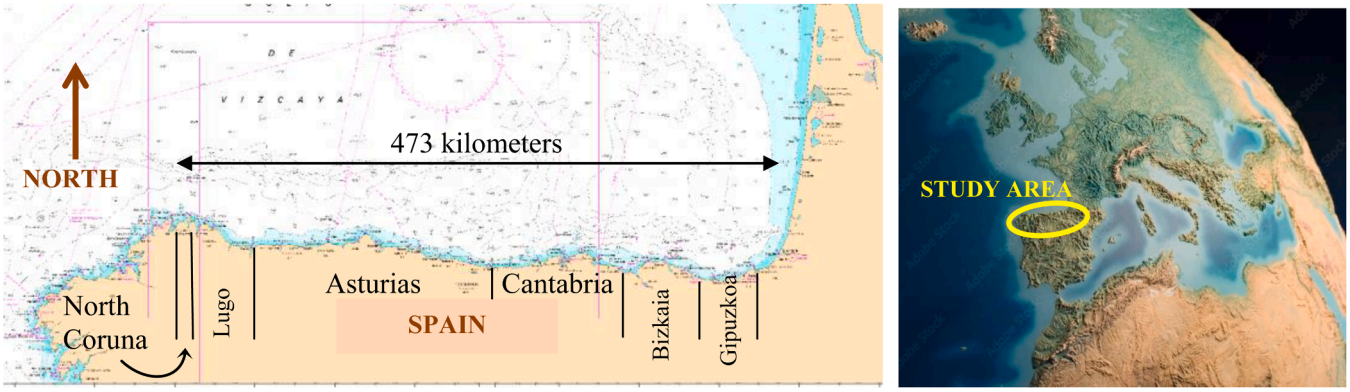


Fig. 2. Study area.

Table 2
Coast length and number of municipalities visited.

	North Corunna	Lugo	Asturias	Cantabria	Biscay	Gipuzkoa
Coast length (km)	40	144	401	284	154	92
Coastal Municipalities	1	8	19	21	20	9
Municipalities visited	1	4	14	8	20	9

currents may reach 2.5 m/s during equinoctial spring tides [51]. Likewise, a high percentage of wave energy comes from the fourth quadrant, especially from West North-West (31 %) and North-West (56 %) [25]. The average significant height of waves collected by the buoys along the northern coast of Spain during the summer of 2018 was 1.25 m and the maximum height 3.95 m [63]. Swell coming from the North Atlantic storms tends to impinge on the beaches with a high energy not permitting the bathing. Additionally, wave energy also favours the appearance of rip currents and depth changes. In addition, wave grouping contributes to the development of flash rip currents. On the other hand, the movement of Atlantic anticyclone from Azores to the European continent at midyear permits light winds from North-East and West North-West along the Northern Spanish shore although the coastal-marine warning systems take into account the potential risk of gales during summer [35].

At the beginning of the summer, the foreshore slope is low and regular due to the high wave energy during the winter; however, the reduction of this energy throughout the summer gradually increases the slope.

2.3. Study beaches

The research reaches more than 20 % of the total length of beaches in each province and almost a third of the total length of beaches along the study area. The occupancy on all study beaches was high/medium and at least 50 % of them with surfing activities. Most of selected beaches were facing the swell coming from north-northwest and were affected by permanent and travelling rip currents. The latter are due to the existence of irregular rocky bottoms within intertidal area. On the other hand, some selected beaches were located in estuaries affected by tidal currents. In addition, the influence of the proximity of the beaches, their management and their rescue systems was taken into account when choosing the beaches.

The sand on study beaches are mainly golden in colour and consists mainly of quartz grains accompanied by other minerals, such as feldspars and carbonates, and some fragments of shells. Nevertheless, some beaches near estuaries have finer white sand and, unusually, the beaches near former industrial facilities are covered by a shiny black sand formed by fragments of foundry slag mixed with golden sand (dark sand). The grain size is medium which causes sand movements throughout the summer that vary the slope at the foreshore of the beach.

Table 3 compares the length, occupancy (high, medium and low) and surf activities between the study beaches and all the beaches of each province, including the beaches that provide lifeguard services and those that do not. The number of visitors on unpatrolled beaches is very low due to their small size and the access difficulties and, consequently, the costs of lifeguarding services would not be justified. In relation to this, the occupancy of the unpatrolled beaches is low on more than 75 % of them and only 8.5 % of them is more than 500 m long [40].

Annex 1 shows the particulars of each study beaches [40].

2.4. Legal and institutional framework

The two basic national laws dealing with the use of the beaches in Spain permit the local regulation of these areas by autonomous, provincial or municipal governments. Currently the basic rules and instructions for human safety at the bathing areas, including beaches, are provided by the national Order 1972. According to this regulation, there are three types of beaches concerning safety-bathing conditions: prohibited beaches, dangerous beaches, and free beaches. The red flag flies on prohibited beaches where the risk to human life is serious, the yellow flag flies on dangerous beaches where the risk to personal injury or human life is potential, and the green flag flies in all other cases on free beaches. Contrary to this, green flag is not used under ISO/ILS flag system since absolute safety conditions cannot guaranteed.

According to the Order 1972, the shape and size of the flags must be rectangular and of a minimum size of 1 × 1.5 m, and they must fly at least 2 m above ground level in a visible place [57]. Although nothing is specified in respect of coastal flags under the Ministerial Order, this rule requires lifeguards to separate properly the swimming area and the channel for the self-propelled watercraft accessing the beach. Nevertheless, there is not a specific regulation on how to do it. Therefore, beach safety flag and signage system in Spain is insufficient in comparison to ILS/ISO standards described by Table 1.

According to article 115.d of the Coast Law 22/1988 [20], it is mandatory for municipal governments to provide a lifeguard service on their beaches, at least during the bathing season and for the most relevant beaches. Therefore, every local government is in charge of allocating the lifeguarding equipment and employing staff for the surveillance on its beaches. That means lifeguards from nearby beaches located in different municipality may have different practice regarding flags. There are some beaches belonging to port waters as Ereaga and Arrigunaga beaches in Bilbao that are not regulated by Coast Law 22/1988 but by the Ports Law 27/1992 [61]. There are not significant changes because the ports delegate the beach safety signage to the autonomous community who, in turn, usually allow municipal government to be responsible for that. On the other hand, there is no national, provincial, or municipal database which gathers beach lifeguard information and only voluntary cooperation of local authorities may provide specific data regarding surveillance on some beaches [6].

Table 3
Comparison between the analysed beaches and the total beaches of each province regarding length, occupancy, surf activities and lifeguarding services.

Province	Length of study beaches	Occupancy on study beaches			Surf on study beaches		Lifeguards on study beaches		Length of all beaches	Occupancy on all beaches			Surf on all beaches		Lifeguards on all beaches	
		H	M	L	Y	N	Y	N		H	M	L	Y	N	Y	N
Corunna	1,000	0	1	0	1	0	1	0	2,770	0	2	1	1	2	1	0
Lugo	5,720	1	6	0	3	4	4	0	27,112	12	27	41	10	71	37	44
Asturias	16,290	13	1	2	9	7	16	0	71,883	63	53	92	21	187	89	119
Cantabria	17,900	5	7	0	9	3	12	0	51,680	21	25	35	22	59	63	18
Bizkaia	8,412	12	0	0	11	1	12	0	14,855	22	3	10	15	20	26	9
Gipuzkoa	6,880	4	2	0	3	7	10	0	14,814	11	6	20	11	26	16	21

Locally, the Harbour Master in charge of marine safety in each region may give special regulations regarding beaches; such is the case of the circular 3/1990 of the General Directorate of the Merchant Marine that results in establishing in Asturias the prohibition of bathing with red flag hoisted. On the other hand, each council may give other specific rules through municipal ordinances regarding the use of the beaches.

Regarding emergency policy, the phone number 112 is used in Spain to contact emergency care services throughout the national territory. Therefore, this phone is present on the information signs on the beaches. The autonomic governments are in charge of the global emergency plans in each region (Galicia, Asturias, Cantabria and Basque Country are the regions in the research). Their performance is twofold: they tend to financially support the municipalities in contracting lifeguarding services and, on the other hand, take part in organising the emergencies on the beach. In this way, the autonomic governments annually allocates a budget to the safety of the beaches and take part in organising the emergencies on the beaches. For instance, there are regional beach safety plans in Galicia and Asturias (SAPRAGA and SAPLA, respectively) to coordinate the emergencies on the beaches. On the other hand, the Basque Country delegates the organisation and financial support to provincial governments of Bizkaia and Gipuzkoa. Fig. 3 shows the institutional framework of beach safety in the study area.

2.5. Lifeguard services

Lifeguard services are provided by non-profit associations or humanitarian institutions such as the Red Cross, as well as by private companies. In some cases, public organizations or municipalities themselves provide the equipment and hire the lifeguards each summer.

Lifeguards in Spain must pass a course to obtain the certificate that qualifies them to perform their job according to [64]. Some autonomous regions, such as Galicia, have a specific regulation for the accreditation of lifeguards based on the number of hours rather than the quality of training [28,65]. Taking into account that the annual budgets on beach safety are fixed by each autonomous government, the beach safety resources may be different on each beach. In consequence, some municipalities had problems in 2017 with the availability of lifeguards due to their seasonal employment and their low salaries compared to accreditation requirements.

3. Results

3.1. Beach managing

Every municipal government is in charge of managing the rescue and first aid services along the north coast of Spain except on Biscay beaches where the provincial government is controlling these services under the same integrated managing system named SIG [75]. Under SIG system, beach safety management is delegated to a single company or institution where its general coordinator is responsible of managing rescue and evacuation services. In Asturias and Galicia, the SAPLA and SAPRAGA plans integrate the coastal municipalities and the services of emergencies to coordinate beach rescue and evacuation through a single command centre [27,72]. The beaches of Gijon deserve special mention under SAPLA plan since they have a particular financial and organizational system. In the case of evacuation to the hospital, each lifeguard station is in charge to call the emergency services directly, or through the coordinator in those regions where a beach safety plan or system is implemented (Galicia, Asturias and Biscay).

Near 20% of analysed beaches are blue-flagged. No special differences were found between blue-flagged and non blue-flagged with regard to the safety flags and signs. Despite Blue Flag Beach Criteria recommends that flags and signs should be in accordance with ISO 20712, the safety signage do not follow ISO standards. Special mention deserves the blue-flagged beach of Berria where two different poster signs were posted at the entry with contradictory information.

The resources of the lifeguarding services in Galicia were very limited. The presence of only two lifeguards on each beach and the lack of equipment as coastal flags was detected during the visits.

The results show that the flag system used at each beach depends on the company that provides the rescue and first aid services. Nevertheless, differences in coastal flags were observed between beaches under the same lifeguard company. Only the Biscay beaches managed under SIG system follows the same flag system. Table 4 shows the different lifeguard companies identified by letters from A to H and the provinces where they work. The services are provided every day in the summertime except on some beaches in Asturias where they are only provided during the weekend.

3.2. General flags

The general flags are posted usually at the entrance of the beach and

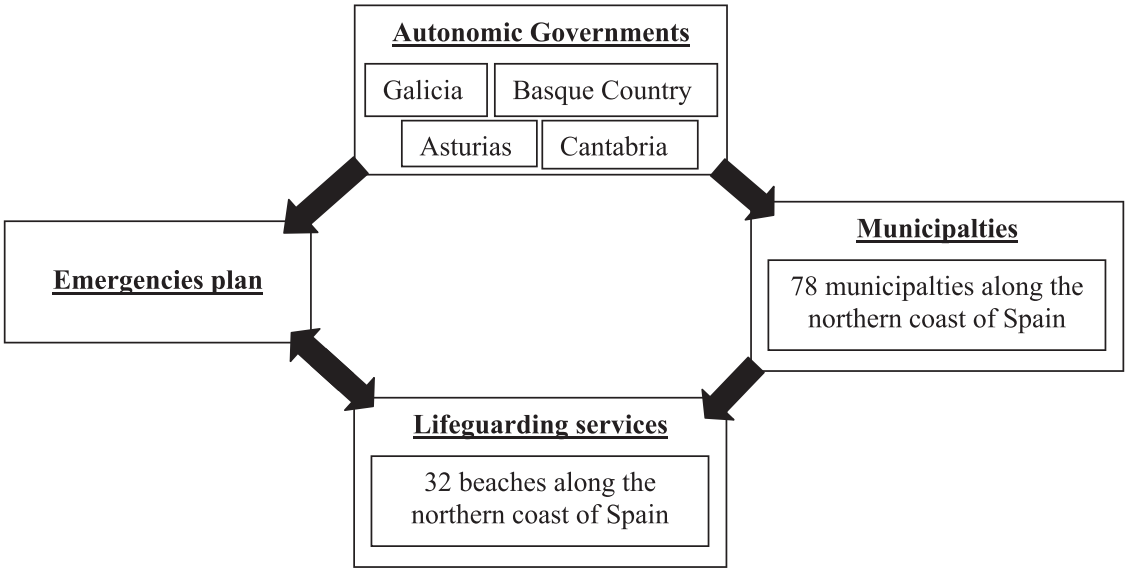


Fig. 3. Institutional framework.

Table 4
Companies providing lifeguard services.

	N. Corunna	Lugo	Asturias	Cantabria	Biscay	Gipuzkoa
A			X	X	X	X
B				X		
C				X		
D (*)			X	X		
E			X			
F		X				
G				X		
H	X					

(*) Lifeguard services managed directly by the municipal government

their size is bigger than coastal flags. They are visible and their dimensions agree with the standardised size. There are no changes with respect to the meaning and the colour of general flags used on all of the examined beaches: red for 'do not enter into the water', yellow for 'swim with caution' and green for 'safe to swim'. The bathers, including surfers, cannot proceed into the water when a red flag was flying in Asturias and Galicia. However, the lifeguards of the rest of provinces allowed a reduced area for the users to cool off, and sometimes permitted experienced surfers into the water who may help in the rescue of bathers [1].

On the other hand, the use of the green flag complies with the Spanish law despite not being included in the ILS and ISO standards since it cannot guarantee that any beach is safe under all conditions [36]. It should be noted that there exist beaches where only general flags fly, and no coastal flags.

Taking into account that the bathing is not permitted by law in Asturias when the general red flag is flying, the lifeguards usually delay the red flag raising until the sea conditions are very hard.

In Noja (Santander) there are two general flags posted at the two entrances to access the beach of Ris which means two different general flags for the same beach with a waterfront no longer than 2200 m. The same occurs on other small beaches embedded in small coves as Gorliz beach where the still water zone is marked with a different general flag from the area facing the open sea. San Lorenzo in Gijon is an urban beach divided into several areas where a different general flag flies and no coastal flags are used.

3.3. Coastal flags

Lifeguards use the coastal flags on the study beaches to delimit the following areas:

- Cooling off area: swimming or bathing is permitting in this area when the red general flag is flying. In this way, beachgoers cool themselves off by bathing on hot days despite red flag is hoisted. This area is under the supervision of lifeguards who generally are patrolling along the shoreline. Surfboards and other watercrafts are not permitted.
- Bathing area: swimming or bathing is only allowed in this area when a general flag other than red flag is hoisted. Generally, lifeguards mark this area to separate bathers from surfers. Surfboards and other watercrafts are not permitted in the bathing area.
- Watercraft area: the use of surfboards, body boards, kayaks and any other watercraft is only permitted in this area. Bathers are not permitted.
- Dangerous area: swimming or bathing is not allowed in this area affected by rip currents or other hazard.

In addition, teardrop banners are used to mark an area for surf schools under instructor supervision.

The dimensions of coastal flags are not standardised and, in some beaches, their size is too small to be visible to users. For instance, the coastal flags in Biscay beaches were changed for larger ones to make them visible. The flag shape is rectangular except in many beaches of Asturias where teardrop banners are used. The colours of flags do not follows ILS/ISO standards and even a mixture of colours were found in the teardrop banners used to mark the bathing and watercraft area on the beaches of El Sablon, Quebrantos y San Pedro.

The Tables 5, 6, 7, 8 and 9 give the results on each study in the form of drawings showing the colour, shape and positioning of the coastal flags. On each table there are four columns separating the cooling off area, the bathing area, the watercraft area and the danger area. Other narrow column is for the acronym LS which indicates the company providing lifeguarding services. Blue-flagged beach is marked with an asterisk.

The signalling of special areas between coastal flags was complicated in some Galician beaches where there was a lack of equipment and personnel to carry out the lifeguard services correctly. For example, only one coastal flag was flown in Marosa beach to mark the watercraft area.

It is remarkable the contradictions in the meaning of the coastal flags on Gerra beach between the visit of July and August. The two green flags observed at Orio to mark the bathing area are also worth noting since the same lifeguard organization used two yellow flags on the rest of nearby beaches.

The red and blue (diagonally) flags to mark the watercraft area were regulated under a law issued by the Harbour Master of Bilbao who is responsible for the safety on the offshore waters belonging to Biscay province [32]. Though this law was abolished later as consequence of general changes in the regulations concerning pleasure boats [33], blue and red flags are still used in the Basque Country.

The rocky and danger area due to a permanent rip currents are marked between two fixed red flags or by means of word signage near the seashore. This area is sometimes extended to cover the flash currents pushing diagonally near the permanent rip currents (it was observed on Laga beach). On the other hand, the travelling rip currents during the change of tide, frequent on many beaches, are marked with movables flags. A special case occurs on La Grande and Peñarronda beaches where a lane rope is used to delimit the permanent danger areas (Fig. 4). Although the red colour is intended to indicate prohibition, it is worthy to mention the use of red flags in many beaches of Cantabria to mark the watercraft area.

3.4. Beach information and safety signs

The poster signage at the entrance to the beach focuses mainly on the meaning of the general safety flags and, on a few beaches, coastal flags for bathing under supervision and/or watercraft areas may be included in a small. In addition, the signs are not properly positioned in a visible place at the entrances of many beaches or, simply, do not exist. On many occasions, its design did not attract beachgoers' attention due to an excessive information (Fig. 5). The existence of a double signage informing on the meaning of coastal flags in a different way on some beaches deserves special attention. Concerning the languages used, the signage is written preferentially in Spanish and local languages (Basque, Asturian, etc) together with other languages such as English to a lesser extent. The use of other languages as French or German is restrictive.

On the other hand, the colours and the graphical symbols of the safety signs do not follow ISO 20712 standards in the most of beaches.

4. Discussion

4.1. Beach safety signage in the study area

The results of the present research denote the inexistence of a common beach flag system along the Northern coast of Spain which is just over 1000 kilometres long. It has been detected that the meaning of the flags changes between nearby beaches and only a few comply with ILS and ISO standards. The radical changes in the colours of coastal flags between very close beaches and the contradictory messages found at the

Table 5
Coastal flags on beaches of Gipuzkoa.

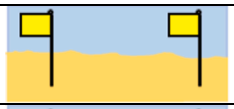
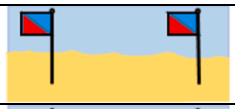
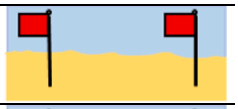
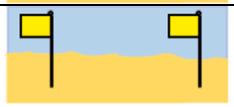
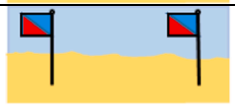
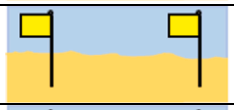
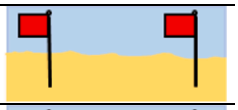
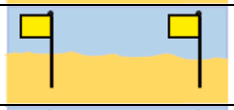
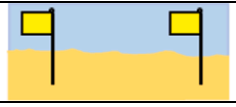
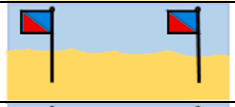
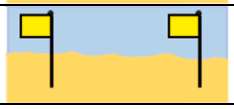
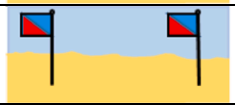
Beach	LS	Cooling off area	Bathing area	Watercraft area	Danger area
Hondarribia La Concha Ondarreta	A		No marked		
Antilla	A				
Zarautz Malkorbe Santiago	A		No marked		
Deba	A				
Mutriku Saturrarán	A		No marked		

Table 6
Coastal flags on beaches of Bizkaia.

Beach	LS	Cooling off area	Bathing area	Watercraft area	Danger area
Karraspio Ogella Laga Laida Bakio Gorliz Plentzia Sopela Barinatxe Arrigunaga Ereaga La Arena	A		No marked		

entrance signage deserve special attention for institutions in charge of beach safety.

Other deficiencies, which were observed during the investigation, concern the frequency and clarity of the signage showing beach flag information at the entry of the beach. Although there is a lack of understanding of beach signage [80] and its efficiency is limited mostly because posters are not frequently noticed [49], signage should follow the standard requirements for creation and design of water safety signs based on the work of the Technical Committee ISO TC 145 [56]. Unlike that, the signage on study beaches on general and safety information was not usually standardised in respect of colours and symbols and, on some beaches, the information was contradictory because of the old posters had not been removed when a new one was posted. In addition, it was not usual to find signage written in various languages to be understood by foreign beachgoers since the drowning rate is higher amongst tourists [54]. For instance, information signs on Biscay beaches were written only in Basque and Spanish despite 32 % of tourists coming from France, United Kingdom, Italy and Germany tend to visit the beaches [5].

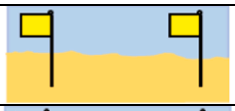
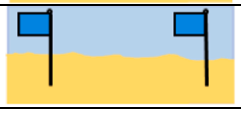
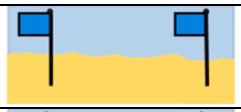
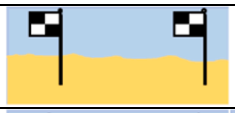
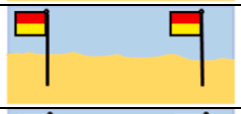
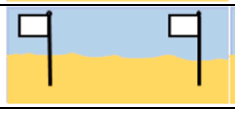
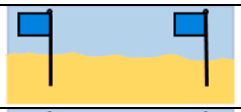
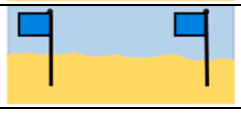
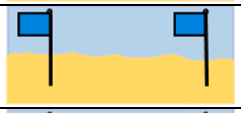
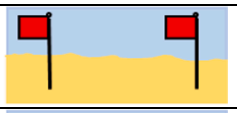
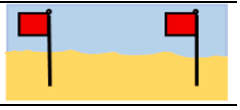
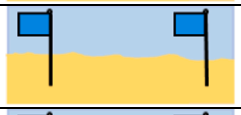
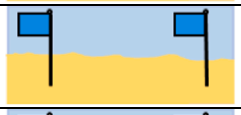
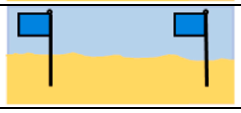
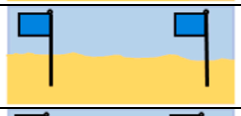
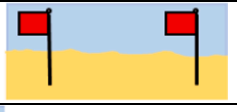
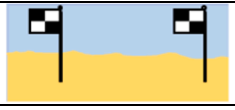
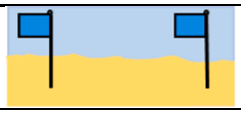
Lifeguards do not use flags preventing marine wildlife although, for example, 15 % of first aid provided by lifeguards on Biscay beaches between 2014 and 2018 were due to lesser weevers, according internal Red Cross information. Only a few danger signal preventing from jellyfishes were observed on some beaches. On the other hand, lifeguards individually warned users to remove inflatable objects, however, an added hazard of flying umbrellas and surfboards in gusty winds was observed and not warned.

In respect of surf schools, teardrop banners are useful to separate the beginner surfers guided by a school instructor from other bathers and surfers. In addition, the group of researchers highlight the coordination work between lifeguards and school instructors to separate an exclusive area for surf schools from other surfers. That is not only a safety measure to prevent accidents by collision but also a way to avoid disputes and arguments at small beaches where there are many surfers to take the good wave [83]. However, it was difficult for lifeguards to find a proper area for beginner surfer on small and overcrowding beaches as Sopela.

4.2. *Cross-country comparison of beach flags management*

Most of the United Kingdom beaches use a common flag system proposed by the main organizations providing lifeguard services: the Royal Life Saving Society UK and the Royal National Lifeboat Institution [67,69]. Moreover, the Maritime and Coastguard Agency issued a beach safety guide including the same flag system which is based on the ISO standard and made up of four flags: red for no bathing, red-yellow for swimming area under supervision, black-white for aquatic activities and

Table 7
Coastal flags on beaches of Cantabria.

Beach	LS	Cooling off area	Bathing area	Watercraft area	Danger area
Oriñón	B		No marked		
Laredo	A			No marked	No marked
Berria*	C	No marked			No marked
Ris*	D	No marked			
Somo	A			No marked	No marked
Piélagos	A		No marked	No marked	
San Juan	A		No marked	No marked	
Tagle*	A			No marked	No marked
Los locos*	A			ISO signs for surf schools	No marked
La concha	A			ISO signs for surf schools	
Comillas*	C	No marked			No marked
Gerra	D			. ← In July	No marked
				← In August	

the orange windsock for limiting the use of inflatable objects [50].

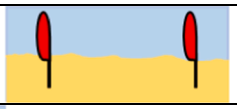
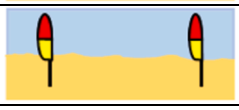
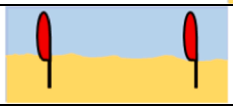
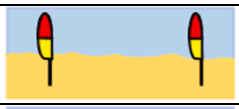
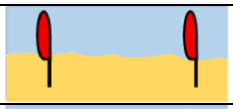
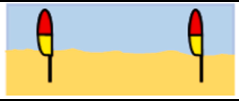
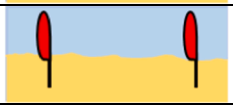
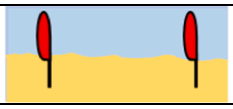
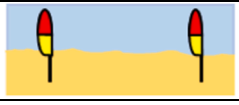
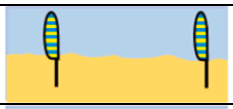
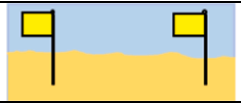
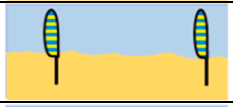
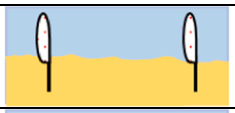
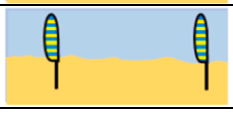
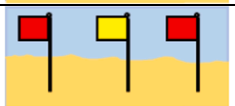
In the case of Australia, Surf Life Saving focuses on the use of red-yellow and black-white coastal flags, both of them included in ISO and ILS standards [77].

In USA, specifically in Florida, a standard system of warning flags was created starting in 2004 which ran from double-red (water closed to public) to green (low hazard). The system complied with ILS standards except for the green flag the meaning of which 'Calm conditions. Exercise with caution' does not imply a total safe condition of the beach unlike in Spain [31].

In France, the general beach flags have triangular shape and the colours are red, which means 'do not enter the water', yellow-orange, which means 'dangerous beach for swimming under surveillance' and green, which means 'swimming under surveillance without particular dangers' [18]. In south western France beaches (adjacent to the study area), coastal flags do not match ISO and ILS standards since the swimming area is marked between two blue flags and the surf area between a green flag with a red ball and a striped black-yellow flag [81].

To conclude this beach flag comparative, it seems that some countries follow a beach flag system by force of habit or culture and others have the ability to adapt more easily to standardised ones. The fact that colour interacts with culture [78] is a detriment to reach a standardised

Table 8
Coastal flags on beaches of Asturias.

Beach	LS	Cooling off area	Bathing area	Watercraft area	Danger area
San Antolín	A	No marked		No marked	No marked
Vega	E	No marked		No marked	
Sta. Marina La Atalaya	E	No marked			No marked
Arra	The council has not contracted lifeguarding services				
Lastres Colunga	E	No marked			No marked
Rodiles*	D	No marked			No marked
San Lorenzo	D	No marked	No marked	No marked	No marked
Carreño	E	No marked			No marked
Xagó	D	No marked		No marked	No marked
El sablón	D	No marked			No marked
Quebrantos	A		No marked		No marked
San Pedro*	D	No marked			No marked
Frejulfe*	D	No marked		No marked	No marked
La Grande	A	No marked			Marked with lane rope
Peñarronda*	A	No marked			Marked with lane rope

beach flag system since, for instance, orange and yellow are the colours in terms of perceived hazard (from low to high) for Chinese people and, on the other hand, blue and red for US people [48]. Other colour combination such as black and white are not used in some Asian countries [36], and red and yellow may not be accepted in Basque Country by political reasons. However, the increase of interaction among people from different countries should promote basic rules to be applied worldwide, overcoming cultural and political obstacles.

4.3. Beach safety management

In the case of Biscay, the SIG plan focuses on the environment and quality, including a safety management system for the rescue and first-aid on the beaches within its procedures. Accordingly, Biscay government are in charge of employing staff for keeping beach safety [75]. The consequence of this is the existence of a standard of flag system in the whole of the Biscay beaches during the time the lifeguard services have been in the same hands.

Beach safety plans in Asturias and Galicia are merely intended to

Table 9
Coastal flags on beaches of Lugo and Coruna (Galicia).

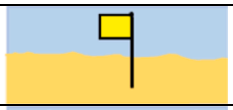
Beach	LS	Cooling off area	Bathing area	Watercraft area	Danger area
Longera Altar Coto San Miguel Rapadoira*	F	There is not a standardised method to sign. Different flags and signs are used to mark different areas each day and throughout the same day.			
Marosa*	F				
Esteiro*	F		No marked		
Esteiro Bares	F	The council has not contracted lifeguarding services			

Fig. 4. Lane rope delimiting permanent rip current on Peñarronda beach.

guarantee coverage and coordinate the emergencies on beaches and aim to promote and disseminate prevention and self-protection measures for beach users. The plan in Asturias and Galicia establishes only a red-yellow-green general beach flag system following the current regulation in Spain. However, lifeguard recruitment is delegated to each town council [27,72]; therefore, the use of coastal flags differs between nearby beaches where the lifeguard services are in the hands of different organizations or companies.

Despite many beaches have quality certifications, there are not many where a safety management system is in place.

4.4. Lifeguards

The lifeguards were skilled to detect rapidly the potential hazards and to define a specific area with coastal flags. Nevertheless, the researchers noted that exclusive priority was given to signalling rip currents when other hazards, such as breaking waves on the shore during high waters, were not adequately prevented, despite the danger for bathers and waders due to the abrupt depth changes and violent swash on the foreshore. It was noted that the equipment to mark danger area was not appropriate and sufficient on some beaches. On the other hand, the knowledge of the lifeguards about the ISO standards is very vague and, in some cases, the coordination between lifeguard posts in respect of safety signage did not work properly [80].

4.5. Limitations

The main limitations of the current study are based on the limited number of beaches observed as well as on the short period of observation. However, the length of the observed beaches is one-third of the total length and their selection included all possible input and output variables. In addition, the observations was spaced in time to detect possible morphological changes of the beach.

Fig. 5. Information signage at entry of Ris beach.

5. Conclusions

The results show the uniformity with respect to the meaning and the colour of the general flags (green-yellow-red) considered by the national Order 1972, what means the legal rules work. On the contrary, there is a non-uniformity in the colours, shapes and sizes of the coastal beach flags along Northern Spanish coast. A Blue Flag hoisted is not a guarantee of ISO standardisation in beach safety signage. The poster information signs at the entry of the beach are not standard in respects of symbols and colours, and the design is not attractive. Sometimes, there is even double signalling providing contradictory information.

Lifeguards adequately mark danger zones and other areas related to physical distribution. In this way, marking a cooling off area for bathing under supervision when the red flag is flying avoids delays in hoisting the general red flag. The coordination of lifeguards and surf schools to mark a special area for novice surfers is essential on overcrowded beaches. However, different local regulations regarding beach flags and different requirements and certifications for lifeguards in each region can lead to a lack of safety at certain beaches.

The fact that local governments are in charge of the beach safety management leads to an imbalance in the human and material resources available to the safety services on each beach. Local governments need to ask themselves what is more important: achieving quality certification for their beaches or increased beach safety. Moreover, the existence of different companies or organizations providing lifeguard services and the lack of a global beach safety plan for the entire Spanish coast leads to different procedures regarding beach safety flags and signage.

Therefore, the involvement of all institutions to reach a national beach safety plan is necessary in order to coordinate and equate the management of all Spanish beaches where the flag colours and the design of signage should follow the standards used in the rest of countries.

Financial support

Diputación Foral de Bizkaia, Spain (Biscay Regional Council Office) has funded this research under grant no PT10372.

Ethical statement

This research has been carried out in accordance with the ethical guidelines of the respective authors' instructions. The research is original having not been previously published and is the result of the authors' intellectual thought.

Authors statement

This research has been carried out in accordance with the ethical guidelines of the respective authors' instructions.

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication before its appearance in the Marine Policy.

Acknowledgements

The authors appreciate very much the cooperation of the Biscay Regional Council Office, the company INGURE and Koldo Larrazabal (General Coordinator of Biscay Red Cross).

ANNEX 1

	Beach	Length	Occupancy	Sand	Swell	Wind	Surf
Gipuzkoa	Hondarribia	700	High	White	Still water	–	No
	La Concha	1350	High	Golden	Soft	–	No
	Ondarreta	600	High	Golden	Soft	–	No
	Antilla	220	Medium	Golden	Heavy	Windy	Yes
	Zarautz	2500	High	Golden	Heavy	Windy	Yes
	Malkorbe	420	High	Golden	Still water	–	No
	Santiago	250	High	Golden	Moderate	–	Yes
	Deba	420	High	Golden	Moderate	Windy	Yes
	Mutriku	120	High	Golden	Moderate	–	Yes
	Saturrarán	300	Medium	Golden	Heavy	Windy	Yes
Bizkaia	Karraspio	462	High	Golden	Moderate	–	Yes
	Ogella	450	High	Golden	Heavy	–	Yes
	Laga	574	High	Golden	Heavy	–	Yes
	Laida	700	High	Golden	Heavy	Windy	Yes
	Bakio	982	High	Golden	Moderate	–	Yes
	Gorliz	842	High	Golden	Moderate	–	Yes
	Plentzia	356	High	Golden	Moderate	–	Yes
	Sopela	826	High	Golden	Heavy	–	Yes
	Barinatxe	752	High	Dark/Golden	Heavy	–	Yes
	Arrigunaga	628	High	Golden	Moderate	–	Yes
	Ereaga	880	High	Golden	Moderate	–	Yes
	La Arena	960	High	Dark/Golden	Moderate	–	Yes
Cantabria	Oriñón	1100	High	Golden	Moderate	Windy	Yes
	Laredo	4250	High	Golden	Moderate	Windy	Yes
	Berria	2000	Medium	Golden	Moderate	Windy	Yes
	Ris	2200	High	Golden	Moderate	Windy	Yes
	Somo	2000	Medium	Golden	Heavy	Windy	Yes
	Piélagos	2800	Medium	Golden	Heavy	Windy	Yes
	San Juan	200	Medium	Golden	Moderate	Windy	No
	Tagle	200	Medium	Golden	Moderate	Windy	No
	Los locos	350	Medium	Golden	Heavy	Windy	Yes
	La concha	1000	High	Golden	Moderate	Windy	Yes
	Comillas	900	High	Golden	Moderate	Windy	No
	Gerra	900	Medium	Golden	Heavy	Windy	Yes
Asturias	San Antolín	1200	High	White	Heavy	Windy	Yes
	Vega	1440	Medium	Golden	Heavy	Windy	Yes
	Santa Marina	1150	High	Golden	Moderate	Windy	No
	La Atalaya	100	Low	Golden	Moderate	Windy	No
	Arra	320	Low	Golden	Moderate	Windy	No
	Lastres	1150	High	Golden	Heavy	Windy	Yes
	Rodiles	1100	High	Golden	Heavy	Windy	Yes
	San Lorenzo	1500	High	Golden	Moderate	–	No
	Carreño	800	High	White	Moderate	–	No
	Xagó	1700	High	Golden	Heavy	–	Yes
	El sablón	2800	High	Golden	Heavy	–	Yes
	Quebrantos	810	High	Dark	Heavy	–	Yes
	San Pedro	390	High	Golden	Moderate	–	No
	Frejulfe	820	High	Dark	Heavy	–	No
	La Grande	410	High	Golden	Moderate	–	Yes
	Peñarronda	600	High	Golden	Moderate	Windy	Yes
Lugo	Longera	400	High	White	Moderate	–	Yes
	Altar	1100	Medium	White	Moderate	–	No
	Coto	1900	Medium	White	Moderate	–	No
	San Miguel	1200	Medium	White	Moderate	–	No
	A Rapadoira	270	High	White	Moderate	–	Yes
	Marosa	250	Medium	White	Moderate	–	No
	Esteiro	400	Medium	Golden	Heavy	–	Yes
	Esteiro de Bares	1000	Medium	Golden	Still water	–	Yes

References

[1] A. Attard, R.W. Brander, W.S. Shaw, Rescues conducted by surfers on Australian beaches, Accid. Anal. Prev. 82 (2015) 70–78.

[2] R. Ballantyne, N. Carr, K. Hughes, Between the flags: an assessment of domestic and international university students' knowledge of beach safety in Australia, Tour. Manag. 26 (4) (2005) 617–622.

[3] R. Barcala-Furelos, P. Carbia-Rodríguez, L. Peixoto-Pino, C. Abelairas-Gómez, A. Rodríguez-Núñez, Implementation of educational programs to prevent drowning. What can be done in nursery school? Med. Intensiv. (2017) https://doi.org/10.1016/j.medin.2017.08.005.

[4] I. Basterretxea-Iribar, I. Sotes, M.M. Maruri, Managing bathers' capacity at overcrowded beaches: A case on the Spanish North Atlantic coast, Tour. Manag. 71 (2019) 453–465.

[5] BFA (Bizkaia Foru Aldundia) 2018. Informe del observatorio de turismo 2018. Retrieved from: ⟨https://www.visitbiscay.eus/es/web/profesionales-y-medios/estadisticas⟩ (Accessed 22/02/2022).

[6] C. Bordehore, C. Alonso, L. Sánchez-Fernández, A. Canepa, M. Acevedo, S. Nogué, V.L. Fuentes, Lifeguard assistance at Spanish Mediterranean beaches: Jellyfish prevail and proposals for improving risk management, Ocean Coast. Manag. 131 (2016) 45–52.

[7] R.W. Brander, Chapter 12 - Rip currents, in: Coastal and Marine Hazards, Risks, and Disasters, Elsevier, 2015, pp. 335–379.

[8] R.W. Brander, D. Drozdzewski, D. Dominey-Howes, Dye in the water: a visual approach to communicating the rip current hazard, Sci. Commun. 36 (6) (2014) 802–810.

[9] C. Brannstrom, H.L. Brown, C. Houser, S. Trimble, A. Santos, You can't see them from sitting here: evaluating beach user understanding of a rip current warning sign, Appl. Geogr. 56 (2015) 61–70.

[10] B.C. Brewster, R. Gould, Comment on Rip current related drowning deaths and rescues in Australia 2004–2011 by Brighton et al. (2013), Nat. Hazards Earth Syst. Sci. 14 (2014) 2203–2204.

[11] B.C. Brewster, R.E. Gould, R.W. Brander, Estimations of rip current rescues and drowning in the United States, Nat. Hazards Earth Syst. Sci. 19 (2019) 389–397.

[12] B. Brighton, S. Sherker, R. Brander, M. Thompson, A. Bradstreet, Rip current related drowning deaths and rescues in Australia 2004–2011, Nat. Hazards Earth Syst. Sci. 13 (2013) 1069–1075.

[13] N. Bruneau, X. Bertin, B. Castelle, Philippe Bonneton, Tide-induced flow signature in rip currents on a meso-macrotidal beach, Ocean Model. 74 (2014) 53–59.

[14] M. Bruno, Application and refinement of the WHO risk framework for recreational waters in Sydney, Australia, J. Water Health 1 (3) (2003) 125–131.

[15] Castelle, B., Almar, R., Dorel, M., Lefebvre, J.P., Sénéchal, N., Anthony, E.J., Laibi, R., Chuchla, R., du Penhoat, Y., 2014. Rip currents and circulation on a high-energy low-tide-terraced beach (Grand Popo, Benin, West Africa). In: Proceedings 13th International Coastal Symposium (Durban, South Africa), Journal of Coastal Research, Special Issue 70, 633–638.

[16] B. Castelle, T. Scott, R. Brander, J. McCarroll, A. Robinet, E. Tellier, E. Korte, B. Simonnet, L.R. Salmi, Environmental controls on surf zone injuries on high-energy beaches, Nat. Hazards Earth Syst. Sci. 19 (2019) 2183–2205.

[17] B. Castelle, T. Scott, R.W. Brander, R.J. McCarroll, Rip current types, circulation and hazard, Earth-Sci. Rev. 163 (2016) 1–21.

[18] CIRCULAIRE 86–204 du 19 juin 1986. Surveillance des plages et lieux de baignade d'accès non payant. ⟨http://baignades.sante.gouv.fr/baignades/editorial/fr/controle/Circulaire%2086–204%20du%2019%20juin%201986.htm⟩.

[19] K.M. Clifford, R.W. Brander, S. Trimble, C. Houser, Beach safety knowledge of visiting international study abroad students to Australia, Tour. Manag. 69 (2018) 487–497.

[20] Coast Law 22/1988, 1988. Retrieved from: ⟨https://www.boe.es/buscar/doc.php?id=BOE-A-1988–18762⟩ (Accessed 01/10/2017).

[21] Criado-Sudau, F.F., Nemes, D.D., Gallo, M.N., 2019. Rip currents dynamic of a swell dominated microtidal beach. In: Silva, R., Martínez, M.L., Chávez, V., and Lithgow, D. (eds.), Integrating Biophysical Components in Coastal Engineering Practices. Journal of Coastal Research, Special Issue No. 92, pp. 121–127. Coconut Creek (Florida).

[22] L. Crowley-Cyr, Public authority responses to marine stinger public health risks: a scenario analysis of the Irukandji health threat in controlled spaces at public beaches in Australia, J. Law Med. 20 (2) (2012) 363–379.

[23] R.A. Dalrymple, J.H. MacMahan, A.J.H.M. Reniers, V. Nelko, Rip currents, Annu. Rev. Fluid Mech. 43 (2011) 551–581.

[24] Davila-Lamas, A.D., Carbajal-Hernandez, J.J., Sanchez-Fernandez, L.P., Hoil-Rosas, C.A., 2019. Analytical hierarchy process based model for safety assessment of coastal touristic locations. In: Carrasco, J.A., Martinez, J.F., Olvera, J.A, Salas, J. (Eds.), 2019. 11th Mexican Conference on Pattern Recognition (MCPR), Queretaro, Mexico, (Springer), pp. 357–367.

[25] I. De Santiago D. Morichon S. Abadie B. Castelle P. Liria I. Epelde Video observation of the morphodynamics of nearshore sandbars on a partially engineered embayed beach. In: Proceedings 12th International Coastal Symposium (Plymouth, England) Journal of Coastal Research, Special Issue, (Coastal Education & Research Foundation, Inc), 65 2013 458–463.

[26] M.L. Dicken, A.J. Booth, Surveys of white sharks (Carcharodon carcharias) off bathing beaches in Algoa Bay, South Africa, Mar. Freshw. Res. 64 (6) (2013) 530–539.

[27] DOG, 2001. RESOLUCIÓN de 22 de mayo de 2001, de la Dirección General de Interior y Protección Civil, por la que se dispone la publicación de la revisión y actualización el Plan de Salvamento en Playas de Galicia (Plan Sapraga), homologado por la Comisión Gallega de Protección Civil. Retrieved from: ⟨https://www.xunta.gal/dog/Publicados/2001/20010619/Anuncio8582_es.html⟩. (Accessed: 01/03/2020).

[28] DOG, 2017. Decreto 35/2017, de 30 de marzo, por el que se modifica el Decreto 104/2012, de 16 de marzo, por el que se fija la formación mínima de los socorristas acuáticos y se crea y regula el Registro Profesional de Socorristas Acuáticos de Galicia. Retrieved from: ⟨https://www.xunta.gal/dog/Publicados/2012/20120409/AnuncioC3C1–020412-14235_es.pdf⟩. (Accessed: 01/03/2020).

[29] Dong-Soo Hur, Woo-Dong Lee, Won-Chul Cho, Yeong-Han Jeong, Yeon-Myeong Jeong, Rip current reduction at the open inlet between double submerged breakwaters by installing a drainage channel, Ocean Eng. 193 (2019) 106–580.

[30] J. Fletemeyer, S. Leatherman, Rip currents and beach safety education, J. Coast. Res. 26 (1) (2010) 1–3.

[31] FLORIDA, 2020. Florida Department of Environmental Protection. Beach Warning Flag Specifications. Retrieved from: ⟨https://floridadep.gov/rcp/fcmp/content/beach-warning-flag-specifications⟩. (Accessed: 01/03/2020).

[32] FOMENTO, 2012. Resolución del Capitán Marítimo de Bilbao de 9 de marzo de 2012, por la que se determinan y desarrollan normas generales de navegación y seguridad marítima en las aguas marítimas de la provincia marítima de Bilbao.

[33] FOMENTO, 2016. Resolución del Capitán Marítimo de Bilbao de 18 de mayo de 2016, por la que se determinan y desarrollan normas generales de navegación y seguridad marítima en las aguas marítimas de la provincia marítima de Bilbao.

[35] S. Gaztelumendi, J. Egana, P. Liria, M. Gonzalez, J.A. Aranda, P. Anitua, The new Euskalmet coastal-maritime warning system, Adv. Sci. Res. 13 (2016) 91–96.

[36] George, P., 2011. Is it possible to achieve an International Beach Safety Flag system?. Retrieved from: ⟨https://www.ilsf.org/library/international-signs-and-beach-safety-flags-is-it-possible-to-achieve-an-international-beach-safety-flag-system/⟩. (Accessed 01/04/2020).

[37] P. Gomes da Silva, R. Medina, M. González, R. Garnier, Infragravity swash parameterization on beaches: the role of the profile shape and the morphodynamic beach state, Coast. Eng. 136 (2018) 41–55.

[38] J. Hatfield, A. Williamson, S. Sherker, R. Brander, A. Hayen, Development and evaluation of an intervention to reduce rip current related beach drowning, Accid. Anal. Prev. 46 (2012) 45–51.

[39] C. Houser, J. Lehner, N. Cherry, P. Wernette, Machine learning analysis of lifeguard flagdecisions and recorded rescues, Nat. Hazards Earth Syst. Sci. 19 (2019) 2541–2549.

[40] IDE, 2020. Guia de playas. Retrieved from: ⟨https://www.miteco.gob.es/es/cartografia-y-sig/ide/descargas/costas-medio-marino/guia-playas-descargas.aspx⟩. (Accessed 02/03/2020).

[41] IGN, 2020. Longitud de la línea de costa por provincias. Retrieved from: ⟨http://www.ign.es/web/ign/portal/ane-datos-geograficos/-/datos-geograficos/datosGenerales?tipoBusqueda=longCosta⟩. (Accessed: 02/03/2020).

[42] ILS, 2010. Beach Safety and Information Flags. Retrieved from: ⟨https://www.ilsf.org/wp-content/uploads/2019/01/LPS-14–2010-Flags.pdf⟩. (Accessed 02/03/2020).

[43] D.M. Kennedy, D. Ierodiaconou, A. Weir, B. Brighton, Wave hazards on microtidal shore platforms: testing the relationship between morphology and exposure, Nat. Hazards 86 (2017) 741–755, https://doi.org/10.1007/s11069-016-2714-1.

[44] D.M. Kennedy, S. Sherker, B. Brighton, A. Weir, C.D. Woodroffe, Rocky coast hazards and public safety: moving beyond the beach in coastal risk management, Ocean Coast. Manag. 82 (2013) 85–94, https://doi.org/10.1016/j.ocecoaman.2013.06.001.

[45] K.R. Laughery, Safety communications: warnings, Appl. Ergon. 37 (4) (2006) 467–478.

[46] K.R. Laughery, M.S. Wogalter, A three-stage model summarizes product warning and environmental sign research, Saf. Sci. 61 (2014) 3–10.

[47] J. Lee, J. Park, I. Kim, D.Y. Kang, Application of vision-based safety warning system to Haeundae Beach, Korea, J. Coast. Res. 91 (2019) 216–220 (The 3rd International Water Safety Symposium).

[48] M.F. Lesch, P.L.P. Rau, Z. Zhao, C. Liu, A cross-cultural comparison of perceived hazard in response to warning components and configurations: US vs, China Appl. Ergon. 40 (2009) 953–961.

[49] B. Matthews, R. Andronaco, A. Adams, Warning signs at beaches: Do they work? Saf. Sci. 62 (2014) 312–318.

[50] MCA, 2014. Keeping safe at the coast: beach safety advice. Advice from the Maritime and Coastguard Agency (MCA) about staying safe on the UK's beaches. Retrieved from: ⟨https://www.gov.uk/government/publications/keeping-safe-at-the-coast-beach-safety-advice⟩. (Accessed: 03/02/2020).

[51] M. Monge-Ganuzas, J. Gainza, P. Liria, I. Epelde, A. Uriarte, R. Garnier, M. González, P. Nuñez, C. Jaramillo, R. Medina, Morphodynamic evolution of Laida beach (Oka estuary, Urdaibai Biosphere Reserve, southeastern Bay of Biscay) in response to supratidal beach nourishment actions, J. Sea Res. 130 (2017) 85–95.

[53] K. Moran, A. Gilmore, Children's understanding of water safety and perceptions of risk at the beach, N. Z. J. Educ. Stud. 53 (2) (2018) 227–239.

[54] D. Morgan, J. Ozanne-Smith, T. Triggs, Descriptive epidemiology of drowning deaths in a surf beach swimmer and surfer population, Inj. Prev. 14 (1) (2008) 62–65.

[55] C. Neff, Australian beach safety and the politics of shark attacks, Coast. Manag. 40 (1) (2012) 88–106.

[56] J. Neves, F.M. da Silva, D. Raposo, J. Silva, Ergonomics and warning design: standardization of graphical symbols for safety signs, Adv. Intell. Syst. Comput. 588 (2018) 233–240.

[57] Orden, 1972 por la que se dictan normas e instrucciones para la seguridad humana en los lugares de baño. Retrieved from: ⟨https://www.boe.es/diario_boe/txt.php?id=BOE-A-1972–1153⟩.

[58] X.A. Padin, A. Alonso-Fernández, A. Lijó, V. Otero, J. Otero, Environmental drivers of lesser weever stings on the northeast Atlantic coast (A Lanzada beach, Spain), Ecol. Indic. 95 (1) (2018) 242–249.

[59] A. Pascual, A. Cearreta, J. Rodríguez-Lázaro, A. Uriarte, Chapter 3 – Geology and Palaeoceanography. Elsevier Oceanography Series, Elsevier, 2004, pp. 53–73.

[60] S.J. Pitman, D. Lee, Determining the accuracy of visual wave height observations and the perception of surfzone hazards made by lifeguards, J. Coast. Res. 35 (4) (2019) 776–783.

[61] Ports Law 27/1992, 1992. Retrieved from: ⟨https://www.boe.es/buscar/act.php?id=BOE-A-2011–16467⟩. (Accessed 19/04/2020).

[62] E. Pranzini, G. Pezzini, G. Anfuso, C.M. Botero, Beach safety management, in: C. Botero, O. Cervantes, C. Finkl (Eds.), Beach Management Tools – Concepts, Methodologies and Case Studies. Coastal Research Library, vol 24, Springer, Cham, 2018, pp. 397–420.

[63] Puertos, 2019. Puertos del Estado Oceanografía. ⟨http://www.puertos.es/es-es/oceanografia/Paginas/portus.aspx⟩. (Accessed 07/10/2019).

[64] Real Decreto 711/2011, 2011. por el que se establecen tres certificados de profesionalidad de la familia profesional Actividades físicas y deportivas que se incluyen en el Repertorio Nacional de certificados de profesionalidad y se actualiza el certificado de profesionalidad establecido en el Real Decreto 1209/2009, de 17 de julio. Retrieved from: ⟨https://www.boe.es/buscar/doc.php?id=BOE-A-2011–10056⟩. (Accessed 01/03/2022).

[65] RFESS, 2018. Real Federación Española de Salvamento y Socorrismo. La Federación Española reclama una formación de calidad y no de cantidad para que haya vigilancia en todos los espacios acuáticos. retrieved from: ⟨https://rfess.es/2018/06/2018–06-27-falta-de-socorristas-en-galicia/#.Yi9m0jWCFhE⟩. (Accessed 01/03/2022).

[66] RFESS, 2020. Real Federación Española de Salvamento y Socorrismo. Informe Anual de Ahogamientos. Retrieved from: ⟨https://rfess.es/2020/01/informe-nacional-de-ahogamientos-ina-compartiva-2015–2019/#.Xsj9Zn9S-Um⟩. (Accessed: 01/05/2020).
[67] RLSS UK, 2020. Water safety at the beach. Retrieved from: ⟨https://www.rlss.org.uk/water-safety-at-the-beach⟩. (Accessed: 01/03/2020).
[68] RLSS, 2008. Using signage to promote water safety and prevent aquatic related injuries in Australia: An examination of the key issues. Retrieved from: ⟨https://www.royallifesaving.com.au/_data/assets/pdf_file/0014/4046/Water_Safety_Signs_-_Final_July_2008.pdf⟩. (Accessed 19/04/2020).
[69] RNLI, 2007. A guide to beach safety signs, flags and symbols. Retrieved from: ⟨https://rnli.org/what-we-do/lifeguards-and-beaches/how-we-keep-beaches-safe⟩. (Accessed: 01/03/2020).
[70] M.P. Ropero, Physical environment of Plentzia. Need and ability of its inhabitants to modify the environment and adapt themselves to it. Uned. Espacio, Tiempo y Forma. Serie VI, Nueva época, Geografía 2 (2009) 69–84.
[71] M. Sanders, E. McCormick, Human factors in engineering and design, Ind. Robot 25 (2) (1998), https://doi.org/10.1108/ir.1998.25.2.153.2.
[72] SAPLA, 2020. Plan de salvamento en Playas del principado de Asturias 2020. Retrieved from: ⟨http://www.112asturias.es/v_portal/apartados/apartado.asp?te=66⟩ (Accessed 15/04/2020).
[73] T. Scott, B. Castelle, R. Almar, N. Senechal, F. Floc'h, G. Detandt, Controls on flash rip current hazard on low-tide terraced tropical beaches in West Africa. Tropical Coastal and Estuarine Dynamics, J. Coast. Res. Spec. Issue 81 (2018) 92–99.
[74] S. Sherker, A. Williamson, J. Hatfield, R. Brander, A. Hayend, Beachgoers' beliefs and behaviours in relation to beach flags and rip currents, Accid. Anal. Prev. 42 (2010) 1785–1804.
[75] SIG, 2018. Sistema Integrado de Gestión. Gestión de Salvamento y Socorrismo. Retrieved from: http://www.bizkaia.eus/herri_administrazioa/kontratu_publikoak/descargar_documento.asp?Ruta=2006\2006–00168\BT\Salvamento%20y%20socorrismo%2007–08\SOS%20ANEXO%201%20_GESTION%20SALVAMENTO%20Y%20SOCORRISMO_%20-%20CAST.pdf. (Accessed: 01/06/2018).
[76] J.S. Silva-Cavalcanti, M.F. Costa, P.S. Pereira, Rip currents signaling and users behaviour at an overcrowded urban beach, Ocean Coast. Manag. 155 (2018) 90–97.
[77] SLS, 2020. Beach flags and signs – Surf Life Saving. Retrieved from: ⟨https://beachsafe.org.au/surf-safety/flags-and-signs⟩. (Accessed: 01/03/2020).
[78] T. Smith-Jackson, Culture and warnings, in: M.S. Wogalter (Ed.), Handbook of Warnings, Lawrence Erlbaum Associates, Mahwah, NJ, 2006, pp. 363–371.
[79] I. Sotes, I. Basterretxea-Iribar, Mercedes Maruri, Maria de las, Are the Biscayne Universitary students ready to go to the beach safely? Ocean Coast. Manag. 151 (2018) 134–149.
[80] I. Sotes, I. Basterretxea-Iribar, J. Sanchez-Beaskoetxea, Maria de las Mercedes Maruri, Environment understanding, signage perception and safety education in Biscay beachgoers under the view of lifeguards, Ocean Coast. Manag. 189 (2020), 105149, https://doi.org/10.1016/j.ocecoaman.2020.105149.
[81] Sud Ouest, 2016. Baignade et surf: ce que signifient les drapeaux sur les plages. Retrieved from: ⟨https://www.sudouest.fr/2016/07/01/baignade-et-surf-ce-que-signifie-les-drapeaux-sur-les-plages-2420884–4018.php⟩ (Accessed: 13/04/2020).
[82] D. Szpilman, M. Tipton, J. Sempsrott, J. Webber, J. Bierens, P. Dawes, A. C. Queiroga, Drowning timeline: a new systematic model of the drowning process, Am. J. Emerg. Med. 34 (11) (2016) 2224–2226, https://doi.org/10.1016/j.ajem.2016.07.063.
[83] L.E. Usher, E. Gomez, Managing stoke: crowding, conflicts, and coping among Virginia beach surfers, J. Park Recreat. Adm. 35 (2) (2017) 9–24.
[84] N.M. Warton, R.W. Brander, Improving tourist beach safety awareness: the benefits of watching Bondi Rescue, Tour. Manag. 63 (2017) 187–200.
[85] WHO, Global Report on Drowning: Preventing a Leading Killer, World Health Organization Press, World Health Organization,, Geneva, Switzerland, 2014.
[86] J. Wilks, H. Kanasa, D. Pendergast, K. Clark, Beach safety education for primary school children, Int. J. Inj. Control Saf. Promot. 24 (3) (2017) 283–292.
[87] M.S. Wogalter, T. Barlow, S.A. Murphy, Compliance to owner's manual warnings: influence of familiarity and the placement of a supplemental directive, Ergonomics 38 (1995) 1081–1091.
[88] L. Benedet, C.W. Finkl, T. Campbell, A. Klein, Predicting the effect of beach nourishment and cross-shore sediment variation on beach morphodynamic assessment, Coastal Engineering 51 (8–9) (2004) 839–861.