

## **Public perception and social network analysis for coastal risk management in Maresme Sud (Barcelona, Catalonia).**

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**Abstract**

Understanding the governance system, stakeholder relationships and perceptions of coastal landscape risk is essential to improving the sustainability of coastal environments. Our main objective was to analyse social networks for the Maresme Sud coastal area in Catalonia and examine public perceptions of risk in order to shed light on how the current governance system could be improved to promote more adaptive coastal landscape risk management. Our methodology was based on semi-structured interviews of key stakeholders and a social network analysis, which provided context-based information on stakeholder interactions and power relationships and the transfer and diffusion of different types of knowledge. In Maresme Sud, the strong presence of public bodies makes the integration of more adaptive and innovative discourses in coastal management practices more difficult. The role of supra-local stakeholders, currently poorly represented in the network, should be enhanced. Coastal partnerships could also act as bridging organizations to facilitate learning, cooperation and knowledge exchange among stakeholders.

**Keywords**

Public perceptions, coastal risk management, social network analysis, Maresme coast.

## 1. Introduction

Risk management is a complex issue due to inherent uncertainties, multiscale dynamics and many competing interests. The issue is particularly significant in coastal areas because of the many physical, environmental and socioeconomic components that are simultaneously affected by natural and anthropogenic threats. In Catalonia, with over 70% of 7.5 million inhabitants living in a 20-km wide coastal corridor, pressure on the coastal fabric is great. The few natural resources that remain are being mortgaged and the coast is under pressure from human activities and uses and from natural phenomena requiring significant management efforts, namely storm surges, rising sea levels and erosion. Moreover, climate change forecasts point to an increase in certain risks (mainly meteorological and geomorphological) that further enhance the tendency to erosion (Arcilla et al., 2012, Mendoza et al., 2006). All these pressures have increased damage to the Catalan coast at a rate of about 40% per decade over the last 50 years (Jiménez et al., 2012). Although scientific understanding of these natural phenomena is growing, assessment of damage and of impact on human activities is often poor; lacking in particular is an overall assessment of coastal risk (Guillen, 2008).

Within the Catalan PaiRisC<sup>1</sup> project, the concept of coastal risk landscape is used to define all risks to which coastal areas are exposed and that require a systemic approach to their characterization in terms of identifying phenomena and their impacts and mechanisms of action, feedback loops and stakeholder perceptions. According to Slovic (2000), defining risk is an exercise in power, as it is inherently subjective and any management strategy will depend on how risk is defined. Therefore, paying attention to perceptions and understanding risks and related factors (psychological, social, institutional and cultural) will, in the long run, improve the relevance and quality of technical analysis and may make the resulting decisions more acceptable (Pearce, 2005; Slovic, 2000). Risk governance and social networks affect perceptions, beliefs and actions through a variety of structural mechanisms that are socially constructed according to relationships between organizations (Knoke and Yang, 2008). Hence understanding the governance system, stakeholder relationships and perceptions

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<sup>1</sup> <http://lim-ciirc.upc.es/pairiscm>.

1 regarding coastal risk landscape management is essential to improving the sustainability  
2 of coastal environments (Olsen, 2000).

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4 Integrated coastal zone management (ICZM) indicates adaptation to be one of the most  
5 promising principles to promote sustainability of coastal areas. Adaptation is a  
6 multidimensional concept of relevance to different management areas, from technical  
7 strategies to cope with threats of climate change — such as “working with nature”  
8 options as promoted by IPCC (2007) — to the design of appropriate governance  
9 systems. Our interest lies in the latter, given that institutional aspects can become  
10 barriers or facilitators of adaptive management.

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12 The networks of stakeholders involved in coastal management can take certain more or  
13 less complex forms or structures, with densities that foster the implementation of  
14 management strategies that are more adaptive to different risks. Ostrom (2005, 2010)  
15 has shown how various horizontal, multiscale structures with interacting networks are  
16 more suitable for the management of natural resources. Accessibility to and circulation  
17 and communication of different types of reliable information are key aspects of this  
18 management, which is also linked to social networks (Folke et al., 2005). The  
19 complexity of networks, even if they are a ‘mess of interactions’, forms the social raw  
20 material that shapes capacity to identify new information, to learn and to cope with  
21 change (Pelling and High, 2005).

22  
23 Adaptive capacity also depends on a balance of power (Scheffer, Westley and Brock.  
24 2003) that gives all stakeholders a voice in decision making. Voices related to  
25 perceptions, values and discourses on sustainability problems can either enhance ICZM  
26 or constrain it, depending on the power and the discourse of each stakeholder. ICZM is  
27 enhanced when there is appropriate understanding of a problem and of possible  
28 solutions and is constrained when deep-rooted individual or societal attitudes and  
29 behaviours undermine the ability to adapt to new situations (Scheffer and Westley  
30 2007). For this reason, perceptual analyses may complement social network analyses.

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32 Our main aim was to analyse public perceptions and social networks for a coastal area  
33 in order to shed light on how the current governance system could foster a more  
34 adaptive form of coastal landscape risk management and enhance the capacity to cope  
35 with risks. In particular, we aimed to identify and inventory stakeholders, analyse risk  
36 management perceptions and discourses and perform social network analysis to  
37 examine links between stakeholders.  
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1 The methodology was applied to Maresme Sud, a densely populated coastal region  
2 lying a short distance north of Barcelona (Catalonia), where transport infrastructures  
3 and recreational uses are at risk.  
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## 8 **2. Methodology**

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10 We collected both qualitative and quantitative data given that this approach is highly  
11 appropriate for sustainability research (Flick, 2006; Bryman, 2001).  
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### 13 **2.1. Documentary and press review**

14 Context matters in coastal management and sustainability issues. Socioeconomic, urban  
15 and land planning characteristics reflect a scenario marked by features that enhance and  
16 add complexity, in our case, population density, many uses and multiple sources of risk  
17 (mainly storm surges and torrential rain). We therefore conducted a documentary review  
18 and investigated urban development and land uses in order to characterize risk in terms  
19 of main sources and potential damages.  
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22 An analysis of local press articles covering risk episodes from recent years yielded an  
23 inventory of stakeholders with management responsibilities or with socioeconomic and  
24 environmental expertise or interest in coastal risk management. Stakeholders were  
25 defined as individuals, groups, organizations or communities, whether formally or  
26 informally interlinked, involved in or affected by decisions to plan and manage coastal  
27 resources (Rockloff and Lockie, 2004). In our approach, we considered stakeholders to  
28 be the most important providers of suitable information on which to base our risk  
29 perception and social network analyses.  
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43 **Table 1:** Inventory of Maresme Sud coastal stakeholders.  
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### 46 **2.2. Semi-structured interviews**

47 To analyse perceptions of the main risks and their socioeconomic and environmental  
48 impacts and to examine relationships between stakeholders, semi-structured interviews  
49 were conducted with experts, managers and other local stakeholders. On the basis of the  
50 stakeholder inventory, a total of 15 interviews were conducted with state-, regional- and  
51 municipal-level risk and coastal planning representatives, socioeconomic and  
52 environmental group representatives and scientific experts.  
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1 The questionnaire had two parts. The first part, aimed at identifying perceptions of risk  
2 impact on infrastructures and economic and leisure activities, consisted of a set of open  
3 questions regarding hazards, impacts, strategies and institutions whose answers were  
4 transcribed and processed using content analysis. This part also included a closed  
5 question that helped synthesize and rate impacts on beach facilities, transport and  
6 mobility infrastructure, marinas, promenades and pathways, campsites, farms,  
7 environmental quality, landscape etc. The results obtained for this part were expressed  
8 in terms of social perceptions and discourses.  
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10 The second part of the questionnaire characterized and quantified relationships between  
11 stakeholders. Respondents were asked which other stakeholders they contacted when  
12 planning and managing risks and whether the contact was made formally (via a law,  
13 plan or project) or informally (due to a personal relationship or geographic proximity).  
14 This information was used to carry out the social network analysis.  
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### 16 **2.3. Social network analysis**

17 Social network theory (Wasserman and Faust, 1994, Degenne and Forsé, 1999) is a  
18 powerful means for quantitatively measuring the number, types, and intensity of social  
19 interactions between social groups. A social network is a structure composed of a set of  
20 stakeholders, some of whose members are connected by a set of one or more  
21 relationships (Knoke and Yang, 2008). The value of social network analysis is that it  
22 provides insights into network density and cohesion and stakeholder importance,  
23 centrality and influence. As quite a novel approach to analysing complex sustainability  
24 problems, it is being used by several authors (Berkes et al. 2003, Adger et al. 2005,  
25 Bodin and Prell. 2011, Crona and et Bodin, 2006, Crona and Parker, 2012, Budapest-  
26 Mengual and Franquesa 2009). to shed light on power relationships and knowledge  
27 distribution in the management of natural resources.  
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29 In social network language, stakeholders' attributes and relationships are presented in  
30 graphs using 'nodes' and 'edges'. Nodes representing stakeholders and edges linking  
31 nodes portray the strength and intimacy of connections between stakeholders, thereby  
32 providing insights to their importance, centrality and influence.  
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34 We mapped the Maresme Sud network drawing on our inventory of stakeholders  
35 (nodes). To identify and quantify relationships (edges) we asked respondents about  
36 other stakeholders they contacted when planning and managing risks.  
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1 We distinguished between formal and informal relationships by asking whether contact  
2 was made via a plan or event or due to personal or geographic proximity. Formal  
3 relationships included interactions contemplated in plans or regulations governing  
4 coastal risk planning and management, namely, consultation, participation, licenses,  
5 authorization, promotion. They were recorded in binary fashion as existing (1) if a  
6 regulation or plan connected both institutions, and otherwise as non-existing (0). Their  
7 existence was mainly deduced from the documentary review and validated through the  
8 in-depth interviews. Informal relationships included ad hoc interactions resulting from  
9 geographic proximity, ideological affinities, etc, which could potentially facilitate  
10 collaboration in new initiatives. These were evaluated on an ordinal scale as non-  
11 existing (0), weak/sporadic (1) or strong/frequent (2), according to the interviewee and  
12 the interpretation of the researcher conducting the interview.

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14 The information collected was processed using the open-source software Gephi<sup>2</sup> which  
15 enabled us to analyse our social network of coastal risk stakeholders for the Maresme  
16 Sud area. The resulting graphs — which reflect how well stakeholders are connected —  
17 were drawn according to node size, which indicates ‘betweenness centrality’ and  
18 ‘closeness centrality’ (two formal network measures). Stakeholders with high  
19 betweenness centrality or closeness centrality can be said to play a potentially important  
20 connecting role in a network of cooperating stakeholders and thus are an indicator of  
21 power and influential capacity (Knoke and Yang, 2008).

22  
23 Closeness centrality takes into account relevant links of a stakeholder with other  
24 stakeholders. A stakeholder may be linked to many other nodes but these nodes may not  
25 be central to a network. Closeness centrality refers to how quickly a stakeholder can  
26 interact with others, by communicating directly or through very few intermediaries  
27 (Knoke and Yang, 2008). We used closeness centrality to represent the local scale and  
28 betweenness centrality to depict the entire network of stakeholders, as this shows the  
29 most influential stakeholders located in geodesic routes between other pairs of  
30 stakeholders in the network (Knoke and Yang, 2008).

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32 Finally, another indicator used was the density of the network, used to compare network  
33 cohesion in the stakeholder system at the local level and reflecting real relationships  
34 relative to potential relationships.

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1 The results were expressed in graphs and indicators and interpreted and validated in the  
2 light of qualitative information from the in-depth interviews.  
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### 6 **3. Case study**

#### 7 **3.1. Territorial context**

8 The case study was conducted in Maresme Sud (Figure 1), a coastal region lying a short  
9 distance north of Barcelona (Catalonia). In socioeconomic and urban terms, the  
10 development of the five municipalities in the area (Montgat, El Masnou, Premià,  
11 Vilassar and Cabrera) has been linked to the growth of the Barcelona Metropolitan Area  
12 and to public transport developments, especially from the 1960s.  
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19 The modern development of the Maresme Sud area, which begun around the end of the  
20 nineteenth century, intensified with the advent of the railway and the gradual  
21 construction of a rail network that aided the population shift to coastal areas. This area  
22 was initially popular as a location for summer residences and for recreation, most  
23 especially for activities associated with the beaches and the sea. The main boom in  
24 urban growth occurred in the 1960s, when expansion of the Barcelona Metropolitan  
25 Area resulted in further development along the coastline, typically of a more permanent  
26 nature (that is, more residential than touristic). Driving population growth were factors  
27 such as the enhanced quality of life, more affordable housing and services and transport  
28 options that enabled links to be maintained with Barcelona. In the five municipalities  
29 studied, population rose from 35,155 inhabitants in 1970 to 86,009 inhabitants in 2012<sup>3</sup>.  
30 The mobility role played by road and rail communications consolidated the switch from  
31 an area of seasonal summer residences to permanent residences.  
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#### 45 **Fig. 1:** Location of Maresme Sud

46 Source: Cartographic Institute of Catalonia ([www.icc.cat](http://www.icc.cat))  
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50 A lack of planning accompanied the early stages of urban development in this area.  
51 Another element that explains the saturation of this region is the intensity of land use,  
52 extending south to north and from the coast inland, with maximum intensity focused on  
53 the coastal towns. In addition, given the proximity between the sea and the lower slopes  
54 of the coastal mountain range (Serralada Litoral), there is little suitable land left for  
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60 <sup>3</sup> IDESCAT- Catalan Institute of Statistics  
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1 agriculture or for development. The land occupation percentage is consequently very  
2 high. Town planning legislation referring to the entire county 20 years ago indicated  
3 that 55% of land was built on or committed to development in the short term; in  
4 Maresme Sud, this percentage was 70% (Lleonart, 1995; Parcerisas, 2012).  
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7 This situation has, from a social and environmental point of view, led to progressive  
8 inefficiency in land use that is particularly pronounced in the coastal area given its great  
9 sensitivity to the resulting impacts. The main evidence of deficient planning is the high  
10 level of residential growth, the disappearance of agricultural land and woods and  
11 interference with rivers and streams, with new barriers shaped by urban and  
12 infrastructure growth increasing the impermeability of the soil and blocking off almost  
13 all the mountain-sea corridors (Parcerisas, 2012; Marrull et al., 2008).  
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16 In the long and narrow Maresme Sud corridor, urban saturation – the result of urban  
17 growth and the nature of the building stock – is intensified by the fact that this corridor  
18 also contains a secondary road (N-II) and a railway line (by the coast), as well as a  
19 motorway (the C-32) built further inland. The N-II interconnects the towns in the area  
20 and also fulfils a local urban function. As well as being extremely saturated in general,  
21 it has one the highest accident rates in Catalonia. The C-32, which was built in the late  
22 1960s as an alternative to the saturated N-II, has even more definitively contributed to  
23 population growth and urban development in the Maresme region.  
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26 The railway, much improved in the last 20 years, in terms of mobility and infrastructure,  
27 brings crowds onto the beaches of the Maresme, mainly people escaping the saturation  
28 of the city beaches of Barcelona. Montgat, the largest of the towns in the studied region,  
29 has also become particularly attractive as a residential area, since it is included in  
30 Barcelona's public transport zone 1 and the city's eastern metropolitan transport lines  
31 terminate there. The fact that the railway and the parallel N-II road cross the county  
32 from end to end parallel to the sea separates the shoreline from the towns. Hence, for the  
33 towns, access to the beaches and seaside promenades is neither easy nor safe.  
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### 36 **3.2. Coastal risks**

37 The waterfront promenades and beaches provide the physical basis for use of the  
38 Catalan coast for recreation and leisure purposes, but also have a coastal defence  
39 function. The Maresme area, however, has an extra function, which is its  
40 accommodation of a transport infrastructure consisting of a road, a railway line and a  
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1 motorway that communicate inland residential areas, coastal urban areas and the  
2 promenades and beaches.

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4 The area is very much marked by unstable coastal dynamics. It suffers a sediment  
5 deficit given the lack of input from rivers and streams, the result of coastal dynamics  
6 disrupted by maritime works that cause an ongoing loss of sand, especially accentuated  
7 during storms. The laying of the railway line in the coastal corridor led to the loss of a  
8 significant part of the beaches, but especially of the dunes that played a key role in  
9 limiting and regulating sand exchange and protecting the coast. The erosion threat posed  
10 for the railway eventually led to the construction of a parallel breakwater. A double  
11 track laid to the northern part of this region in the 1980s also had to be protected by a  
12 breakwater, which further reduced beaches in the southern and central parts of the  
13 Maresme.

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15 The study area contains almost 90,000 year-round inhabitants, to which must be added  
16 an additional floating population of between 10% and 20% (depending on the season),  
17 mainly originating in the Barcelona area. The fact that people live in relatively dense  
18 neighbourhoods, with few open spaces, means that the narrow coastal strip represents  
19 the great outdoors as far as leisure and related activities are concerned. The location of  
20 these activities constitute yet another corridor running parallel to the beaches, typically  
21 narrow and, in some cases, virtually non-existent (as in Cabrera).

22  
23 Since 1986, timely beach replenishment operations have remedied sand losses. Such  
24 interventions to replace sand, typically repeated at the beginning of each summer  
25 season, support the recreational uses of the beaches. This solution only mitigates the  
26 problem, however, and very precariously at that. It is also costly and environmentally  
27 damaging and has impacted negatively on the fishing industry and areas where sand is  
28 dredged. To date no other solution has been applied and no other policy has been  
29 developed. In short, the area's socioeconomic survival is at risk from ongoing erosion  
30 and sporadic and repeated flooding.

## 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 **4. Results**

### 53 54 **4.1. Social perceptions of risk**

55 Perception analysis aimed to assess the main threats perceived to affect the coast in  
56 Maresme Sud. Perceptions regarding the scope, intensity and frequency of risks need to  
57 be considered in terms of how they affect activities and uses, infrastructures and  
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1 environmental resources, with a view to understanding the main management priorities  
2 as indicated by the interviewed stakeholders.

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4 The two main threats identified by interviewees were storm surges and torrential rains.  
5 The railway infrastructure is particularly affected, as mass use means that it is very  
6 sensitive to impacts that affect mobility. Beaches were perceived to be the next most  
7 threatened element, since they are very vulnerable to storm surges and the endemic  
8 problem of erosion and flash floods. There is also an economic impact on businesses  
9 (beach licensees and services) in terms of lost earnings when a beach is damaged or  
10 rendered unusable. This is how some interviewees explain matters:

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12 *From here ... there's no sand, and there, where we usually set up the beach bar,*  
13 *we can't, because there's no sand ... at one point it's only rock.*

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15 *The beach bars they're fewer... with more sand the promenade could be larger,*  
16 *more suitable for people and bikes ...*

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18 *The municipalities in the lower Maresme area are constantly affected by storms,*  
19 *every year we lose sand ...*

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21 *For the moment ... this path is possible, but when the land will be needed for the*  
22 *railway ... in theory ... it's a delicate balance ... "*

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24 *Regeneration using trees ... but no study has ever been done on whether or not the*  
25 *regeneration could be natural, what has been tried wherever it was possible*  
26 *(especially on the waterfront promenade) was planting trees.*

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28 As shown in Figure 2 perceptions of impact extend to the entire recreational experience,  
29 but are especially significant for the land-sea connections. Thus, defence works,  
30 especially around the mouths of rivers and streams, and sewage installations are  
31 perceived to be at risk. A major attraction for people is the coast and associated  
32 activities, complemented by restaurants and nightlife. In these cases, however,  
33 perceived vulnerability is not so great, as hotels, restaurants and marinas are associated  
34 with the lowest levels of risk. The environment and landscape are likewise not  
35 considered to be especially sensitive.

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54 **Fig. 2:** Impact perceptions.

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57 A common perception that emerges is the sensation of close ties between the towns and  
58 the coast. Although the railway and road act as barriers, by sheer force of habit, crossing  
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1 them in order to get to the beaches has come to be accepted as entirely natural by the  
2 local people. The beaches are prized possessions for the recreational possibilities they  
3 offer, especially during the swimming season, while year-round, informal and  
4 unregulated use (cycling, walking, jogging, etc) is made of the promenade/pathway  
5 (Figure 3). Since this narrow corridor offers a large number and variety of recreational,  
6 sport and leisure uses, the possible loss of the recreational value of their coastline is  
7 perceived to be a major risk by local stakeholders. Hence, while other areas of Catalonia  
8 may be more touristic, this coast is used mainly by local people for year-round  
9 recreation. Therefore, over and above the need to retain the beach itself, there is a need  
10 for intervention in the management of the seafront as a public space, through actions  
11 involving fixtures, accessibility, connectivity to town centres, improvements to the  
12 landscape and green spaces, etc.

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25 **Fig. 3.** Seafront promenade (left) and the railway-road barrier (right).

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28 As well as the need to protect leisure and recreational uses, there is a need to protect the  
29 coast due to the vulnerability of the railway and the promenade. A path that runs more  
30 or less continuously from Barcelona to Mataró acts as a narrow service road for railroad  
31 and other amenities. This promenade-pathway is on land belonging to the railway  
32 infrastructure authority (ADIF), a public entity attached to the Spanish Ministry of  
33 Public Works. However, located as it is in a transect where public interests coincide and  
34 overlap (maritime and terrestrial areas and the railway), management is rendered  
35 difficult by the fact that responsibilities are shared by local authorities, ADIF and the  
36 Spanish Coastal Authority (SCA). In fact, one of the main problems is the distribution  
37 of authority regarding the coast and the presence of different coastal authorities. As an  
38 interviewee explains:  
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48 *"One of the big problems is that the coastline has thousands of owners [sic]:*  
49 *councils, coastal bodies, ministries, rescue bodies, etc. Many authorities have to link*  
50 *up for any government intervention in the area and this is a difficult issue to*  
51 *manage."*  
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55 The complexity that this adds to management is a feature of the entire Catalan coast and  
56 often leads to conflict in regard to what is a tight space crammed with activities and  
57 uses.  
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1 As for management priorities, apart from responding to widespread demand to preserve  
2 the beach surface, there is a demand for intervention in the organization and quality of  
3 the seafront as a public space, with all that this entails in terms of facilities,  
4 accessibility, connectedness, landscaping, etc. Environmental and social groups — often  
5 peripheral to decision making — demand urban acupuncture actions to improve the  
6 quality of public spaces, as more flexibly deployed less costly solutions with social  
7 merit.

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13 However, a more urgent and immediate battle against sand loss is fought at higher  
14 administrative levels. A priority is interventions against storm surges and dealing with  
15 the impact of marinas and marinas. The demand to intervene in areas most affected by  
16 natural phenomena is a priority in urban areas and in the most vulnerable sections of the  
17 railway line. The only truly effective solution, however, would be major – and costly –  
18 engineering interventions, currently not feasible given the economic situation.

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24 Nonetheless, actions to improve the quality of urban public spaces do not necessarily  
25 require costly investments and theoretically can be implemented rapidly. Improved  
26 inter-agency coordination is necessary, however, to overcome the administrative tangle,  
27 which is currently the main stumbling block to action by local authorities. Greater  
28 collaboration would also ensure better coordination between urban planning and  
29 sectoral water, beach and infrastructure planning and this would ultimately contribute to  
30 reducing the vulnerability of the Maresme Sud area.

#### 31 32 33 34 35 36 37 38 39 **4.2. Social network analysis**

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1 **Fig. 4:** Total relationships (edges) and betweenness centrality (nodes) in the Maresme  
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3 Sud social network.

4 **Fig. 5:** Informal relationships (edges) and betweenness centrality (nodes) in the  
5  
6 Maresme Sud social network.  
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10 The best connected stakeholder (Figure 4) with the most central position in the  
11 institutional framework is the SCA (attached to the Spanish Ministry of the  
12 Environment and Rural and Marine Affairs). Its great betweenness centrality (indicated  
13 by the size of its node) indicates that it is optimally located regarding the geodesic paths  
14 between other stakeholders in the network, indicating its power and the dependence on  
15 it of many other stakeholders regarding coastal planning decisions. This body is the  
16 ultimate authority on terrestrial and maritime land management in the public domain,  
17 even though planning and management at the regional level corresponds to the regional  
18 Catalan Coastal Authority (CS).  
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26 Ultimate responsibility for risk prevention and emergency management rests with the  
27 Catalan branch of the General Directorate for Civil Defence (DGPC). Regional  
28 government is also represented, although to a lesser extent, primarily by the Catalan  
29 Water Board (ACA), with responsibilities for bathing water quality and flood planning  
30 for rivers and streams entering the sea in the area of the beaches. Three marina  
31 authorities (Masnou, Premià and Mataró) are represented, although ultimate authority  
32 for marinas in Catalonia rests with the Catalan government.  
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39 For any interventions affecting the railway ADIF has to be consulted. Storm surges  
40 cause damage to the rail infrastructure and significantly affect functioning.  
41 Consequently, ADIF managers are actively involved in DGPC risk management  
42 committees that deal with damage prevention and actual damage. Relationships with  
43 local entities are sporadic and mainly occur when authorization is required regarding the  
44 impact of town council actions and licensee operations on railway land. Although the  
45 role is not a prominent one, its proximity to more powerful stakeholders gives it a  
46 strong position in the network.  
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54 Figure 5 shows how the central role of the SCA is diluted in informal relationships.  
55 Local stakeholders, instead, play a more dominant role in their connectedness to other  
56 social and economic stakeholders. These represent the main connection nodes with  
57 stakeholders more involved in local and day-to-day management, such as licensees  
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1 (CM, CE, CV, CP, CC), rescue services (RX, PRO) and clubs (MM, ME, MP, MV,  
2 MC). Through plans for beach use, these maintain an ordered relationship and keep in  
3 constant contact, most especially in summer. Between them, as they ensure that the  
4 beaches have adequate amenities and services, they constitute an informal  
5 communication network involving routine and emergency situations.  
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10 The Red Cross and licensed private security and rescue companies have their own  
11 procedures for recognizing and communicating risks: observing waves and water  
12 quality, detecting pollution and dangerous animals, issuing information and advice,  
13 signalling using flags, etc).  
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17 Table 2 also indicates the importance of informal relationships, as it shows that their  
18 density is greater than for the formal networks. This is clearly an issue that needs to be  
19 considered in overall risk management.  
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25 **Table 2.** Social network densities.  
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29 Figures 6-9 represent stakeholder networks for two towns in Maresme Sud: Montgat  
30 (AM) and El Masnou (AE), each of which has a marina playing a role in local  
31 dynamics. In both cases, the main connecting nodes are the local authorities, primarily  
32 responsible for preparing and deploying beach use plans, given that neither the county  
33 councils (CC) or provincial council (DB) play any role in coastal management tasks.  
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36 Closeness centrality, as represented by the size of the nodes, indicates that stakeholders  
37 are connected to a greater degree and, consequently, their influence is more diluted,  
38 although the role of the town council is predominant.  
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45 **Fig 6:** Total relationships (edges) and closeness centrality (nodes) in the Mongat town  
46 social network.  
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49 **Fig 7:** Formal relationships (edges) and closeness centrality (nodes) in the Mongat town  
50 social network.  
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53 **Fig 8:** Total relationships (edges) and closeness centrality (nodes) in El Masnou town  
54 social network.  
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57 **Fig 9:** Formal relationships (edges) and closeness centrality (nodes) in El Masnou town  
58 social network.  
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1 Note that Montgat local authority (AM), as part of the Barcelona Metropolitan Area  
2 AMB), has the latter's support in coastal planning and also has its own municipal  
3 company (MSL) to implement beach use plans. It is interesting to note that this  
4 collaboration results in a consistent image of quality. As one example, during a storm  
5 surge, installations were removed that could have been affected and damage was  
6 quickly repaired.  
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11 The presence of these stakeholders could explain why networks in Montgat are denser  
12 than in El Masnou. Although El Masnou's marina is perceived as a boost for coastal  
13 activity, nonetheless, the graphs show that it does not greatly strengthen the network in  
14 terms of risk management.  
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19 Finally, comparing formal and total networks (Figures 7 and 9 vs Figures 6 and 8)  
20 confirms the importance of informal networks in terms of local connections between  
21 environment bodies (ECO) and universities (UNI). The role played by these  
22 stakeholders is sporadic because they are only loosely connected to the main decision  
23 makers; nonetheless, they could be interesting sources of innovative ideas.  
24 Environmentalists are generally limited, however, to reporting infringements, raising  
25 awareness and managing restoration of increasingly reduced dunes.  
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## 33 **5. Discussion**

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35 A corpus of literature (Ostrom, 1990; Gunderson Hollings and Light, 1995; Berkes and  
36 Folke, 1998; Westley, 2002; Tompkins and Adger, 2004) argues that governance of  
37 complex environmental problems, such as coastal risks, is better managed if multiple  
38 stakeholders are involved. As for top-down centralized management, this has been  
39 shown to be a poor approach to dealing with uncertain and dynamic systems.  
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44 Our networks, despite some diversity and multi-scalarity, are characterized by the  
45 strong presence and centrality of public administration. Our analysis of networks for the  
46 Maresme Sud area indicated that the Spanish state authority for coasts (SCA) is well  
47 positioned and so concentrates more power. This hierarchical, sectoral and  
48 administration-oriented model for managing the Spanish coastline is very far removed  
49 from the kind of horizontal and diversified governance model that would be more  
50 appropriate for an adaptive risk policy as defended in the above-mentioned literature.  
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55 The strong administrative presence is not conducive to coordination in a scenario where  
56 management is greatly fragmented. Local government demands more inter-agency  
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1 coordination and an improved fit between urban planning and sectoral planning  
2 covering water quality, beaches, infrastructure and marinas as a way of ultimately  
3 reducing the vulnerability of Maresme Sud. An integrated response is necessary, to deal  
4 with coastal dynamics and defences and with socioeconomic issues, such as protection  
5 of the railway, the promenade/pathway and the beaches as well as the broad range of  
6 uses and activities associated with them.  
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11 Institutions shape the definition of alternatives and influence perceptions (March and  
12 Olsen, 1996). In our case, administrations that concentrate the power to define  
13 management strategies have a vision of 'controlling' the coastline. This dominant  
14 discourse in Spanish administrations is based on the perception that human capability  
15 and technology is enough to stabilize and maintain coastal system equilibrium (Roca et  
16 Villares, 2012). This perception is influenced by widespread implementation in recent  
17 decades of policies based on building rigid infrastructures. That means that  
18 institutionalized discourse defines actions, so the discussion as to which type of  
19 knowledge is used in decision making is very relevant. In our case, confidence in  
20 marine engineering has predominated over other, 'softer' disciplines that could prove to  
21 be more adaptive (IPCC, 2007). This is also evident again in new central government,  
22 regional government and local authority strategies to secure stable beach fronts through  
23 actions such as breakwaters, the use of geotextiles, etc.  
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36 We have seen that, in Maresme Sud (and along the entire Catalan coast), the network  
37 structure is characterized by very peripheral actors, indicating a poor capacity to access  
38 information and participate in decision making. This may represent a barrier to the kind  
39 of more adaptive and innovative discourses that often come from the university  
40 community or social or grassroots movements — typically located in very peripheral  
41 positions in Maresme Sud. For example, as seen in the study of perceptions, the demand  
42 for a more ordered seafront in terms of urban intervention the avoidance of major  
43 engineering works tends to feature less in the discourses of the more central  
44 administrations and more in the discourses of environmental groups and local experts. A  
45 more diversified network that incorporates these voices from the periphery — mainly  
46 academics and environmentalists — could promote new values that are more aligned  
47 with resilience and adaptation. This, in turn, would create denser networks and would  
48 have a positive impact on collaboration, knowledge sharing, trust building and the  
49 strengthening of social capital (Olsson et al, 2006; Evans, 1996).  
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1 In Maresme Sud, networks are made more dense through informal relationships  
2 resulting from the proximity of stakeholders living and working in the same area,  
3 sharing ideological affinities or sporadically participating in joint projects. Closer  
4 relationships and intensive interactions dispose stakeholders to better information  
5 sharing, greater awareness and higher susceptibility to influencing or being influences  
6 by other (Knoke and Yang, 2008). The role of these informal relationships is crucial to  
7 the management of coastal resources because they can help counter the power  
8 concentrated in the central state.  
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10 More connections increase the capacity for innovation and for finding solutions to  
11 complex problems and improving network adaptive capacities. Given the need to  
12 diversify and to create a denser network and so ensure the incorporation of new  
13 discourses and a more equitable distribution of power, the roles of certain organizations  
14 is central. We saw the example of Montgat local authority cooperating closely with the  
15 Barcelona Metropolitan Area in planning and managing the seafront. In the network as a  
16 whole, both the county council (CC) and the provincial council (DB) — as currently  
17 under active supra-local stakeholders — could play a bridging role by liaising between  
18 authorities and society, adding density to the network and facilitating information flows.  
19 Other authors (Stojanovic and Ballinger, 2009) propose a more elaborate form of  
20 bridging and participatory organizations — based on coastal partnerships that can  
21 function as a key mechanism within the institutional ICZM framework — and  
22 particularly highlighting their locally adaptable approach as well as their neutral role in  
23 promoting dialogue and communication between different stakeholders.  
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## 43 **6. Conclusions**

44 Understanding the governance system, stakeholder relationships and their perceptions  
45 of coastal landscape risk management is essential to improving the sustainability of  
46 coastal environments. Our main objective was to analyse social networks and public  
47 perceptions for Maresme Sud in order to shed light on how the current governance  
48 system could be improved to promote more adaptive management.  
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54 The strong presence of public administration bodies in Maresme Sud acts as a brake on  
55 the integration of more adaptive and innovative discourses from peripheral stakeholders  
56 in coastal management practices. A more active role for supra-local stakeholders and  
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1 the creation of coastal partnerships could function as bridging mechanisms that facilitate  
2 learning, cooperation and knowledge exchange among stakeholders.

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4 This research demonstrates the value of social network analysis for coastal risk  
5 management in that it correlates stakeholder interactions and network structure with the  
6 generation, transfer and diffusion of different types of knowledge about the  
7 management of coastal systems. Understanding how existing institutional structures  
8 function and determining the dominant and weak discourses and perceptions are  
9 important preliminary steps to any management proposal. The existence of a social  
10 network that actively promotes public engagement, participation, information  
11 dissemination and communication may raise public interest and lead to greater  
12 environmental awareness as well as a shift towards pro-environmental coastal practices.  
13 Much research is needed in this area especially regarding a better understanding of  
14 governance structures in different contexts, monitoring how networks of stakeholders  
15 evolve and observing how stakeholders may change perceptions and attitudes toward  
16 management strategies.  
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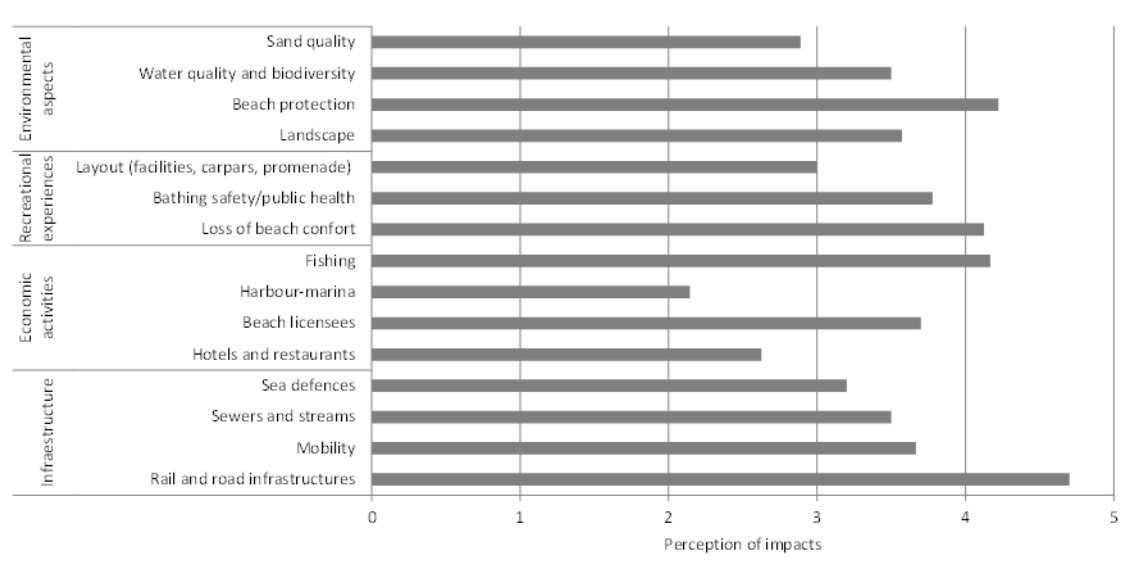
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**Fig. 1:** Location of Maresme Sud



**Fig. 2: Impact perceptions.**

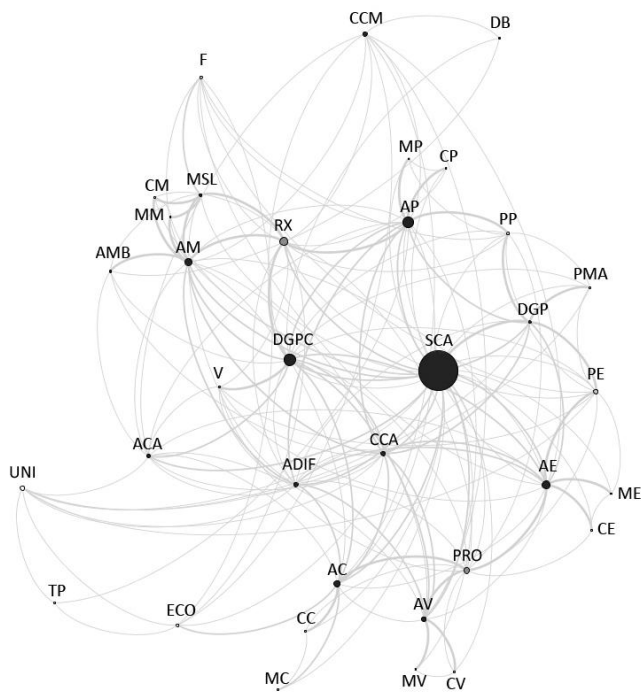




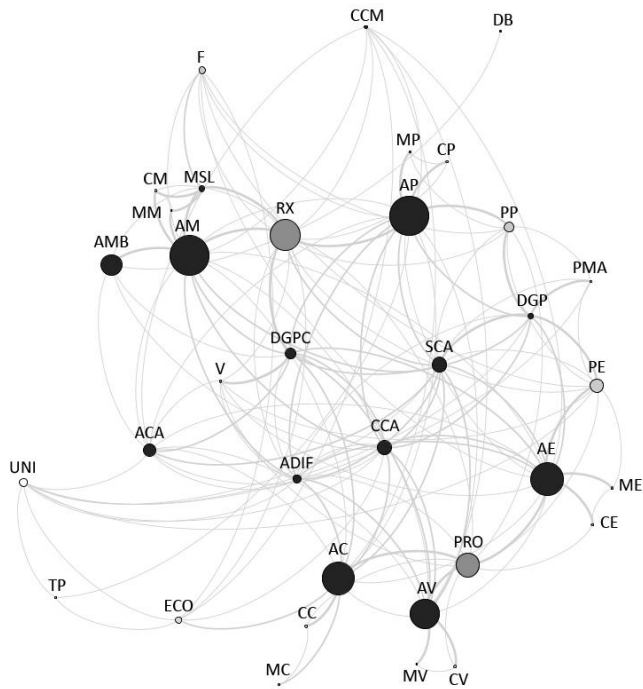
**Fig. 3.** Seafront promenade (left) and the railway-road barrier (right).



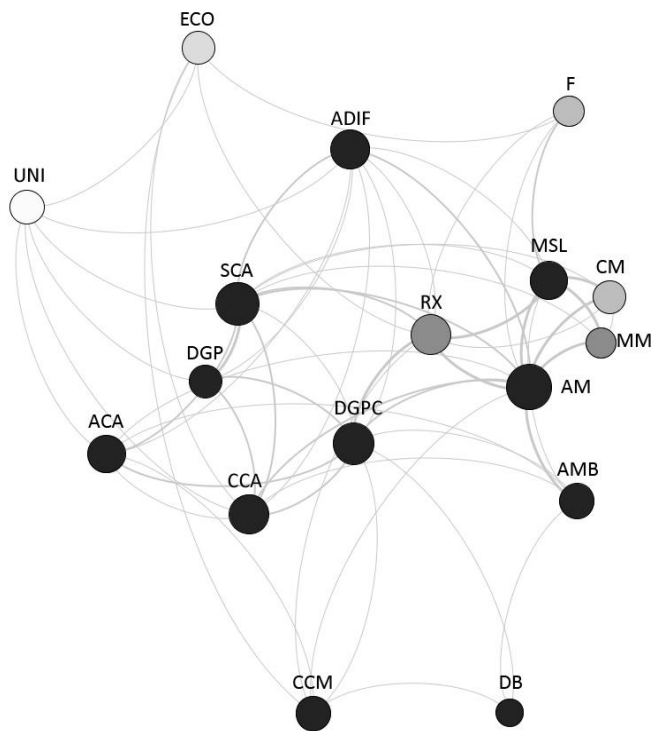
**Fig. 4:** Total relationships (edges) and betweenness centrality (nodes) in the Maresme Sud social network.



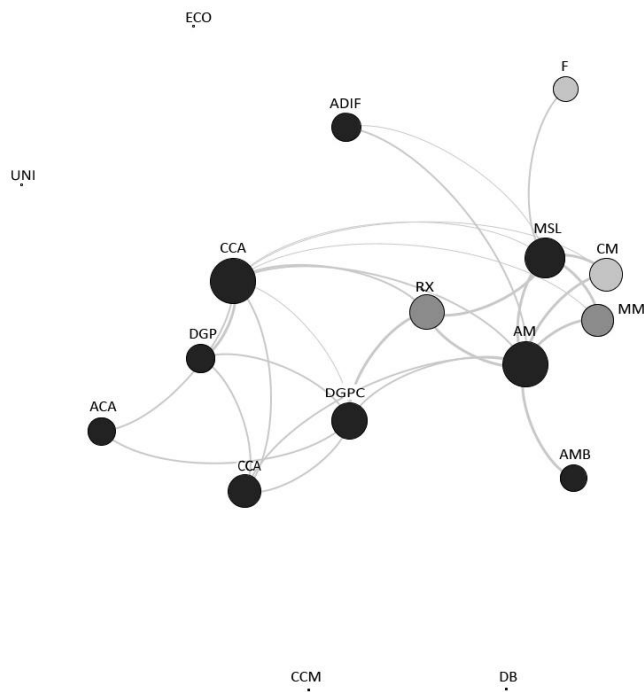
**Fig. 5:** Informal relationships (edges) and betweenness centrality (nodes) in the Maresme Sud social network.



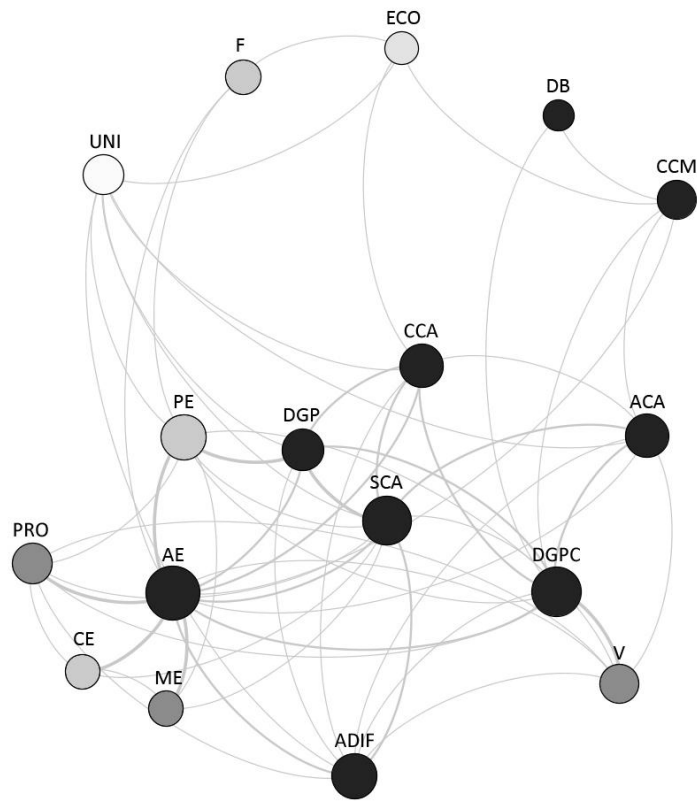
**Fig 6:** Total relationships (edges) and closeness centrality (nodes) in the Mongat town social network.



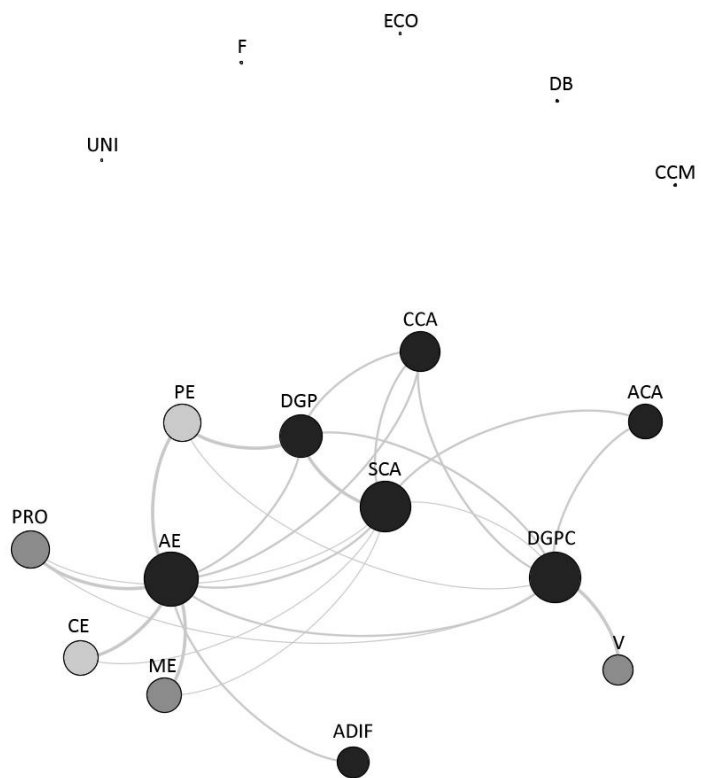
**Fig 7:** Formal relationships (edges) and closeness centrality (nodes) in the Mongat town social network.



**Fig 8:** Total relationships (edges) and closeness centrality (nodes) in El Masnou town social network.



**Fig 9:** Formal relationships (edges) and closeness centrality (nodes) in El Masnou town social network.



**Table 1:** Inventory of Maresme Sud coastal stakeholders.

Abbreviation	Stakeholder	Level	Role
<b>SCA</b>	Demarcació de Costes de Catalunya (Spanish Coastal Authority)	State	Public admin.
<b>ADIF</b>	ADIF (Railway Infrastructure)	State	Public admin.
<b>DGP</b>	DG Ports de la Generalitat (Catalan harbour authority)	Regional	Public admin.
<b>DGPC</b>	DG Protecció Civil - Centre de Coordinació Operativa de Catalunya (civil defence)	Regional	Public admin.
<b>CCA</b>	Servei de Costes (Catalan coastal service)	Regional	Public admin.
<b>ACA</b>	Agència Catalana de l'Aigua ACA (Catalan water board)	Regional	Public admin.
<b>CCM</b>	Consell Comarcal del Maresme (county council)	Supralocal	Public admin.
<b>DB</b>	Diputació de Barcelona (provincial council)	Supralocal	Public admin.
<b>AMB</b>	Area Metropolitana de Barcelona (Metropolitan area management body)	Supralocal	Public admin.
<b>AM</b>	Ajuntament de Montgat (local authority)	Local	Public admin.
<b>AE</b>	Ajuntament de El Masnou (local authority)	Local	Public admin.
<b>AP</b>	Ajuntament de Premià de Mar (local authority)	Local	Public admin.
<b>AV</b>	Ajuntament de Vilassar de Mar (local authority)	Local	Public admin.
<b>AC</b>	Ajuntament de Cabrera de Mar (local authority)	Local	Public admin.
<b>PE</b>	Port de El Masnou (port authority)	Local	Economic agent
<b>PP</b>	Port de Premià de Mar (port authority)	Local	Economic agent
<b>PMA</b>	Port de Mataró (port authority)	Local	Economic agent
<b>MSL</b>	Platges de Montgat S.L.(beach management body)	Local	Public admin.
<b>CM/CE/CV/ CP/CC</b>	Beach licensees of each municipality	Local	Economic agent
<b>RX</b>	Creu Roja (Red Cross lifeguard service)	Supralocal	Social agent
<b>PRO</b>	Proactiva (Proactiva lifeguard service)	Local	Social agent
<b>F</b>	Confraria de pescadors de Montgat (fishers' association)	Supralocal	Economic agent
<b>MM</b>	Club Marítim Montgat (marine club)	Local	Social agent
<b>ME</b>	Club Nàutic El Masnou (marine club)	Local	Social agent
<b>MP</b>	Club Nàutic Premià (marine club)	Local	Social agent
<b>MV</b>	Club Nàutic de Vilassa de Mar (marine club)	Local	Social agent
<b>MC</b>	Club Nàutic de Cabrera de Mar (marine club)	Local	Social agent
<b>ECO</b>	Grups ecologistes (ecologists)	Supralocal	Environmental agent
<b>V</b>	Associació de Voluntaris de Protecció Civil del Masnou (civil defence volunteers)	Local	Social agent
<b>TP</b>	Fundació Territori i Paisatge Caixa de Catalunya (environmental body)	Regional	Environmental agent
<b>UNI</b>	University	State	Expert



**Table 2.** Social network densities.

<b>Network</b>	<b>Formal network</b>	<b>Informal network</b>	<b>Total Network</b>
<b>Complete network</b>	0,129	0,242	0,277
<b>Network of Montgat Municipality</b>	0,199	0,404	0,441
<b>Network of El Masnou Municipality</b>	0,176	0,390	0,434