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## SETTLEMENT, WAY OF LIFE AND WORLDVIEWS

How socio-environmental changes impact and  
are interpreted by artisanal fishing communities  
in Portugal

*Yorgos Stratoudakis, Patrícia Gonçalves, Daniel Oliveira  
and Mônica Mesquita*

### Introduction

The contemporary history of Portugal is tightly linked with fishing. Throughout the Middle Ages and up to the 1830s, small-scale fishing was mainly performed within designated areas, in rivers, lagoons and estuaries, following authorisation of the private, monastic or regal landowner (Coelho, 1995). The activity involved payment of rent and taxes, as well as membership fees in local brotherhoods or *cofrarias*, that reduced fisher's yield and monetary returns (Santos et al., 2012). The liberal revolution in the early 19th century (Costa Pinto and Monteiro, 2020) led to a political and social reconfiguration that increased the importance of fishing for making a living (Garrido, 2018). In the 1830s, the legislative abolition of taxes and religious or social obligations and the passage of fisheries' administration to the state, turned fishing into the most important activity for coastal and riverine communities in Portugal (Garrido, 2018). The importance of fishing was reinforced in 1864 by a regal decree that declared water, coasts and seabed as public property administered by the state. By the end of the 19th century, a large fraction of the active population near the coast were living from fishing (Baldaque da Silva, 1892) or were employed in the sardine (*Sardina pilchardus*) canning industry that was starting to grow in the country (Pulido Valente, 1981).

The western coast of mainland Portugal is exposed to the swell and winds from the northeast Atlantic Ocean. These create highly energetic littoral environments and shape coastal topography. Rivers in northern and central Portugal provide a sedimentary outflow that follows a southwards littoral drift according to the prevailing wave regime (Lira et al., 2016). Long stretches of exposed lowland coastal areas in northern and central Portugal are covered with sandy dunes and its characteristic sparse vegetation (Costa et al., 2000). Sandy dunes could once reach several kilometres wide and become highly mobile under the influence of the wind, particularly in landscapes void of trees. For many centuries most exposed oceanic coasts were probably desert (*terra nullis* in citation of Freitas et al., 2018). Until the end of the 19th century, these stretches had a positive sedimentary budget (accretion) with a net supply of sand piling onto the coast (Freitas et al., 2018).

Such coasts were rather hostile environments for humans (Freitas, 2007), where occasional flooding after heavy rain formed wetlands attractive for mosquitoes, vectors of diseases like malaria (e.g., Palma et al., 2022). Like in most of the European Atlantic coastline, until the 20th century, few people lived along the open coast of mainland Portugal. The main regular human presence was fishers who temporarily settled during the summer months, when storms were less likely and wave height diminished, reducing the risk of capsizing in the surf area (Freitas et al., 2018). Up to the 18th century, most of these fishers created temporary coastal settlements (perishable wooden structures with thatched roofs known as *palheiros* – Freitas et al., 2018) and moved to the interior during the harsher winter months (Garrido, 2018). Accumulated experience from trial-and-error practices that sustained survival in such demanding environments allowed fishing communities to create a wealth of traditional ecological knowledge (TEK) (Freitas et al., 2018). Among other benefits to local communities, TEK allows them to make use of locally available resources and existing technologies to create societal responses to cope with adverse and dynamic environmental conditions (Berkes et al., 2000). This body of knowledge is transmitted across generations through oral history and cultural practices and may be lost when significant sociodemographic changes take place in a community (Freitas et al., 2018; Delgado-Ramírez et al., 2023; Stratoudakis et al., 2023).

Early fishers' settlements in the sandy lowland of the Portuguese coast were mostly linked to the seasonal operation of *Arte-Xávega* (beach seines). Summer weather conditions permitted fishing for sardine, horse mackerel (*Trachurus trachurus*), chub mackerel (*Scomber colias*) and related species in shallow coastal areas with sandy bottoms (Cabral et al., 2003). The *Arte-Xávega* consisted in using an encircling gear towed to the beach using an auxiliary vessel (“*chaveiro*” or “*semi-liua*”) and human or animal force to pull the net onshore with long ropes (Martins et al., 2000). Fishing communities using *Arte-Xávega* started to settle permanently along the coast during the late 18th and 19th centuries to provide food for increasing city populations and services for the increasing numbers of beachgoers (Freitas, 2007). Fishing with *Arte-Xávega* occurs at the land-ocean interface and demands a plurality of skills and understandings, simultaneously requiring knowledge on fish species and habitats, understanding of oceanographic forcing in very dynamic environments, and skills to interpret signs in coastal morphology and local economy (Smart Fishing, 2021). Nowadays *Arte-Xávega* is considered Immaterial Cultural Heritage in Portugal (INPCI, 2021) and is still practised in several coastal municipalities, mainly in central Portugal.

The aim of this chapter is to capture and compare the environmental knowledge, practices and adaptations of *Arte-Xávega* over the past century in two neighbouring communities that settled at two different periods of time. The selected communities are less than 10 km away from each other and share a very strong common inheritance related to fishing and, especially, *Arte-Xávega*. In both places, experience, thoughts, emotions and social relationships have been for many generations locally structured by artisanal fishing, from which individuals and communities have been deriving meaning, beliefs, symbols, values and feelings (Chapin and Knapp, 2015). These communities have been locally modifying their socio-environmental surroundings through mind facts and artefacts related to *Arte-Xávega* (D’Ambrosio, 2001). In-depth interviews, directed questionnaires, literature information and participant observations were used to describe a century of experience, observations and interpretations of socio-environmental changes and respective impacts on fishing practice. In the process, sense of place and worldviews based on the local relation with fishing and the sea were described and compared between these two fishing communities on the Atlantic coast of central Portugal, where climatic change is perceived as just one among the drivers of change affecting their daily life and income. Minor, but perceptible, differences emerging in the way of life and worldviews of the two communities are also used to hypothesise on the direction of possible changes in the coming decades.

## Material and methods

We worked in two communities founded by *Arte-Xavega* fishers in the late 18th and the early 20th centuries, Costa de Caparica (CdC) and Fonte da Telha (FT), respectively. Both communities are in the Municipality of Almada on the Atlantic coast southwards of the river Tagus' estuary (Figure 9.1). The sites extend along an exposed oceanic stretch of 20 km from the southern tip of the Tagus estuary to the Albufeira lagoon, a semi-enclosed coastal lagoon near Cape Espichel. Landwards of the sandy stretch and its system of dunes (Palma et al., 2022), a Protected Landscape Area that has existed since 1984, classified for its geological, geomorphological and landscape value. The southernmost part of the Protected Landscape has also been a Botanical Reserve since 1971 (Oliveira, 2015).

Although very close to the capital (less than 20 km by road from the centre of Lisbon), the two sites differ in their degree of exposure to urban life. Currently, CdC is a large peri-urban agglomerate of 15,000 permanent inhabitants, administratively considered a city since 2004. During the summer, CdC multiplies several times its population and becomes culturally invaded as a result of beach-going, surfing and tourism by seasonal holiday homeowners from Lisbon and by international visitors. CdC fishers are currently concentrated in a neighbourhood at the southern city limit, close to where they deploy their vessels. This differs from the central location they occupied since the original settlement and up to 50 years ago. The closest fishing port is Trafaria, at the edge of the Tagus estuary (Figure 9.1). FT, although just 6 km southwards of CdC along a continuous

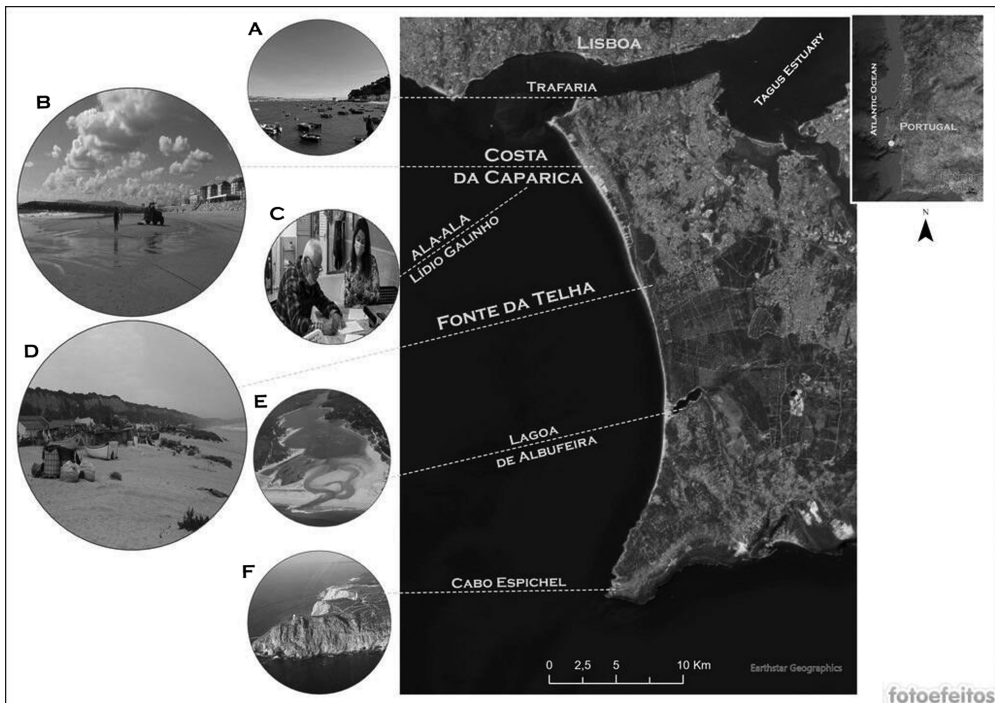


Figure 9.1 Location of study sites in Portugal and related place names. (A) Trafaria, (B) Costa de Caparica, (C) Lídio Galinho (founder and president of fishery association Ala-Ala) signing the Free Prior Informed Consent before the livelihood interview, (D) Fonte da Telha, (E) Lagoa de Albufeira, (F) Cape Espichel.

sandy beach stretch, remains an isolated village with a single road entry that splits along the coast into the fishers' neighbourhood northwards and the touristic neighbourhood southwards. Both sites have a *lota*, a fish auction house where local landings are marketed daily. During the summer, some transactions with tourists also occur on the beach.

Fishing takes place along 10–12 km of sandy beaches (Figure 9.1 – southwards of the groynes and seawall that delimit the touristic area in CdC and northwards of Lagoa de Albufeira) and up to 1.5 km from the coast. Landmarks along this stretch with local toponyms identify the main spots for gear deployment (*lanços*) in a fishing activity without territoriality. The predominant benthic habitat is mobile sediment (sand) with a gentle slope (Freire, 1986) that frequently leads to resuspension due to wave action (fishing area mostly less than 20 m deep). *Arte-Xávega* remains the emblematic fishing activity in both sites, with vessels and gear currently deployed with the help of tractors (Martins et al., 2000). A net of approximately 500 m wide is towed landwards from 1 km offshore by tractors and with the assistance of a crew of about 20 people (*companha*, which can include women and teenagers), of which three to five are in the boat. Activity is seasonal (usually from March–April to October–November) as during rough weather the boats cannot overcome the surf zone. During the summer tourist season, fishing operations are regulated to start in the evening and stop in the morning. Fishers in the two sites also perform other fishing activities, especially with trammel nets operated from the same or from other fishing vessels (Souto, 1998). Vessels are either deployed from the beach or come out from Trafaria. Fishing may also involve gill nets, lines and long-lines, especially within the Tagus estuary, which offers an alternative fishing area under rough oceanic weather. In total, fishing involves 34 small-scale vessels in the two sites (16 in CdC and 18 in FT) and over a hundred fishers in each site, many of them women.

The encounter spaces in an investigation are fundamental elements for the dynamics of the dialogue that sustains it (Mesquita et al., 2016). Previous research carried out in this territory with the fishing communities follows a trajectory of active participation and action, promoting co-construction of knowledge where fishers become researchers of their own practices. These fishing communities have been working with the same research group since 2008, initially on D.A.R. Costa Tr@nsFormArte (a government project of local intervention) and Urban Boundaries (<http://fronteirasurbanas.ie.ul.pt/>). Ties were further strengthened with the development of the Oceanic Literacy Observatory – OLO ([www.olo.blue](http://www.olo.blue)) in 2016 and the formal integration of some members of the fishing community into it. More recently the Partibridges (<https://partibridges.eu/partibridges-portugal/>) and Smart Fishing (<http://smartfishing.olo.blue/>) projects have encouraged the co-construction of a shared interest in the development and sustainability of local artisanal fisheries. In this journey, a bond of belonging to local causes, both fishing and academic, has been created. This facilitated the entry and active participation of fishers in research on climate change impacts following the LICCI protocol (Reyes-García et al., 2023), fostering their interest and willingness to share knowledge and behaviours, strengthen their trust and participatory action. It also allowed fishers to expand their circle of trust by interacting with a new researcher on a new topic – through a critical and slow social pedagogy (Mesquita et al., 2016). Finally, this bond also permitted the inclusion of a critical ethnographic context in the current research (Thomas, 1993), tapping on the past experience of the research team members consolidated during the site contacts for the new research topic (direct and participant observation).

The fisheries LICCI protocol was followed (Miñarro et al., 2020). COVID limitations prolonged the research for almost two years and permanently interrupted the interview with Lídio Galinho, the president of an influential local fishers' association (see acknowledgements). Livelihood interviews took place with the most senior members of the two communities (four men and three women, 64–94 years old). Thematic questions were prepared following a standardised protocol (Miñarro et al., 2020; Reyes-García et al., 2023), but the interviewees were left to provide

additional information and memories they considered fit in the conversation. Memories and significant events reported in the interviews were cross-checked with selected literature (Freire, 1986; Rodrigues, 2000; Silva, 2008; Oliveira, 2015) and online sources of information (e.g., historical archives from the Municipality of Almada and Lisboa) to construct the timeline of the study site. An interview regarding species used was transformed into a questionnaire that was responded to by 18 fishers (7 from CdC and 11 from FT, 32–78 years old and a mean fishing experience of 41 years). Livelihood interviews (3) and questionnaires (3) included women respondents from both sites, but gender analysis was not an objective of this study.

Questionnaire respondents had a mean age of 58 years old and came from families that, on average, had already had the three previous generations into *Arte-Xávega* fishing. Some respondents represented the fifth generation, thus also providing information to consolidate the local timeline. Each fisher provided a list of species caught nowadays, in decreasing order of abundance in the catch, and further indicated whether abundance had changed since that person started fishing (five levels response scale: Decreased a lot, Decreased, Unchanged, Increased, or Increased a lot since onset of fishing). Other questions focused on whether species had appeared or disappeared since the onset of fishing, including those with no commercial interest, and whether the number of weekly meals including fish had changed over the past 20 years. The LICCI classification tree was used to specify typologies of change for the atmospheric, physical and life systems (Reyes-García et al., 2023). Informed consent was provided in writing before the interviews. Validation was based on the degree of overlap between the livelihood interviews and the questionnaires. Differences in questionnaire replies between the two sites and between past and present, by site and overall, were tested with Wilcoxon rank sum tests.

## Results

The timeline presented in Figure 9.2 spans from the end of the 19th century to the present across four national political phases. It reports temporal marks that have shaped coastal, marine and fisheries operations in Portugal during that period, as well as regional or local development acts and events (the latter reported for CdC but covering the two sites).

During the end of the 19th century, CdC was a large fishing community isolated from the rest of the municipality and from urban centres. Approximately 700 fishers and another 500 people offering land assistance (fish work) were almost exclusively dependent on *Arte-Xávega* and sardine fishing. This period is within the indirect memory span of the oldest fishers interviewed, evoked through comments and memories transmitted from parents or grandparents. During that time, life was harsh and largely dependent on intra-community solidarity, particularly among members of the *companha* of each vessel who tended to live in neighbouring *palheiros*, as well as on the capacity to culturally transmit traditional knowledge on the marine resource system and the fishing practices to guarantee food and survival. Fatal accidents during the artisanal fishing operation occurred frequently and required the solidarity of the families of surviving members of the *companha* to fend for the descendants of the deceased. The *Costa Pinto* fire in the 1880s was the onset of basic improvements in housing in CdC, since, before that moment, *palheiros* did not have even basic infrastructures available. Further improvements were introduced with the *Casa dos Pescadores*, until arriving more recently to the current *Bairro dos Pescadores* with good housing conditions, but peripheral to the city centre.

Events specifically reported for FT in Figure 9.2 demonstrate the delayed process of community settlement, compared to CdC. Contrastingly to CdC, permanent settlement of fishers in FT only started in the 1930s. This is within the direct memory span of some interviewees that moved there as young children within the families of the first settlers. Brick houses, sanitation and

Period (Political Phase)	Late 19th Century Monarchy	Early 20th Century First Republic	1930s Dictatorial Regime	1940s	1950s	1960s	1970s Restoration Democracy	Late 20th Century Entry to EC	21st Century
	Portugal (coastal, marine, and fisheries marks)	<p>Creation of Fisheries Commission (1878)<sup>2</sup> and agreement with Spain determines rules for beach seines<sup>3</sup></p> <p>National plan for dune afforestation and drainage of wetlands (1880s)<sup>6</sup></p> <p>Decree on port authority and systematic collection of fisheries data (1895)<sup>2</sup></p>	<p>National survey for bathymetric mapping of Portuguese coast (1910)<sup>2</sup></p> <p>Fishing for small pelagic fish with steam engine vessels and conflict with <i>armações</i> and <i>Arte-Xávega</i><sup>2</sup></p> <p>Rapid growth and historic maximum of canning industry (400 units in 1925)<sup>2</sup></p>	<p>Extinction of fisher syndicates and creation of <i>Casas dos pescadores</i> (1933*)<sup>2</sup></p> <p>Urbanistic plan south of Lisbon to deal with increasing urban population<sup>7</sup></p> <p>Inspection of fish landing by maritime authority and payment of 28% tax*</p>	<p>Extreme storm in Portugal and flooding in the Tagus estuary (1941)</p> <p>National policy for hydroelectric supplement of energy supply (1944)<sup>7</sup></p>	<p>Creation of fish first sale landing site (DOCAPESCA, 1956)<sup>2</sup></p> <p>Creation of industry for frozen fish (GELMAR, 1957)<sup>2</sup></p> <p>Portugal attains maximum of 48300 registered fishers (1958)<sup>2</sup></p>	<p>Inauguration of bridge over Tagus (1966)*<sup>4</sup></p> <p>Portugal attains maximum annual fish landings of 564 thousand tonnes (1967)<sup>2</sup></p>	<p>Establishment of 200 nm EEZ and 12 nm territorial waters (1977)<sup>2</sup></p>	<p>National regulation of common fisheries policy (1987)<sup>3</sup></p> <p>Specific regulation for <i>Arte-Xávega</i> fishing (1996)<sup>3</sup></p> <p>Transposition of European legislation on the occupation, use and transformation of the coastal zone (1990)</p> <p>Train connection across Tagus (1999)<sup>7</sup></p>
Costa de Caparica CdC	<p>Large, isolated fishing community, living in <i>palheiros</i> and depending on <i>Arte-Xávega</i>*<sup>3</sup></p> <p>Large fire on <i>palheiros</i> (1884, <i>fogo Costa Pinto</i>)<sup>4,4</sup></p> <p>Dune afforestation in Trafaria and CdC and swamp drainage creates vine agricultural land (1883-86)<sup>5,6</sup></p>	<p>Trafaria becomes the first sea bathing resort (1901)<sup>4</sup></p> <p>Dune afforestation (1903-10)<sup>6</sup></p> <p>River Tagus regular boat crossing to Trafaria (1911)*<sup>4</sup></p> <p>Decree establishes CdC as summer resort for wealthy urban families (1925)<sup>4</sup></p> <p><i>Arte-Xávega Pensativo</i> shipwreck (1929)*</p>	<p>Dune afforestation (1926-38)<sup>3</sup></p> <p>Public forest becomes target to build summer camps, nursing homes and holiday resorts*<sup>6</sup></p> <p>Inauguration of hotel <i>Praia do Sol</i>, the first in the Setúbal district (1934)*<sup>4</sup></p> <p>Local <i>Casa dos Pescadores</i> with health service and primary school (1938)*<sup>4</sup></p>	<p>Start of deficit in sedimentary budget of beaches and erosion<sup>1</sup></p> <p>CdC becomes <i>freguesia</i> (1949)<sup>4</sup></p>	<p>First engineering plan for beach protection (1958)<sup>6</sup></p> <p>Ice factory in Trafaria*</p> <p>Fish sale in central villa location (open air)*</p> <p>First sewage network (1955)<sup>4</sup></p> <p>Inauguration of <i>Cine Copacabana</i> with the first TV in CdC (1957)*<sup>4</sup></p>	<p>Construction of fisher neighborhood by central fisheries administration ("Bairro do Pescadores")*<sup>4</sup></p> <p>Inauguration of beach train line (1960)*<sup>4</sup></p> <p>Diesel engines on local fishing boats*</p>	<p>Introduction of engine in most <i>Arte-Xávega</i>, change of vessel structure and reduction of crew onboard*</p> <p>Coastal pine forest <i>Mata dos medos</i> becomes botanical reserve (1971)<sup>4</sup></p>	<p>100 apartments allocated to fishers in fisher neighbourhood of CdC (1989)*</p> <p>Coverage of drainage system (1995)<sup>4</sup></p> <p>Demolition of <i>Casa da Coroa</i> the first brick house to be built in CdC in 1800 (1998)*<sup>4</sup></p> <p>Introduction of tractors to push beach seine gear and vessel*</p>	<p>CdC becomes city (2004)<sup>4</sup></p> <p>POLIS program and fisher <i>alveoli</i> (2007-2014)*<sup>4</sup></p> <p>Creation of fisher association Ala-Ala (2013)*</p> <p>Dunar retreat (2014) and plan for beach sand nourishment and groynes repair<sup>6</sup></p>
Fonte da Telha FT	<p>Continuous sandy stretch with dunes without any human construction or regular presence*</p> <p>Occasional use of fishing grounds by CdC <i>Arte-Xávega</i>, without land settlement*</p>	<p>Plantations by Charneca farmers, irrigating from local fountain (<i>Fonte da Telha</i>)*</p> <p>Night fishing by visiting farmers during the summer*</p> <p><i>Palheiros</i> to protect gear and for temporary settlement*</p>	<p>Permanent settlement of farmers/fishers from Charneca and construction of larger <i>palheiros</i> on the beach*</p>	<p>Fishers from CdC travel on foot along the beach to fish at FT*</p>	<p>First primary school (temporary, in children summer camp)*</p> <p>Convenience store opens by early settling fishers*</p>		<p>Construction of first brick houses by early settled fishers*</p>	<p>More fishers move from CdC to reduce competition and better fishing conditions*</p> <p>Electrification of FT and water and sewage system (1990s)*</p> <p>Municipal register of existing households and payment of annual housing property tax*</p>	<p>FT becomes popular resort, with an expansion of restaurants and bars</p> <p>Contentious opening of tar road (2021)</p>

\* indicates events mentioned during the interviews

<sup>1</sup>Costa Pinto & Monteiro (2020); <sup>2</sup>Garrido (2018); <sup>3</sup>Martins et al. (2000); <sup>4</sup>Oliveira (2015); <sup>5</sup>Silva (2008); <sup>6</sup>Palma et al. (2022); <sup>7</sup>Rodrigues (2000); <sup>8</sup>Baldaque da Silva (1892).

Instituto Geográfico Nacional, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS

Figure 9.2 Infogram of historical timeline from the late 19th century onwards, based on the span of interviewees' memories and supported by literature review (asterisk indicates events mentioned during the interviews).

electrification only occurred in FT during the 1990s, while the process of property registration is still ongoing. This later settlement and the continuing village isolation from urban settings can explain some of the distinctions in the sense of belonging to the place detected in the two communities (Table 9.1). Despite the close geographical proximity, the common provenance of some community members, and the identical fishing practices, there are detectable differences in the daily life, mind facts and artefacts that currently shape the way of living in the two sites. Some of the fishing materials and practices (including the organisation of storing space for gear next to their home within *quintais*) in FT are still related to the traditional operation at the origin of these communities, while in CdC more modern practices have been adopted. Reduced topological

Table 9.1 Common and distinctive elements in the sense of place attributed to fishers from Costa de Caparica and Fonte da Telha, based on ethnographic observations consolidated with interviews and participant observation

	<i>Costa de Caparica (CdC)</i>	<i>Fonte da Telha (FT)</i>
Sense of Place (common element in CdC and FT)	(distinctive element in CdC)	(distinctive element in FT)
Daily life and income (Fishermen, more than fisherwomen, frequent the local <i>Lota</i> on a daily basis)	Daily routine not only around fishing and fish work (some, especially in younger generations, also have other jobs) Some fishers do not live in CdC	Daily routine and individual occupations are all around fishing and fish-work, including younger generations All fishers live in FT
Mindfacts (Fishing identity related to <i>Arte-Xávega</i> ; Relationship with the ocean and its natural elements)	Sense of belonging to the fishing community of CdC is intertwined with a sense of urbanity, where the fisher is inserted and makes part of The fishing community does not reveal unity in its topology, fishers isolate in the modern <i>Alvéolo</i>	Sense of belonging to FT is deep and remains inextricably linked to fishing practices, especially <i>Arte-Xávega</i> The fishing community reveals unity through its topological distribution, by its feeling of neighbourhood
Artefacts (Fishing arts; Revenue repartition within <i>companha</i> ; Dynamic and static references to fishing practices; Landmark toponyms as <i>lanços</i> )	Some <i>companhas</i> need to find fishermen in FT to mend their nets All fishing materials are industrialised Fisher storing places are part of the national coastal rehabilitation project (POLIS). Fishers still denominate the modern structure with its ancestral name – <i>Alvéolo</i> . All fishers have an identical space, built by an architect, with reduced space for storage. The houses of fishers are far from this place, sometimes in CdC, sometimes in another municipality.	Fishermen mend their nets locally Some fishing materials are handmade, still produced locally in wood (needles) and cotton (pieces of nets) Fisher storing places are traditional, on sand, between the ocean and the fisher homes. Fishers still denominate the storing places as <i>Quintais</i> – as their ancestors. Each <i>Quintal</i> occupies the traditional place where each family has constructed them, with a tendency to enlarge them to add new or more artefacts. The <i>Quintais</i> vary in size and attend to the space that each fishing family needs.

proximity and diversification of income sources, especially for the younger generations of fishers, are also signs that urbanisation in CdC is modifying daily dynamics and routines away from the all-embracing role that artisanal fishing had on previous CdC generations and still has in FT.

Figure 9.2 also describes the changes that took place in the local *Arte-Xávega* fishing during the past 40 years (reported for CdC but applying to both sites, practically at the same time). Mechanisation, through the use of boat engines and tractors, and technological innovation, through the use of more resistant fishing material and weather predictions, created safer conditions, prolonged oceanic operations and increased fishing effort. In parallel, livelihood interviews indicated that, until the fisher generation before the present, all meals in these two communities were fully dependent on fish, either fresh during the fishing season or salted dry in winter when weather did not permit fishing. In the questionnaires, fishers reported a current median of seven meals per week containing fish. The difference with fish consumption 20 years ago is statistically significant ( $W = 47.5$ ,  $p < 0.001$ ), without significant differences between the two sites. Nowadays, approximately half of the sample (56%) still only consume fish they have captured, while the rest also buy from the local fish market, again without significant differences between the two sites.

The questionnaire replies reported 44 marine taxa as part of the current catch in *Arte-Xávega* belonging to 41 species or genera, of which seven were invertebrates. Three names were colloquial names for juvenile forms of sardine and horse mackerel. More taxa were reported in CdC (median: 9; total: 38) than in FT (median: 5, total: 26), and the difference was highly significant between sites ( $W = 8081$ ,  $p < 0.001$ ), although there was no significant difference in the number of species listed according to fishers' age, years fishing, or years since settlement. Chub mackerel, horse mackerel and squid (*Loligo* sp.) were mentioned by all fishers, and sardine, Henslow's swimming crab (*pilado*, referring to *Polybius henslowii*), and jellyfish (*alforrecas*, referring to *Catostylus tagii*) were mentioned by all but one. Half or more also mentioned garfish (*Belone belone*) and seabream (*Sparus aurata*). More than a quarter mentioned salema (*Sarpa salpa*), cuttlefish (*Sepia officinalis*), meagre (*Argyrosomus regius*), seabass (*Dicentrarchus labrax*), weavers (predominantly the lesser weaver *Echiichthys vipera*), bogue (*Boops boops*), annular seabream (*Diplodus annularis*) and other species of the genus *Diplodus* (*sargos*). In terms of current abundance in the catch, there were no significant differences between the two sites: chub mackerel is currently considered the most abundant species, followed by horse mackerel and then sardine. Although mentioned less frequently, salema was ranked as slightly more abundant than the three invertebrate species (swimming crab, jellyfish and squid) that followed.

In relation to climatic changes reported, the most frequent changes observed relate to the 'Marine physical' subsystem and the subsystems 'Air masses' and 'Seasons' of the atmospheric system. Practically, all fishers mentioned either a decrease in the number of windy days (*vendavais*), a decrease in the frequency of storms (*maresias*, *tempestadas*), or both, in recent years, with a consequent prevalence of milder weather and less agitated sea. A third of fishers from both sites also referred to changes in the seasonality, with the blurring and disappearance of seasons, the rapid (daily) modification of conditions and the prevalence of warmer weather. Several fishers from the two sites also mentioned an increase in sea level and the disappearance of the primary dune system. Some fishers provided more specific or additional information on the topics above. For example, some mentioned a decrease in the intensity of storms, a reduction of the duration of the season with storms (from autumn and winter to just winter), a delay in the period with northerly winds (*nortadas*), a reduction of the sand available to the coastal system, and warmer summer nights in recent times. Interestingly, the above impacted elements were also mentioned in the livelihood interviews, when asked about environmental changes they had experienced. The respondents further mentioned important changes related to a decrease in precipitation, including

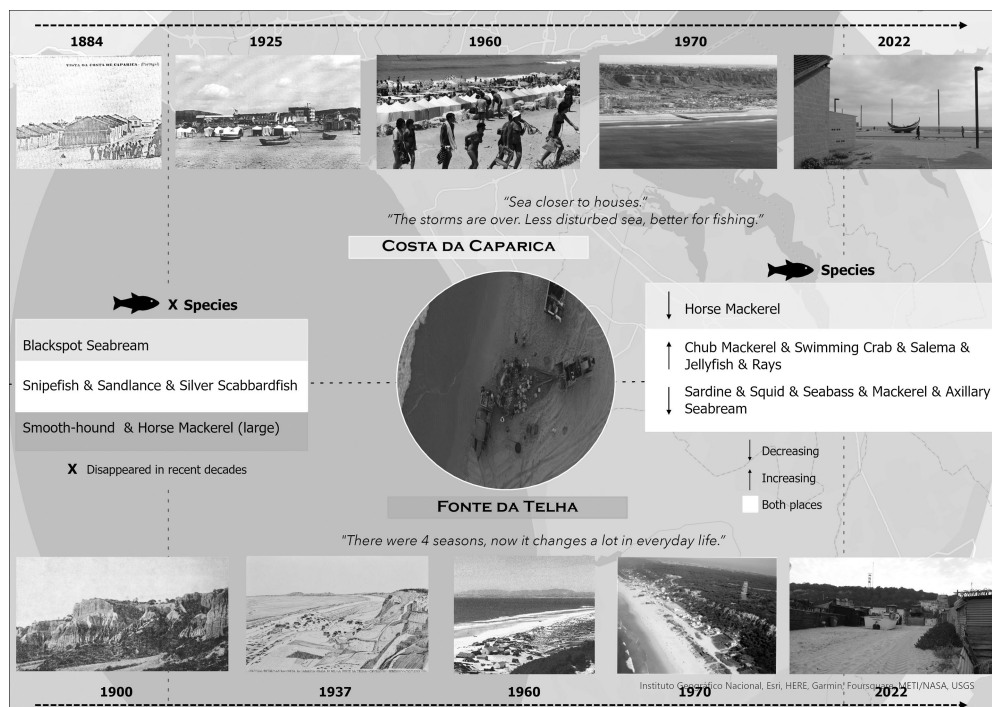


Figure 9.3 Infogram of Arte-Xávega fishing and evolution during the study period, both socially (landscape and communities) and biologically (change in species presence and abundance in the catch) in Costa de Caparica and Fonte da Telha.

the reduction of freshwater outflow from the river Tagus, more permanent closure of the Lagoa de Albufeira, and reduction of water runoff to the coast from the cliffs at FT in recent years, but these changes were not mentioned when responding to the questionnaire.

Fishers reported many changes in the marine biological system. All fishers answering the questionnaire mentioned that snipefish (*Macroramphosus* sp.) have disappeared from the catch in recent times and a third of the sample referred the same for the juvenile and/or adult of axillary seabream (*Pagellus acarne*). Three fishers from CdC also mentioned the recent disappearance of juvenile blackspot seabream (*Pagellus bogaraveo*), four fishers from FT mentioned the disappearance of smooth-hound (*Mustelus* sp.), and three mentioned the disappearance of large horse mackerel (*chicharo*). During the interviews, but not during the questionnaires, the disappearance of sandlance (*Ammodytes* sp.) and juveniles of silver scabbardfish (*Lepidopus caudatus*) in recent decades was also mentioned. In relation to species still present in the catch but less abundant in relation to the onset of fishing, questionnaire replies indicated a decrease for sardine, which was found to be highly significant overall ( $V = 91, p = 0.001$ ) and significant in each site ( $V = 21, p = 0.030$  in CdC;  $V = 28, p = 0.018$  in FT); a decrease for squid, highly significant overall ( $V = 111, p = 0.003$ ) and significant in each site ( $V = 26.5, p = 0.035$  in CdC;  $V = 32.5, p = 0.040$  in FT); and a decrease for horse mackerel, highly significant overall ( $V = 45, p = 0.007$ ), significant in CdC ( $V = 21, p = 0.032$ ) but not when considering perceptions of temporal change only in FT ( $V = 6, p = 0.174$ ).

A marginally significant decrease in yield was also detected overall for seabass ( $V = 15, p = 0.048$ ). A large reduction in yield was also reported for mackerel (*Scomber scombrus*), but the species

was reported too few times for the answer to be statistically significant. On the contrary, there was a significant increase in reported current abundance of rays (*Raja* sp.) in the catch ( $V = 0$ ,  $p = 0.038$ ). For the remaining main species currently caught by *Arte-Xávega* (chub mackerel, swimming crab, salema and jellyfish), there was no evidence of significant change based on the interview responses, but some indication of non-significant increase in recent years for the latter two species (Figure 9.3).

When asked in the questionnaire whether the climatic changes reported above have had an impact on fishing, most fishers answered affirmatively (only 22% denied it), but when asked whether this has led to a modification of fishing practices, the answer was predominantly negative (56% reported no change). A reference to climatic impacts on fishing practices was further presented in the livelihood interviews in relation to the past appearance of stranded brown algae on the beach (after southerly winds during winter months) that were collected, dried and sold. In recent decades, these kelp forests near Cape Espichel have disappeared and the activity has stopped.

## Discussion

There is no doubt that, from the time the communities were originally settled to the present, artisanal fishing and *Arte-Xávega* have structured the way of living of fishers in CdC and FT. The livelihood interviews and timeline (Figure 9.2) showed that, in both places, fishing and fish work constituted the defining elements of daily family lives and routines and shaped individual and group identities and values. This corresponds to a worldview underpinned by artisanal fishing (Delgado-Ramírez et al., 2023), where TEK contributes to livelihood practices and worldviews across generations (Berkes et al., 2000). However, the present study also revealed that in recent decades, these livelihoods have experienced a change in several dimensions of life (environmental and climatic, social and technological) that have impacted the two communities and shaped individual fishers' perceptions, interpretations and strategies for adaptation. Some of these impacts and interpretations are common in the two fishing communities and some are distinct, allowing us to hypothesise a diverging direction of possible changes for the two communities in the coming decades.

The technological upgrade of fishing with *Arte-Xávega* since the 1970s occurred in the same way in the two communities (Figure 9.2), with some differences in the evolution of artefacts related to fishing (Table 9.1). On the one hand, construction of better boats with an engine, mechanical support on land, the improvement in the design of the gears and the use of weather information occurred practically simultaneously in the two communities and had the same results. Mechanisation and innovation created safer conditions for sea-going and increased fishing capacity for all fishers, increasing, accordingly, fishing effort and exploitation rate. On the other hand, wider social changes from the 1950s onwards affected the two communities differently. Urbanisation and tourist influx and massification had a much greater impact on the CdC than on the FT fishing community, breaking the topological unity and modifying the sense of belonging in the former but not in the latter (Table 9.1).

The 20th century also brought broader social transformations to the littoral of Portugal (Figure 9.2), including the arrival of new populations and the growth of urban areas (Costa Pinto and Monteiro, 2020). These social changes have also created environmental impacts that were visible to the respondents of the two communities in similar ways. Over the past 50–60 years, fluvial and maritime engineering works in the Tagus river and around its estuary have contributed to a reduction of sedimentary availability and the destruction of the natural defences of coastal systems, leaving them more vulnerable to extreme weather events and erosion (Palma et al., 2022). Several respondents mentioned coastal erosion as clearly visible within their lifetime and a threat for the

future of their local community. In the livelihood interviews, less precipitation and construction of dams in the Tagus river were also associated with limited outflow of nutrient-rich brackish waters that attract horse mackerel in more recent decades. Receding freshwater outflow in FT (whose name comes from a natural fountain at the centre of the village) and increasing salinisation of the Tagus estuary (with a concomitant modification in the plant species used in lowland agriculture and increasing residence period for aquatic species that use the estuary seasonally) were also mentioned.

In terms of fishing, changes in the relative abundance of the main target species have been observed over time, without creating major alterations in the fishing practice. More than a century after the original description of Baldaque da Silva (1892), sardine continues to be an important species for *Arte-Xávega*, although in recent decades, it has been substituted by chub mackerel as the most abundant species. Artisanal fishers, used to seasonal and interannual variation in target species abundance, rapidly adapted to the new situations, although markets tended to react more slowly. In the 1990s–2000s, catch in CdC (Martins et al., 2000) and FT (Cabral et al., 2003) was dominated by chub mackerel, with a part being discarded at the time due to limited commercial interest. Nowadays, market circuits on land have adapted to the new reality and all chub mackerel is sold. Fish are mainly exported to Spain for tuna ranching, although there were many complaints on the sale price at *lota*. In relation to wider environmental changes, the main difference in fish species composition compared to the 1990s is the disappearance of snipefish and its substitution by jellyfish, although some differences are also detected between the two communities (Figure 9.3). Large inter-decadal variations in the local abundance of snipefish (Marques et al., 2005), as well as a northwards expansion of chub mackerel in recent decades (Martins et al., 2013) have been reported in Portugal, matching the information provided locally.

Finally, the study also revealed that the above changes contributed towards two prevailing socio-environmental discourses in relation to fishing with *Arte-Xávega* in recent decades. These discourses were not community-specific and both attributed limited importance to climate as a driver of change in local livelihoods. In the first and more prominent discourse, the main changes over time were considered essentially technological, due to the increase in fishing capacity. Under this discourse, environmental and climatic changes were observed but not considered relevant in the formation of daily routines and the provision of income. There was a recognition of cascading environmental impacts on livelihoods due to reduced fish abundance in recent times, but decreasing fish abundance was not associated with changing climatic conditions (in one interview, it was even suggested that milder current weather is mainly a perception resulting from better housing and vessels) or locally-induced overexploitation. *Arte-Xávega* fishers have previously experienced interannual and seasonal variation in pelagic fish abundance, so reduced fish availability and profitability in recent decades were attributed to overexploitation derived mainly from the use of other fishing gears (trawlers) or inefficient function of the local fish market circuits.

In the second discourse, there was a prevalence to point at a socio-environmental interaction as the main driver of change in the local fishing activity. Marine productivity was reported to have been decreasing in recent decades due to reduced storminess and windiness. This, in turn, is considered to reduce the quantity and diversity of available species to fish with *Arte-Xávega*. Under this discourse, climatic drivers of change gained some relevance as they were seen to directly affect the daily routine and income related to fishing by diminishing the food sources for pelagic and semi-pelagic target species. Questionnaire replies corroborated and reinforced the relationship between storminess/windiness and fish productivity, explained through reduced food availability to fish. This could be due to the less-frequent resuspension of organic matter from the sediments during agitation and column mixing, mentioned by several fishers, or due to the diminishing influx

of nutrients through upwelling under northerly winds, mentioned in one interview. However, some fishers also indicated that, simultaneously, less adverse weather permitted longer fishing seasons and hauls and less damage on gear, thus increasing fishing effort, catch, and exploitation rate and reducing price for the most abundant species. This narrative re-introduced a social and technological dimension in the main drivers of change, as milder climatic conditions in recent decades were also perceived to facilitate a overexploitation and inefficient market functioning.

Overall, although some socio-environmental changes have a similar impact and interpretation, subtle differences are emerging between these two neighbouring communities that operate in the same ecosystems, under the same rules and using the same fishing gears. Taking a prospective view to coming decades, it seems more likely that FT fishers will maintain the current way of living and practices than CdC fishers. TEK seems likely to continue to play an important role in FT, while in CdC is more likely to emerge the generational gap currently formed in other artisanal fishing communities in Portugal (Stratoudakis et al., 2023). Nuanced differences between apparently similar artisanal fishing communities are starting to be ethnographically registered (Delgado-Ramírez et al., 2023), but further research will need to consolidate concepts and methods to test the above predictions. In particular, it will be interesting to observe how the climatic concerns related to coastal erosion and altering productivity of the coastal pelagic habitat expressed here will be interpreted in the future by two communities under diverging mechanisms for the social transmission of experience and knowledge.

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