



Eco-toxicological Health Status of Fish, Quality of the Estuary and their Impacts on Human Health: A Case Study of Consumers in Rabat, Morocco

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ABSTRACT

The geographical location of Morocco is surrounded by two seas: The Atlantic Ocean and the Mediterranean, and more than 3,000 km of coastline. This great maritime richness translates into a remarkable consumption of fish by Moroccans. Fishing in Morocco, particularly in the area around the capital Rabat, revealed a rich variety of aquatic life. Oued Bouregreg is the second major river in Morocco and has its source in the Middle Atlas at an altitude of 1627 m. This basin is drained by three main hydrological arteries: The Oued Bouregreg, the Oued Grou, and the Oued Korifla. Due to the Sidi Mohammed Ben Abdellah dam's construction, the Bouregreg estuary's ecosystem has been completely disrupted. As a result, the growth of the human population and industrial development poses a very serious threat to the aquatic ecosystem, the estuary's quality, and human health at the level of the Oued Bouregreg. Numerous construction initiatives have been recognized for the Bouregreg estuary since 2006, including the construction of the Grand Theatre, the Marina, and Tour Mohammed VI. The aim of this investigation was a statistical analysis that highlights the quality of the estuary as well as the effects of these construction projects on fish health and human health.

Keywords: Ecosystem, Estuary quality, Fish harvesting, Human health.

Introduction

Since ancient times, fish has been considered the most diverse and popular food in many human diets around the world.¹ Similarly, fish and other products of the sea, in general, contribute significantly to Morocco's socio-economic development and the creation of jobs in the country's struggle against poverty.² These aquatic resources, including fish, are however threatened by human activities, such as overexploitation of fishery resources as well as pollution from land-based development.³ Moroccan exports of maritime products reached 778,000 tons in 2021, valued at 24.2 billion dirhams (2.5 billion dollars).⁴ Discharges into the river alter the aquatic system and disturb the estuary environment. As a result of these changes in the ecosystem, hydrological regimes, and biological conditions, cause major alterations in fish communities and other faunal structures.⁵ This study was conducted to evaluate the socio-economic condition of fishermen and sellers as well as the actual condition of fish, and their impact on the health of the consumers in Oued Bouregreg in Morocco.

Materials and Methods

Study location

The study was carried out in Oued Bouregreg (coordinate Maps: 34.02832682198946, -6.825633394383696) in the region of Rabat, Morocco.

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Administration of the study questionnaire

In the statistical study, questionnaire was administered to a group of people to collect information about their general knowledge of the fish and ecosystem of Oued Bouregreg. Three categories of people were identified, which included the general public, fishermen, and vendors. For the public, a structured survey using an online tool was administered, while for the other two targets, a semi-structured questionnaire was used to interview them.

Public: An online survey tool was chosen to collect data on participants' perceptions of fish consumption. The questionnaire was publicly shared on online platforms and social media (Gmail, Facebook, WhatsApp, and LinkedIn).

Fishermen: A semi-structured questionnaire was used to collect data on the knowledge of fishermen and participants working in the region of Rabat-Sale-Kenitra and specifically in Oued Bouregreg. The visit took place on March 29 and 30, 2022, and the interviews were conducted at the fishing sites using a semi-structured interview model. The fishermen who have been located all along the salty river coast and at their assembly points, have been the target of the interview. They were organized into several groups.

Vendors: Two categories of vendors were identified. The first category of vendors was the professionals, who fell into two points of sale: the central market and the Marissa. The second category was amateur fishermen. They were sellers located in the vicinity of the fishing area.

Data collection

A survey was prepared in advance based on previous studies. In a survey, it is necessary to collect certain information such as general (place and date), social (name, age, and sex), and faunistic (vernacular name of the fish, zoological name, fish appearance, quantity of fish caught, and fishing tools). The three categories of participants were pre-informed of the purpose of the research. They responded voluntarily and anonymously to the statistical study. The online statistical study survey was anonymous with short and simple questions, focusing on multiple-choice questions created on Google Forms. The question sheet was divided into four sections: personal information, general knowledge of Oued Bouregreg, water quality, and fish species. The languages used

were Arabic and French, and the study was conducted between May 5 and 12, 2022.

The second group of interviewees consisted of 57 fishermen from the Rabat-Sale region (Figure 1) and specifically the Oued Bouregreg (Figure 2). The survey was conducted in March 2022 using a semi-structured individual questioning model. The direct interview lasted between 10 and 20 minutes, depending on the interviewer's knowledge of the subject. The language used during the interview was the Moroccan dialect, commonly known as Darija. The third group of interviewees was made up of the vendors in the two outlets (Marissa and the central salty market). Statistical information on fish was collected using a semi-structured individual interview in April 2022.

Data analysis

The data were collected, translated, and grouped by category according to the answers using an Excel sheet. Then, simple statistical tools for determining percentages and graphical representations with Excel (Microsoft Office 2015) were employed for the analysis.

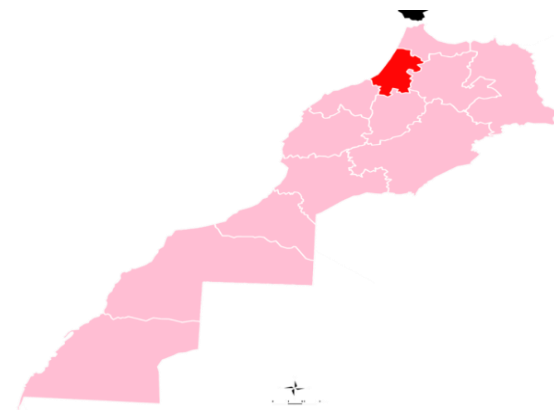


Figure 1: Location of the Rabat region in Morocco

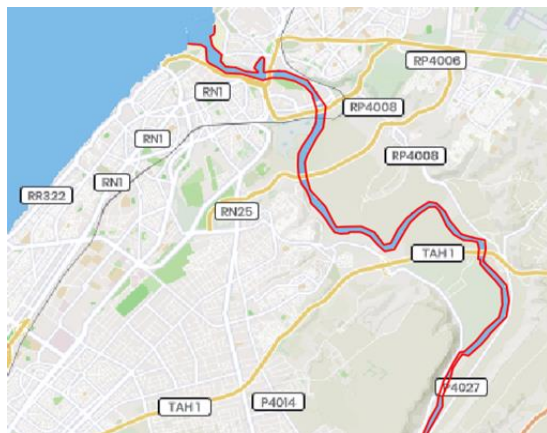


Figure 2: The map of the Bouregreg estuary and its location in the region of Rabat, Morocco

Results and Discussion

a) Responses by the general public

Socio-demographic status of the participants

The socio-demographic status of the participants is presented in Figure 3a. It was possible to obtain 200 responses from the public investigations conducted online, as shown in Figures 3b and 3c. There was a rate of 54% (n = 108) for men and 46% (n = 92) for women in terms of distribution by sex. According to the study results of participants in Germany, women use smartphones more frequently than men, although social media platforms like WhatsApp and Facebook are major drivers of smartphone usage.⁶ The highest age percentage (Figures 4 and 7) was 77% (n = 154), followed by 17% (n = 34), which ranged from 18-30 to 30-40, respectively. Then, a rate of 2% was collected for the under-18 age group, as well as 2% (n = 4) and 1% (n = 2) for the 40-50 and 50-60 age groups, respectively. More so, a value of 1% (n = 2) was observed for age group >60. The results of this study concerning the age of online participants are perfectly consistent with the findings of Lynett in 2019.⁷ The highest percentage in terms of educational achievement is 93% (n = 186), which represents individuals with post-baccalaureate education. This is followed by 6% (n = 12) who had a bachelor's degree and only 1% (n = 2) who had no qualifications. These observations are in line with the reports of Sobaih,⁸ who showed that 96% of university graduates were internet users. Figure 5 shows the distribution of participants according to their region of residence. The region of Rabat-Sale-Kenitra has the highest percentage with 47.24% (n = 95), followed by the region of Grand Casablanca and then the region of Marrakech-Safi with 4.52% (n = 9) and the regions of Fes-Boulemane and Souss-Massa-Drâa with 3% (n = 6). This could be due to the algorithm used by social media, which is based on recurrence, popularity, content type, and relationships.

The outcome of the general questions

In this part of the survey, general questions about the Oued Bouregreg and its fauna have been addressed, starting with basic questions about general awareness of it (Figure 6a). The results showed that 92% of the population (n = 184) knew what Oued Bouregreg is, while 8% (n = 16) have never heard of this river. The graph in Figure 6b shows that 77% (n = 154) of the questionnaire participants did not know the species of fish in the river, while 23% (n = 46) of the participants were aware of the existence of fish species in Oued Bouregreg. Figure 7a highlights that 89.5% (n = 179) of the participants have never fished in the Bouregreg river, while 10.5% (n = 21) have ever fished in the Bouregreg River, with only a small proportion of the community practicing fishing. For the participants to successfully identify the fish species of Oued Bouregreg, photos were also presented. As depicted in Figure 7b, 59.8% of the participants (n = 119) recognized *Mugilidae* as a fish species of Oued Bouregreg, while 34.2% of the participants (n = 68) knew the *Solea* fish. A high percentage (82.9% [n = 165]) of the participants had never heard of these species, while only 17.1% (n = 34) were aware of the problem of the extinction of fish species in Oued Bouregreg (Figures 8a and 8b).

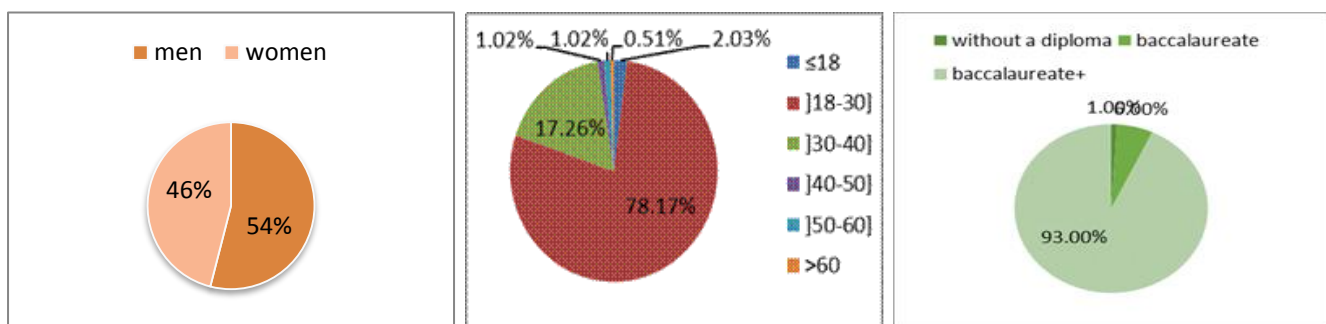


Figure 3: (a) Breakdown of participants; (b) Breakdown of participants by age; (c) Breakdown of participants by level of study

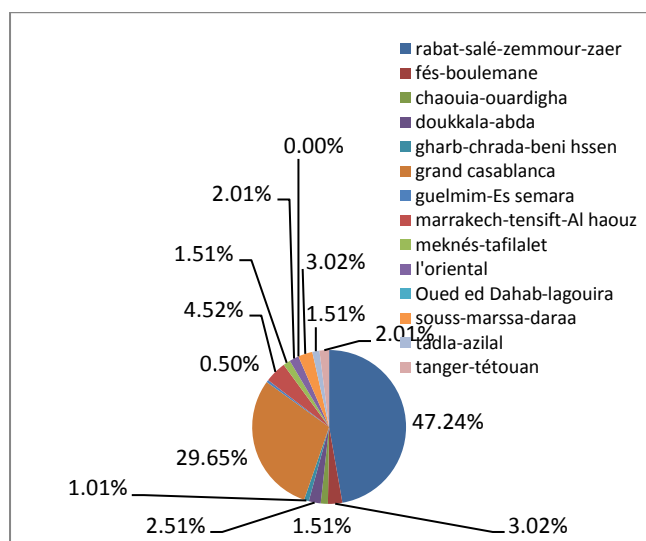


Figure 4: The distribution of participants according to their region of residence

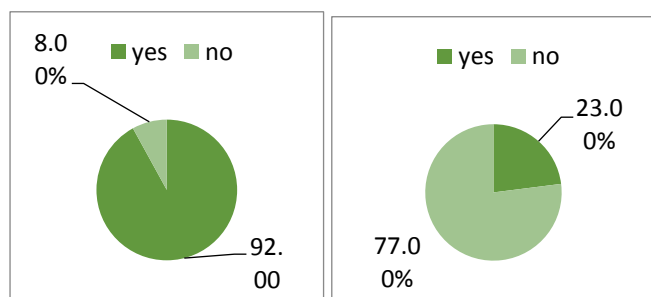


Figure 5: (a) percentage of participants on Bouregreg knowledge of wadi Bouregreg; (b) percentage of participants on knowledge of wadi fish spaces

Alosa sapidissima was the most threatened fish by extinction according to the responses of the participants (58.82% [n=20]), followed by *Sciaena aquila*, *Anguillidae* species, *Saparus aurata* and *Diplodus sargus*, which have the same percentage of extinction as observed in Figure 8b.

The outcome of the consumer questions

The results showed that more than half of the respondents (60.91%) were not consumers of fish (n = 120), while 39% of the participants were consumers of these types of fish (Figure 9). For the points of purchase, 54.3% (n = 108) of the participants choose another place to buy these fishes, while 17.6% (n = 35) bought them from the central

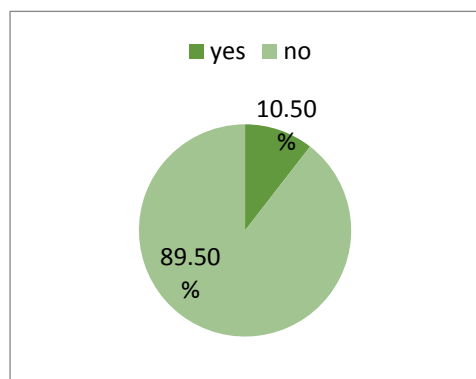


Figure 6: (a)the percentage of participants practicing fishing at Oued Bouregreg; (b) fish species from the Bouregreg river

market of sale, followed by Marissa of sale 16.1% (n = 3,2) and lastly from amateur fishermen (12.1% [n = 12]). Concerning the amount of fish consumed weekly, 45.19% (n = 61) of participants consumed 100g, while 41.19% (n = 56) of participants consumed 250-500 g. The largest amount of 1 kg of fish was consumed by 13.33% (n = 18) of the participants. This result is in agreement with the findings of Gomna in 2007.⁹ To obtain information on how much wadi fish was consumed each month per person, a question was posed in this direction. The results (Figure 10) show that 68.89% (n = 93) of the participants consumed between 1-5 kg, which is consistent with the previous study on the amount of weekly consumption. This high demand is due to a combination of factors indicating a preference for fish consumption. Among these factors is the fact that fish is a healthy and balanced food preferred by people.¹⁰ The results (Figure 11) on the method of cooking the fish show that frying was the most embraced method by the participants at 72.9% (n = 145), followed by grilling at 64.8% (n = 129) and then boiling at 10.1% (n = 20). Summer was the most popular season for consumers, with a percentage of 78.9% (n = 157), followed by winter and spring at 56.8% (n = 113) and 54.3% (n = 108), respectively.

The outcome of the fish health status questions

In this part of the online survey, three questions were asked. The first of which is shown in Figure 12a and 12b. In Figure 13a, the circular diagram represents participants' responses regarding their knowledge of fish quality. It was observed that 50.25% (n = 100) of participants were aware of fish quality, while the remaining half were not. For symptoms after eating these fish, only 10% (n = 20) showed evidence of infection, while 90% (n = 180) of the participants did not show any symptoms, as illustrated in Figure 13b. Among the symptoms reported by the 16 participants, 50% (n = 6) were for skin allergies, 30% (n = 6) were for manifestations of mycosis of the mouth, and 10% (n = 2) of the participants reported nausea and vomiting, Figure 13c and 13d. The same percentage was observed for those who declared abdominal pain. One of the participants found that fish retailers were commonly infected with some diseases like the common cold (cough, coryza), diarrhea, and lesions (lesions on the hands, lesions between the fingers, lesions between the toes, e.t.c.).

This is due to the large variety of fish among vertebrates. Due to human exposure to a wide range of intact allergens, the allergenic molecules in fish and their preparation and cooking methods vary, which causes allergic changes.¹¹

b) Responses by the fishermen

Socio-demographic status of participants

In March 2022, surveys of fishermen (Figure 13) were undertaken to gather information using a semi-structured questionnaire. Of the 81 fish harvesters questioned, only 57 agreed to provide information.

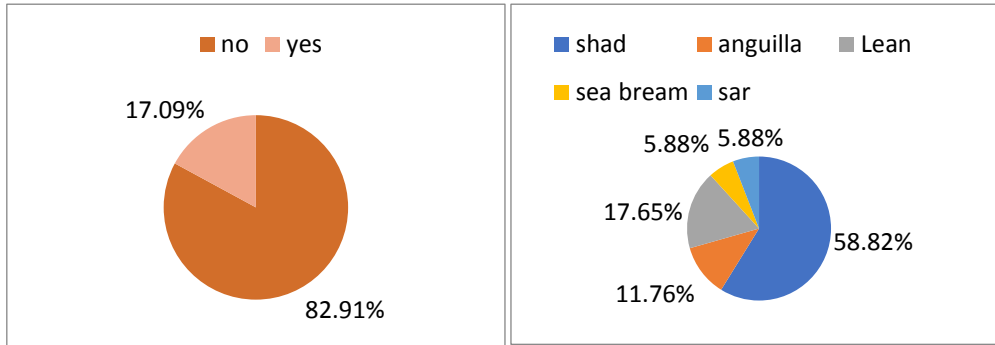


Figure 7: (a) knowledge about the extinction of fish species in Oued Bouregreg; (b) Extinct fish species in Oued Bouregreg

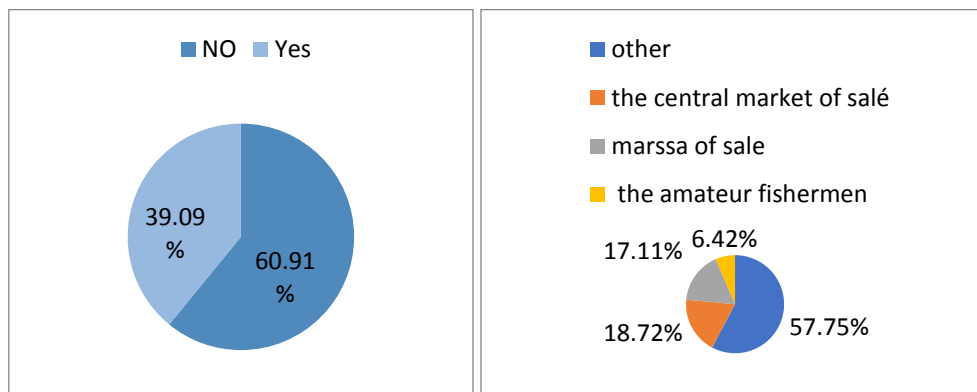


Figure 8: (a) the percentage of consumers of fish from Oued Bouregreg; (b) points to buy fish from Bouregreg

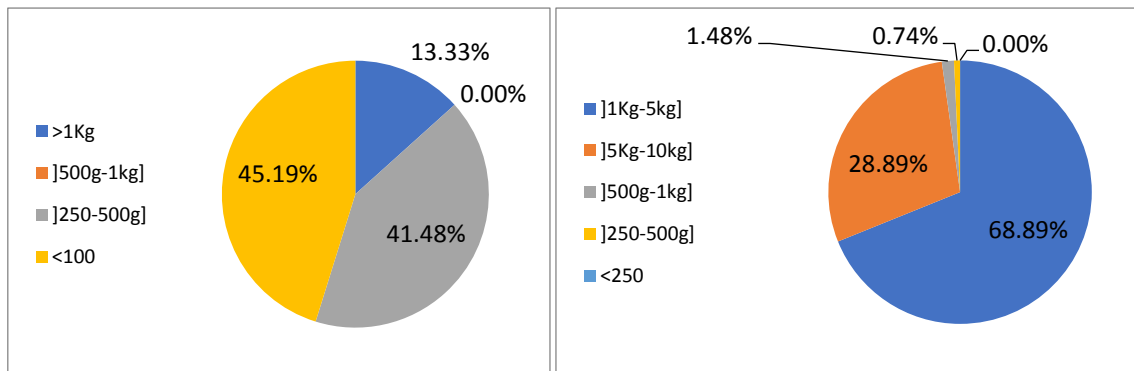


Figure 9: (a) la quantité de consommation des poissons consommés hebdomadaire; (b) The amount of fish consumed monthly

The fishermen were chosen at random. Descriptive statistics using frequencies and percentages were used to analyze the fishermen's socio-demographic data, and the results are presented in Figure 14a. The distribution of traditional fishermen by gender shows that 100% (n = 57) were men. The distribution of fishermen by age (Figure 14b) indicated that the highest age group was 30-40 with a rate of 42.1% (n = 24). The practice of this occupation by this age group is consistent with the findings of research carried out by Rani in Bangladesh in 2015.(9)The 40-50 age group came in second with 21.1% (n = 12), followed by the 50-60 age group with 15.8% (n = 9). Only 10.5% (n = 6) of the 18-30 years and the same percentage of people over 60 years old were observed. In terms of educational attainment, the highest percentage was 96.49% (n = 55) for those without a diploma and 3.51% (n = 2) for those who had a secondary education (Figure 14c and 14d). This observation is in agreement with the findings of the study of Mahmoud,¹² conducted in river regions, which indicated that the proportion of people with a primary education was the highest. The distribution of fishermen by region of residence revealed that the region of Rabat-Sale-Kenitra had the highest percentage with 100% (n = 57).

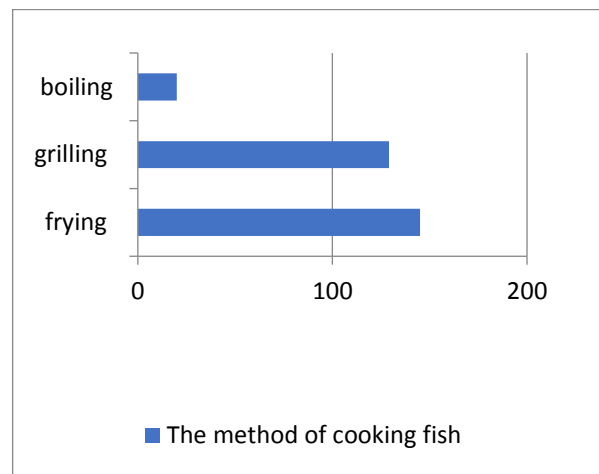


Figure 10: The method of cooking fish from Oued Bouregreg

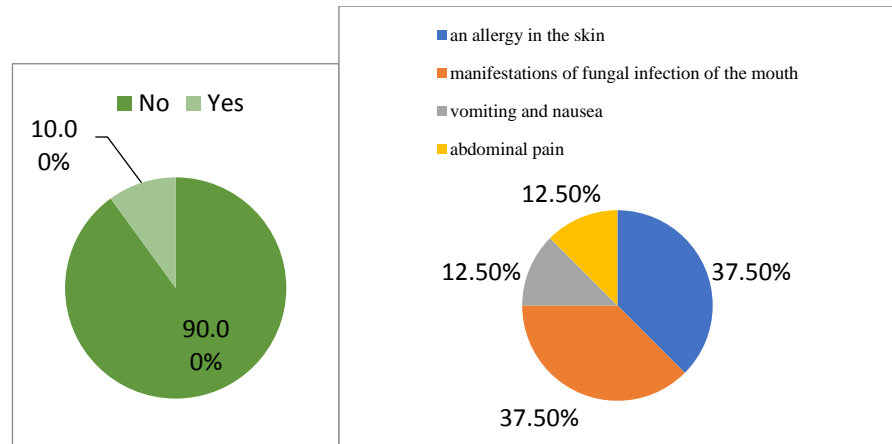


Figure 11: (a) Knowledge of fish quality; (b) Percentage of participants who exhibited symptoms; (c) the different symptoms that appeared after consumption

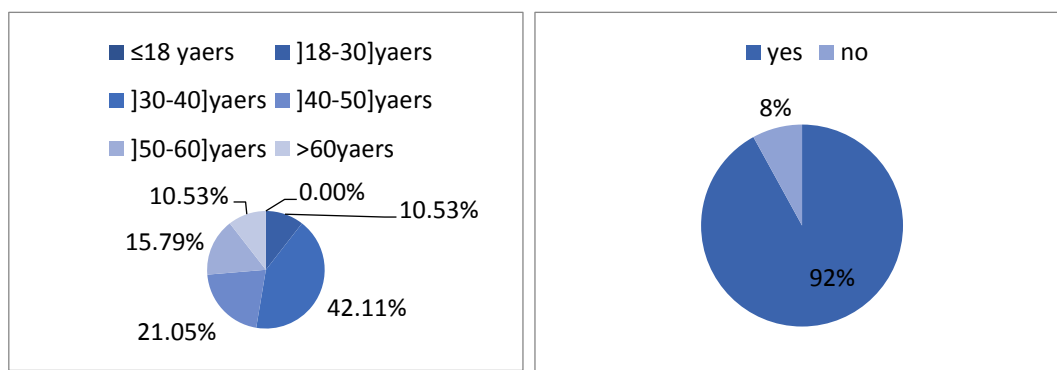


Figure 12: (a) The distribution of participants by age; (b) Distribution of participants by education level

The outcome of the general questions

In this survey, the knowledge of the field of fishing and the fish species of Oued Bouregreg were evaluated. Figure 15 shows the distribution of the responses based on the number of fishermen. The number of boats, the species captured, the species of fish that disappeared, the outlets for those fish, fishing points, fishing seasons, limitations of fishing on the Bouregreg River, and observations on the quality of the river were all captured. In terms of the number of fishermen (Figure 15a), the participant's responses showed that 87.7% (n = 50) stated that the number of fishermen was 80-100, while 7.02% (n = 4) claimed that the number was >100, and 5.26% (n = 3) said it was 60-80. The majority of participants (100% [n = 57]) reported 40 boats, with varying numbers of fishermen on each boat (Figure 15b). The percentage change in the species caught is presented in Figures 15c and d. About 84.2% (n = 47) of the participants claimed to have fished for *Mugilidae*, whereas 70.17% (n = 40) of the participants said they caught *Solea*, and 57.9% (n = 33) of the participants said they caught *Lophius*.

Concerning extinct fish species on the Bouregreg river, 94.7% (n = 54) of the participants attested to the disappearance of the *Alosa sapidissima*, 89.4% (n = 51) confirmed the disappearance of the *Anguillidae*, and 59.6% (n = 34) affirmed the disappearance of the *Sciaena aquila*. The reasons for this observation may be due to the construction of canals, the rise of the marine transportation industry, the unintentional and intentional dumping of the aquaculture trade into fishing baits and aquariums, and horticultural activities.¹³ As shown in Figure 16a, 85.9% (n = 49) of participants reported selling fish to wholesalers, and 8.77% (n = 5) of the participants proved that they sold their fish to reputable restaurants in the Rabat region. Meanwhile, 5.26% (n = 3) of the fishermen reported direct sales to consumers. Regarding the fishing points on Oued Bouregreg, 52.6% (n=30) of the participants selected the Moulay Youcef bridge as the fishing point, followed by 66.6% (n = 38) who named the Mohammed 6 bridge as a second fishing location, and 92.98% (n = 53) who selected the Hassan

I bridge. The fishing seasons in the Bouregreg River as depicted in Figure 16b and 16c, showed that 98.26% (n = 56) of participants fished in the summer, 96.49% (n = 55) preferred to fish in the spring, while the percentage of participants who fished in the autumn season was 70.17% (n = 40), and only 40.23% (n = 23) of participants fished in the winter. One hundred percent (n = 57) of the participants could only fish on Oued Bouregreg. The amount of fish in the Bouregreg River has declined recently, with 75.44% (n = 43) of participants claiming that it was 20-25 kg, 17.54% (n = 10) demonstrated that it was 25-30 kg, and 7.02% (n = 4) claiming that it was 10-15 kg. According to Gillson, the decrease in fish abundance is due to climate change, which is causing changes in fish communities.¹⁴ The results of the river and fish quality obtained from the participants during the present study revealed that 54.39% (n = 31) of respondents reported a decrease in river depth, 57.89% (n = 33) reported a foul smell coming from the valley, especially in summer, while 47.37% (n = 27) of fishermen noticed the presence of waste in the valley. Meanwhile, all of the fishermen confirmed a significant decrease in the number of fish. Similarly, only 8.77% (n = 5) of participants reported having found dead fish in the river. The results of this survey are consistent with previous studies by Islam in 2017.¹⁵

The outcome of the consumer questions

As shown in Figure 17a, 100% (n = 57) of participants were fish consumers from the Bouregreg River. Eighty-seven percent (n = 46) of the participants consumed more than 1 kg of fish per week, 12.28% (n = 7) consumed between 500 g-1 kg, and 7.0% (n = 4) consumed between 250-500 g. To get a reliable outcome of fish consumption by participants, the monthly amount of fish consumption from the river was evaluated. The results (Figure 17) show that 77.19% (n = 44) of the participants consumed 1-5 kg. This value is lower than among fishermen in Portugal in 2022.¹⁶ The results of the different fish grills are presented in Figure 17b and they indicated that 64.91% (n = 37) of participants chose to grill as a method of cooking fish, 24.56% (n = 14)

of participants stated that scrambling was the best way to cook a fish, and only 10.53% (n = 6) of participants preferred fried fish. Regarding the seasons, 92.98% (n = 53) of the participants stated that all seasons were preferred for fish consumption, while 7.02% (n = 4) of the participants eat fish only in the summer and spring seasons.

The outcome of the fish health status questions

When the participating fishermen were questioned about the quality of the fish, the responses they provided are shown in Figure 18. Among the participants, 84.21% (n = 48) said they caught river fish, compared to 79% (n = 9) of fishermen who claimed they did not. When it comes to fish quality, 42.86% (n = 24) of fishermen claimed that the river's fish

was of excellent quality, while 35.71% claimed that the quality was average, and only 21.43% (n = 12) of participants indicated that the fish were of poor quality. Following fish consumption from the Bouregreg River, 87.72% (n = 50) of participants reported no symptoms, while 12.28% (n = 7) of participants admitted to experiencing symptoms. Of the symptoms experienced by the 7 participants, oral yeast infections accounted for 42.86% (n = 3), skin allergies for 28.5% (n = 2), and vomiting and abdominal pain for 14.29% (n = 1). Fish poisoning can be caused by parasites and chemical impurities that render them hazardous, as well as by human activities that contaminate fish. Eating these fish puts human health at risk.¹⁷

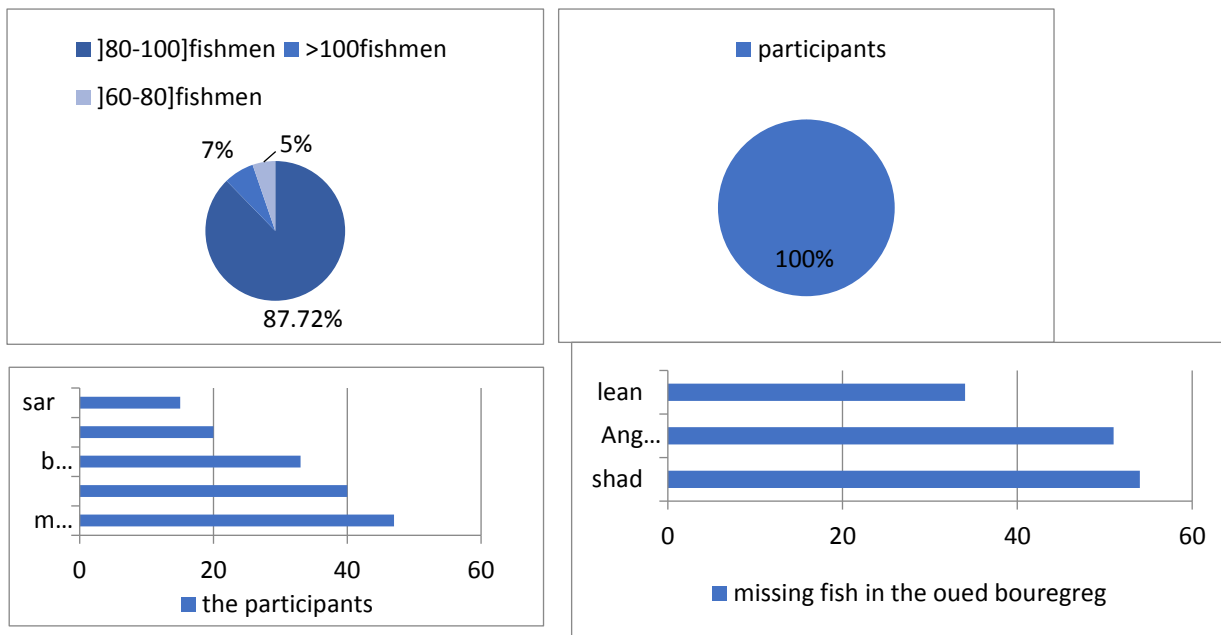


Figure 13: (a)The percentage of participants' rewards out of the number of fishermen; (b) the percentage of participants' answers on the number of boats; (c) species of fish caught by the fishermen of Bouregreg river; (d) Fishermen's responses on the species of fish that disappeared

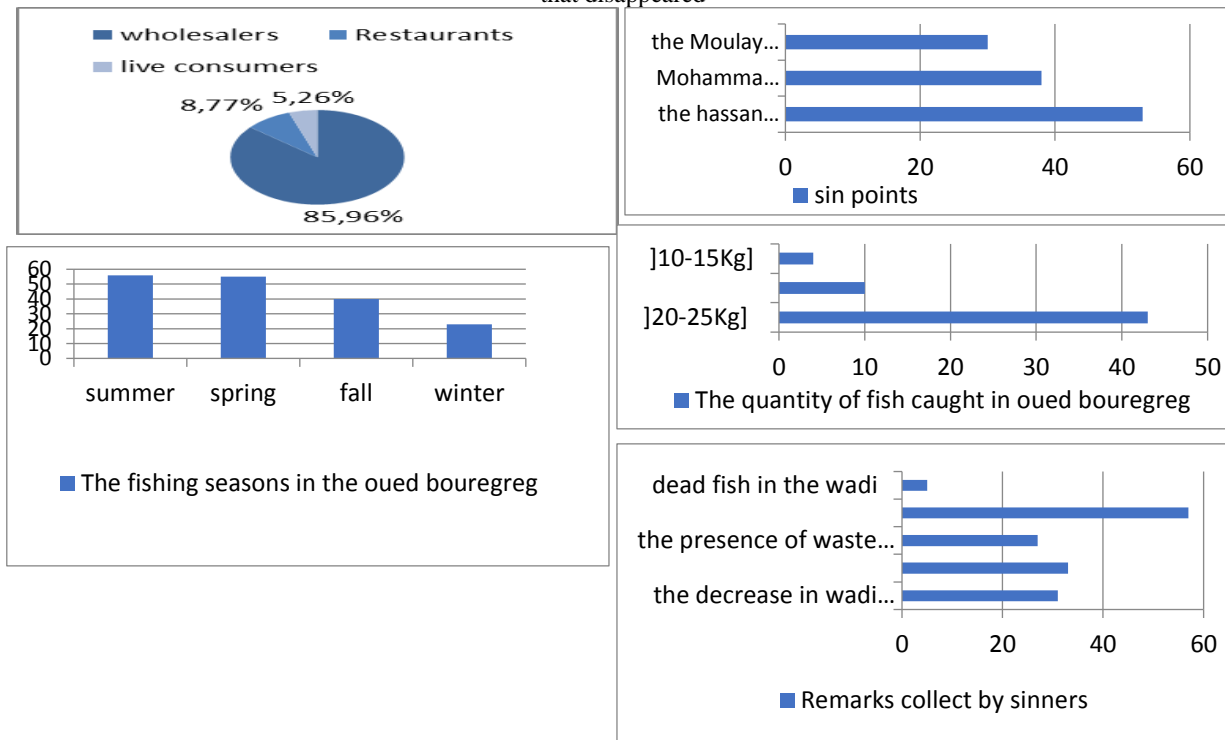


Figure 14: (a) Bouregreg fish selling points; (b) les points de pêche pour les pêcheurs d oued Bouregreg; (c) Fishing seasons in Oued Bouregreg; (d) la quantité des poissons pêchés dans oued Bouregreg ; (e) the different remarks made by the fishermen

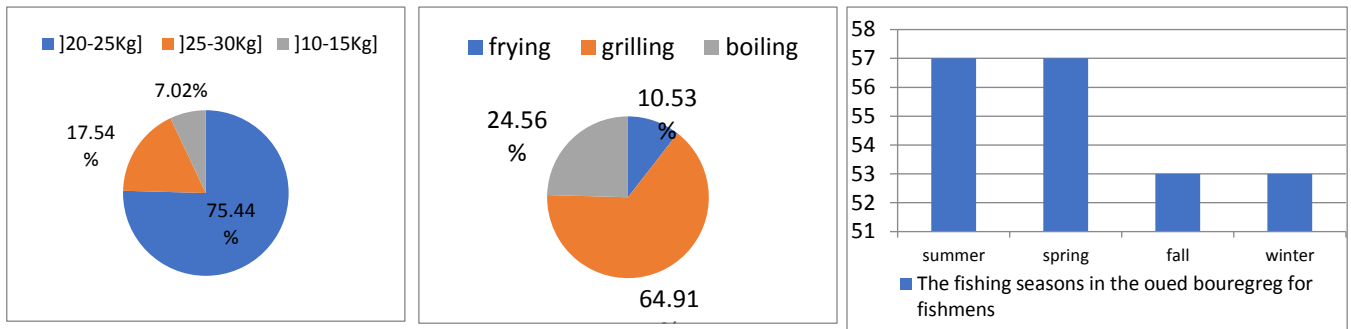


Figure 15: (a) the quantity of fish consumed weekly; (b) the different methods of cooking fish in Oued Bouregreg according to the fishermen; (c) the preferred season for consuming fish from Oued Bouregreg

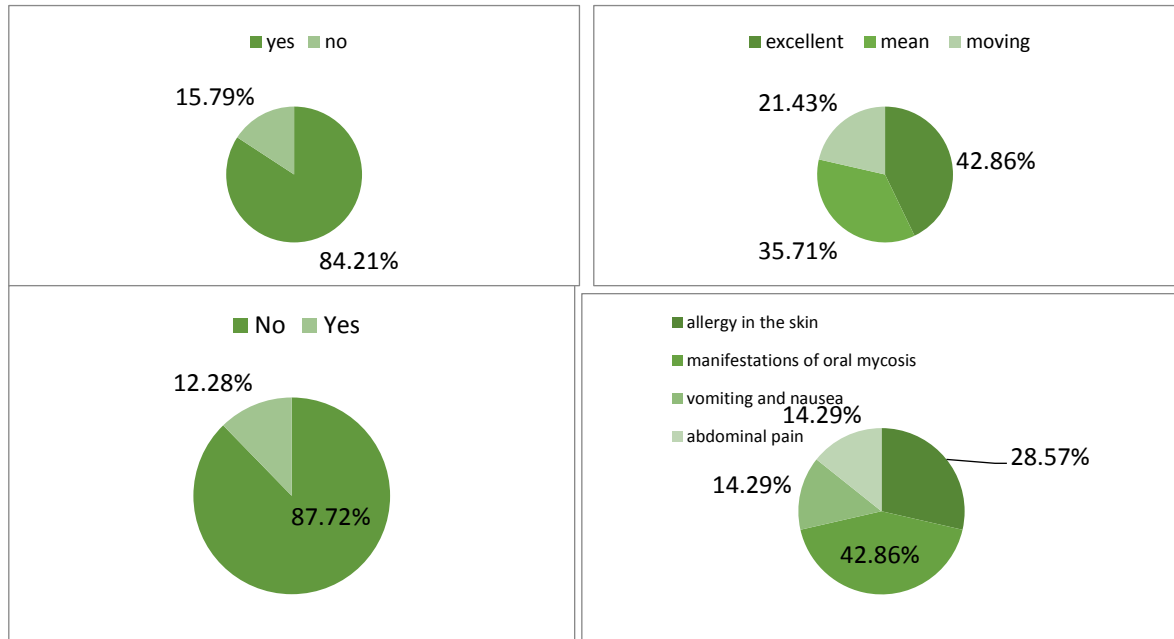


Figure 16: (a) Knowledge on the quality of fish in Oued Bouregreg; (b): the different quality levels of fish in Oued Bouregreg; (c): Percentage of Participants with Symptoms; (d): the different symptoms that participants get

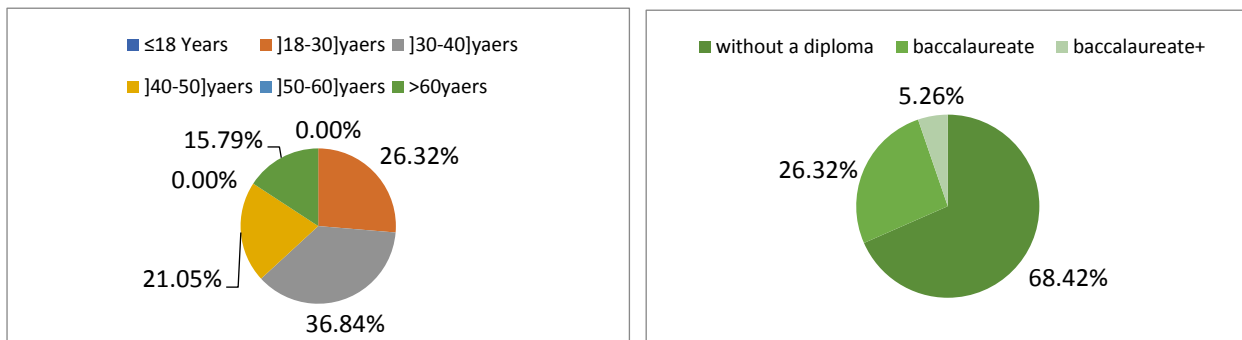


Figure 17: (a) Age distribution of participants; (b): Distribution of participants by education level

c) Responses by the fish vendors

Socio-demographic status of the participants

The fish were supplied to sellers in two locations: the central market of sale and the Marissa of salt, following field research and investigation with wholesalers. In contrast to the Danba survey in Japan,¹⁸ which found that 66.7% of sellers were men at home, the distribution of sellers by sex in the present study revealed that 100% (n = 19) of them were men. The distribution of sellers by age showed that the highest age group was 30-40 with a rate of 36.84% (n = 7), followed by 18-30 years with 26.32% (n = 5), then 40-50 years with 21.05% (n = 4), and finally 15.79% (n = 3) of the participants were >60 years old. For educational qualification, 68.42% (n = 13) of the sellers have no diploma, while

26.32% (n = 5) of the participants have a baccalaureate, and only 5.26% (n = 1) had post-secondary degrees (Figure 19). All of the participants in the survey were from the Rabat-Sale-Kenitra region with a value of 100% (n = 19).

The outcome of the questions for fish vendors

In this part of the survey, the focus was on the quantities of fish sold, the most sold species, and the selling prices. In terms of the weights of fish sold (Figure 19a), 52.63% (n = 10) of participants sold fish, while 31.58% (n = 6) of vendors sold weights greater than 30 kg, accounting for 15.79% (n = 3) of their total sales. The fish of Oued Bouregreg sold in the two sales outlets were the only fish sold by the entire fishing

community, with the *Mugilidae* confirmed by 78.95% (n = 15) of the sellers, the *Lophius* confirmed by 68.42% (n = 13), the *Anarhichas lupus* confirmed by 47.37% (n = 9), and the sale of other fish only proven by 26.32% (n = 5) of the sellers (Figure 19b). According to 78.95% of participants (n = 15), the *Solea* was the best-selling fish species, followed by *Lophius* (15.79% of participants, n = 3), and *Mugilidae* (5.26% of participants, n = 1), which sells the fastest and was the most popular fish species in Mexico.¹⁹ Fish prices vary by season and availability. Generally, the basic price ranges from 10 to 50 dinars for all vendors, and the presence of middlemen in the distribution of fresh fish products causes price

volatility and the high cost of fish in the study area.²⁰ Concerning popular days for vendors, 84.21% (n = 16) of the participants preferred weekends, while 15.79% (n = 3) stated Thursday and Tuesday were the most active days for their merchandise. For 10.53% (n = 2) of participants, Wednesday was the most active day for their merchandise, and only one vendor (5.26% [n = 1]) chose Monday. Only two vendors were still purchasing fish from direct harvesters, and 63.16% (n = 12) of the participants got their fish via wholesale distributors. In contrast, 26.32% (n = 5) preferred to get their seafood from Marissa.

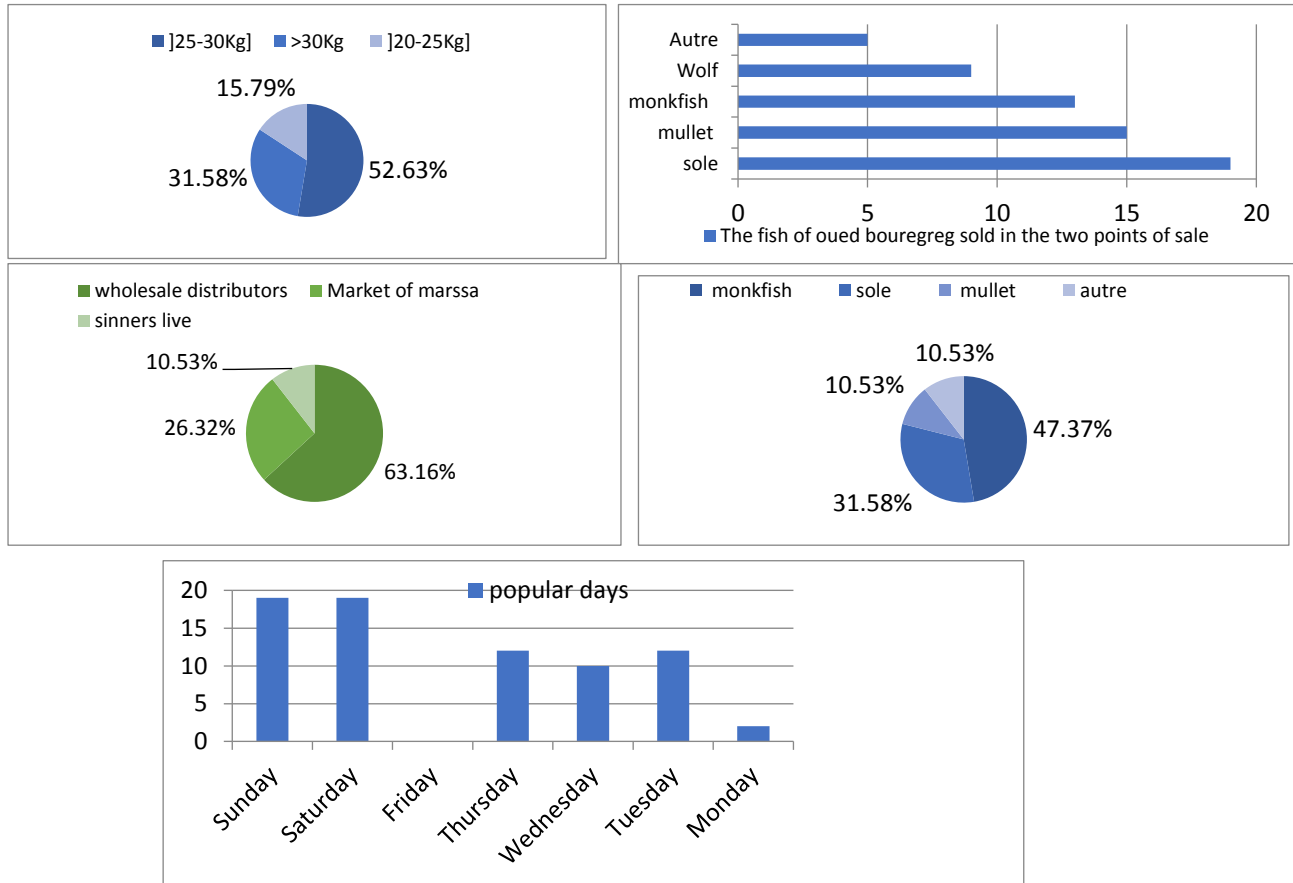


Figure 18: (a) the quantity of fish from the Bouregreg River sold daily; (b) : les espèces des poissons d’oued Bouregreg vendu; (c): Percentage of most sold fish according to sellers' answers; (d): the percentage of origin of distribution of fish in Bouregreg River; (e) Popular days for goods as reported by vendors

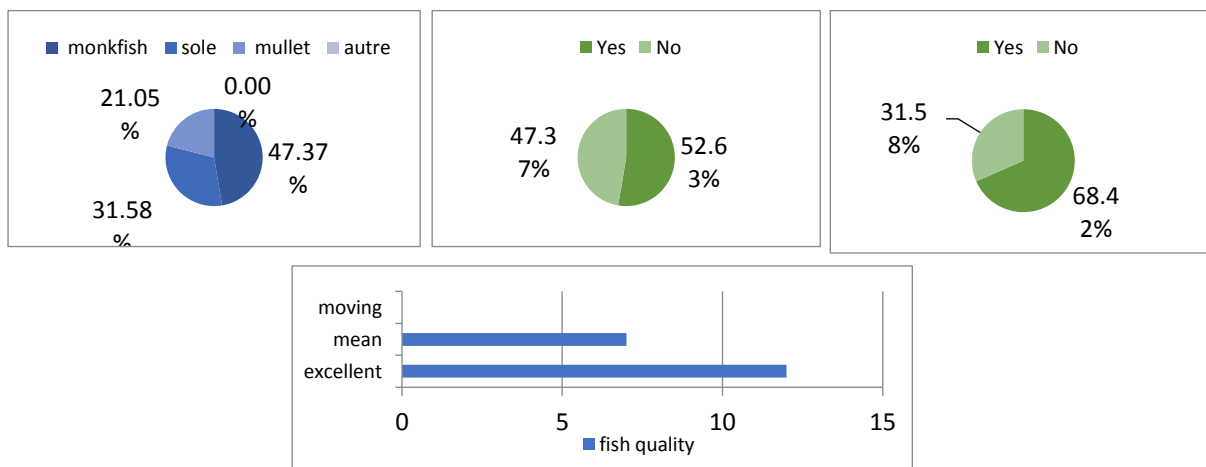


Figure 19: (a) Percentage of fish species most consumed by vendors; (b): percentage of chronic clients for fish from Oued Bouregreg; (c): the percentage of sellers' knowledge of the fishing points of Bouregreg fish; (d): the different quality levels of fish from Oued Bouregreg according to the sellers

The outcome of the consumption questions

All the vendors consumed the fish themselves,²¹ according to the results presented in Figure 19c. *Lophius* was the most consumed fish among the vendors (47.37% [n = 9]), 31.58% (n = 6) of the participants preferred *Solea*, while 21.05% (n = 4) consumed *Mugilidae*. At the client level, 52.63% (n = 10) reported having recurring and chronic clients, compared to 47.37% (n = 9) who did not. According to the sellers' responses in Figure 19d, 68.42% (n = 13) of the participants were aware of the fishing points for these species, whereas 31.38% (n = 6) were not interested in them. As observed in Figure 19d, every seller acknowledged that they were aware of the fish's quality. Of the 12 sellers, 63.16% claimed that the fish was of excellent quality, while the remaining sellers, 36.84% (n = 7), claimed that the fish were of average quality, which is comparable to the fair-to-good quality scores of fish in Puerto Rico.²²

The outcome of the fish health status questions

Responses from vendors questioned the validity of the toxicological quality of the fish. About 73.68% (n = 14) of participants reported that they did not develop symptoms after eating the fish, but 26.32% (n = 5) of participants demonstrated contamination by the fish (Figure 20a). For

the five vendors (Figure 20b), 20% (n = 1) showed a skin allergy, 40% (n = 2) indicated that yeast was present in the mouth, and 40% (n = 2) experienced headaches, nausea, and vomiting as a result of the activation and release of neurotransmitters in the central nervous system.²³

Conclusion

In Morocco, fish consumption is the same for all age groups, and cooking methods vary between individuals. The statistical survey was not yet representative or sufficient to detail all fish quality information in the Bouregreg estuary, after geographic changes, and naturally occurring hydrological and sedimentological processes. The online survey focused only on internet users, resulting in the marginalization of those without a social media account. The main limitation for fishermen is the absence of a sign-up sheet that includes the addresses of Moroccan fishermen. It was explained to the sellers that it is difficult to keep up with the steadfast buyers of such fish to get more precise statistics on the effects of consuming fish from Oued Bouregreg. Fish are abundant in Oued Bouregreg, and it should be blanketed and authorized that their hygienic situation is investigated by conducting chemical and microbiological investigations on those fish.

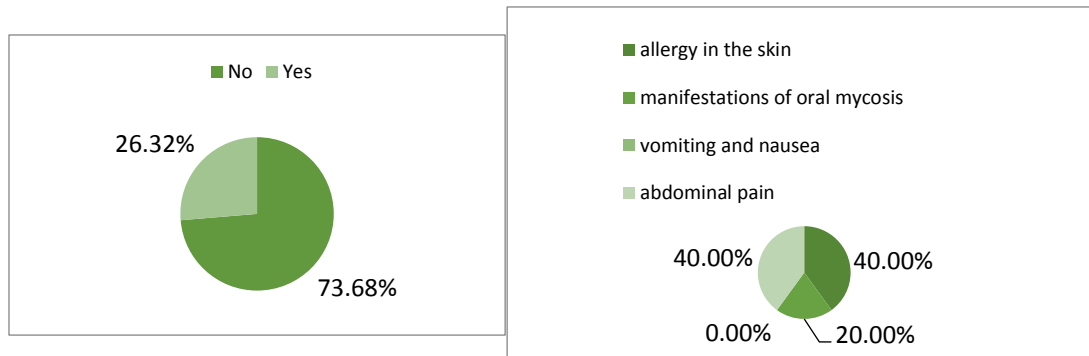


Figure 20: (a)Percentage of participants who experienced symptoms after eating fish from Bouregreg; (b): the different symptoms that participants experienced after eating Bouregreg fish Lists of tales

Table 1: Table of Questionnaire for collecting information from the public

general information:						
gender	male	Female				
Age	≤18	]18-30]	]30-40]	]40-50]	]50-60]	>60
level of study	without diploma	baccalaureate	baccalaureate+	Doukkala-Abda	Gharb-Chrarda-	Greater
region	Rabat-Salé-	Fès-Boulemane	Chaouia	L'Oriental	Beni Hssen	Casablanca
	Zemmour-Zaër	Marrakech-	Ouardigha		Laâyoune-	Oued ed
	Guelmim-Es	Tensift-Al Haouz	Meknès-		Boujdour-Sakia el	Dahab-
	Semara	Tadla-Azilal	Tafilalet		Hamra	Lagouira
	Souss-Massa-Drâa		Tanger-Tétouan			
general questions						
- Do you know oued bouregreg?	No	Yes				
- Do you know fish species in wadi?	No	Yes				
	mullet	Monkfish	sole	Wolf fish	Other	
- If so, are these species among the fish that you know of in the wadi?	No	Yes				
- Have you practiced fishing in Oued Bouregreg ?						
consumer questions						

(Electronic)

- Have you heard of the extinction of fish species in Oued Bouregreg?	No	Yes					
- If so, what are these species?	No	Yes					
have you ever eaten wadi fish?	central market of sale	Anchor of salé	amateur fishermen	Other			
- The points of buying the fish?	100g	]100-250g]	]250-500g]	]500g-1kg]	>1Kg	>10Kg	
- Amount of fish eaten per week	100g	]250-500g]	]250-500g]	]1Kg-5kg]	]5Kg-10kg]		
- Quantity of fish consumed per month	≤250g	grillade	]500g-1kg]	fall			
- How to cook these fish	Fried	winter	Boiled				
In what season did you eat these fish?	summer		spring				
Eco-toxicological issues							
do you know the quality of these fish?	No	Yes					
Have you ever noticed any symptoms after eating these fish?	No	Yes					
if yes what are its symptoms							

Table 2: Table of Questionnaire to collect information from fishermen

general information:							
gender	male	Female					
Age	≤18	]18-30]	]30-40]	]40-50]	]50-60]	>60	
level of study	without diploma	baccalaureate	baccalaureate+	Doukkala-	Gharb-Chrarda-Beni	Greater	
region	Rabat-Salé-Zemmour-Zaër Guelmim-Es Semara Souss-Massa-Drâa	Fès-Boulemane Marrakech-Tensift-Al Haouz Tadla-Azilal	Chaouia Ouardigha Meknès-Tafilalet Tanger-Tétouan	Abda L'Oriental	Hssen Laâyoune-Boujdour-Sakia el Hamra	Casablanca Oued ed Dahab-Lagouira	
questions from sinners							
The number of sinners	≤20	]20-40]	]40-60]	]60-80]	]80-100]	>100	
the number of boats							
species fished							
species of extinct fishes	shad	lean	anguilla				
The sellers of the fish of oued bouregreg	Wholesalers	Restaurants					
the points of sin	the hassan1 bridge	the Mohammed 6 bridge	the Moulay Youcef bridge				
the seasons of sin	summer	winter	spring	fall			
the limits of sin on oued bouregreg							
The amount of daily fishing	]10-15Kg]	]20-25Kg]	]25-30Kg]	>30Kg			
Comments collected on wadi							
consumer questions							

have you ever eaten wadi fish?	No	Yes			
amount of fish eaten per week	100g	]100-250g]	]250-500g]	]500g-1kg]	>1Kg
how to cook these fish	Fried	grillade	Boiled	fall	
In what season did you eat these fish?	summer	winter	Spring		
eco-toxicological questions					
Do you know the quality of these fish?	No	yes			
The quality of the fish have you ever noticed any symptoms after eating these fish? if so, what are the symptoms	was moving	mean	excellent		
	No	yes			

Table 3: Table of Questionnaire to collect information from vendors

general information:						
gender	male	Female				
Age	≤18	]18-30]	]30-40]	]40-50] ans	]50-60] ans	>60
level of study	without diploma	baccalaureate	baccalaureate+	Doukkala-	Gharb-Chrarda-Beni	Greater
region	Rabat-Salé-Zemmour-Zaër Guelmim-Es Semara Massa-Drâa	Fès-Boulemane Marrakech-Tensift-Al Haouz Tadla-Azilal	Chaouia Ouardigha Meknès-Tafilalet Tanger-Tétouan	Abda L'Oriental	Hssen Laâyoune-Boujdour-Sakia el Hamra	Casablanca Oued ed Dahab-Lagouira
questions for sellers						
the quantity of fish sold daily	]10-15Kg]	]20-25Kg]	]25-30Kg]	>30Kg		
The species of oued bouregreg fish sold	sole	Monkfish	mullet	Wolf fish	other	
The best-selling wadi bouregreg species	sole	Monkfish	mullet	Wolf fish	other	
How much did you sell these fish						
What are the days to sell	Week end	Monday	tuesday	Wednesday	Thursday	Thursday
The points of purchase of your fish	Wholesale distributors	sinnners live	Anchor of salé			
You eat the fish yourself	yes	No				
What species do you eat	sole	Monkfish	mullet	Wolf fish		
You have loyal customers who consume fish in a chronic way	yes	No				

you know the points of sins	yes	No	
You know the quality of these fish	yes	No	
The quality of the fish	was moving	mean	excellent

Eco-toxicological questions

have you ever noticed any symptoms after eating these fish? if so, what are the symptoms	No	yes	
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Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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