RELATÓRIOS CIENTÍFICOS E TÉCNICOS

SÉRIE DIGITAL

RIA FORMOSA ECOSYSTEM: SOCIO-ECONOMIC APPROACH

Dalila Serpa, Dora Jesus, Manuela Falcão e
Luís Cancela da Fonseca

IPIMAR

2005

28

Os **RELATÓRIOS CIENTÍFICOS E TÉCNICOS DO IPIMAR** destinam-se a uma divulgação rápida de resultados preliminares de carácter científico e técnico, resultantes de actividades de investigação e de desenvolvimento e inovação tecnológica. Esta publicação é aberta à comunidade científica e aos utentes do sector, podendo os trabalhos serem escritos em português, em francês ou em inglês.

A **SÉRIE COOPERAÇÃO** destina-se, primordialmente, à divulgação de trabalhos realizados com países terceiros no âmbito de programas de cooperação.

A **SÉRIE DIGITAL** destina-se a promover uma consulta mais diversificada e expedita dos trabalhos na área da investigação das pescas e do mar.

RIA FORMOSA ECOSYSTEM: SOCIO-ECONOMIC APPROACH

Dalila Serpa, Dora Jesus, Manuela Falcão, Luís Cancela da Fonseca

IPIMAR/CRIPSul – Centro Regional de Investigação Pesqueira do Sul
Av. 5 de Outubro, 8700-305-Olhão, Portugal

ABSTRACT

The ecological assets of an area provide the basic inputs for economic processes. However, economic activities directly depending on the environment may affect the ecological (biological, chemical and physical) processes. The Ria Formosa is a multiple-use area, where terrestrial human activities (agriculture, tourism, trading, building construction and industry) may conflict with marine human activities (fishing, aquaculture, salt and sand extraction). The main objective of the present report, developed within the scope of the DITTY Project "Development of an Information Technology Tool for the Management of European Southern Lagoons under the influence of river-basin runoff", was to improve the knowledge on the main socio-economic activities in the Ria Formosa lagoon in order to identify the main stakeholders involved in the ecosystem functioning, and who are the gainers and losers of management options. According to the information gathered in this work, construction, trading and tourism are the most relevant economical activities concerning to revenues, although they may affect the aquatic environment. As primary sector (e.g. fishing, aquaculture) and secondary sector activities (e.g. salt extraction, sand extraction) are highly dependent on the ecosystem's ecological equilibrium, it becomes essential an integrated management of all activities affecting and depending on the environment in order to assure a sustainable development.

Keywords: Socio- economy, aquatic environment, integrated management

RESUMO

Título: SISTEMA LAGUNAR DA RIA FORMOSA: ABORDAGEM SOCIO-ECONÓMICA

Os recursos naturais de uma determinada área constituem a base da economia local. Contudo, as actividades económicas que dependem directamente do meio ambiente podem causar alterações ao nível dos processos físicos, químicos e biológicos do ecossistema. O sistema lagunar Ria Formosa é uma área multi-usos, onde as actividades humanas terrestres (agricultura, turismo, comércio, construção civil e indústria) podem ter impactes negativos nas actividades marinhas (pesca, aquacultura, extracção de sal e areias). O presente trabalho, desenvolvido no âmbito do Projecto EU – DITTY "Development of an Information Technology Tool for the Management of European Southern Lagoons under the Influence of River-basin runoff", teve como principal objectivo a recolha e compilação da informação existente sobre as principais actividades socio-económicas, de modo a identificar os agentes económicos intervenientes no funcionamento deste sistema que ganham/perdem com as opções de gestão. De acordo com a informação recolhida neste estudo, as actividades económicas mais relevantes, em termos de receitas geradas, são a construção civil, o comércio e o turismo que podem afectar, directa ou indirectamente, o ambiente aquático. Como as actividades dos sectores primário (pesca e aquacultura) e secundário (extracção de sal e areias) dependem fortemente do equilíbrio ecológico do ecossistema, torna-se necessária uma gestão integrada de todas as actividades que afectam e dependem do meio ambiente de modo a assegurar um desenvolvimento sustentável.

Palavras chave: Socioeconomia, ambiente aquático, gestão integrada.

REFERÊNCIA BIBLIOGRÁFICA

SERPA, D.; JESUS, D.; FALCÃO, M.; CANCELA DA FONSECA, L. 2005. Ria Formosa ecosystem: socio-economic approach. **Relat. Cient. Téc. IPIMAR**, *Série digital* (http://ipimar-iniap.ipimar.pt) n.º 28, 50p.

Table of contents

1. SITE DESCRIPTION

1.1. Watershed

The Ria Formosa watershed located in the southernmost part of Portugal (Algarve region) extends over 864 km^2 with a perimeter of 166 km (PH&P, 2000a). The watershed is delimited, at north, by Serra do Caldeirão (maximum altitude, 522 m) and, at south, by the Ria Formosa lagoon (Fig. 1.1).
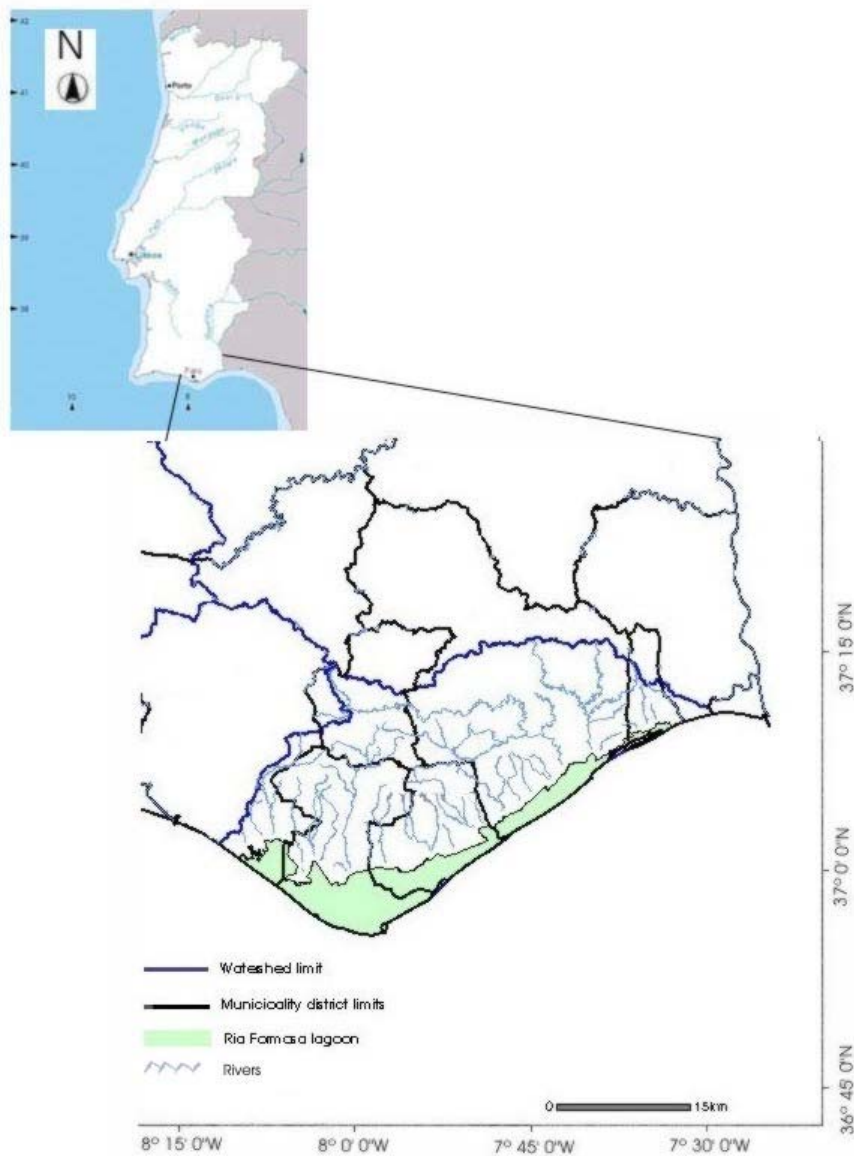

Figure 1.1 - Ria Formosa watershed (CCDRAlg, 2002).

The numerous sporadic streams that drain the Ria Formosa watershed (Table 1.1) have a torrential regime during winter and a very reduced or practically inexistent runoff during the rest of the year. Only a river - Gilão - drains the watershed all year long (PH&P, 2000a).

Table 1.1 - Characteristics of the most important river and streams of the Ria Formosa watershed (PH&P, 2000a).

	Length (km)	Max altitude (m)	Min altitude (m)	Δh (m)	Average slope (%)	Mean annual discharge (m^3/ year)
Gilão	32.7	326	0	326	1.0	7.7×10^7
Almargem	49.5	453	16	437	0.9	3.6×10^6
S. Lourenço	24.7	340	0	340	1.4	2.2×10^6
Seco	21.3	310	0.8	309	1.5	4.1×10^6
Cacela	6.4	119	0	119	1.9	2.4×10^5

Several municipalities are within the watershed limits covering different areas: Loulé (12 %), Faro (100 %), S. Brás de Alportel (62 %), Olhão (100%), Tavira (57 %), Vila Real de St.º António (50 %) and Castro Marim (3 %), as shown in figure 1.2.
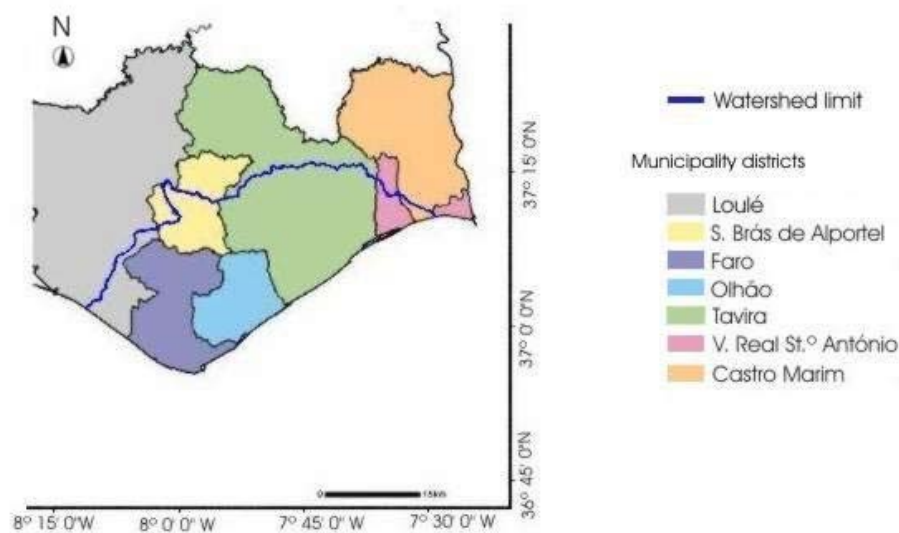
Figure 1. 2 - Municipalities within the Ria Formosa watershed (PH&P, 2000a).

1.2. Climate

The climate of the Algarve region is typically Mediterranean with warm dry summers and mild winters.

1.2.1. Temperature

In the eastern part of the lagoon, the mean annual air temperature range from 16 ºC to 17.5 ºC, while in the western part of the lagoon it ranges from 17.5 ºC to 20 ºC (Fig. 1.3). Minimum temperature values are observed in January and February (8 - 9 ºC) and maximum values (29 – 30 ºC) in July-August (IM, 2001).
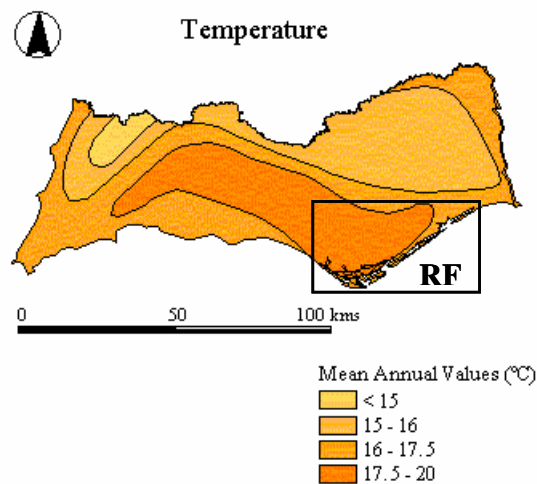
Figure 1.3 - Annual mean temperature (ºC) in the Ria Formosa watershed (RF) (CCDRAlgarve, 2002).

1.2.2. Rainfall

In the Ria Formosa, the mean annual values of rainfall vary between 400 and 600 mm y^{-1} (Fig. 1.4). Generally, the wettest month is December with about 25 % of the total annual rainfall, and the driest months are July and August with less than 1 % of the annual rainfall (IM, 2001).
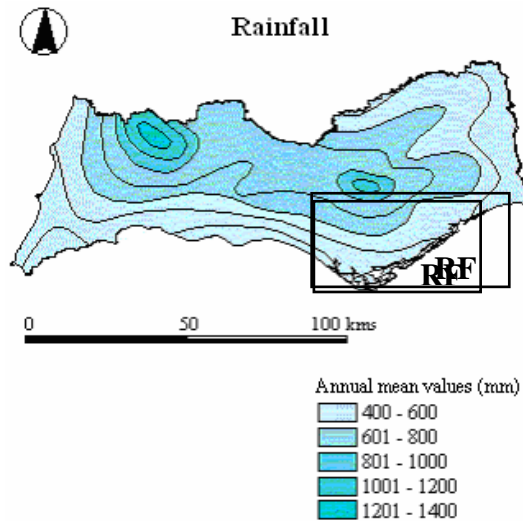
Figure 1.4 - Annual mean values of rainfall (mm year^{-1}) in the Ria Formosa watershed (RF) (CCDRAlgarve, 2002).

1.2.3. Solar radiation and insolation

In the Ria Formosa, solar radiation is high with annual mean values ranging between 161 and 165 kcal cm^{-2}, except in the extreme west of the lagoon where values above 165 kcal cm^{-2} are reached (Fig. 1.5). Insolation is also high varying between 3000 and 3200 hours *per* year (CCDRAlgarve, 2002).
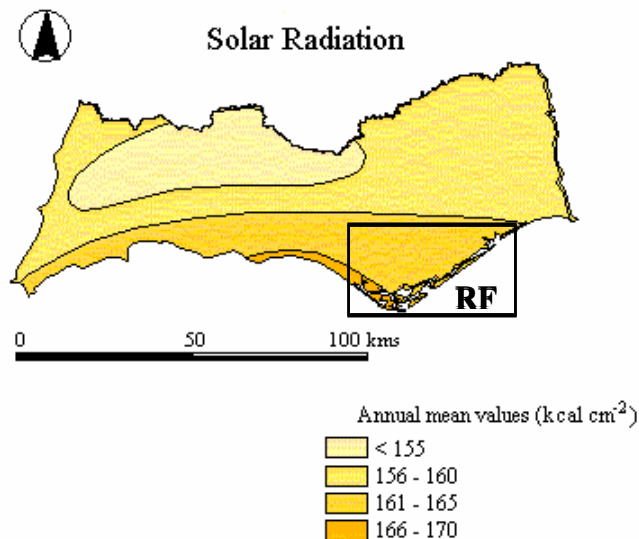

Figure 1.5 - Annual mean values of solar radiation (kcal cm^{-2}) in the Ria Formosa watershed (RF) (CCDRAlgarve, 2002).

1.2.4. Winds

In the eastern part of the Algarve region winds blow predominantly from west and southwest. However during spring and summer there is a high incidence of winds blowing from east and southeast (Granja, 1984). The mean wind speed is about 13 km/h in the western side of the watershed and 10 km/h in the eastern side (ISA, 2001).

1.3. Geomorphology

In the Ria Formosa watershed, three geomorphological units may be identified (Fig. 1.6):

  ➢ **Serra** (mountain) – characterized by old rocky blooms of loamy schist and greywacke. The main geomorphologic aspect of this unit is the prevalence of large erosion surfaces, such as furrows, ditches and deep ravines, which are continuously dissected and lowered by diffuse and/or torrential runoff (PH&P, 2000a).

  ➢ **Barrocal** (Strip between the mountain and the coast) – in this narrow strip of muddy sandstone formations (Triassic) overlapped by limestone, grit sand and conglomerate (Jurassic) and other materials of reduced expression such as grit sand and clays (Cretaceous and Miocene), an erosion surface has developed (East-West direction). The Jurassic formations towards the coast, presents some strong karstic characteristics (PH&P, 2000b). In this compartment, the underground drainage assumes great importance being observed numerous infiltration and resurgence sites (PH&P, 2000a).

  ➢ **Litoral** (Coastal strip) – this zone is mainly constituted by sand materials, which present great geomorphological sensibility due to weak resistance of the materials to the marine forces. A close link between human population and this coastal zone is particularly evident since the majority of human population lives in this area (PH&P, 2000a).
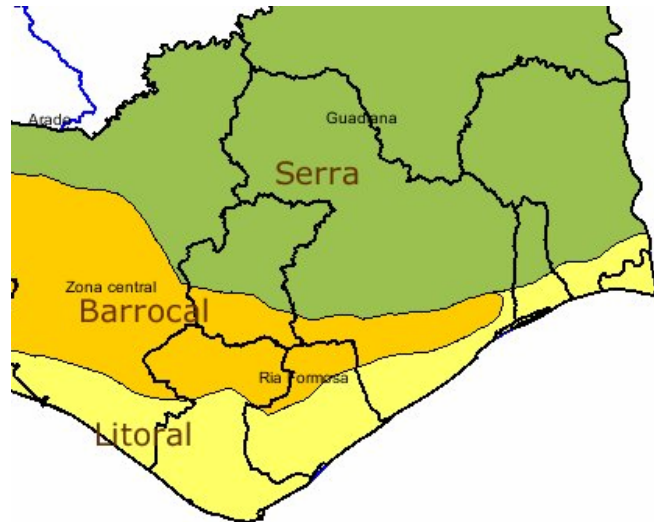
Figure 1.6 - Geomorphological units of the Ria Formosa watershed (IA, 2003).

1.4. Soils

Figure 1-7 presents the dominant soil types in the different geomorphological units of the Ria Formosa watershed. In the *Serra* unit, Lithosols and Luvisols are dominant; instead the *Barrocal* presents a great complexity of soils, mainly constituted by calcareous formations with rocky emergences in which Luvisols and Cambisols prevail. These rocky emergences are formed by hard limestone, dolomites, maerl in isolated stains or in rocky blooms (PH&P, 2000b). The *Litoral* is mainly dominated by Cambisols, Luvisols, Fluvisols and Solonchaks. Fluvisols occur specially in the lower parts of the watercourses, whereas Solonchaks stains occur in salt marsh areas and barrier islands (PH&P, 2000b).
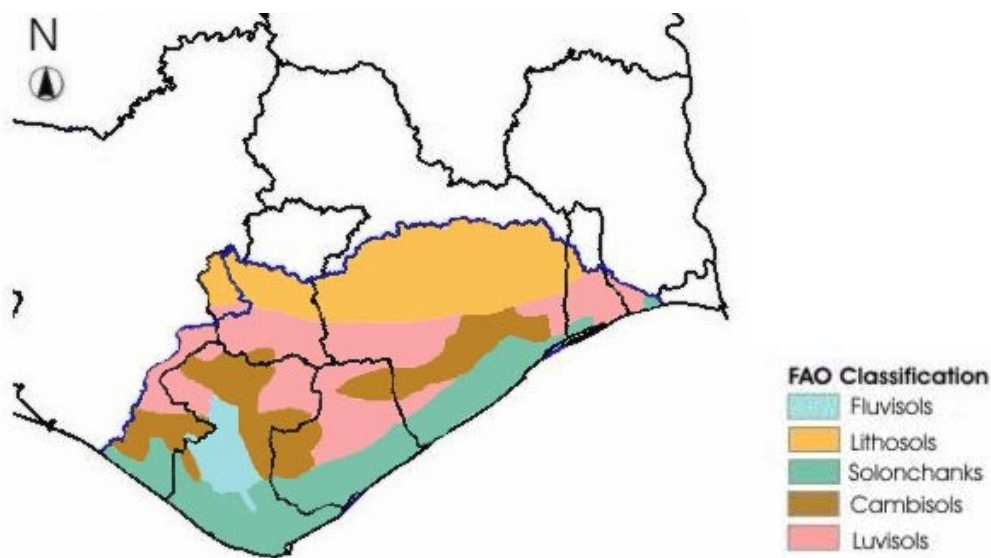
Figure 1.7 - Soil types in the Ria Formosa's watershed geomorphological units (IA, 2003).

2. POPULATION

2.1. Resident population

In the Ria Formosa watershed, the number of resident inhabitants has increased gradually since 1864**,** following the same pattern of variation of the regional and national resident population (Fig. 2.1).

Figure 2.1 - Evolution of the resident population in the Ria Formosa watershed, in the Algarve region and in Portugal, from 1864 to 2001 (INE, 2002; ICN, 2004).

According to INE (2002), the number of resident inhabitants in the western side municipalities (Faro and Olhão) was clearly higher than in the eastern municipalities, Tavira and Vila Real de Santo António (Table 2.1). In São Brás de Alportel, a rural municipality, the number of inhabitants was much lower than in the other watershed municipalities probably due to the distance from the main urban and employment centers.

Demographic density is an indicator of population's pressure on the physical space. Olhão was the most densely populated municipality, with 316 inhabitants *per* km^2 followed by Vila Real de Santo António (272 inhabitants km^{-2}) and Faro (290 inhabitants km^{-2}), as shown in Table 2.1. Rural municipalities, São Brás de Alportel and Tavira, are less densely populated, 68 and 41 inhabitants *per* km^2 respectively.

Table 2.1- Resident population and demographic density in the Ria Formosa municipalities, in 2001 (INE, 2002).

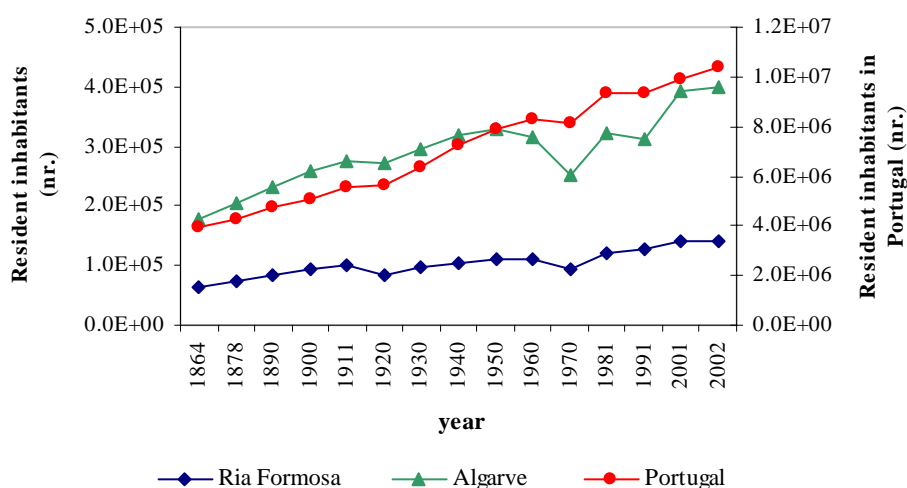| Municipality	Resident population (nr.)	Area (km^2)	Demographic density (inhabitants km^{-2})
Faro	58620	202	290
S. Brás Alportel	10224	150	68
Olhão	41098	130	316
Tavira	24960	609	41
V.R.S.A.	18217	67	294

2.2. Non-resident population

A significant increase in population occurs during summer mainly due to touristic activities. Although most non-resident inhabitants stay in tourist establishments (hotels, apart-hotels, tourist apartments, etc.), others rent local houses. The population in the Ria Formosa's local houses, duplicated during the "high" season (Fig. 2.2) in 2001. In Vila Real de Santo António, population grew about 56 % from winter to summer, while in Tavira this increase was slightly lower (45 %). Littoral municipalities, Faro and Olhão, registered a low summer growth (30 %) probably due to the reduced tourist offer. In São Brás de Alportel, the population increase during summer was practically irrelevant (9 %) since this is a rural municipality.
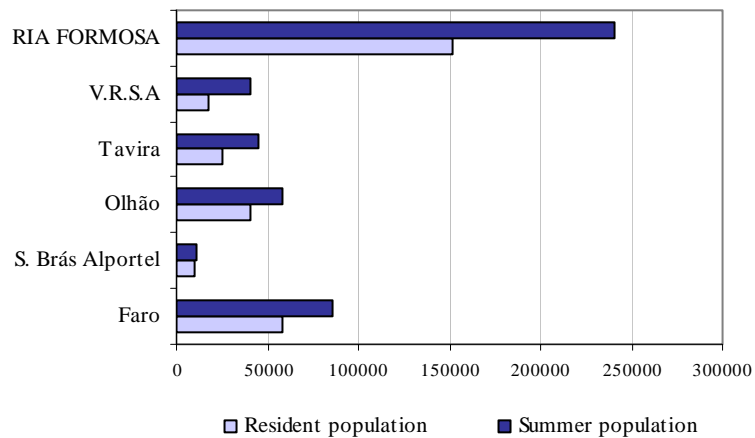
Figure 2.2 - Resident population and population in classic familiar accommodations during summer, in Ria Formosa municipalities (ICN, 2004).

2.3. Active population

The Ria Formosa active population in 2001 corresponded to 45 % of the resident population, and 34 % of the regional active population (Tables 2.1 and 2.2). About 7 % of the active population was unemployed. Unemployment rate (i.e. unemployed population/active population) was higher in Vila Real de Santo António and Olhão (8 %) probably because these are fishing-dependent municipalities suffering the effects of fisheries decline. In Tavira, a municipality where the primary sector activities (ex. agriculture) are most important, the unemployment rate reached 6 %, whereas Faro more dependent on tourism and public services, the unemployment rate was lower, about 5 %.

Table 2.2 - Active, employed and unemployed population in Ria Formosa municipalities, in 2001 (INE, 2002).

	Active population	Employed population	Unemployed population
	individuals nr.	individuals nr.	individuals nr.
Faro	29841	28158	1683
São Brás Alportel	4569	4284	285
Olhão	18912	17473	1439
Tavira	10919	10221	698
V.R.S.A.	8427	7722	705
RIA FORMOSA	72668	67858	4810
ALGARVE	199600	189100	10500

As a consequence of increasing tourism activity, the tertiary sector became the most important productive sector for the Algarve´s economy. In 2001, almost 70 % of the regional employed population worked on tertiary sector activities, whereas only 6 % was employed in the primary sector (Fig. 2.3). A similar situation was observed in the Ria Formosa municipalities, namely in Faro and Vila Real de Santo António where 87 % of the employed population worked on the tertiary sector. In Tavira and Olhão the importance of the tourism sector is lower than in the other municipalities mainly due to the fact that a higher number of people work on the primary sector, 12 % and 9 % of the employed population respectively. São Brás de Alportel is the most important municipality concerning to the secondary sector activities (15 %), being dominant the wood and cork industries and quarrying related-activities.
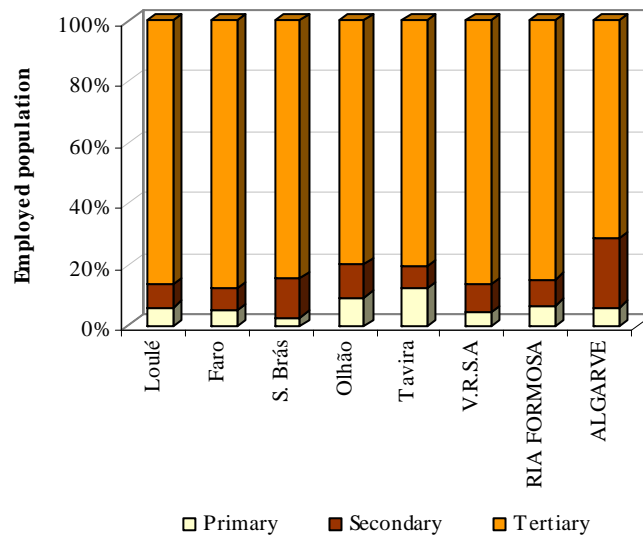
Figure 2.3 - Employed population by economic sector in the Ria Formosa municipalities and in the Algarve region, in 2001 (INE, 2002).

3. ECONOMICAL ACTIVITIES

3.1. PRIMARY SECTOR

In the Algarve region the primary sector ensures employment for 7 % of the active population (INE, 2004), having a low contribution to the local economy. Table 3.1 presents the added value of the main economical activities of this sector for the Algarve region.

Table 3.1 - Added value of the primary sector's activities (10^6 €) for the Algarve region (INE, 2003, 2004).

Activity sector	1995	1996	1997	1998	1999	2000	2001
Fishing	70	79	84	97	99	113	113
Agriculture; animal rearing; hunting and forestry	150	139	152	156	175	143	241

3.1.1. Fishing

The Ria Formosa lagoon is considered a nursery for a large number of coastal fish and shellfish species, therefore fishing activity is reduced inside the system. Most of catching

methods are not allowed in the lagoon where only a few techniques and fishing gears may be used. From the main 66 fish species found in the lagoon, most of them are occasional (36), while others are migratory (22) and sedentary (8). Almost 60 % of all species have medium/high commercial value, enhancing the importance of this ecosystem for local fisheries (Monteiro, 1989).

The Sparidae, Soleidae, Triglidae, Scombridae and Clupeidae are the main commercial fish families. The diagram of seasonal migrations for these species (Fig. 3.1) evidences two recruitment periods: the 1st during the winter–spring transition and the 2nd during the summer–autumn transition. Species that migrate to the lagoon during the 1st recruitment period leave the system in late summer, while those from the 2nd recruitment leave during the autumn-winter period (Monteiro, 1989). Juveniles recruited seasonally from the lagoon have an important contribution to fish stocks exploited in the adjacent oceanic waters (Monteiro, 1989).
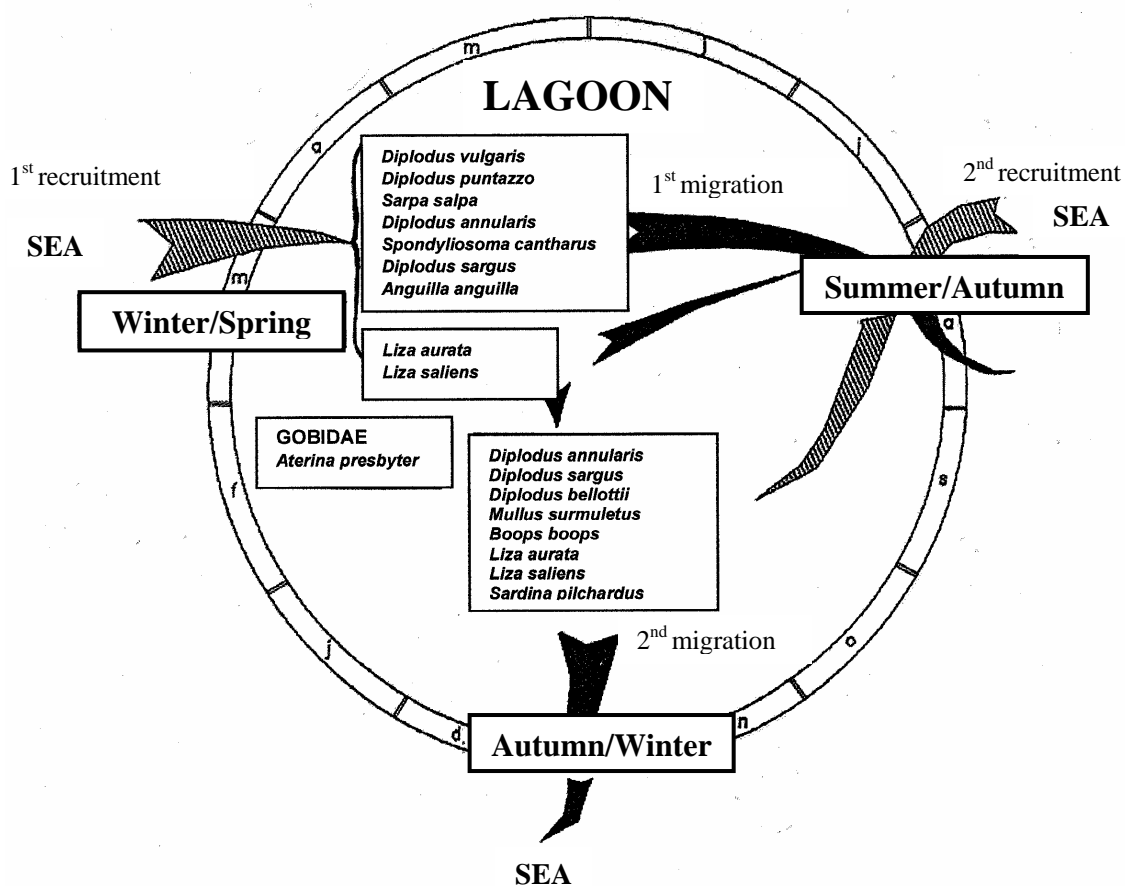

Figure 3.1 - Cyclic migrations of the main commercial fish species in the lagoon (adapted from Monteiro, 1989).

According to the Fisheries Statistics (INE, 2004), nearly 11 000 tons of marine fishes, 1 000 tons of crustaceans and 4 000 tons of molluscs were unloaded in the Ria Formosa fishing ports in the year 2002 (Fig. 3.2); corresponding respectively to 46 %, 98 % and 69 % of these resources in the Algarve region.
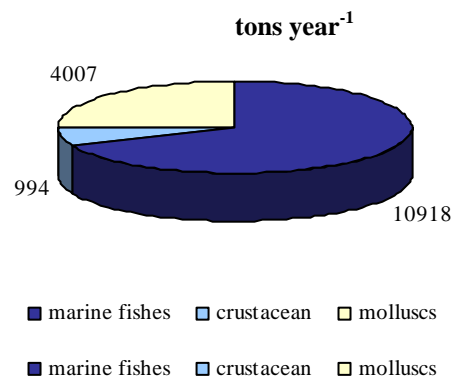
Figure 3.2 - Landings (tons) of marine fishes, crustacean and molluscs in the Ria Formosa fishing ports, in 2002 (INE, 2004).

Landings of marine fishes are mostly of sardine (4 500 tons), chub mackerel (1 800 tons), horse mackerel (1 040 tons) and European hake (500 tons), as shown in Table 3.2. However, these species do not present a high commercial value. According to DGPA (2002a), the sole (13 €/kg), the wreckfish (9 €/kg), the seabass (8 €/kg), the striped red mullet (7.5 €/kg) and the meagre (6.5 €/kg) are the species with highest market value in the Algarve region. Concerning to the crustacean landings, the prawn is the most unloaded species in the Ria Formosa ports (480 tons), although the Norway lobster has the highest commercial value (17 €/kg). Relatively to molluscs, the cephalopods landings are the most relevant, especially octopus (1 780 tons) and cuttlefish (360 tons), whose market prices are 5 €/kg and 4 €/kg, respectively.

Table 3.2 - Fish landings (tons) by species in the main Ria Formosa fishing ports (Olhão, Tavira and Vila Real St. António); and the species market price (€/kg) (DGPA, 2002a; INE, 2004).

Species	Market price	Fish landings		
		Olhão	Tavira	Vila Real St. António
	€/kg	tons	Tons	tons
Marine fishes		**9428**	**412**	**1078**
Axilary seabream	3.98	164	44	7
Horse mackerel	1.43	926	84	30
Chub mackerel	0.38	1739	24	53
Conger	7.02	77	4	17
European hake	4.16	340	14	140
Sardine	0.60	4006	9	502
Crustaceans		**7**	**1**	**978**
Prawn	16.40	0	0	479
Norway lobster	17.00	a)	0	342
Molluscs		**3076**	**773**	**158**
Clams	10.00	821	1	50
Cuttlefish	4.03	295	30	34
Octopus	4.71	995	728	56

According to INE (2004), the most important fishing ports in the eastern part of the Algarve are located on the Ria Formosa (Olhão, Tavira and Vila Real de St. António). In the year 2002, Olhão was the main fishing port of the lagoon: almost 12 500 tons of fish (marine fish, crustacean and molluscs) were unloaded on this port, representing 79 % of the total landings for the lagoon (Fig. 3.3) and 47 % of the total revenues (Fig. 3.4). Olhão was also the main port in the Algarve region (41 % of regional fisheries) and it represented 8 % of national fisheries.
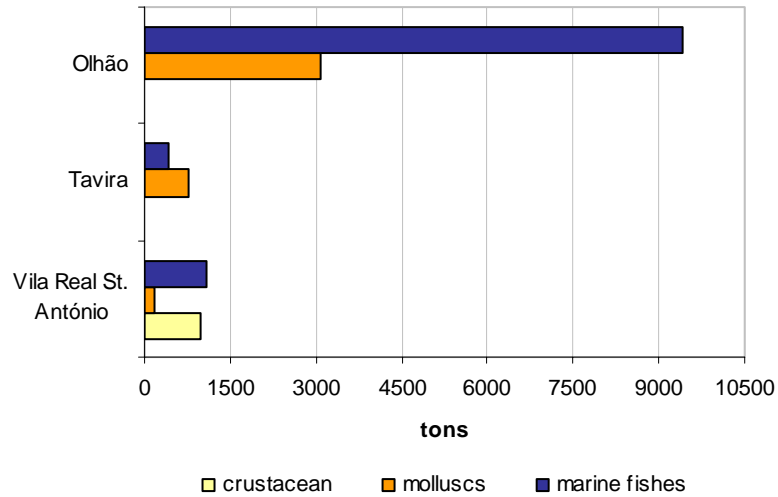
Figure 3.3 - Annual landings (tons) of marine fishes, crustacean and molluscs in the Ria Formosa fishing ports (Olhão, Tavira e Vila Real St. António), in 2002 (INE, 2004).

However, concerning to crustacean fisheries and revenues, the most important fishing port in 2002 was Vila Real de Santo António (Fig. 3.3, 3.4); near 1000 tons of crustaceans were unloaded on this port (INE, 2004) generating revenues of 17 million euros. The crustacean fisheries of this Ria Formosa port were also very important on the regional and national context, corresponding to 97 % and 67 % of regional and national crustacean fisheries, respectively.

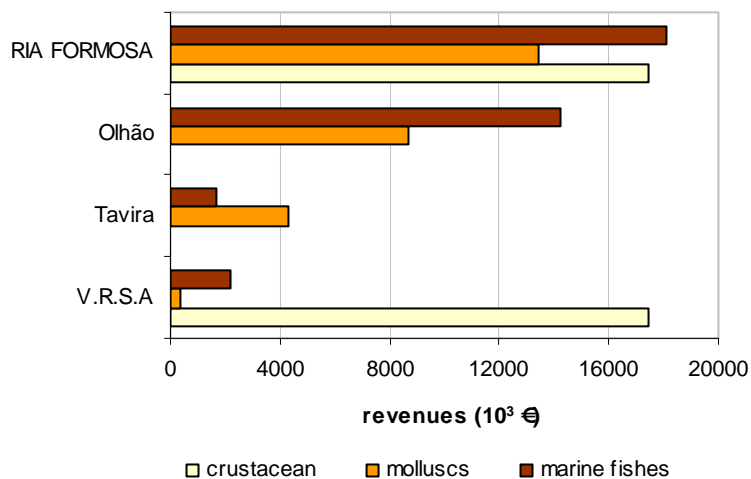**Figure 3.4** - Annual revenues (10^3 euros) from marine fish, crustacean and molluscs fisheries in the Ria Formosa fishing ports (Olhão, Tavira e Vila Real St. António), in 2002 (INE, 2004).

Olhão and Vila Real de Santo António, as main ports of the lagoon are provided with good facilities (Table 3.3). Fuzeta and Santa Luzia are also very important accessory ports due to the existence of essential port facilities.

Table 3.3 - Port facilities in the Ria Formosa (ICN, 2004).

Sites	Port facilities					
	Ports	Whole sale fishmarket	Freezing facilities	Back-up warehouses	Ramps	Hoisting devices
Quarteira	X	X	X			X
Ilha Barreta		X				
Faro	X	X				
Olhão	X	X	X	X	X	X
Fuzeta	X	X	X		X	
St. Luzia	X	X	X		X	
Tavira	X	X	X			
Montegordo		X				
V. Real S^to António	X	X	X	X		X

In spite of an increase of fish landings in the Ria Formosa from 1997 to 2000 (Fig. 3.5), recently there has been a clear tendency to a decrease in fisheries. From 2000 to 2002, fish landings decreased about 25 % in the Ria Formosa fishing ports.
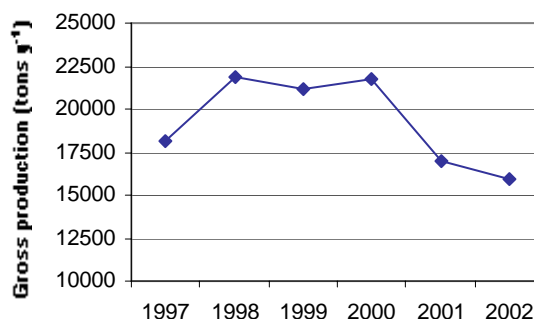

Figure 3.5 - Annual gross production (marine fish, crustacean and molluscs) in the Ria Formosa (DGPA, 2002a; INE, 2004).

Following the fisheries tendency, the number of registered fishermen in the Ria Formosa fishing ports decreased from 1999 to 2002, except for the Vila Real St. António port where the number has slightly increased (Table 3.4).

Table 3.4 - Registered fishermen (nr.) in the main Ria Formosa fishing ports (Olhão, Tavira and Vila Real St. António) (INE, 2002, 2003, 2004).

Fishing ports	Registered fishermen (nr.)			
	1999	**2000**	**2001**	**2002**
Olhão	4078	3896	3477	3408
Tavira	544	464	464	464
V.R.S.A.	460	495	515	519

The importance of Ria Formosa fishermen in the regional context decreased slightly from 1999 (75 %) to 2002 (71 %). In spite of this decrease, the lagoon's importance, in the national context, was maintained in the last years, contributing with 20 % of the total number of fishermen registered in Portugal.

In 2001, the number of fishing vessels (with and without engine) registered in the Ria Formosa ports represented a significant part (64 %) of the Algarve's fishing fleet (Fig. 3.6). During this period, 1425 fishing vessels were registered in the lagoon ports, from which 1218 with engine and 207 without engine.
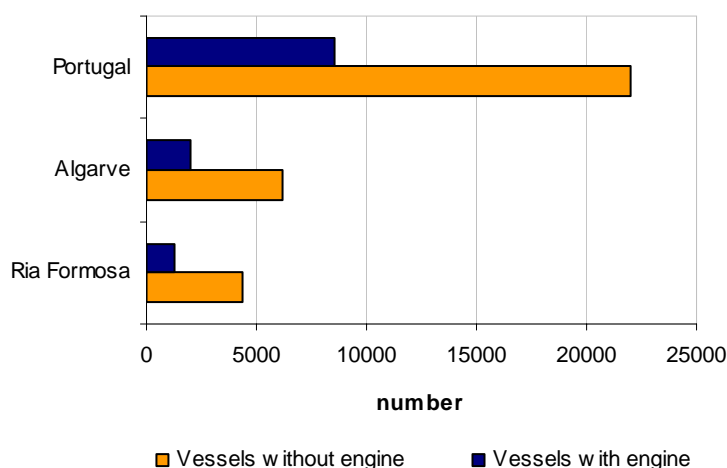

Figure 3.6 - Number of fishing vessels (with and without engine) registered in the main fishing ports of Ria Formosa, Algarve region and Portugal (2001) (INE, 2003).

3.1.2. Agriculture

Agricultural areas cover about 64 % of the Ria Formosa watershed (55 000 ha), corresponding to approximately 5 700 agricultural explorations (Table 3.5). However, 36 %

(20 000 ha) of agricultural land is not used and about 16 % (8 600 ha) corresponds to forest or wood areas. The Used Agricultural Surface (UAS) represents almost half (26 000 ha) of the total agricultural area. The UAS *per* exploration is higher in the eastern side of the watershed than in the western side probably because in the eastern zone, agriculture is typically extensive with diversified crops, whereas in the western side of the watershed there are mainly intensive and specialized crops (PH&P, 2000a).

Table 3.5 - Agricultural area, number of agricultural explorations, UAS, UAS *per* exploration, areas of forest and woods, and unused agricultural surface for the main municipalities of the Ria Formosa watershed (INE, 2001).

Municipality	Agricultural Area	Agricultural explorations	Used Agricultural Surface (UAS)	UAS/exploration	Forest and woods	Unused Agricultural Surface
	ha	nr	ha	Ha	ha	ha
Faro	6 587	1 554	4 987	3.21	375	1 013
Olhão	5 436	1 165	4 407	3.80	333	608
S. Brás Alportel	5 396	563	1 867	3.33	2 580	906
Tavira	34 732	2 163	12 260	5.70	5 129	16 884
V.R.S.A.	2 705	323	2 163	6.87	165	352

Permanent crops occupy about 66 % (17 000 ha) of the UAS in the watershed from which 174 ha are vegetable gardens (Table 3.6). Temporary crops, mainly of cereals, forage, potato and horticultures cover 3 600 ha, an area similar to that occupied by fallow lands (3900 ha). Permanent grasslands and pastures, particularly important for the cattle, represent 3 % (800 ha) of the UAS.

Table 3.6 - Agricultural area occupied by permanent crops, grasslands and pastures, temporary crops, vegetable gardens and fallow lands for the main municipalities of the Ria Formosa watershed (INE, 2001).

Municipality	Permanent crops (ha)	Permanent grasslands and pastures (ha)	Temporary crops (ha)	Vegetable gardens (ha)	Fallow lands (ha)
Faro	3 975	21	572	13	406
Olhão	3 474	24	388	26	494
S. Brás Alportel	1 236	36	211	19	276
Tavira	7 337	473	2 102	108	2 241
V.R.S.A.	1 086	244	306	8	518
RIA FORMOSA	17 108	798	3 579	174	3 935

The most typical crops on the watershed are: dried fruits (27 % of the UAS, 7 000 ha), citrines (21 % of the UAS, 5 300 ha) and olives (11 % of the UAS, 2800 ha), covering over half of the UAS (Fig. 3.7). Cereals (6 % of the UAS), fresh fruits (4 % of the UAS) and horticultures (4 % of the UAS) are examples of other crops cultivated in the watershed. In the eastern side municipalities (Tavira and Vila Real de St. António), the cereals and vine crops occupy larger areas than in the western side. Conversely, intensive crops of citrines and horticultures are more representative in the western zone. The percentage of UAS occupied by dried fruits crops and olive yards is relatively similar in the different municipalities of the watershed.
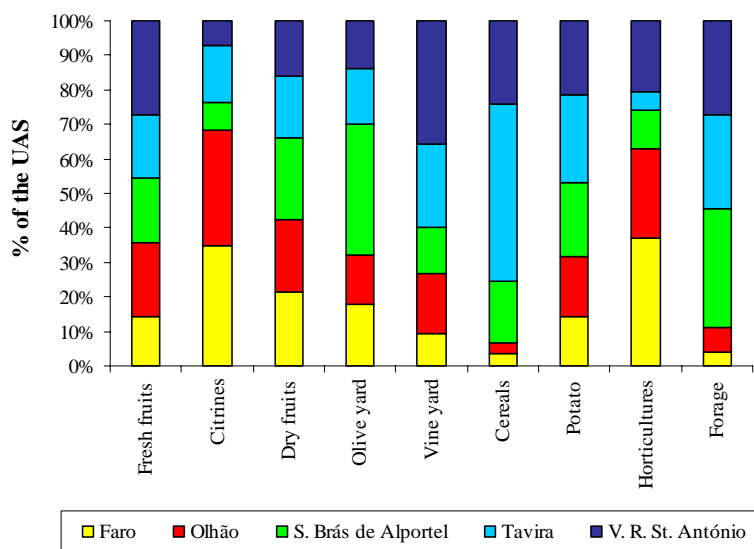
Figure 3.7 - Agricultural area (% of the UAS) occupied by permanent crops (fresh fruits, citrines, dried fruits, olive yards, vine yards) and temporary crops (cereals, potato, horticultures, forage) for the Ria Formosa municipalities (INE, 2001).

3.1.3. Animal rearing

In the Ria Formosa watershed, poultry (mainly chicken) and sheep are the most commonly reared animals (Fig. 3.8). Tavira is the most important municipality concerning to animal rearing, with the exception for swine production whose livestock is higher in Faro (7450 animals).

Figure 3.8 - Livestock of cattle (bovine), sheep (ovine), goats (caprine), pigs (swine), rabbits and poultry, for the Ria Formosa municipalities (INE, 2001).

3.1.4. Aquaculture

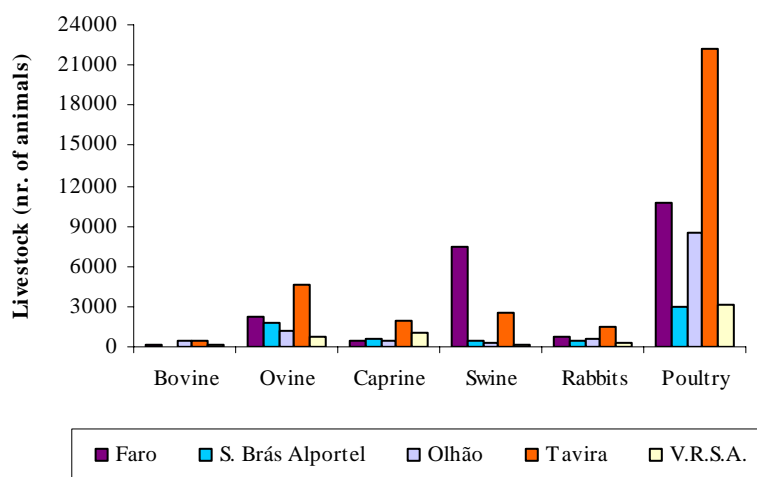The Ria Formosa is very important for the national aquaculture sector, contributing with almost 40 % for the national production and 81 % for the number of aquaculture units (DGPA, 2002b). This lagoon is also important in the regional context once it contributes with 84 % and 43 % of the regional shellfish and fish production. Shellfish farming represents 84 % of Ria Formosa's aquaculture production, whereas the remaining 16 % comes from fish farming (DGPA, 2002b).

3.1.4.1. Shellfish farming

Shellfish farming is one of the main economical activities in the lagoon, since species of high economical value, such as the clam (*Ruditapes decussatus*) and the Portuguese oyster (*Crassostrea angulata*), are reared on the Ria Formosa tidal flats. There are 1 223 active concessions for shellfish farming (Table 3.7), occupying 500 ha of inter-tidal area. Shellfish rearing areas are mainly located in the Olhão and Faro municipalities, which hold respectively 79 % and 16 % of the active concessions in the Ria Formosa (Table 3.7).

Table 3.7 - Number of active shellfish growth banks in Ria Formosa's municipalities and in the Algarve region (2001) (DGPA, 2002b).

	Growth banks (nr.)
Faro	196
Olhão	963
Tavira	56
V.R.S.A.	8
RIA FORMOSA	1223
ALGARVE	1256

The lagoon produced 5 000 tons year^{-1} of clams in 2001, representing 98 % of the regional production and 90 % of national production. On the other hand, the oyster production reached almost 2000 tons year^{-1} contributing for 26 % of the national production. Other ostreidae species are also cultivated in the lagoon but at a lower scale (Table 3.8).

Table 3.8 - Annual production (ton year^{-1}) of shellfish in the Ria Formosa lagoon (DGPA, 2002b).

	Scientific name	Common name	Production (ton year^{-1})
Shellfish farming	*Ruditapes decussatus*	clam	5000
	Crassostrea angulata	Portuguese oyster	2000
	Ostreidae	oysters	187

In last years, clam's production has decreased probably due to environmental factors that contribute to high mortality of these organisms. During summer, at neap tides, the chemical and biological processes taking place at the sediment-water interface are very intensive inducing sharp variations in dissolved oxygen concentrations that may affect filter feeders. According to Falcão *et al.* (2000), the mortality of benthic organisms is directly related to the cultivated biomass, anthropogenic inputs from urban areas and the system's hydrodynamics.

3.1.4.2. Fish farming

Annually, fish farming yields about 2700 tons year^{-1} of fish (DGPA, 2002b). However, some authors consider that the lagoon's potential for fish farming is not fully exploited (ICN, 2004).

Inshore, fish farming is traditionally practiced in inactive saltpans and soils without agricultural aptitude. Fish is mainly reared in earthen ponds (Fig. 3.9) nevertheless fishponds may be made of synthetic materials like fiberglass, concrete or plastic.

Figure 3.9 – Earthen ponds in the Ria Formosa lagoon (IPIMAR – National Institute for Sea Research-experimental station).

From the 18 fishponds existing in Ria Formosa in 2001, half were located in the Olhão municipality (Fig. 3.10).
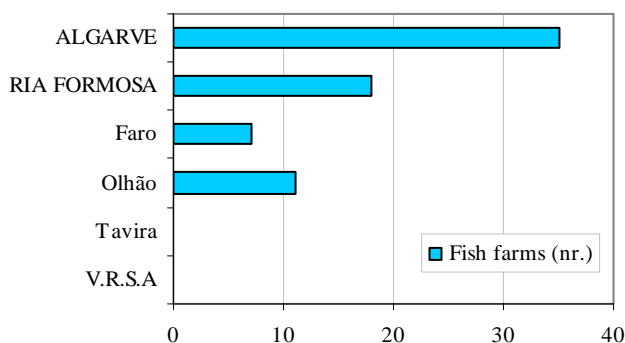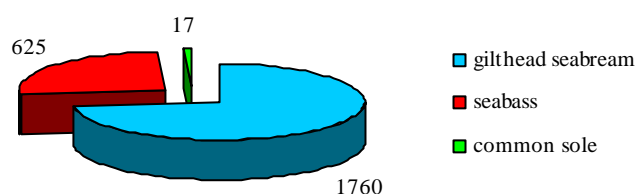

Figure 3.10 - Number of fish farms in the Ria Formosa municipality and in the Algarve region, in 2001 (DGPA, 2002b).

ton year^{-1}

Figure 3.11 - Annual production (ton year^{-1}) of gilthead seabream (*Sparus aurata*), seabass (*Dicentrarchus labrax*), common sole (*Solea vulgaris*) in aquaculture (DGPA, 2002b).

In general, fish farms can be implemented in the Ria Formosa inter-tidal areas provided that farms have accessibility to lagoon water of good quality. Thus, areas close to urban and industrial centres are excluded due to the risk of pollution. According to the production regime (semi-intensive and intensive) the exclusion of barrier islands, beaches and tourist sites is also recommended. As this lagoon is included in a Natural Park, relevant areas for nature conservation may be also excluded. The high investments in this activity, mainly for energy, require optimization of costs/benefits.

Offshore fish production (in cages) is still at an experimental phase (Fish Operational Program – Programa Operacional das Pescas/Mare). This aquaculture technique has to obey to several conditions: a minimum depth (three times the depth of the cage), a maximum depth (to allow the cage's fixation to the bottom) and a minimum distance between cages. Currents and wave regime are also determinant factors for the implementation of these structures. As for the inshore production, species cultivated offshore must be autochthonous species. Offshore fish production should be excluded from fish banks, navigational routes, nautical areas due to the potential risk of pollution and also from areas with strong currents as the inlets (Fish Operational Program – Programa Operacional das Pescas/Mare – Estação Piloto off-shore).

3.2. SECONDARY SECTOR

In Ria Formosa, the secondary sector includes mainly the extractive industry (salt extraction, mining and quarrying), manufacturing industry and building construction. In 2001, this activity sector was responsible for 13 % of the regional added value, corresponding to about 530 million euros (Table 3.9).

Table 3.9 - Added value for the secondary sector activities (10^6 €) in the Algarve region (INE, 2003, 2004).

Activity	1995	1996	1997	1998	1999	2000	2001
Extractive industry (mining and quarrying)	8	9	11	14	14	12	14
Manufacturing	113	123	127	141	159	170	162
Building Construction	142	155	183	207	239	286	354

3.2.1. Extractive industry

3.2.1.1. Salt extraction

Recently the Ria Formosa's salt production decreased (Table 3.10) probably due to several factors such as, increase of production costs, use of ineffective production methods, international competition and devaluation of salt, resulting in a decrease of the number and area of saltpans (ICN, 2004).

Table 3.10 - Salt production in the Ria Formosa lagoon (ICN, 2004).

	2000	2001
Saltpans (nr)	35	27
Production area (ha)	1 069	911
Production (ton/year)	79 122	77 955

During 2001, almost all the national production of salt (98 %) came from the 27 active saltpans existing in Ria Formosa (Table 3.11), meaning that the other Portuguese saltpans have low productivity values. The municipality with the highest number of saltpans is Tavira (11). However Vila Real de St. António was the municipality with highest salt production (33 000 tons), representing 43 % of the Ria Formosa total production. Olhão is the second most important municipality concerning saltpans number, although it has the lowest salt production (7244 ton year^{-1}).

Table 3.11 - Number of saltpans and annual salt production (ton year^{-1}) in the Ria Formosa municipalities and Portugal, in 2001 (ICN, 2004).

	Saltpans (nr)	Production (ton year^{-1})
Loulé	1	9000
Faro	4	7311
Olhão	6	7244
Tavira	11	21142
V.R.S.A.	5	33258
RIA FORMOSA	27	77955
PORTUGAL	71	79752

Based on the mean price for industrial salt (0.30 €/kg), one may estimate that salt extraction in the Ria Formosa yields about 23 million euros.

Besides their economical value, the Ria Formosa saltpans (Fig. 3.12) are also very important from the ecological point of view providing shelter, resting and feeding places for numerous bird species. The strategic position of the lagoon, between Europe and Africa, makes it an ideal sanctuary for migratory species, and therefore an ideal habitat that should be preserved.

Figure 3.12 - Saltpans in the Olhão municipality.

3.2.1.2. Sand extraction

In the Ria Formosa lagoon, sand extraction is mainly for the maintenance of the system's hydrodynamics, and the dredged material end-user is the construction sector. A decrease in the quantity of material dredged from the lagoon has been observed during the last years (Table 3.12). In the Faro channel and S. Luís inlet, this decrease may be explained by the restriction, imposed by Port Authorities, in dredging only silted up areas (> 8 m above tidal datum) in order to maintain the system's equilibrium. In the Tavira inlet the decrease in sand extraction was probably related to a reduction of market demand. Revenues from sand extraction make it a relevant activity for the Ria Formosa's economy.

Table 3.12 - Quantities of sand dredged (m^3) from the Ria Formosa lagoon (IPTM, 2004).

Year	Dredged material (m^3)		Revenues
	Faro channel and S.Luís inlet	Tavira inlet	(€)
2001	561 830	82 250	16 095 559
2002	581 650	73 995	16 384 569
2003	453 277	60 390	12 835 289
2004	280 517	55 395	8 394 441

3.2.1.3. Mining and quarrying

Mining has practically no expression in the Algarve region, representing 1 % of the national mining production (1.5 millions €) in 1999 (IGM, 2000). The only active mine in this region, a rock salt mine, is located in the Loulé municipality, producing about 100 000 tons year^{-1} (17 % of national production).

Quarrying represents about 89 % of the regional extractive industry's production and is specially directed towards industrial rocks extraction (77 % of the regional production) and ornamental rocks extraction (19 % of the regional production). The remaining 4 % corresponds to the production of sand, clay, gypsum, syenite and schist for industrial purposes. In the Ria Formosa watershed, industrial rock extraction is more important in Faro (5 industrial units) (IGM, 2000; PH&P, 2000a). The main extracted industrial rock, calcareous, is specially used in the construction industry and yields about 5 million euros *per* year. Ornamental rock extraction, namely of yellow and grey carbonated breccias, occurs mainly in S. Brás de Alportel (21 industrial units) and Tavira (4 industrial units) and is an exclusive of the Algarve region. Annually, about 17 tons of breccias are extracted yielding about 1.5 million euros (IGM, 2000).

3.2.2. Manufacturing industry

An important number of manufacturing firms and companies (3299) operated in the Algarve region in 2002, employing approximately 9 % of the region's working population (INE, 2004). Most of this industry was located in the eastern municipalities (Faro and Olhão), corresponding to 65 % of the Ria Formosa manufacturing industry (Fig. 3.13). During this period, S. Brás was the municipality where this activity was less important (10 %) probably because it is located on the mountainside of the watershed.
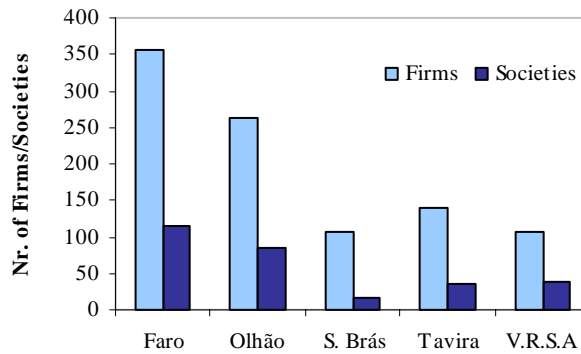
Figure 3.13 - Number of manufacturing firms and societies in the Ria Formosa municipalities, in 2002 (INE, 2004).

In the Ria Formosa, the metallurgic industry (25 %), provision industry (17 %) and cork industry (15 %) are the main manufacturing sub-sectors (INE, 2004). These industries are most important in Faro and Olhão. However, relatively to the provision and metallurgic industries, Vila Real de St. António is also a relevant municipality. In S. Brás, the most important manufacturing activity concerns the cork industry. Although the Algarve's manufacturing industry is practically irrelevant in the national context (2 %), data from INE (2004) revealed that societies with head office in this region generated about 289 million euros in 2002, from which about 50 % came from Ria Formosa municipalities.

From the provision industry, the fish can industry is the most relevant in lagoon municipalities, especially in Olhão and Vila Real de St. António. This industry is extremely important for the Algarve region, representing about 90 % of the regional production. It is also very important for the national fishery industry, since fish cans represent almost 50 % of this industry exports (DGPA, 2002a). In 2002, about 3400 tons of caned fish were produced in Ria Formosa, mostly caned sardine (Fig. 3.14). However, this industry has been declining since 1998, having suffered almost a 50 % decrease. The highest reduction was registered in the production of caned sardine and tuna, probably due to the decline of these species fisheries in the lagoon.
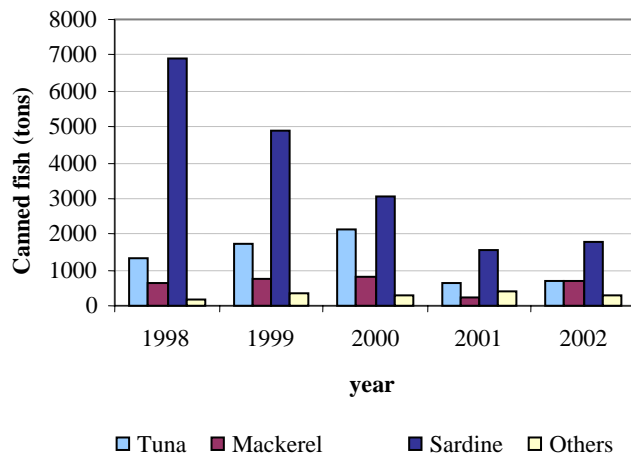
Figure 3.14 – Annual production of tuna, mackerel, sardine and other crustacean and molluscs cans in Ria Formosa (DGPA, 1999, 2000, 2002a).

3.2.3. Building construction

Building construction is a growing activity in whole the Algarve region mainly due to the increasing touristic development. The number of construction licenses in this region, indicator of the sector expansion, increased in recent years as shown in figure 3.15.
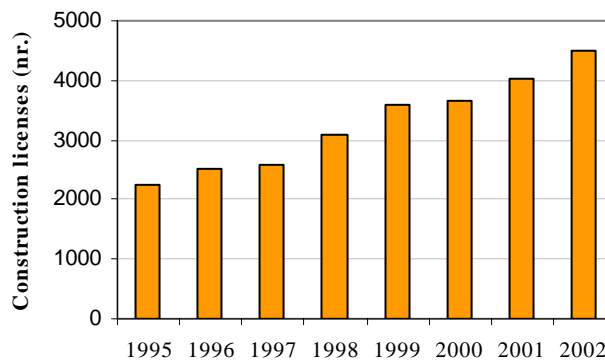

Figure 3.15 - Evolution of the number of construction licenses in the Algarve region (INE, 2001, 2002, 2003, 2004).

The Ria Formosa construction sector gives an important contribute to the Algarve's building construction, representing about 30 % of the regional number of construction firms and 50 % of the number of construction licenses granted in the Algarve in 2002 (INE, 2004). The number of licenses conceded by the different municipalities is rather similar, although slightly higher in Vila Real de Santo António and Tavira (each contributing with 26 % of the

Ria Formosa construction licenses), which are the most important touristic municipalities in the watershed (Fig. 3.16). S. Brás represents only 6 % of the Ria Formosa construction licenses.
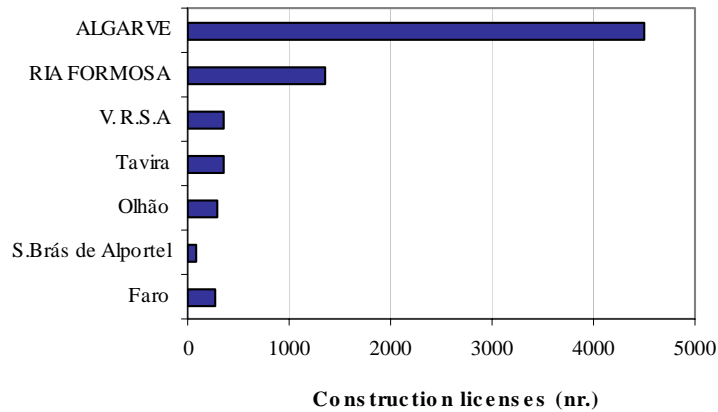

Figure 3.16 - Construction licenses (nr.) in the Ria Formosa municipalities and in the Algarve region, in 2002 (INE, 2004).

As for the number of licenses, the number of construction works finished in 2002 was rather similar in the watershed municipalities, except for São Brás de Alportel, which represented 10 % of the watershed's finished construction works (Fig. 3.17). However this indicator registered higher values in Faro and Olhão (25 % of the watershed's finished construction works), followed closely by Vila Real de St. António (21 %) and Tavira (18 %).
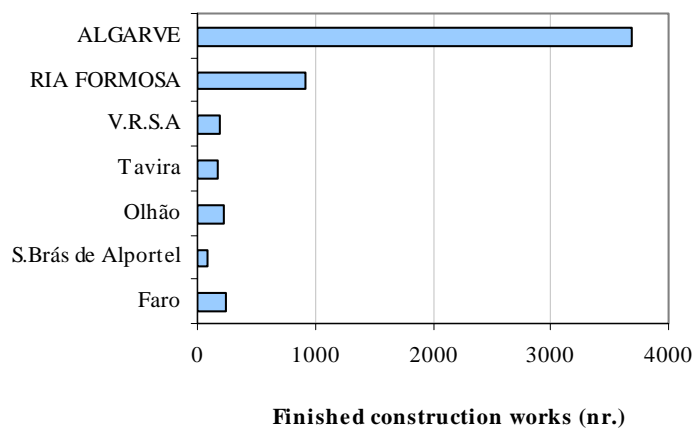

Figure 3.17 - Number of construction works finished in the Ria Formosa municipalities and in the Algarve region, in 2002 (INE, 2004).

Ria Formosa's construction works yielded about 404 million euros in 2002, representing 24 % and 2 %, respectively of the regional and national incomes from this sector (Table 3.13).

The municipality with highest revenues was Faro, representing about 35 % of the watershed revenues, followed by Tavira (23 %) and Olhão (21 %). S. Brás de Alportel had the lowest revenues (5 %), as expected from the reduced number of construction licenses and finished construction works.

Table 3.13 - Revenues from building transactions (10^6 €) in the Ria Formosa municipalities, Algarve region and Portugal, in 2002 (INE, 2004).

	Construction revenues
	10^6 €
Faro	139
S. B. Alportel	21
Olhão	86
Tavira	94
V.R.S.A.	64
RIA FORMOSA	404
ALGARVE	1 716
PORTUGAL	20 023

3.3. TERTIARY SECTOR

The economic sector of tourism and trading is the most important for the Algarve's economy, contributing 6 % to the national added value on this sector, in 2002 (INE, 2004). Table 3.14 shows the added value for tourism related activities in the Algarve region, in 2002.

Table 3.14 - Added value (10^6 euros) for tertiary sector activities in the Algarve region, from 1995 to 2001 (INE, 2003, 2004).

Activity sector	1995	1996	1997	1998	1999	2000	2001
Lodging and restaurants	342	347	390	427	458	482	553
Trading	395	418	443	492	519	561	600

3.3.1. Tourism

During the last decades, tourism became the base of the Algarve's economy. Besides the activities directly related with tourism (lodging and restaurants), this sector indirectly contributes to the development of other activities such as construction and trading. The social importance of tourism and its related activities is reinforced by the Ria Formosa's population working on lodging and restaurants (20 % of employed population) and on trading and construction (20 %), as referred in INE (2004).

3.3.1.1. Touristic offer

3.3.1.1.1. Touristic establishments

The number of certified touristic establishments in the Ria Formosa watershed was maintained from 1991 to 2002, conversely to the regional number that grew about 32 % during this period (Fig. 3.18).

The distribution of touristic establishments in the watershed is not uniform (Fig. 3.18). Faro was the municipality with the highest number of touristic establishments (35 %) according to INE (2002), while Olhão and S. Brás de Alportel represented respectively, 7 % and 2 % of the watershed establishments. In the eastern side of the watershed, 29 % of touristic establishments are located in Vila Real de Santo António, which registered a 40 % increase since 1991. In Tavira, there was also a remarkable increment in touristic offer (31 %) during the 90´s, holding about 28 % of the watershed's touristic establishments, in 2002.
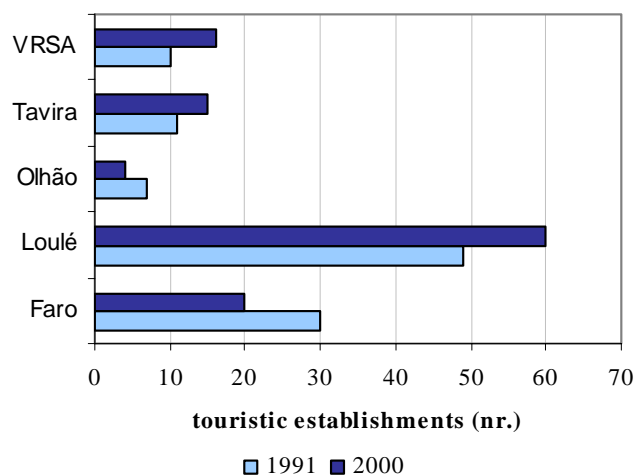
Figure 3.18 - Evolution of the number of touristic establishments in the Ria Formosa municipalities from 1991 to 2002 (INE, 2002, 2004).

As shown in figure 3.19, boarding houses were the most frequent touristic establishment in the watershed (47 %), followed by hotels (22 %) and apart-hotels (12 %). In Faro, touristic offer corresponded to 60 % of boarding houses, 20 % of hotels and 10 % of tourist apartments and of motels and hostels, whereas the Olhão's touristic offer was mainly boarding houses (75 %) and hotels (25 %). In Tavira, the dominant types of touristic establishment were boarding houses (50 %), apart-hotels (19 %) and tourist villages (19 %). Conversely to the other watershed municipalities, in Vila Real de Santo António there were mainly hotels (41 %), boarding houses (24 %) and apart-hotels (24 %), and in São Brás de Alportel there was only one hostel.
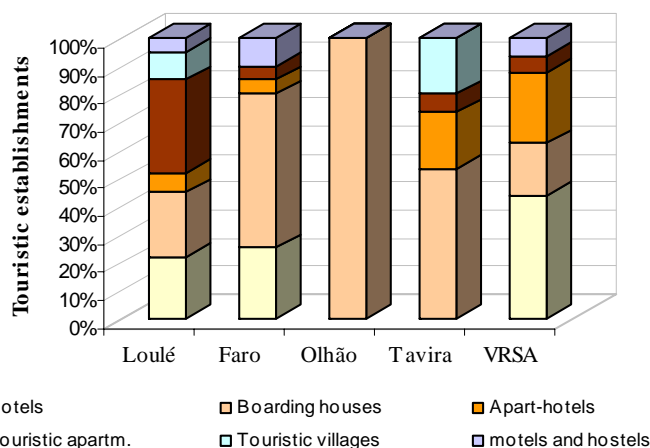

Figure 3.19 – Relative percentage of the different types of touristic establishments by Ria Formosa's municipality, in 2002 (INE, 2004).

3.3.1.1.2. Accommodation capacity

The Ria Formosa accommodation capacity, 9400 beds in 2002, represented respectively 10 % and 4 % of the regional and national accommodation capacity (Fig. 3.20). Vila Real de Santo António is the municipality with highest accommodation capacity representing 42 % of the number of beds in the watershed, followed by Tavira (41 %) and Faro (15 %). São Brás de Alportel and Olhão were the municipalities with the lowest accommodation capacity, each holding about 1 % of the number of beds existing in Ria Formosa.

Figure 3.20 evidences that only Vila Real de Santo António has a positive evolution in the accommodation capacity, since 1991. In the other municipalities there was a decrease in the accommodation capacity; Olhão lost about 62 % of beds whereas in Faro and Tavira the accommodation capacity decreased 11 % and 35 %, respectively.
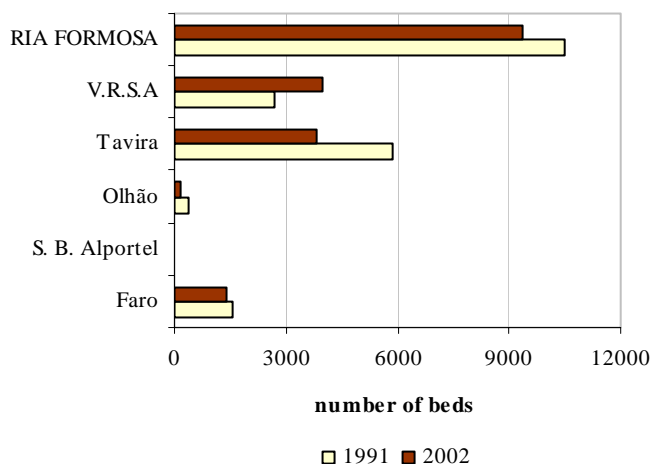

Figure 3.20 - Evolution of accommodation capacity (number of beds) in Ria Formosa municipalities, from 1991 to 2002 (INE, 2001, 2004).

Although being the most frequent touristic establishments in the Ria Formosa watershed, boarding houses were not the establishments with the highest accommodation capacity (Table 3.15). Apart-hotels, hotels and touristic villages registered the highest accommodation capacity, thus Tavira and Vila Real de Santo António, had the highest bed availability.

Table 3.15 - Number and accommodation capacity of the different types of touristic establishments in Ria Formosa municipalities, in 2002 (INE, 2004).

	Typology of touristic establishment											
	Hotels		Board. houses		Apart-hotels		Tour. apartm.		Tour. villages		Motels & hostels	
	Nr.	Beds	Nr.	Beds	Nr.	Beds	Nr.	Beds	Nr.	Beds	Nr.	Beds
Faro	4	666	12	602	0	0	2	52	0	0	2	77
S. B. Alportel	0	0	0	0	0	0	0	0	0	0	1	64
Olhão	1	104	3	47	0	0	0	0	0	0	0	0
Tavira	1	322	8	323	3	1051	1	138	3	1976	0	0
V.R.S.A.	7	1826	4	184	4	1543	1	358	0	0	1	47
RIA FORMOSA	13	2918	27	1156	7	2594	4	548	3	1976	4	188

3.3.1.2. Touristic demand

3.3.1.2.1. Number of guests

During the 90's, the number of guests registered in the Ria Formosa touristic establishments increased 26 % (Table 3.16), overcoming the regional growth of guests.

The Ria Formosa municipalities represented in 2002, 14 % and 3 % of the regional and national guests number respectively (Table 3.16). During this year, 37 % of the total number of guests in the watershed stayed in Faro. Relatively to this tourism's indicator, Vila Real de Santo António and Tavira were the second and third most important municipalities, holding 35 % and 28 % of the watershed guest number. Olhão, which lost about 48 % of its guests during the last decade, represented less than 1 % of the total Ria Formosa guest number in 2002.

Table 3.16 - Number of guests in the Ria Formosa municipalities, Algarve region and Portugal, in 1991 and 2002 (INE, 2001, 2004).

	Guests number	
	1991	2002
Faro	94630	123261
S.B. Alportel	0	a)
Olhão	3526	1840
Tavira	70331	92604
V.R.S.A.	81184	118268
RIA FORMOSA	249671	335973
ALGARVE	1906008	2468256
PORTUGAL	7694569	10546892

Hotels registered the highest number of guests (53 % of the watershed's guest number), although these establishments are not the most frequent in the Ria Formosa municipalities (Fig. 3.21). This disparity between the number of guests and the number of establishments might be explained by the high accommodation capacity of hotels. The second most

important type of establishment regarding guest's number is the apart-hotels (18 %), followed by boarding houses (15 %) and touristic villages (10 %).
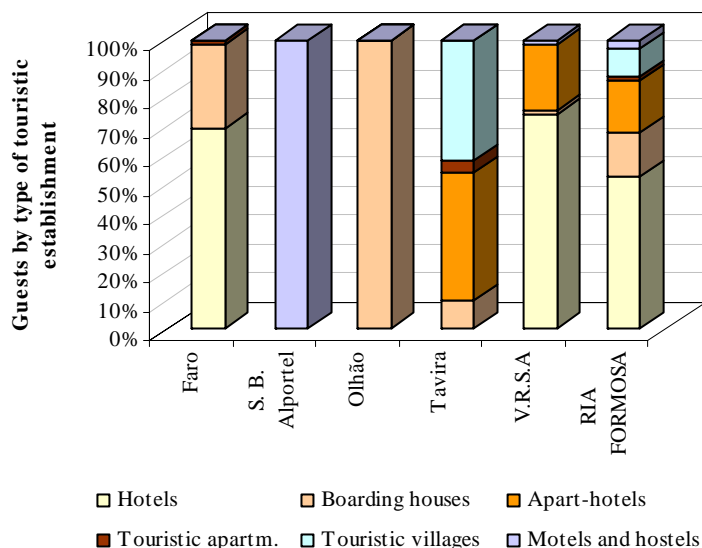

Figure 3.21 - Guests (%) by type of touristic establishment in Ria Formosa municipalities, in 2002 (INE, 2004).

As observed in Table 3.15 and figure 3.21, the number of guests in the Ria Formosa municipalities was directly related to the accommodation capacity of touristic establishments.

The majority of tourists staying in the watershed (95 %) came from European Union countries (Fig. 3.22). In Tavira and Vila Real de Santo António, the percentage of EU guests was higher than 95 %, whereas in the Faro and Olhão it was slightly lower (93 %) once these municipalities receive a higher number of tourists from other countries (outside EU).
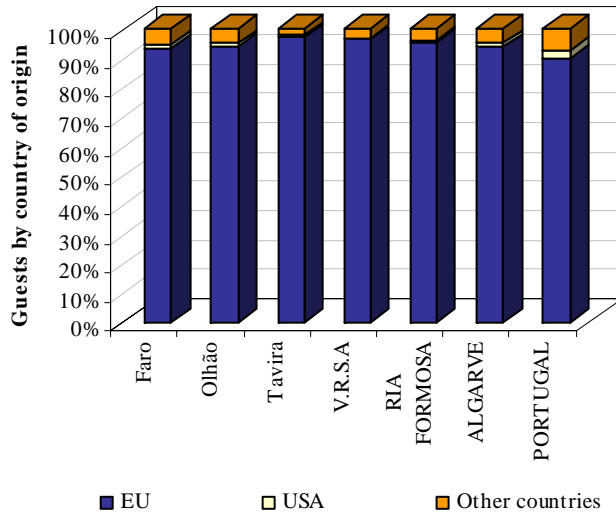
Figure 3.22 – Guests (%) from European Union (EU), United States of America (USA) and other world countries in Ria Formosa municipalities, Algarve region and Portugal in 2002 (INE, 2004).

3.3.1.2.2. Mean stay duration

In the Ria Formosa watershed, mean stay duration decreased from 4 to 3.2 days between 1991 and 2002 (Fig. 3.23), whereas in the Algarve region it decreased from 6 to 5.7 days during the same period. In 2002, this indicator registered the highest values in the eastern municipalities, Tavira and Vila Real de Santo António, and the lowest values in the western municipalities. In Olhão, mean stay duration decreased 0.8 days during the last decade mainly due to a decrease in touristic offer.
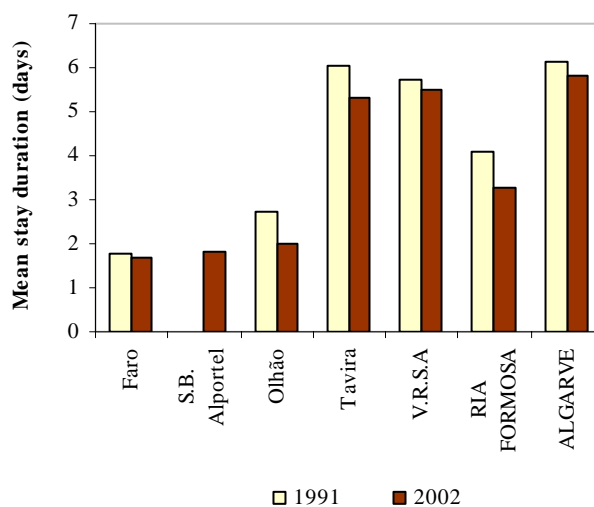

Figure 3.23 - Evolution of mean stay duration (days) in Ria Formosa municipalities and in the Algarve region, from 1991 to 2002 (INE, 2001, 2004).

As observed in Table 3.17, touristic establishments with higher accommodation capacity (touristic villages and apart-hotels) registered the highest values of mean stay duration.

Table 3.17 - Mean stay duration by type of touristic establishment, in Ria Formosa municipalities, and in the Algarve region, in 2002 (INE, 2004).

	Mean stay duration (days)						
	Total	Hotels	Boarding houses	Apart-hotels	Touristic apartments	Touristic villages	Motels and hostels
Faro	1.7	1.5	1.8	-	2.0	-	a)
S. B. Alportel	1.8	-	-	-	-	-	1.8
Olhão	2.0	2.0	2.0	-	-	-	-
Tavira	5.3	1.2	2.1	6.0	6.0	8.0	-
V.R.S.A.	5.5	5.0	3.3	8.7	a)	-	a)
ALGARVE	5.8	4.5	3.0	6.5	7.3	6.9	4.0

a) – Data not available

In the study area, foreign tourists mainly from the Netherlands, United Kingdom and Germany, stayed for longer periods than Portuguese tourists (Fig. 3.24), except in Faro and Olhão where Portuguese tourists stayed more days.
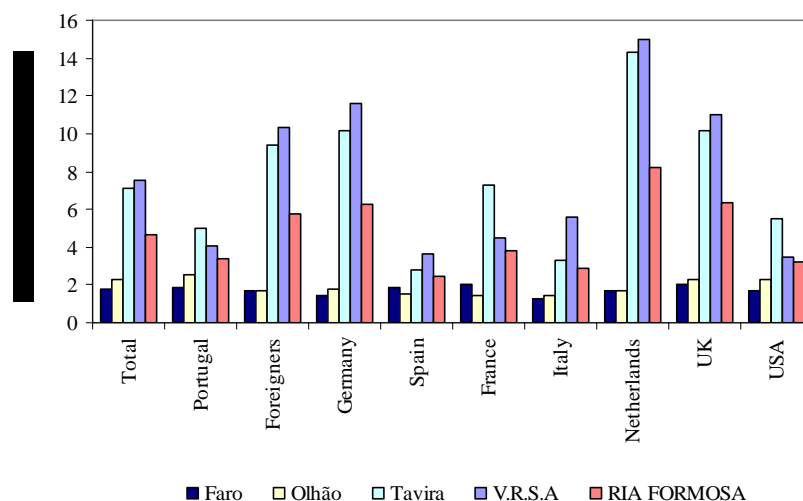

Figure 3.24 - Mean stay duration of tourists in Ria Formosa municipalities in 2002, according to the country of origin (ICN, 2004).

3.3.1.2.3. Bed occupancy rate

During the last decade, the bed occupancy rate in the Ria Formosa watershed increased from 26 % in 1991 to 39 % in 2002 (Fig. 3.25). Either in 1991 or 2002, Vila Real de Santo António was the municipality with the highest bed occupancy rate (53 %), overcoming the regional mean value of this indicator. São Brás de Alportel (50 %) and Faro (41 %) were the second and third most important municipalities respectively, in 2002. Olhão and Tavira also registered an increment in their bed occupancy rate during the last decade, 7 % and 20 % respectively.
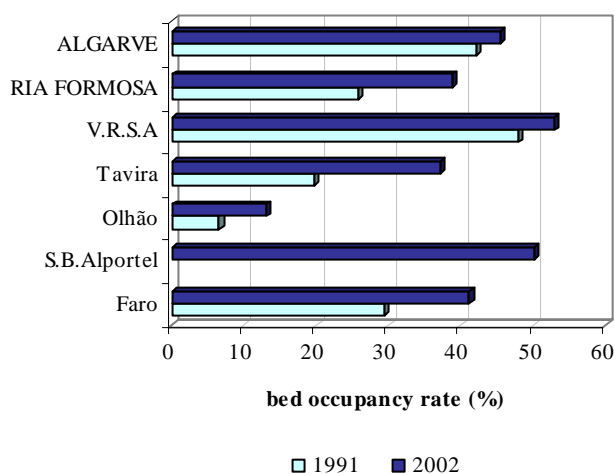

Figure 3.25 - Evolution of the bed occupancy rate in Ria Formosa municipalities and in the Algarve region (INE, 2001, 2004).

As shown in Table 3.18, hotels and motels and hostels were the touristic establishments with the highest occupancy rate in the Ria Formosa municipalities (53 %) in 2002, conversely to boarding houses that registered the lowest value for this indicator (13 %). In Vila Real de Santo António, hotels registered the highest occupancy rate in the municipality (55 %), whilst in Tavira, apart-hotels were the most important touristic establishments with a bed occupancy rate of 48 %. In Faro, hotels were the establishments with the highest occupancy rate (52 %), while in Olhão boarding houses recorded 13 % of occupancy. In São Brás de Alportel, the bed occupancy rate of the only existing hostel was about 50 %.

Table 3.18 - Bed occupancy rate by type of touristic establishment in Ria Formosa municipalities and in the Algarve region, in 2002 (INE, 2004).

	Bed occupancy rate (%)						
	Total	Hotels	Boarding houses	Apart-hotels	Touristic apartments	Touristic villages	Motels and hostels
Faro	41.2	52.0	29.8	-	34.0	-	a)
S.B. Alportel	50.2	-	-	-	-	-	50.2
Olhão	13.0	a)	12.7	-	-	-	-
Tavira	37.3	-	13.4	48.4	32.3	35.7	-
V.R.S.A.	52.9	55.3	a)	8.7	a)	-	45.2
ALGARVE	45.6	54.6	30.6	50.4	41.0	40.2	35.0

a) Data not available

3.3.1.3. Tourism's revenues

The revenues of Ria Formosa's certified touristic establishments generated a total of 31.5 million euros in 2000, representing 7 % of the regional tourism revenues (Table 3.19). Vila Real de Santo António, the municipality where tourists stayed for longer periods generated the highest revenues (48 % of the total watershed revenues). Faro is the second most important municipality concerning tourism's revenues (28 %), followed by Tavira (24 %). Olhão registered the lowest revenues, less than 1 % of the watershed's revenues.

Table 3.19 – Tourism's revenues (10^3 euros) from Ria Formosa municipalities, Algarve region and Portugal, in 2002 (INE, 2004).

	Total revenues (10^3 €)
Faro	6 537
S. B. Alportel	500
Olhão	52
Tavira	7 997
V.R.S.A.	10 764
RIA FORMOSA	25 850
ALGARVE	32 2306
PORTUGAL	995 758

3.3.2. International Trading

The international trading fluxes of the Algarve region are mainly with European Union countries. This region exports for EU countries about 49 million euros, while imports reached values three times higher in 2002 (Fig. 3.26). During this period, the number of intra EU import firms with head office in this region (289) was six times higher than the intra EU export firms. Intra EU trading concerned mainly to export of live animals, animal products and vegetable products while the main imports corresponded to electric equipment, machinery, plastic and rubber products and metals. Extra-EU trading is also of great importance for this region, existing 355 extra-EU import firms and 191 export firms, which transacted about 17 and 10 million euros respectively in 2002 (Fig. 3.27). The export to third countries mainly include vegetable products, food and drinks, machinery and electric equipment. The import trading is mainly machinery, electric and transportation equipment (INE, 2004).

3.3.2.1. Intra - EU trading

Trading firms with head office in the Ria Formosa watershed were responsible for 45 % and 73 % of Algarve's intra-EU imports and exports respectively (Fig. 3.26). In Olhão, the revenues from exports to EU countries yielded 16 million euros in 2002, while in Faro and São Brás de Alportel revenues reached lower values, 13 and 5.5 million euros respectively. Due to some missing data it was not possible to evaluate the contribution of Tavira and Vila Real de Santo António for intra-EU exports. Relatively to intra-EU imports, the highest values were recorded in Faro (60 % of Ria Formosa's exports), followed by Olhão (19 %) and São Brás de Alportel (11 %). In Tavira and Vila Real de Santo António, imports values were lower than in the other watershed municipalities, 3.8 and 2 million euros respectively.
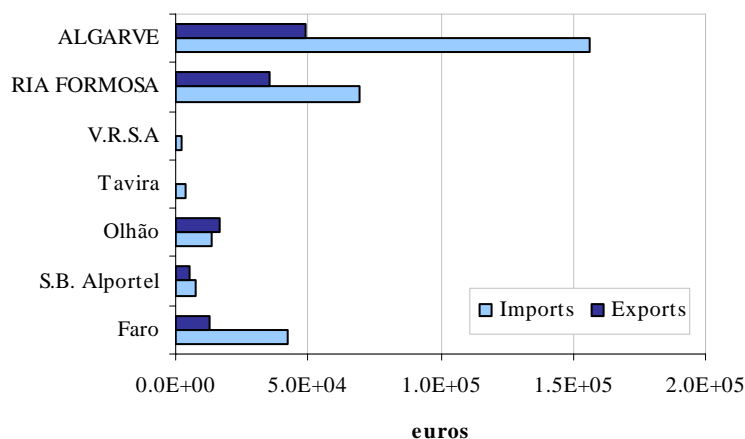
Figure 3.26 - Intra-European Union (EU) imports and exports from/for Ria Formosa municipalities and Algarve region, in 2002 (INE, 2004).

3.3.2.2. Extra-EU trading

Extra-communitarian exports were particularly relevant in Faro, generating incomes of 5.4 million euros, as shown in figure 3.27. In Olhão and Vila Real de Santo António, the revenues from extra-EU exports were lower than in Faro, 1.7 and 0.5 million euros respectively. Concerning extra-EU imports, Faro was the most important municipality (71 % of Ria Formosa's imports), followed by Olhão (23 %) whose import values reached 1.5 million euros in 2002. The other watershed municipalities represented less than 7 % of extra-EU imports.
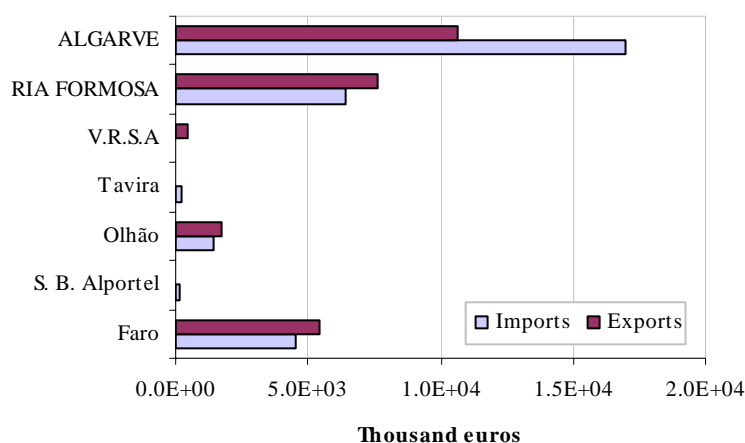

Figure 3.27 - Extra-European Union (EU) imports and exports from/for Ria Formosa municipalities and Algarve region, in 2002 (INE, 2004).

4. FINAL CONSIDERATIONS

Primary sector activities have the lowest contribute for the revenues of the Ria Formosa ecosystem (280 million euros). Most revenues come from aquaculture (50 %), namely from fish and shellfish farming, which generate about 70 and 65 million euros *per* year, respectively (Fig. 4.1). Fishing of marine fishes, crustacean and molluscs is also a relevant activity generating by itself 50 % of the revenues generated by whole of watershed activities (agriculture, animal rearing, hunting and forestry). Concerning to primary sector activities, this system has an important contribute, of approximately 40 %, to Algarve's added value.
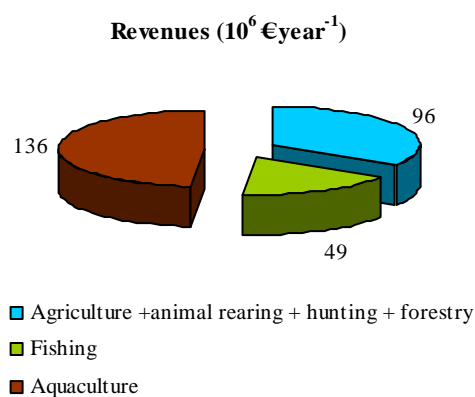
Revenues (10^6 €year^{-1})

96

136

49

- ■ Agriculture +animal rearing + hunting + forestry
- ■ Fishing
- ■ Aquaculture

Figure 4.1 - Annual revenues (10^6 euros) from primary sector activities of the Ria Formosa watershed.

The main activity of the secondary sector in the Ria Formosa watershed is building construction (strongly related with tourism), which exhibited a large expansion at local and regional level, during the last decade. According to official data (INE, 2004), building transactions from Ria Formosa municipalities generated about 400 million euros in 2002, a value that corresponds to 70 % of secondary sector incomes (Fig. 4.2). The manufacturing industry, including mainly metallurgy, provisions and cork industry, is the second most important source of secondary sector incomes, generating about 140 million euros *per* year (INE, 2004). Salt and sand extraction are strongly dependent on the lagoon natural resources, therefore the incomes from these activities may be strongly affected by the degradation of environmental conditions. Quarrying is the less important secondary sector activity, representing only 1 % of the local incomes for this sector (IGM, 2000).
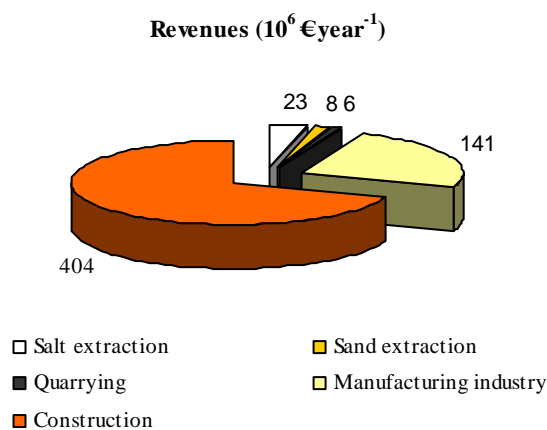
Revenues (10^6 €year^{-1})

Figure 4.2 - Annual revenues (10^6 euros) from the main secondary sector activities in the Ria Formosa watershed.

The tertiary sector is mainly divided in three sub-sectors: trading, tourism and other services (education, health, banks, public administration, communications, etc.). National and international trading is a relevant activity for the local economy generating about 340 million euros *per* year (Fig. 4.3). International trading incomes were estimated from the export incomes from Ria Formosa municipalities, while national trading incomes were estimated by assuming that Ria Formosa represents 50 % of the regional added value for this activity. The tourism activity, which includes mainly lodging and restaurants services, is also an important source of incomes at local level generating about 110 million euros *per* year, a value that corresponds to 20 % of this sector's added value for the Algarve region. Based on the added value for the services sector in the Algarve region and assuming that Ria Formosa municipalities contribution is about 50 % of this value, one may estimate that education, health, public administration, communications and other services generate about 1 300 million euros *per* year.
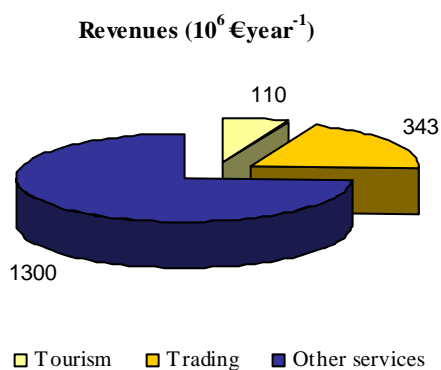
Revenues (10^6 €year^{-1})

Figure 4.3 - Annual revenues (10^6 euros) from the main tertiary sector activities in the Ria Formosa watershed.

The information gathered in the present work evidences that economical activities of tertiary and secondary sectors generate the highest revenues in the Ria Formosa ecosystem. However, as these activities depend on the local natural heritage, an efficient management of the ecosystem (lagoon and watershed) is determinant in order to assure the sustainability of the referred activities. One may also reinforce, that all the system's economical activities are interdependent and sustained by a good environmental quality.

ACKNOWLEDGMENTS

REFERENCES

CCDRAlgarve (Comissão de Coordenação e Desenvolvimento Regional do Algarve –Ambiente e Território), 2002. http://www.dra-alg.min-amb.pt/pages/produtoseserviços/atlas.asp

DGPA (Direcção Geral das Pescas e Aquicultura), 1999. Data Pescas. Ministério da Agricultura, Desenvolvimento Rural e Pescas, n.º 43.

DGPA (Direcção Geral das Pescas e Aquicultura), 2000. Data Pescas. Ministério da Agricultura, Desenvolvimento Rural e Pescas, n.º 47.

DGPA (Direcção Geral das Pescas e Aquicultura), 2002a. Data Pescas. Ministério da Agricultura, Desenvolvimento Rural e Pescas, n.º 55.

DGPA (Direcção Geral das Pescas e Aquicultura), 2002b. Boletins da DGPA. Ministério da Agricultura, Desenvolvimento Rural e Pescas.

FALCÃO, M.; DUARTE, P.; MATIAS, D.; JOAQUIM, S.; FONTES, T.; MENESES, R., 2000. Relatório final do Projecto "Gestão do cultivo de bivalves na Ria Formosa com recurso à modelação matemática". Parque Natural da Ria Formosa, Instituto de Conservação da Natureza.

GRANJA, H., 1984. Étude geomorphologique, sedimentologique et geochimique de la Ria Formosa (Algarve-Portugal). Thèse en Océanologie. Université Bordeaux I, 254 p.

IA (Instituto do Ambiente), 2003. http://www.iambiente.pt/atlas

ICN (Instituto de Conservação da Natureza), 2004. http://www.icn.pt/popnrf/web

IGM (Instituto Geológico e Mineiro), 2000. Indústria Extractiva. Versão Online – http://www.igm.pt/edicoes_online/diversos/ind_extractiva/indice.htm.

IM (Instituto de Meteorologia Português), 2001. http://www.meteo.pt

INE (Instituto Nacional de Estatística), 2001. Anuário Estatístico da Região do Algarve. Instituto Nacional de Estatística (eds.), Faro, 170 p.

INE (Instituto Nacional de Estatística), 2002. Anuário Estatístico da Região do Algarve. Instituto Nacional de Estatística (eds.), Faro, 170 p.

INE (Instituto Nacional de Estatística), 2003. Anuário Estatístico da Região do Algarve. Instituto Nacional de Estatística (eds.), Faro, 198 p.

INE (Instituto Nacional de Estatística), 2004. Anuário Estatístico da Região do Algarve. Instituto Nacional de Estatística (eds.), Faro, 176 p.

IPTM (Instituto Portuário e dos Transportes Marítimos), 2004. www.imarpor.pt

ISA (Instituto Superior de Agronomia), 2001. Base de Dados da Secção de Agricultura. http://agricultura.isa.utl.pt/agricultura/agribase.htm

MONTEIRO, C., 1989. La faune ichtyologique de la lagune Ria Formosa (sud Portugal)-répartition et organisation spatio-temporelle des communautés: application à l'aménagement des ressources. Thèse de doctorat. Université des Sciences et techniques du Languedoc, 219 p.

PH&P (PROCESL, HIDRO4 & PROSISTEMAS), 2000a. Plano de Bacia Hidrográfica das Ribeiras do Algarve – Caracterização Geral da Bacia Hidrográfica, 1ª Fase – Análise e Diagnóstico da Situação de Referência, Vol. I – Síntese, 186 p.

PH&P (PROCESL, HIDRO4 & PROSISTEMAS), 2000b. Plano de Bacia Hidrográfica das Ribeiras do Algarve – 1ª Fase Análise e Diagnóstico da Situação de Referência. Vol. III – Análise; Capítulo 1 – Caracterização Geral da Bacia Hidrográfica, 78 p.