

ULUSLARARASI SOSYAL ARAŐTIRMALAR DERĐİŐİ THE JOURNAL OF INTERNATIONAL SOCIAL RESEARCH

Uluslararası Sosyal Arařtırmalar Dergisi / The Journal of International Social Research
Cilt: 13 Sayı: 73 Ekim 2020 & Volume: 13 Issue: 73 October 2020
www.sosyalarastirmalar.com Issn: 1307-9581

AQUACULTURE IN SOUTHERN PROVINCES OF TURKEY, ITS DISTRIBUTION, AND SIGNIFICANCE

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Abstract

An increase in the world population and severe pressure on fish stocks require new studies and precautions. At this point, the development of aquaculture, the determination of spaces where it can be developed, and the distribution of these spaces are quite significant. Worldwide, aquaculture constituted 80 million tons of 170.9 million tons of fish production in 2016. Depending on the regions and countries, the increase in each one is important. In Turkey, aquaculture constituted 1.5% of the total fish production in 1990. However, it reached 43.83% in 2017. Of the total aquaculture production in Turkey, 43% is provided from the southern coastal provinces of Turkey. Therefore, the importance of aquaculture in the southern coastal areas of Turkey, where there are bays and gulfs with a high potential for aquaculture, its general status, and its place and significance in aquaculture in Turkey were examined, and the spatial distribution of aquaculture was assessed. In this spatial distribution, attention was paid to Muğla, Antalya, Mersin, Adana, and Hatay provinces, which are located in the south of Turkey. The main species cultivated in the south of Turkey are sea bream (*Sparus aurata*), sea bass (*Lateolabrax japonicus*), rainbow trout (*Oncorhynchus mykiss*), mirror carp (*Cyprinus carpio carpio*), meagre (*Argyrosomus regius*), and shi drum (*Umbrina cirrosa*) while the most cultivated ones are sea bream, sea bass, and rainbow trout. Numerous scientific studies and practices are carried on in Turkey, as well as worldwide, regarding the development of aquaculture. Aquaculture is performed in many parts of Turkey, and Muğla specifically comes into prominence among the provinces on the southern coasts of Turkey. Muğla is the top province among those in the research site for providing 93% of the total production. The production share of Muğla within overall Turkey constitutes 36% of the aquaculture production in Turkey. It is necessary to make good use of this potential and develop aquaculture in other provinces as well.

Keywords: Aquaculture, Aquaculture in Turkey, Aquaculture in the south of Turkey, The spatial distribution of aquaculture in Turkey.

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Introduction

Aquaculture is the control of aquatic organisms or the production and cultivation of the environment (Ashley, 1977, 2). Fishery, which used to be carried out under very primitive conditions in the past, has become diversified and gained an intensive character nowadays. Fish farming has been increasing rapidly in recent years. Aquaculture is a major method of seafood production (Fisheries, 2014; The State of World Fisheries and Aquaculture, 2012; FAO, 2019; Hynes, 2014; Nimmo, 2014; Olafsen, 2012; FAO, 2018).

In parallel to the rapid population growth, the increasing demand for food, increasing environmental problems, and severe pressure on natural resources also threaten fish reserves, and accordingly, pressure and decline are observed in many fish reserves (Diamond, 1989; Smith and etc, 1993, 495; Morris and Heidinga, 1997, 287; McKinney and Lockwood, 1999, 450). In recent years, the pressure on fish reserves and the relative decrease in the amount of the caught fish have been among the most important dynamics of the development of aquaculture (Econsearch, 2014; Hynes etc, 2014; Nimmo etc, 2011). The world population is approaching 8 billion. The contribution of aquaculture is very important in meeting the nutritional needs of this rapidly growing population, providing people with healthy nutrition, providing raw materials for the industrial sector, and creating employment opportunities. Supporting rural development, increasing export opportunities, and encouraging the conservation of biodiversity are other significant contributions (Filipski and Belton, 2018, 217). Upon assessing the statistics, it is observed that aquaculture activities around the world have increased substantially and had significant developments in recent years, and in line with this increase, numerous scientific studies and practices are carried out around the world and in Turkey regarding the development of aquaculture (Krøvel etc, 2019; Sicuro, 2019; Lindland etc, 2019; Willot etc 2019; Guillen etc, 2019; Memis etc, 2002; Kayhan, 2014; Yucel-Gier, 2009). Firstly, carp and trout were cultivated in aquaculture, and although freshwater and saltwater aquaculture made progress every day, the increase in production was mainly achieved with developments in marine sciences as of the 19th century. Seafood production is very important for developing countries. It is essential that developing countries consume 86.4% of the products grown by aquaculture.

The amount of fish produced by aquaculture in the world was 13.13 million tons in 1990 and reached 80 million tons in 2016. In capture production, this amount was 85.88 million tons in 1990; however, it reached 90.9 million tons in 2016 (<http://www.fao.org>). These increases in capture and aquaculture between the years reveal the importance of aquaculture.

The annual rate of increase in fish production in the world aquaculture was 5.8% between 2001 and 2016. During the same period, the increase in Africa was faster (11.7%). Essentially 92.7% of all aquaculture production (as nutrients) is produced by 15 producer countries. Furthermore, many people are employed in fishing activities. Employment in the sector is increasing very rapidly. The ratio of employed in aquaculture increased from 17 (1990) to 32 percent (2016). 59.6 million people were engaged in the primary sector of capture fisheries and aquaculture in 2016, with 19.3 million engaged in aquaculture. The employment of women is important in the sector. In 2016, 85 percent of the global population engaged in the fishery and aquaculture sectors was in Asia, followed by Africa with 10%, and Latin America and the Caribbean with 4% (www.fao.org).

Of the 171 million tons of the total fish production in 2016, about 88 percent (over 151 million tons) were utilized for direct human consumption. Although it varies by countries and regions, approximately 17% of animal proteins are supplied from fish. The highest fish consumption per capita, over 50 kg, is found in several Small Island Developing States (SIDS), particularly in Oceania, while the lowest levels, just above 2 kg, are in Central Asia and some landlocked countries. In developing countries, more than 50% of the population meets 40% of the animal protein requirement from fish. While 9.9 kg of fish on average was consumed per capita around the world in the 1960s, this amount increased to 20.3 kg in 2016 (www.fao.org).

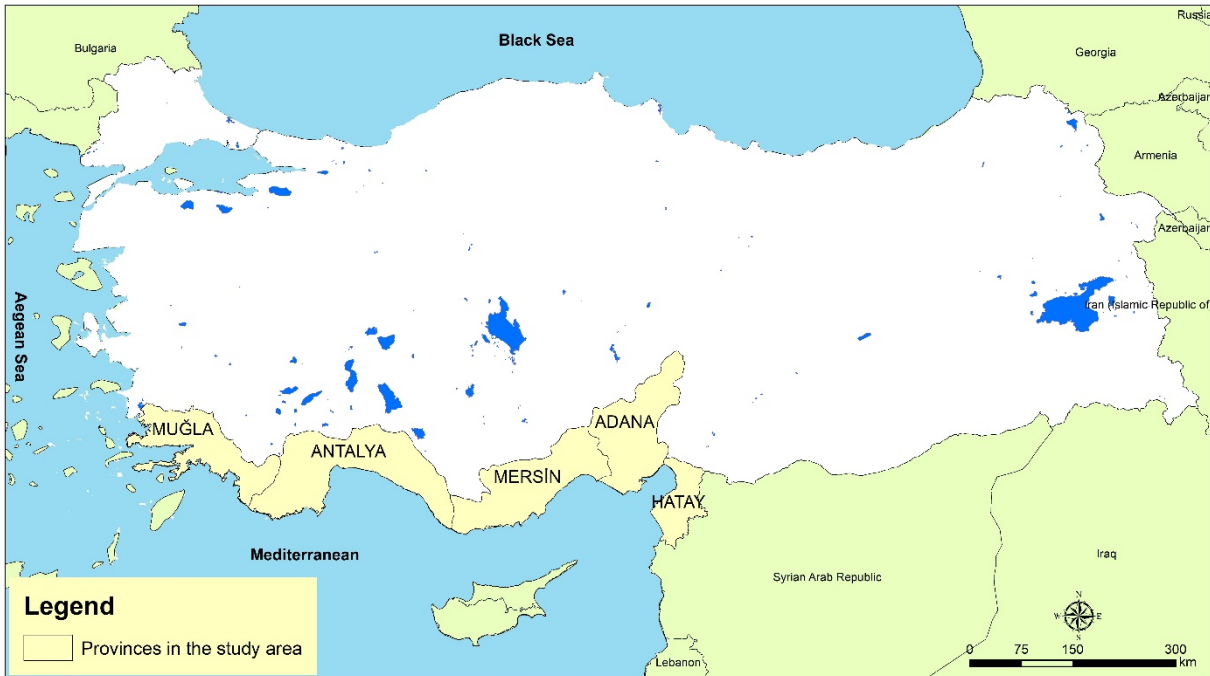
The global aquaculture production (including aquatic plants) in 2016 was 110.2 million tons, with the first sale value estimated at USD 243.5 billion. The total production included 80.0 million tons of food fish (USD 231.6 billion) and 30.1 million tons of aquatic plants (USD 11.7 billion), as well as 37.900 tons of non-food products (USD 214.6 million). The farmed food fish production included 54.1 million tons of finfish (USD 138.5 billion), 17.1 million tons of molluscs (USD 29.2 billion), 7.9 million tons of crustaceans (USD 57.1 billion), and 938.500 tons of other aquatic animals (USD 6.8 billion) such as turtles, sea cucumbers, sea urchins, frogs, and edible jellyfish. Farmed aquatic plants included mostly seaweed and a much smaller production volume of microalgae. Non-food products included only ornamental shells and pearls (www.fao.org).



Significant technological developments in fishing have been effective in the increase of aquaculture production in Turkey, as well as worldwide. However, despite the rapid development of technology, the rate of increase in production decreased and regressed from time to time due to the excessive demand for fish stocks in Turkey, as around the world. It exhibited positive developments, especially with improvements after the 1970s (Akova, 2015, 163; Akbulut, 2004, 9). However, fish consumption in Turkey is still very low compared to international standards and the world average, and the amount of fish consumed per capita is 5.5 kg on average (<https://arastirma.tarimorman.gov.tr>)

Materials and Methods

The study area includes the southern coastal areas of Turkey, where aquaculture is developed the best in Turkey due to natural and human conditions. Here, Muğla, Antalya, Mersin, Adana, and Hatay provinces were examined as coastal provinces. The bibliography, statistical data, and field studies on the subject monitored for many years formed the basis of the study. Research has been conducted, especially in these coastal areas, and field studies have been concretized further with statistical data. In the study, statistical data of FAO on fishery, statistical data of TURKSTAT on fishery, statistical data of the General Directorate of Fisheries and Aquaculture of the Ministry of Food, Agriculture and Livestock, and statistical data of the Central Union of Aquaculture Producers were used. The ArcGIS 10.1 program was used to prepare maps.



1. Location Map

1. Aquaculture in Turkey

Aquaculture in Turkey is performed with the permission of the Ministry of Food, Agriculture and Livestock. The Ministry made new arrangements to carry out aquaculture more regularly, to minimize environmental impacts, and to ensure healthy and high-quality production, and the "Regulation on Aquaculture" was published in the Official Gazette dated 29.06.2004 and numbered 25507 and entered into force within the framework of the harmonization rules of the EU Common Fisheries Policy. Production support practices that have started to be implemented since 2003 have contributed significantly to the rapid development and progress of the aquaculture sector (Akova, 2015, 163).

In 1994, a protocol was signed and put into practice to initiate aquaculture in cages in reservoirs (dam lakes) owned by the General Directorate of State Hydraulic Works (DSI). The protocol was revised in 2004 and expanded to allow semi-intensive and extensive production. In 1995, the initiation of aquaculture in network cages in natural lakes by the Ministry of Agriculture and Rural Affairs and in dam lakes by DSI is one of the reasons for the increase in production (Akova, 2015, 163).

While there was one aquaculture facility in 1971, there are a total of 2308 aquaculture facilities today, 1881 of which are inland water fish facilities and 427 of which are marine fish facilities. The total project



capacity is 487 859 ton/year, 233 419 tons of which are inland water and 254 440 tons are sea([http://www tarim gov tr](http://www.tarim.gov.tr))

Turkey has a rapidly growing aquafeed industry The fish feed industry had 15 fish feed plants in 2008, and it increased to 25 in 2017 This number will reach 30 and above in the next few years Turkey ranks first in relation to fish feed production among all Mediterranean countries (Kop, 2018, 2).

As seen in aquaculture across the world from time to time as a result of feed-induced contamination on the coasts coming to the agenda and the increase in complaints of the tourism sector, fish farms established in the seas cannot be established up to 0 6 nautical miles away from the coast and in waters shallower than 30 m in accordance with the regulations enacted by the Ministry of Environment and Urbanization after 2009 Furthermore, technological developments, such as the introduction of automatic feeding systems, feeding according to programs, and its monitoring in the digital environment, have prevented feed-induced contamination to a great extent(DPT , 2014, 8).

As seen in Table 1, while the culture fish production in Turkey was 5782 tons in 1990, it reached 276 502 tons in 2017 While the share of aquaculture was 1 5% in 1990, its share reached 43 83% in 2017 Especially after the year 2000, increases have been very significant The inclusion of aquaculture in the support scope for the first time in 2003, the increase in supports to encourage the cultivation of new species in 2005, and also the support of the production of juvenile fish primarily have an effect on this development (<http://www tarim gov tr>).

Table 1. Amount of Fishery Products by Capture and Aquaculture in Turkey (Selected Years between 1985 and 2017)

Years	Capture (Ton)			Aquaculture (Ton)			Total	Aquaculture Percentage (%)
	Marine	Inland	Total	Marine	Inland	Total		
1985	532 602	45 471	578 073	0	0	0	578 073	0,0
1990	342 017	37 315	379 332	1 545	4 237	5 782	385 114	1,5
1995	582 610	44 983	627 593	8 494	13 113	21 607	649 200	3,3
2000	460 521	42 824	503 345	35 646	43 385	79 031	582 376	13,57
2004	504 897	45 585	550 482	49 895	44 115	94 010	644 492	14,59
2008	453 113	41 011	494 124	85 629	66 557	152 186	646 310	23,55
2012	396 322	36 120	432 442	100 853	111 557	212 410	644 852	32,94
2015	397 731	34 176	431 907	138 879	101 455	240 334	672 241	35,75
2016	301 464	33 856	335 320	151 794	101 601	253 395	588 715	43,04
2017	322 173	32 145	354 318	172 492	104 010	276 502	630 820	43,83

Source: BSGM, Edited from August 2018

With scientific, technological, and economic developments in aquaculture, aquaculture in our country has increased rapidly in recent years Of aquaculture, 37 6% is performed in inland waters, and 62 4% is performed in the seas The most important species cultivated are sea bass, sea bream, and trout Trout takes first place with a share of 56%, followed by sea bass with 29%, and sea bream with 15% Trout is widely cultivated in inland waters, while seam bream and sea bass are widely cultivated in the seas The cultivated species vary according to the market conditions, and significant increases have occurred in trout production among inland water fish and in sea bream and sea bass production in the seas Trout production approximately doubled over a period of 9 years between 2008 and 2017 in inland waters Similarly, it increased by more than two times in the same process in the marine environment Sea bass and sea bream production also increased by almost two times in the seas While 1136 tons of tuna, which has gained importance in recent years, was produced in 2014, its production has reached 3802 tons as of 2017, i e increased by more than three times ([https://arastirma tarimorman gov .tr](https://arastirma.tarimorman.gov.tr)).



Table 2. Turkey Inland and Marine Fish Species Farmed and Their Respective Production Amounts (in Ton)

Type of Fish	2008	2010	2012	2014	2017
Total	152 186	167 141	212 410	235 133	276 502
Trout (Rainbow trout)	65 928	78 165	111 335	107 533	101 761
Trout (Salmo sp)*	-	-	-	450	1 944
Carp	629	403	222	157	233
Sturgeon*	-	-	-	17	13
Tilapia*	-	-	-	32	8
European catfish**	-	-	-	-	8
Frog*	-	-	-	50	43
Trout (Rainbow trout)	2 721	7 079	3 234	4 812	4 972
Trout (Salmo sp)*	-	-	-	798	980
Sea bream	31 670	28 157	30 743	41 873	61 090
Sea bass	49 270	50 796	65 512	74 653	99 971
Common seabream*	-	-	-	106	20
Bluespotted seabream**	-	-	-	-	122
Redbanded seabream**	-	-	-	-	66
Corb*	-	-	-	39	125
Meagre*	-	-	-	3 281	697
Dentex*	-	-	-	113	51
Sharpsnout seabream*	-	-	-	8	-
Blue spatled bream*	-	-	-	75	107
Bluefin tuna*	-	-	-	1 136	3 802
Mussel	196	340	-	-	489
Other	1 772	2 201	1 364	-	-

*It was compiled starting from 2014

**It was compiled starting from 2017

Source: Data on administrative register of Ministry of Food, Agriculture and Livestock

2. Areas of Aquaculture in Southern Coastal Provinces of Turkey and Their Characteristics

The south of Turkey is rich in water resources due to its location and is very suitable for aquaculture with its climatic properties and the potential of water resources. These are also important factors for the development of the aquaculture sector. The coastal length in the area in the south of Turkey, which is the subject of research (Muğla, Antalya, Mersin, Adana, and Hatay), is 1999.3 km. Bays are extremely suitable for sponge fishing and fishing. To talk about the main water resources from west to east, the main lakes within the borders of Muğla province are Lake Köyceğiz, Lake Baba (Camici), Lake Hacet (Tuzla), Lakes Denizcik, Sulundur and Koca, and except these, there are Mumcular and Geyik dams, and Ula and Kazan ponds for irrigation purposes. The Dalaman Stream and the Eşen Stream should be mentioned among the main streams.

To the north of the Elmalı Plain on the Teke Peninsula to the west of the Gulf of Antalya, there are lakes among the mountain ranges extending in the east-west direction, at the plateaus of the surrounding villages. For example, Lake Yeşil in Akdağ, Lake Girdev, which is the plateau of the villages of Fethiye district in Muğla and Elmalı district in Antalya, and Lake Baranda within the borders of İslamlar village of Elmalı can be listed. The biggest mountain lake in the region is Lake Eğri within the boundaries of Gündoğmuş district. In Lake Eğri, which does not dry during summer, delicious mirror carp fed on snow water is cultivated. Lake Karın is one of the non-drying lakes of the Gündoğmuş Mountains. Among them, there are Lake Susam and Lake Yenice Pazar, which are at the plateaus of some Manavgat villages, and Lake Dipsiz, Söğüt, Lake Kara, and Lake Avlan. The dam lakes are Oymapınar Dam Lake on the Manavgat Stream, Alakır Dam Lake on the Alakır Stream, and Korkuteli Dam Lake on the Korkuteli Water. The main streams are the Alakır Stream, Aksu, Manavgat, Demre, Alara and Düden Streams, and the Köprüçay River.



The natural lakes in Mersin province are Akgöl, Lake Paradeniz, and Lake Keklik in Silifke, and Lake Aygır, Lake Kamışlı, Lake Uzun in Gülnar, while dam lakes and ponds are Gezende and Berdan Dam Lakes, Evcili, Değirmendere, and Tepeköy Gölpmarı in the city center, Çavuşlu Kaleönü in Tarsus, Karakız and Esenpınar ponds in Erdemli, and crater lakes are Karagöl and Lake Çinili in Çamlıyayla. In addition to these, there are Gezende and Berdan Dam Lakes and numerous irrigation ponds in the region. Among these, in Gezende Dam Lake, a significant improvement has been achieved since 2003 in aquaculture that was firstly started with the establishment of 5 trout farms in 1992. The main streams are the Berdan Stream (90 km) and the Göksu (299 km) Stream. There are also many streams and creeks except these. Some of them are the Mezitli Creek, Tece Creek, Müftü (Efrenk) Creek, and Deliçay Creek in Mersin, the Dragos Stream, Sultan Stream, and the Melleç Creek in Anamur, Menekşe and the Gözsüzce Creek in Aydıncık, the Siniçay Creek and the Aksaz Creek in Bozyazı, and the Alata Stream and the Lamos Stream in Erdemli.

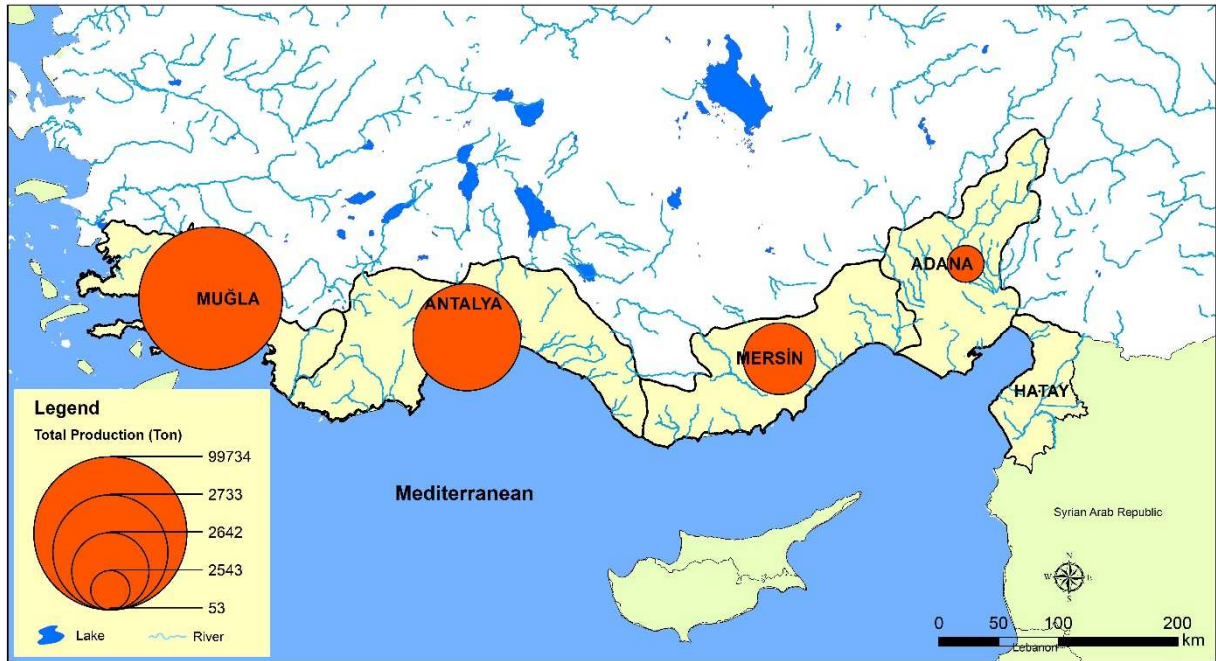
The main streams in Adana are the Seyhan River (560 km) and the Ceyhan River (509 km). The main dam lakes and lakes are Seyhan Dam Lake, Çatalan Dam Lake, Kozan Dam Lake, Nergizlik Dam Lake, and Lakes Akyatan and Akyayan. Fishpond fishing is performed in the lakes.

The most important stream of Hatay province is the Asi River (556 km). The other important streams are the Küçükkaçay, Büyükkaçay, Afrin, and Karasu Streams that are the tributaries of the Asi River. Small lakes such as Lake Balık (Gölbaşı) and Lake Yenişehir, and Yarseli and Yayladağı Dam Lakes constitute the leading natural lakes and dam lakes.

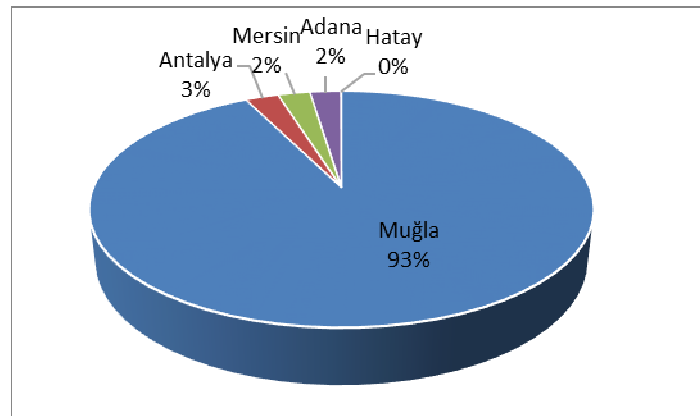
To provide some information about the characteristics of the sea waters in the south of the study area, the temperatures in the surface waters in the Mediterranean Sea are higher when the average annual temperatures are considered. Due to the low rainfall and the high evaporation rate in the Mediterranean Sea, the seawater is very salty. Salinity is like 38-39‰ [34]. Salinity decreases toward the north and especially in areas where rivers flow into the sea. There is a surface current from the Black Sea to the Marmara Sea through the straits and a bottom current in the opposite direction. These currents affect both sea salinity and temperatures.

3. Distribution of Aquaculture in the South of Turkey

The provinces on the southern coasts of Turkey, in other words, the study area, constitute the important production areas of Turkey. Of the overall aquaculture production in Turkey, 43% is provided from the study area. Upon examining the distribution of production within the region itself, it is observed that 93% of the production amount is produced in Muğla, 2.5% in Antalya, 2.5% in Mersin, 2.4% in Adana, and 0.05% in Hatay. As is seen, Muğla is well ahead in aquaculture. Muğla is followed by Antalya, Mersin, and Adana with almost the same shares, and by Hatay with a much smaller share. The production share of Muğla in Turkey, which has almost the whole production share in the region, constitutes 36% of aquaculture production. Muğla province takes an essential place in aquaculture. Its indented coast and suitable conditions in terms of aquaculture have prepared the ground for the start of aquaculture in Muğla since 1982. Successful practices have increased after 1986.



Map 2. Distribution of Aquaculture in Research Area by Provinces (2017)



Graph 1. Share Of Aquaculture As Of Provinces In Southern Turkey (2017)

Table 3. Aquaculture in Research Area by Provinces (Species and Amounts (Ton), 2000 and 2017)

Species	Muğla		Antalya		Mersin		Adana		Hatay		Total	
	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017
Mirror carp (inland water)	27		22	25			58	15		33	107	73
Sea Bream	11027	35500	345	955	157	1060	81	6			11610	37521
Sea Bass	10743	46000	412	143	162	1380	327	22			11644	47545
Trout (Rainbow), (Inland Water)	5220	17500	1722	1610	283	202	312	2490	210	20	7747	21822
Sturgeon								10			0	10
Shi drum		125									0	125
Meagre		609									0	609
Shrimp							27				27	0
Total	27017	99734	2501	2733	602	2642	805	2543	210	53	31135	107705

Source: TÜİK, 2019

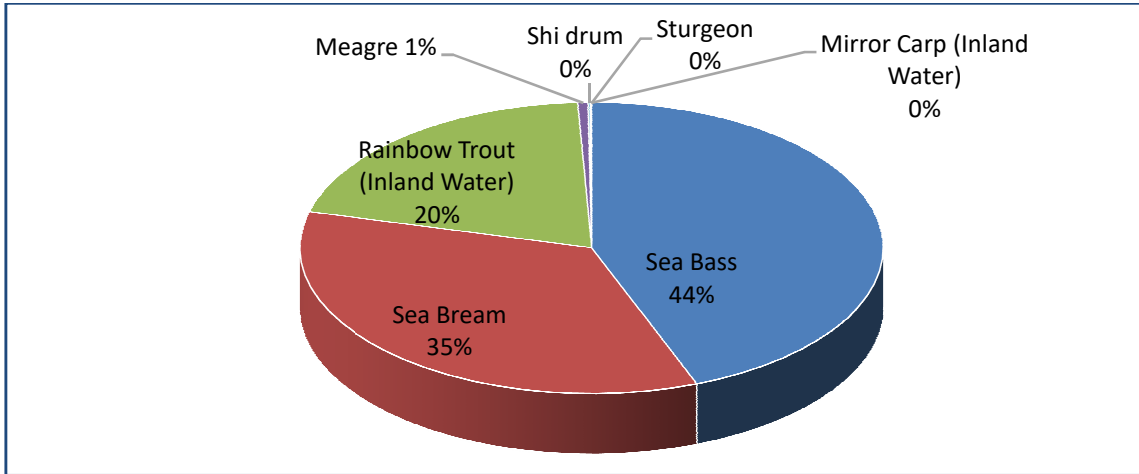


Upon examining the change in production in the region between 2000 and 2017, the total production is observed to have increased by 3.5 times. Considering this change by provinces, while 27,017 tons were produced in Muğla in 2000, the production increased to 99,734 tons in 2017. The increase in production has almost quadrupled. The increase in the same period in Antalya was 9%, in Mersin 339%, in Adana 216%, and -75% in Hatay. New regulations of the Ministry of Food, Agriculture and Livestock to ensure that aquaculture is performed in a more organized way, to decrease its environmental impacts and to achieve healthy and quality production and its implementations to support the production which began to be carried out as of 2003 made significant contributions to the rapid development of the aquaculture sector in the region, as well as across Turkey. In 2005, the increase in the supports provided for promoting the cultivation of new species and the supported juvenile fish production had a primary effect on this development. Some implementations were executed in 1994 for the initiation of aquaculture production in cages in reservoirs (dam lakes) owned by the General Directorate for State Hydraulic Works (DSI), and the initiation of aquaculture in network cages in natural lakes by the Ministry of Agriculture and Rural Affairs and in dam lakes by DSI in 1995 is one of the reasons leading to the increase in production (Akova, 2015, 163).



Map 3. Distribution of Fish Species in Research Area by Provinces (2017)

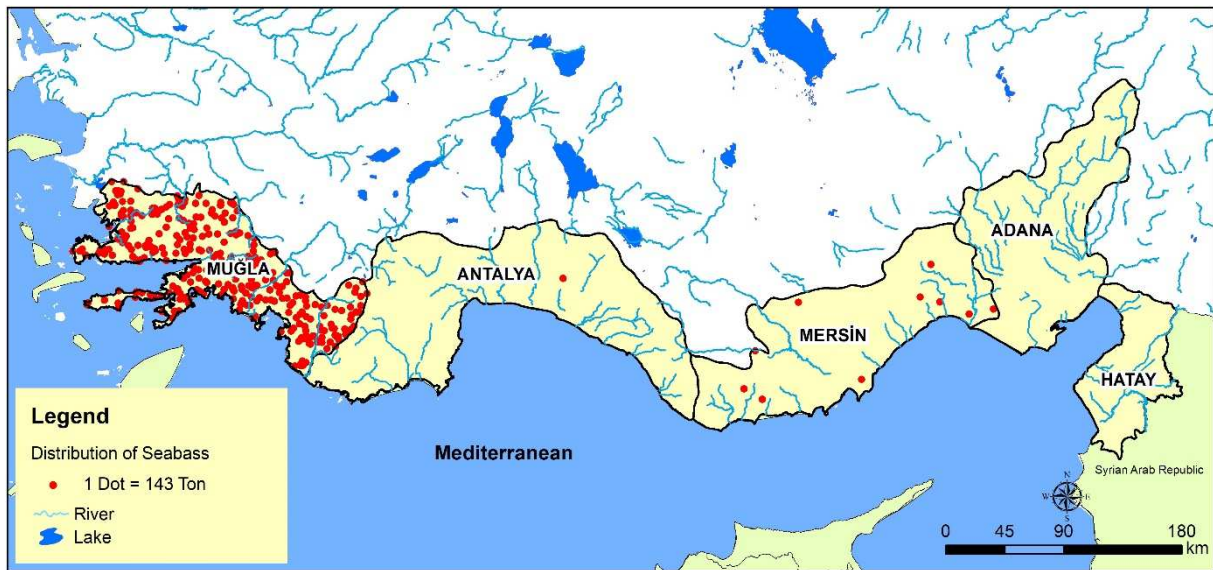
The main species cultivated in the south of Turkey are sea bream (*Sparus aurata*), sea bass (*Lateolabrax japonicus*), rainbow trout (*Oncorhynchus mykiss*), mirror carp (*Cyprinus carpio carpio*), meagre (*Argyrosomus regius*), and shi drum (*Umbrina cirrosa*), while the most cultivated ones are sea bream, sea bass, and trout. It is observed that some other species were also cultivated in different years. For example, shrimp was grown in Adana in 2000. Of the cultivated fish, 44% is sea bass, 34.8% is sea bream, 20.3% is rainbow trout, 1% is meagre, 0.12% is shi drum, 0.07% is mirror carp, and 0.01% is sturgeon (*Acipenseridae*).



Graph 2. Major Fish species grown in the Research Area and their share (2017)

Upon comparing the cultivated species with the production amount in Turkey, sea bream constitutes 61.4% of Turkey's production, sea bass 47.6%, mirror carp 31.3%, trout 21.4%, sturgeon 76.9%, shi drum 100%, and meagre constitutes 87.4%

Of the mirror carp cultivated in inland waters, 45.2% is cultivated in Hatay, 34.2% in Antalya, and 20.5% is cultivated in Adana. Of sea bream, 94.6% is cultivated in Muğla, 5.2% in Mersin, 2.5% in Antalya, while of the most cultivated sea bass, 96.8% is cultivated in Muğla, 2.9% in Mersin, 0.3% in Antalya, 80.2% of trout is cultivated in Muğla, 11.4% in Adana, 7.4% in Antalya, 0.9% in Mersin, and 0.1% in Hatay



Map 4. Distribution of Seabass Farming in Research Area by Provinces (2017)

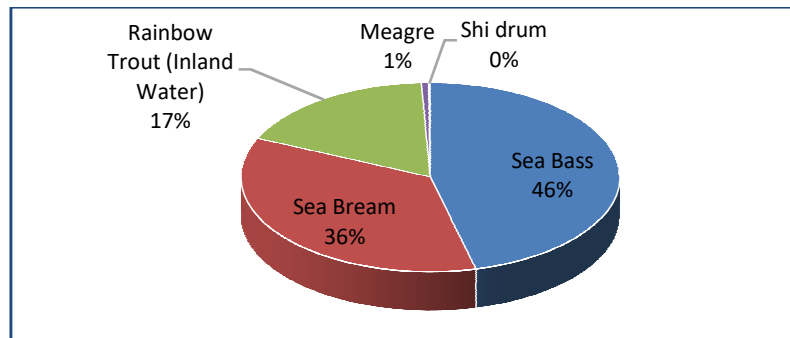


Map 5. Distribution of sea bream Farming in Research Area by Provinces (2017)



Map 6. Distribution of Rainbow Trout Farming in Research Area by Provinces (2017)

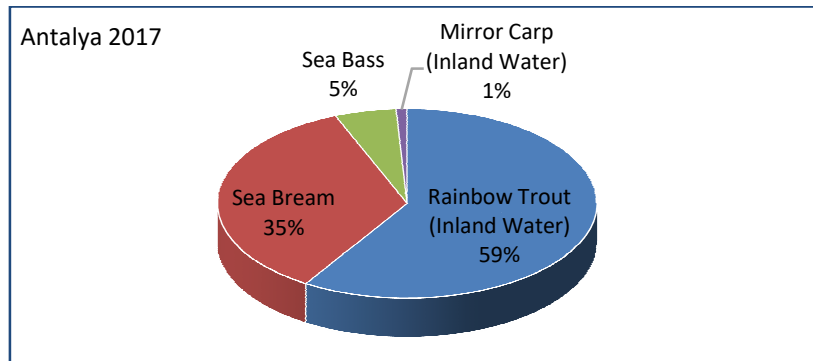
Upon examining the cultivated species and their amounts on the basis of provinces, approximately half of the production in Muğla (46 000 tons) constitutes sea bass. Sea bass is followed by sea bream with 35 500 tons and rainbow trout with 17 500 tons, while shi drum and meagre are produced in small shares of 125 tons and 609 tons, respectively. Of the sea bream produced in Turkey, 58.1% is produced in Muğla, whereas 46% of sea bass and 17% of trout are produced in Muğla.



Graph 3. Major Fish species grown in Muğla and their share (2017)

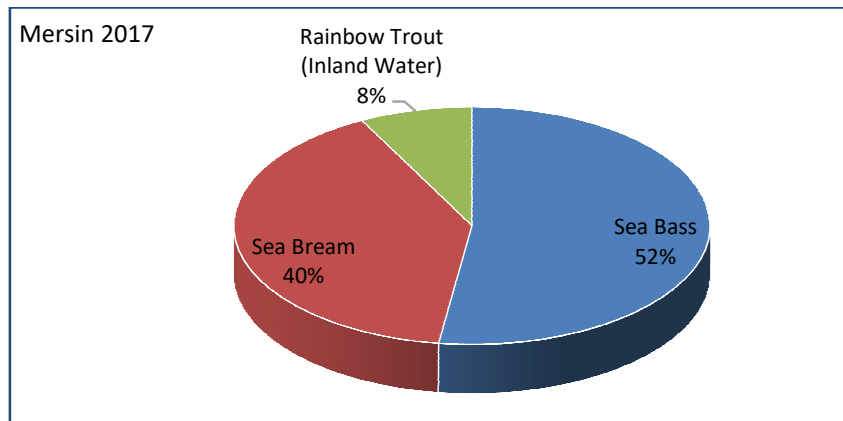


More than half of the production in Antalya (1 610 tons) constitutes rainbow trout. Rainbow trout is followed by sea bream with 955 tons and sea bass with 143 tons, whereas mirror carp is produced in a smaller amount of 25 tons.



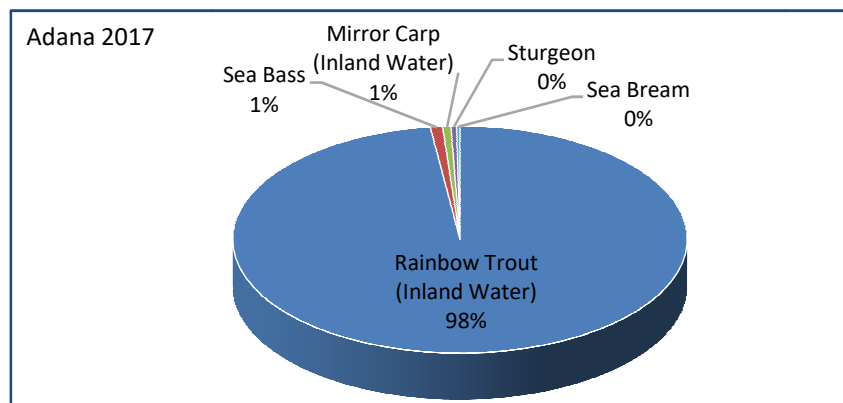
Graph 4. Major Fish species grown in Antalya and their share (2017)

More than half of the production in Mersin (1380 tons) constitutes sea bass, which is followed by sea bream with 1060 tons and rainbow trout with 202 tons.



Graph 5. Major Fish species grown in Mersin and their share (2017)

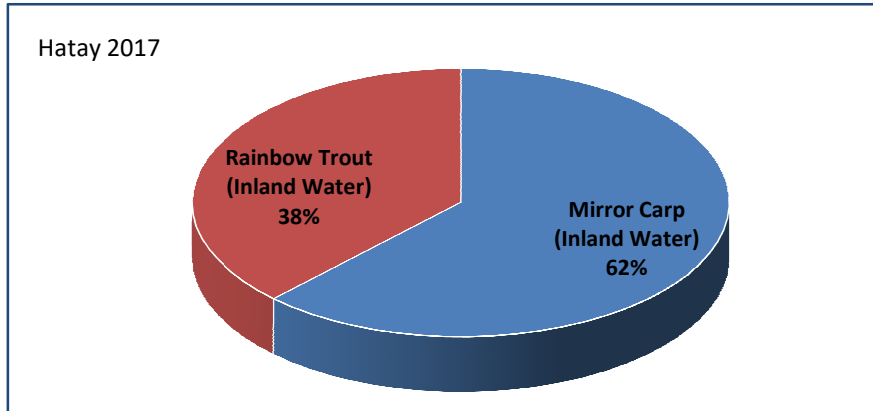
Almost all of the production in Adana (2490 tons) constitutes rainbow trout, and the other cultivated species are sea bass (22 tons), mirror carp (15 tons), sturgeon (10 tons), and sea bream (6 tons).



Graph 6. Major Fish species grown in Adana and their share (2017)



The production in Hatay is not intense. Of the production amount, which is 53 tons, mirror carp constitutes 33 tons, and rainbow trout constitutes 20 tons.



Graph 7. Major Fish species grown in Hatay and their share (2017)

4. The Total Project Capacity and the Number of Facilities in the Region

The total capacity of aquaculture facilities in Turkey is 687 289 tons (2018), and the number of facilities is 2307. Every day, Turkey utilizes its potential in a better way and increases both the number of facilities and capacity. Thus, while there was only one aquaculture facility in 1971, its number increased to 1444 in 1999 and to 2307 in 2018. In other words, the number of aquaculture facilities has increased by approximately 60% over the last 20 years. The first trout farm was established in the 1970s, while a sea bass and sea bream farm was established in 1985.



Map 7. Distribution of Fish Farms in Research Area by Provinces (2017)



Map 8. Distribution of Fish Capacity in Research Area by Provinces (2017)

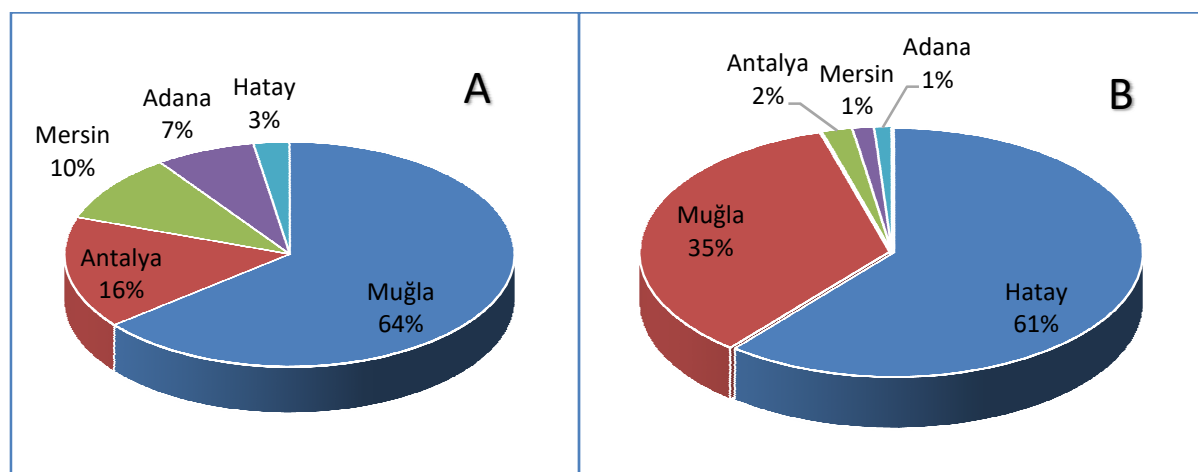
On the southern coasts of Turkey, there are a total of 544 facilities, including 256 inland water facilities and 288 marine facilities. Their project capacity is 330 747 tons in total, including 7107 5 tons in inland water facilities and 9196 5 tons in marine facilities. The region has 24% of the total number of facilities in Turkey and 48% of its total project capacity.

Table 4. Provinces By Number of Facilities and Total Project Capacity

Provinces	Number of Facilities			Project Capacity (Ton)		
	Inland	Marine	Total	inland	Marine	Total
Muğla	83	266	349	15 287	98 985	114 272
Antalya	84	4	88	2 981	3 550	6 531
Mersin	43	11	54	498	4 080	4 578
Adana	36	3	39	3 628,5	27,5	3 656
Hatay	10	4	14	200 171	1 539	201 710
Total	256	288	544	7 107,5	9 196,5	330 747

Source: Calculated with data from www.tarim.gov.tr 2019

Muğla ranks first within the region in terms of both the number of facilities and capacity. Of the total facilities, 64 2% are located in Muğla. Muğla is followed by Antalya with a share of 16 2%, by Mersin with 9 9%, Adana with 7 2%, and Hatay with 2 6%. In terms of capacity, Hatay ranks first with a share of 61%, and almost 100% of the project capacity constitutes aquarium fish. It is followed by Muğla with 34 5%, and Antalya with a share of 2%, Mersin with a share of 1 4%, and Adana with a share of 1 1%.



Graph 8. (A) The Share of Facilities and (B) The Share of Project Capacities on the Basis of Provinces in the South of Turkey

5. Juvenile Fish Production and Its Distribution Areas in the South of Turkey

The juvenile fish needed in aquaculture is provided as a result of its collection from nature, production in hatcheries, or import from abroad. After 2000, it is forbidden to collect fish from nature because of damage to natural stocks. Juvenile fish production for aquaculture was performed in the coastal regions of Turkey. Of the hatcheries and facilities with hatchery across Turkey, 34% are located in the region, and 25.9% of Turkey's juvenile fish production is met in the region. As seen in Table 5, at 79 facilities in the region, 643 886 690 juvenile fish were produced. Of the juvenile production for aquaculture, 22.8% is realized in Muğla province in the region. Furthermore, fishery works are ongoing.

In hatcheries of the private sector, sea bream and sea bass production is carried out successfully, and the desired amount of juvenile fish is grown. Since the number of fish, which takes a very significant place in nutrition, is gradually decreasing in the seas, the production of new species is of great importance. With the successful cultivation of new species, export-based diversity will increase, and an easier market will be found.

Species of which production is considered, such as blackspot seabream, rock grouper, dentex, and shrimp, are species with reduced population in natural waters and high economic value. Sea trout, zander, freshwater perch, brown trout, and eel are indicated as potential species in inland waters.

Table 5. Saltwater Fish Hatcheries in Research Area (Hatchery-Hatchery Facility - February 2018)

Location	Number of Facilities	Fry Capacity (Pieces)	Produced Species
Muğla	36	566 667 690	Trout
Antalya	18	52 550 000	Trout, Aquarium Fishes
Mersin	8	11 214 000	Trout, Aquarium Fishes
Adana	16	65 905 000	Sea Bream, Sea Bass, Shrimp, Trout, Carp, Sturgeon, Aquarium Fishes
Hatay	1	100 000	Aquarium Fishes
Total	79	696 436 690	
Turkey	2307	2 484 394 836	

Source: Edited from <http://www.tarim.gov.tr/> 2019



Map 9. Distribution of Fish Hatcheries in Research Area (2018)

Conclusion

Aquaculture is important for fulfilling the rapidly increasing demand for food and the need for healthy nutrition, creating employment, developing export, and other socio-economic factors around the world, and it is necessary to make good use of physical and human potentials for the development of aquaculture. In order to make better use of the existing potential, it is of significance to know the distribution of areas where aquaculture is performed in terms of the development of the activity.

The physical and human conditions of the southern coasts of Turkey are quite suitable for the development of aquaculture. Especially the deeply indented coasts of Muğla province in the west of the region, the existence of the appropriate water resources and qualified human power in this issue, and the consolidation of these dynamics with laws and incentives substantially increase the momentum of development in aquaculture. Provinces on the southern coasts constitute significant production areas of Turkey nowadays. The total production in the region increased by 3.5 times when we review the change in the production between 2000 and 2017. The production based on aquaculture on the southern coasts of Turkey comprises 43% of the total production amount of Turkey in aquaculture. Muğla also stands out within the region. As the most important factors in this development, water resources suitable for aquaculture, the existence of enterprising and qualified human power, new regulations of the Ministry of Food, Agriculture and Livestock to ensure that aquaculture is performed in a more organized way, to keep its environmental impacts at a minimum level and achieve healthy and quality production, the enactment of the "Regulation on Aquaculture" within the framework of the European Union Common Fisheries Policy Acquis Compliance Rules, and its implementations to support the production which began to be carried out as of 2003, the increase in the supports provided for promoting the production of new species in 2005, and the supported juvenile fish production made significant contributions to the rapid development and progress of the aquaculture sector [30]. The main fish species cultivated in the research site are sea bream, sea bass, rainbow trout, mirror carp, meagre and shi drum, and sea bream, sea bass, and trout are the ones mostly produced. Sea bream constitutes 61.4%, sea bass 47.6%, mirror carp 31.3%, trout 21.4%, sturgeon 76.9%, shi drum 100%, and meagre 87.4% of the production in Turkey.

It is necessary not to ignore environmental problems, which are a significant issue in aquaculture. Problems are likely to occur on the basis of aquaculture (Pillay, 2008; Hansen etc, 1991; Edwards, 1991, 2015; Xiong etc, 2015). In the past, the rapidly increasing and developing aquaculture on our southern coasts used to clash with the tourism sector from time to time. Aquaculture was presented to public opinion as a negative development, especially for tourism activities. Nowadays, the precautions taken in this issue and new implementations in aquaculture have cleared the way for aquaculture. Fish farms established in the seas were moved to open and deep waters in accordance with certain criteria, as required by the regulations that were put into force after 2009. Moreover, technological developments, such as the introduction of automatic



feedings systems, the execution of feeding according to programs, and monitoring and tracking of feeding in the digital environment, have largely prevented feed-induced contamination(DPT, 2014).

As seen in the study, the cultivated species are quite limited. Breeding the existing species in line with the principle of sustainability, increasing the number of cultivated species, diversity of production will have an effect on the better utilization of water potential and expansion of the market and will increase the share of aquaculture in the national economy.

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