

## RELOCATION OF THE FISH FARMS IN GULLUK BAY

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### Abstract

During the last two decades, in Turkey, fish farming has had an increasing importance, and this can be explained, in part, by the fact that after the many major marine fishery resources have been depleted. Based upon this tendency, fish farming has accelerated throughout the country, and the total production has reached 170,000 tons in 2010. As a result of this significant development, several conflicts among the stakeholders were raised, parallel to increased water degradation and pollution of the environment. The issue has become important from the point of view of public interest, the government objectives and the regional development priorities. But there were no technical criteria or measures in order to help to establish a sustainable and fair development model. After a certain period of time, in 2009, on the basis of a series of studies carried out, and the new regulation for aquaculture, most sea farm cages, including those in Gulluk Bay, were relocated by towing them from shallow water to relatively deeper areas. Site selection for fish farming was an important issue, still is, despite some progress. Concordantly, as a representative case of fish farming relocation program, this paper presents preliminary studies related to the development of a GIS based archive at Dokuz Eylul University (DEU), in Izmir, Turkey, to help and support to regional Integrated Coastal Zone Management (ICZM) efforts.

**Keywords:** Gulluk Bay, Coastal Zone Management, Fish Farming, Site Selection, Environmental Impact Studies

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### 1. INTRODUCTION

Although many valuable initiatives have been carried out on the planning, development, conservation and management of coastal areas for the last decade, there are still significant stresses on the wetlands in Turkey. The coastal region, with about 10,560 km coastline including the islands and the major lakes, has different features from geography to climate, from economy to social life, etc. Although the region covers only 30% of the national territory, its GDP (Gross domestic product by provinces) reached to 64% (TurkStat, 2011a). A recent spatial analysis based on the 2010 census data, has indicated that the population density of this region (approx. 215 persons per square kilometer) is about twice relative to the rest of the country (TurkStat, 2011b). On the other hand, the coastal region, with a settlement population of over 26 million people, has several characteristics in common with many other Mediterranean countries: high population density, fast population growth, vast amount of economic and industrial activities, waste water disposal into water resources (seas, lakes, rivers, and wetlands as well), and pollution from agriculture and industry. Due to dense housing/buildings, roads, dams and other infrastructure constructions, the rapid losses of natural habitats and biodiversity were came up. As a result of this tendency, the traditional fishery is dwindling due to reduced fish stocks, while marine aquaculture is rising.

Marine aquaculture was a very profitable industry in Turkey during the end of 1990s and early 2000s (Demirak et al, 2006; Yucel-Gier et al, 2009). Especially Gulluk Bay, which is one of the seven largest gulfs and bays on the west coast of Turkey and contributes about 70% of countries' aquaculture production, has attracted special attention recently since rapid and uncontrolled urban development activities, as well as mariculture, have created considerable threats and problems on its valuable resources. Unfortunately, at the beginning, careful and proper site selection for marine cages could be made. According to scientists, before given any permission for mariculture, all aspects such as hydrographic conditions of the area (temperature, current speed, etc.), water quality, terrestrial inputs, wave climate, wind patterns, seabed characteristics and dynamics, accessibility, available facilities and even possible potential conflicts with other water/land uses should be taken into account (Villalba, 2008). Although understanding how farming affects the environment is clear, the real identification of the sources of pollution still remains disputable, due to the large variety of anthropogenic and naturally occurring pollutants, and the fact that much of the pollution originates from non-point sources. However, after the rapid deterioration of water quality, with high levels of turbidity and suspended particles in coastal waters, fish farming had attracted attention to itself.

For instance, tourism is very important for many countries around the world. However, tourism definitely needs several facilities, security accommodation, trained people, history, cultural heritage and especially undisturbed natural landscapes. Since the presence of fish farming could potentially influence the

travel plan of the visitors, the relationship between fish farming and tourism should be investigated (Nimmo et al, 2009).

The real challenge is to be able to cope with the growing pressures on coastal areas and marine resources; meanwhile, to develop a fair system that protects the rights of all stakeholders. To achieve this challenge, some researchers outline the rules for an effective and robust development, and how to create a realistic framework for assessing options for mariculture development that integrates all social, economic and environmental parameters (Burbridge et al, 2001).

In Turkey, during the same period, several action plans and strategies were proposed to accomplish the reduction of degradation of the environment from land-based sources of pollution in coastal areas, mostly undertaken by “The Priority Actions Programme Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan (MAP)–UNEP” (UNEP 1993, 1994, 2001 and 2005). All these efforts and initiatives led to the country an adequate level in order to promote a better managerial talent. Despite all these advances, there are still some organizational insufficiency, that negatively affects regional planning and managerial decision-making (Yucel-Gier et al, 2010). Now, several independent research efforts are currently underway, largely under different institutions, following different strategies (Arisoy et al, 2011).

The general ICZM rules propose that all required monitoring and analysis procedures must be implemented to identify the natural and human-induced stresses on the marine environment, and to resolve potential conflicts of interest. In order to realize this goal, before executing any action, suitable, practical and reliable indicators of should be determined. In terms of environmental analysis and evaluation, Geographic Information Systems (GIS) is a very useful tool, not only for capturing, storing, organizing, displaying and reporting of information but also for analyzing and modeling of spatial data (FAO, 2007). Because of some difficulties in data sharing among the related disciplines or institutions, to develop the full potential of GIS and other decision making tools for management has been challenging.

In this paper, one of the major GIS development efforts at DEU, in Izmir, Turkey is presented. The objective of this study is to collect and integrate the relevant data regarding coastal zone land use, in order to underline the basic layout of the seven largest gulfs and bays on the west coast of Turkey. Significant progress was made some of them (like Izmir, Gökova and Gulluk Bays). The implementation and outcomes will be assessed for potential use and integration into the indicators related to the environmental concerns and management goals.

## 2. STUDY AREA

The major bays and gulfs along the eastern Aegean coastline, which are Saros, Edremit, Candarli, Izmir, Kusadasi, Gulluk and Gokova, were selected for an ongoing prospective study at DEU. Gulluk Bay, which is one of them, is located on the South East Aegean in Mugla Province (Figure 1).



Figure 1 Location of the study area

The bay is formed basically by four large natural coves and many smaller bays and inlets, and it has a surface area of about 670.5 square kilometers and a coastline of around 262 kilometer. Gulluk Bay is the most important area in terms of marine fish production within the Aegean Sea, and it is also on the route of famous blue cruise (blue voyage) extending from Kusadasi to Fethiye. Public port and private piers in Gulluk Bay has a present capacity of handling over 5 million tons of cargo per year. The bay and the surrounding

areas have attracted special attention recently due to the negative environmental impact, such as high levels of turbidity, landscape modification, or rapid biodiversity change. Subsequently, the general public awareness on the conservation of the natural environment has been increasing, arguing that all of these most likely originated from the increasing number of fish farming.

### 3. MATERIAL AND METHOD

In this study, base maps and data were obtained from different sources: The General Command of Mapping of the Turkish Navy Department of Navigation, Hydrography and Oceanography, the Ministry of the Environment and Forestry, the Ministry of Agriculture and Rural Affairs, and the archives of Civil Engineering Department of the Engineering Faculty and the Institute of Marine Sciences and Technology (IMST) of Dokuz Eylul University. All these large volumes of spatial and non-spatial data sets, from different sources, in different formats, with different coordinate systems and units, were converted into a standard GIS format. MapInfo GIS software package was used to map, query, and analyze the data.

Before creating the GIS datasets, all spatial data was manually verified and corrected. Remote sensing data was also used for verification and correction as a base layer. Paper maps were scanned or digitized and then converted to forms suitable for analysis. Some GIS layers, such as those for fish farming, military zones, and special environmental protection areas and so on were generated, based on the coordinate information in relevant documents. A new digital coastline map was generated based on the existing 1:25,000 scale military topographic map and on the navigation charts. Because all this data came from a variety of different sources, before creating the final GIS datasets, all spatial data was again verified and small discrepancies and omissions were corrected by reference to the draft base map, before a final conversion into a standard GIS format. New data set have been transformed to the Turkish Coordinate System. So far, over 100 layers have been organized in Gulluk Bay. A limited number of them are in raster format; all others are in vector format data in three categories: Points, lines, and polygons (Figure 2).

The developed GIS, in this study, provide an easy, modifiable and reliable tool to identify the basic layout of the study area. The system is capable to obtain the properties of the mapped features, such as area and length, and to visualize multiple layers of data. It is also helping people to generate models that are suitable for different kinds of investigations and applications. For instance, a TRIX (Trophic Index) model was developed by use of GIS and its capabilities.

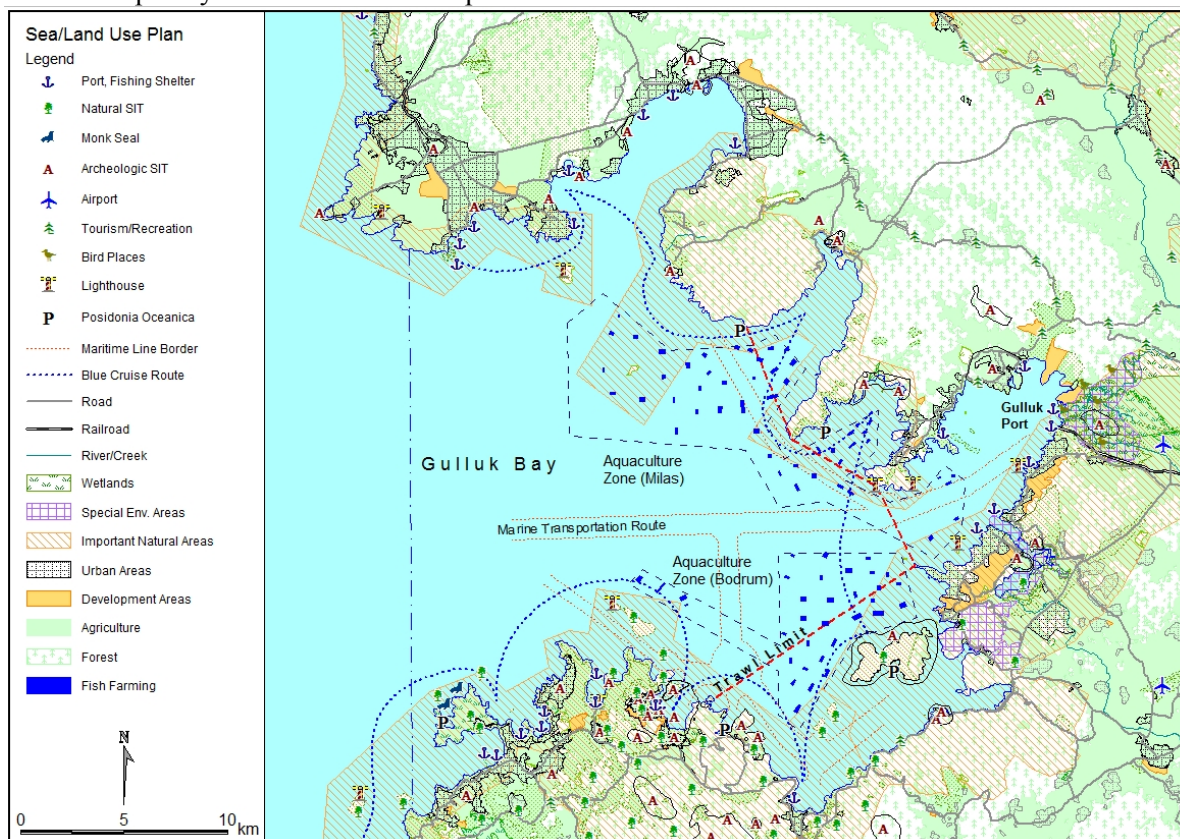


Figure 2. General layout of Gulluk Bay

#### 4. THE PRELIMINARY RESULTS

It is well known that ICZM is not easy task, especially when involving a large number of stakeholders, as is in Gulluk Bay. The competition among different users leads conflict, and that conflict creates a situation that impacts all activities from navigation to harbor development, from tourism to fish farming, and more. Especially marine aquaculture and its negative effects have attracted attention recently; several legal instruments and regulations have been constituted for aquaculture management (MEF, 2007). A summary of the actions undertaken in the context of the impact of marine aquaculture industry was presented by Guzel-Gier et al (2010). For example, the Commission of the European Community has developed a strategy for sustainable aquaculture; considering that all related parties and all existing and potential activities are contained (CEC, 2002). Increasing pressure on fish farming in the coastal zones in Turkey was ended up with a new regulation; the Ministry of the Environment amended the existing environmental legislation forcing the fishing cages to move to deeper areas (MARA, 2008).

A thematic map generated based on the trophic index data, commonly referred to assess eutrophication status, shows that the high TRIX values appear, to a great extent, in the shallow waters and the vicinity of the fish cages. Although it was a model output, the map indicates that there is strong relationship between aquaculture and water quality. Thus, it can be accepted as supporting evidence demonstrating the negative impacts of fish farms on coastal environment. Consequently, the Ministry of the Environment, by influencing public opinion in this manner, has decided to relocate the fish farms, including those in Gulluk Bay. By the end of the year 2009, fish farms in Gulluk bay were relocated to new places, although it is not clear to what extent this study was effective on the decision of the Ministry of the Environment and Forestry. Figure 3 shows the facility's locations before and after the relocation. But, the discussions on this issue are still available despite the fact that their locations have been changed. The main argument of the farming firms is their belief that the potential impact of fish farming industry on coastal environment is aggregated because the reserved area for fish farming is not large enough relative to the total surface area of Gulluk Bay. The numbers on the allocation of the area among users support this argument; for instance, according to the calculations based on GIS maps generated in this study, the percentages of the reserved area for fish farming are only 0.4% (3.03 km<sup>2</sup>) in Gulluk Bay. But, satellite images and other aerial pictures clearly show that the reserved area around the fish ponds is not only the affected area because of the dispersion of feed and faecal wastes (Figure 4). Naturally, turbidity caused by all kind of particles is generally undesirable because of not only from an aesthetic standpoint but also reducing light penetration to the bottom of sea (Karakassis et al., 2000; Dominguez et al., 2001; Carroll et al., 2003).

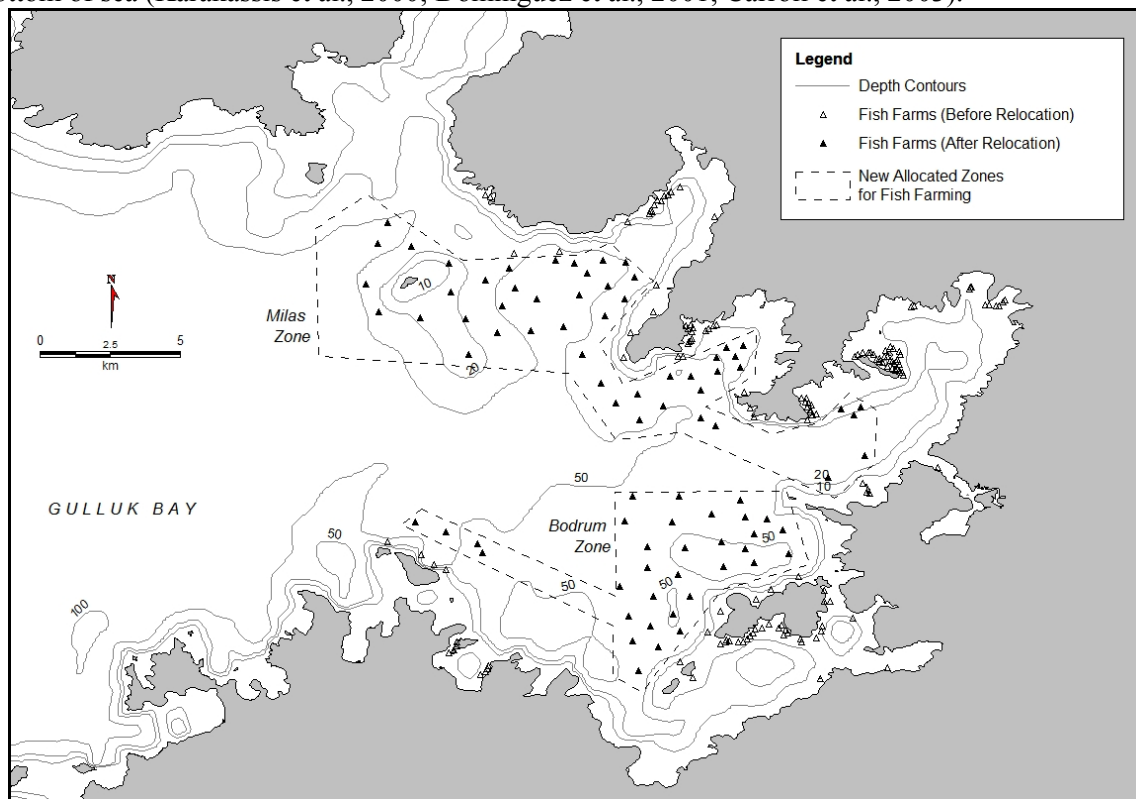


Figure 3 Gulluk Bay before and after the relocation of the fish farms



**Figure 4 Google Image showing the turbidity dispersal around the fishing cages in Gulluk Bay**

However, tourism business and fish farming, as two major sides of the issue, dissatisfied with the relocation process: Tourism business owners claim that the new spots would cause serious harm to the tourism areas. Most environmentalists also support this idea arguing that the government's new plan would not help but instead further damage to the marine environment, since the designated new locations are very close to the natural and archaeologically protected areas. On the other hand, fish farm managers also complain about this decision, claiming that moving from inshore to offshore has become an additional financial burden for them. For now, it seems likely that the debate on this issue will continue, unless otherwise an unexpected development occurred. Meanwhile, any ICZM effort (individual, institutional or governmental level) intended to contribute to the establishment of the criteria and methodology for the evaluation process will be beneficial to all parties concerned. For instance, after collecting new TRIX data, a similar thematic map given above would help to clarify to what extent the relocation process will be successful.

## **5. CONCLUSION**

The debate on the effects of fish farming on the marine environment has been ongoing from the beginning. When the rapid deterioration of water quality became obvious in parallel to the increasing number of fish cages in the coastal zones, naturally, local communities blame the farming companies without a scientific evidence base. The absence of scientific studies that demonstrate the true identification and evaluation of the pollution sources leads this preconceived opinion. It is likely that this debate will continue until resolved by a true coastal zone management plan. Coastal zone management has to protect sensitive habitats, to ensure the sustainability of water resources and natural ecosystems, and finally to prevent potential conflicts among coastal users. Some research studies, such as this one, will contribute to the understanding of the impacts of fish farms on coastal environment, and to help to establish to this kind of planning and management tools.

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