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CONTENT

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Analysis of Collision Accidents in Maritime Transportation by FTA Method

Deniz Taşımacılığında Çatışma Kazalarının Hata Ağacı Analiz Yöntemi ile Analizi

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 8 Sayı: 1 (2022) 15-30

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ABSTRACT

The aim of this study is to determine the possible causes of collision accidents by using Fault Tree Analysis (FTA). In this study, we were able to examine the potential cause of collision accidents, then develop a fault tree model of the root causes of the accidents using the FTA approach, and finally provide the probability of basic event combinations leading the occurrence of accidents. A total of 62 collision accident reports providing detailed information about the causes of accidents were obtained by Marine Accident Investigation Branch (MAIB) between 2005 and 2020.The study found that most of the factors (E_1/Misuse of navigational tools, E_3/COLREG Rule-5 (Look-out)) that had the greatest effect on the collision were mainly due to the inadequacy to keep a safe navigation watch. For that reason, the findings of the study are very important in terms of determining the strategies to eliminate the risks for future accident prevention. For future studies, it should collect more accidents data on varying types of ships to improve their prediction performance, incorporate expert opinions with fuzzy evidence into the model to minimize uncertainties, and enhance model expressiveness. In addition, alternative risk assessment methods should be applied considering other types of vessels for better comparisons.

Keywords: Accident analysis, Collision, Fault Tree Analysis, Marine accident

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ÖZET

Bu çalışmanın amacı, hata ağacı analizi (FTA) kullanılarak çatışma kazalarının olası nedenlerini belirlemektir. Bu çalışmada, ilk olarak çatışma kazalarının olası nedenleri belirlendi, ikinci olarak, FTA yöntemi kullanılarak kazaların kök nedenlerine ait hata ağacı modeli oluşturuldu ve son olarak, kazaya neden olan temel olay kombinasyonlarının olasılığı hesaplanmıştır. Deniz Kazaları Araştırma Şubesi (MAIB) tarafından 2005-2020 yılları arasında kazaların kök nedenleri hakkında detaylı bilgi veren toplam 62 adet çarpışma kazası raporu alınmıştır. Çalışmanın sonucunda, gemilerin çatışma riski olasılığına en büyük etkiye sahip olan faktörlerin ((E_1/Seyir ekipmanlarının yanlış kullanımı, E_3/COLREG(Denizde Çatışmayı Önleme Tüzüğü) Kural-5 (Gözcülük)) esas olarak emniyetli bir seyir vardiyası tutma yetersizliğinden kaynaklandığı tespit edilmiştir. Bu nedenle, çalışmanın bulguları gelecekteki kazaların önlenmesi açısından riskleri ortadan kaldıracak stratejilerin belirlenmesi adına oldukça önemlidir. Gelecekteki çalışmalar için, tahmin performanslarını iyileştirmek adına çeşitli tipteki gemiler hakkında daha fazla kaza verisi toplanmalı, belirsizlikleri en aza indirgemek için uzman görüşlerini bulanık kanıtlarla modele dâhil edilmeli ve modelin anlamlılığı artırılmalıdır. Ayrıca daha iyi karşılaştırmalar için farklı gemi türleri de dikkate alınarak alternatif risk değerlendirme yöntemleri uygulanmalıdır.

Anahtar Kelimeler: Kaza analizi, Çatışma, Hata Ağacı Analizi, Deniz Kazaları

1. INTRODUCTION

Shipping plays an important role in representing more than 90% of global trade by huge cargo volumes cost-effectively, cleanly, and efficiently (Chen *et al*., 2019; UNCTAD, 2019). On the other hand, maritime transport is one of the hazardous industries because of entails a variety of accidents such as collision, grounding, fire etc. (IMO, 2019; Du *et al*., 2020). Marine accidents not only threaten the lives of crew members but also cause major economic losses and property destruction, thus causing severe negative impacts in coastal countries on the marine ecosystems (Chang *et al*., 2014; Chen *et al*., 2019). Despite significant attempts to ensure maritime safety through different systems, there is still an increase in the number of dangerous accidents that make safety and environmental concerns (Eliopoulou *et al*., 2016; Kececi and Arslan, 2017). As a result, maritime safety has become a growing concern.

According to AGCS (Allianz Global Corporate & Specialty) (2021) Safety and Shipping Review reports that 2,815 incidents in total including 41 total losses vessels over 100GT has occurred. The report shows that sinking and collision accidents are the most expensive cause of loss for insurers, accounting for 16% of the value of all damages - more than $ 1.5 billion. Data from European Maritime Safety Agency (EMSA) between 2014 to 2019 distribution of casualty events per cargo ship type report states that collisions represent 22.6% of all events, followed by contacts (18%) and loss of propulsion power (17%). Another report in 2020, 706 marine accidents were reported to the Japan Transport Safety Board (JSTB). The most frequent types of marine accidents in 2020 were collision (27.4%), grounding (22.8%), and contact (13.5%). Machinery and propulsion failure (76.6%) are leading factors to cause accidents. For this reason, the collision accidents are among the most frequent marine accidents, and ongoing attempts have been made to avoid this issue or minimize the consequences.

Analyzing marine accidents is one of the effective ways to reduce maritime safety risks (Fan *et al*., 2020). It is important to identify the reasons that contribute to the ship accidents in order to deter such accidents from happening in the future (Luo and Shin, 2019). Because accident risk avoidance is important not only for protecting human life and the environment, but also for mitigating financial costs (De Maya *et al*., 2020). The review on marine accident analysis clearly states that the current approaches have just targeted specific causes (human error, technical failure, etc.). However, the occurrence of marine accidents commonly depends upon different failures in a variety of safety barriers (Wang *et al*., 2021). For this reason, it is important research domain the determine causes of accidents for the purpose of improving safety and prevent future accidents. The principal focus of this paper is to present an analytical framework based on a fault tree analysis (FTA), which proposes interpreting the probability and importance of leading factors to ship collision accidents.

Within this concept, the aim of this study is to determine the factors associated with collision accident probability based on the Marine Accident Investigation Branch (MAIB) database using Fault Tree methodology. The rest of the paper depicts as follows. Section 2 describes the research gap based on literature review about marine accident severity, which is mostly dependent on FTA applications. An ordered Fault Tree analysis and the data for the study are introduced in Section 3. Section 4 presents the findings of the risk factors and analyses a total of 62 collision accidents between 2005 and 2020. The final section summarizes the study's conclusion and discussion.

2. LITERATURE REVIEW

Marine accidents have affected and changed the shipping industry from its origin, informing regulators, designers and operators that better action is needed to avoid similar consequences (Eliopoulou *et al*., 2016; De Maya and Kurt, 2020). Despite the maritime industry adopting new regulations and rules or a range of safety-enhancing measures, marine accidents remain a major concern (Zhang *et al*., 2021).

Many researchers have varying approaches and perspectives on the factors that influence marine accidents, but it is widely accepted that defining a root cause of accidents is a systematic research method influenced by many factors such as geographical factors, human factors, or any technological failure (Arslan *et al*., 2018; Chen *et al*., 2019). Lu and Tsai (2008) and Eliopoulou *et al*. (2013) state that the impact of the safety climate is leading root cause of crew fatality rate on container ship accidents. Yip *et al*. (2015) and Puisa *et al*. (2018) examined the passenger vessels collision accidents severity and the role of the broader socio-technical environment in accident causation. According to Wang and Yang (2018), the ship type and date of built were the most important factors affecting accident occurrence. Other significant findings from Zhang (2019) indicate that approximately 80% of collision and grounding accident causes include at least human failures or controversial judgments, and approximately 20% are subject to technical errors.

Maritime transportation entails a variety of risks because of the requirements of the profession, which might have serious implications (Zhang *et al*., 2021). In order to mitigate the risks on any operations onboard and improve maritime safety, Risk variables must be reduced to an acceptable level (Goerlandt and Montewka, 2015). The risk can be characterized as a function of the likelihood of a hazard/failure occurring and the severity of the consequences (Akyuz *et al*., 2020). One of the most effective ways to identify and reduce the hazards of marine transportation, as well as determine the most potential strategies to manage the risk, is to do a risk assessment (Zhang *et al*., 2016; Kuzu *et al*., 2019). Until now, research about ship collision risk management has concentrated on (a) empirical and (b) probabilistic risk analysis models (Zhang *et al*., 2021). Research on collision accidents primarily has used accident causality theory, statistical analysis, and methods to examine accident occurrence mechanisms and to determine contributing factors on the basis of accident statistical data and professional judgment (Zhang *et al*., 2019). Fault Tree Analysis (Antao and Soares, 2006; Ugurlu *et al*., 2015, Arslan *et al*., 2018), Bayesian Networks (Hänninen and Kujala, 2012; Chen *et al*., 2015; Wang and Yang, 2018; Aydın *et al*., 2021), Spatial analysis (Rong *et al*., 2021; Zhang *et al*., 2021) and Event Trees (Papanikolaou *et al*., 2007; Arici *et al*., 2020) methodologies are all common modeling tools for risk assessment of ship collision accidents. These methods are useful for determining the risk of a collision in a certain maritime area.

Antao and Soares (2006) investigated the possible dangers of accidents that may arise from

RoPax ships and the role of human error in accidents based on FTA methodology. Failure of radar and propulsion system is the highest probability contributions to the top event. Papanikolaou *et al*. (2007) conducted a fault tree and event tree accident analysis by determining the possibility of reasons that caused environmental pollution and economic losses in Aframax tanker accidents. Of these, navigational failure and failure of avoidance manoeuvring are the major reason of occurrence of collision accidents. Hänninen and Kujala (2012) proposed Bayesian Belief Networks methodology to analyze probability of the impact of human factors on ship collision accidents in the Gulf of Finland. Chen *et al*. (2015) suggested Bayesian Network and FTA analysis together to reveal the possibility of marine accidents based on traffic flow and historical data in Shenzhen waters. Failure of manoeuvring, human error and meteorological factors are the initial events of the risk of collision accidents. Ugurlu *et al*.'s (2015) paper on fault tree analysis of collision and grounding accidents discusses main causes of oil tanker accidents. Human failure, error of procedure and the lack of communication failure are the main reason of occurrence accidents between 1998 and 2010. Arslan *et al*. (2018) calculated the probability of three different accident type. Human error, lack of training and lack of skills failure are the highest contribution of probabilities. Guan *et al*. (2018) presented a fault tree model to analyze fire and explosion accident based on Chinese inland dual fuel ships. In general, the outcome of a collision accident (i.e. human life loss, property damage cost) is influenced by a number of factors, including the type of a ship, environmental conditions, accident periods, navigational stations, accident location, human mistake, and so on. The fault tree analysis method allows a deeper examination of the internal links between the top event in the system and all the basic events that caused the top event, and also has the advantage of allowing a better understanding of the system in light of the conditions that caused the accident. Based on the benefits listed below, this article applies the fault tree analysis method to determine the factors affecting ship collision accidents and identify the main factors that ultimately led to the accident (Arslan *et al*., 2018). Assessing and calculating the probability of ship collisions is of great importance as FTA methodology gives a cost-effective and practical way to risk mitigation.

The critical review on collision accident analysis clearly shows that the current methods have targeted certain aspects such as human error, mechanical or technical failure. However, the occurrence of collision accidents commonly depends upon various causes in different parts of safety and navigational obstacles. To focus on this topic, the FTA methodology was used to reveal the probability calculations of causes of ship collision accidents and the main factors affecting them.

3. MATERIALS AND METHODS

FTA is a powerful risk assessment tool that identifies the root causes of top event (Antao and Soares, 2006; Khakzad *et al*., 2011; Arslan *et al*., 2018). It is an inferential and visual technique that is widely used to measure the failure probability of accidents evaluated using Boolean logic. (Ugurlu *et al*., 2015). The basic components of a fault tree can be classified as the top event, primary events, intermediate events, and logical gates (Zhou *et al*., 2017). Figure 1 is presented as a basic fault tree.

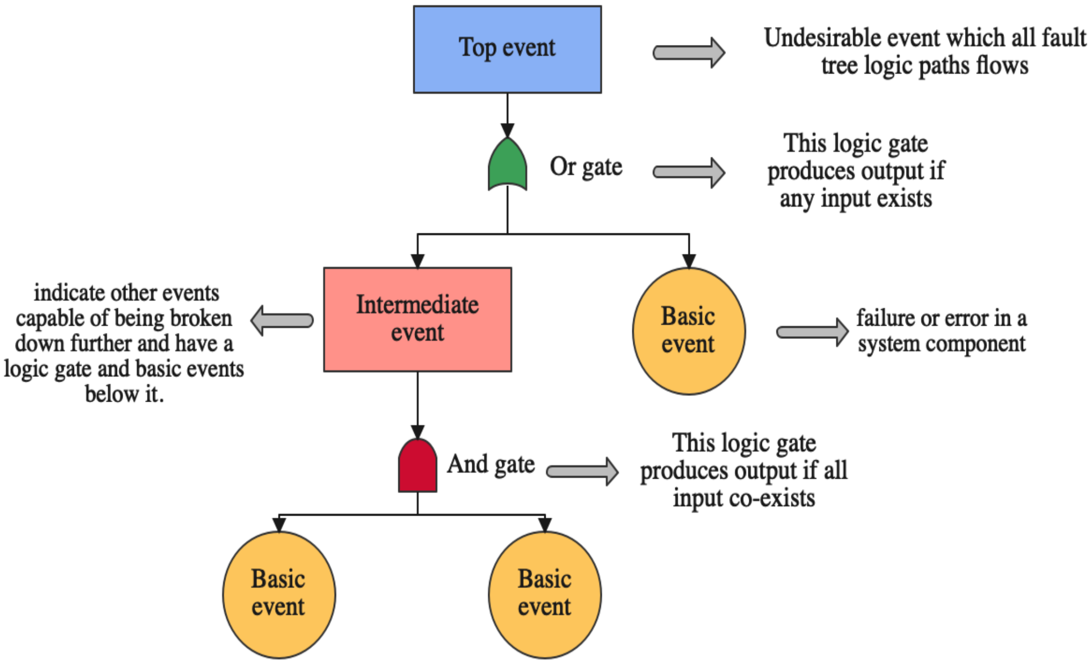

Figure 1. Basic Fault Tree Analysis

The probability of top event is closely related to the basic event failure probability causes in minimal cut sets. To do this, the intermediate event ("AND" or "OR" logic gates) probabilities are determined, beginning at the root of the tree, and progressing until the probability of top event is achieved (Ruijters and Stoelinga, 2015). For an "AND" and "OR" logic gate event, the following equation can be used for the probability of occurrence of a top event (Eq.1 and Eq. 2). Where $\varphi(x)$ represents the top event used to describe the complex system of undesired event; and x_i are basic events of i. "OR" logic gate occurs when at least one input factor occurs, "AND" logic gate occurs when both input factors occur (Zhang *et al.*, 2019).

$$\varphi(x) = \sum_{i=1}^{n} x_i = \{x_1 + x_2 + \ldots + x_n\} \quad (1)$$
$$\varphi(x) = \coprod_{i=1}^{n} x_i = \{x_1 \times x_2 \times \ldots \times x_n\} \quad (2)$$

To perform a fault tree, the Open FTA program, which is known a fault tree analysis (FTA) program, has been used for determining the probability of causes in collision accidents. The Open FTA program is in charge of qualitative fault tree analysis to establish minimal cut sets and quantitative fault tree analysis, which includes a Monte Carlo simulation (FSC, 2005).

A total of 62 collision accident reports providing detailed information about the causes of accidents were obtained by Marine Accident Investigation Branch (MAIB) between 2005 and 2020. The MAIB database is responsible for carrying out investigations of all vessels' accidents to determine the causes of accidents at sea and take attempts for improving international co-operation in marine accident investigations (MAIB, 2021).

In this study, the FTA involves two phases: qualitative and quantitative steps. The qualitative step was used in the first part to categorize the accident causes, decide the probability values, and create a logical relationship between the reasons. The second part, the quantitative step, has calculated the minimal cut sets, analyzed the accident occurrence combinations, and presented the importance degree of the basic events causing the accident occurrence (Antao and Soares, 2006; Ruijters and Stoelinga, 2015; Ugurlu *et al.*, 2015). To achieve this, a graphic was drawn using the Open FTA, a tool used for fault tree analysis, to explore the relationship between the causes both qualitatively and quantitatively. The main factors that cause collision were classified with reference to the DNV/GL–Marine Systematic Cause Analysis Technique. Initially, the root causes were determined and grouped according to the accident reports received by MAIB, and then the failure probabilities of each case were evaluated with the following equations (Ugurlu *et al*., 2015):

$$\mathrm{TCAC} = \frac{1}{\mathrm{RC}_1} + \frac{1}{\mathrm{RC}_2} + \cdots + \frac{1}{\mathrm{RC}_n} \quad (3)$$

Where TCAC indicates the total contribution value of cause, and RC1 represents the total number of root causes for the accident of the ship no.1. Also, failure probability of each basic event is calculated by:

$$\mathrm{PVAC} = \frac{\mathrm{TCAC}}{\mathrm{SN} \times \mathrm{TY}} \quad (4)$$

Where PVAC indicates the probability value of the accident cause, SN indicates the number of ships, and TY indicates the total year.

To begin, review MAIB investigation reports from ship collision accidents to determine the fault tree's top event and any relevant contributing events. To finish the diagram, build the basic fault tree diagram and double-check the logical linkages between the underlying events. After the fault tree has been formed, one of the most critical steps in Fault Tree application is to explore all of the basic event combinations, which is both a necessary and sufficient condition for the top event to occur. Minimal Cut Sets are the name for these combinations (MCS) (Antao and Soares, 2006; Ugurlu *et al*., 2015). To compute the probability of a ship collision, the fault tree must first be described using Boolean algebra, which is then simplified to obtain minimal cut sets (Chen *et al*., 2015). The bottom-up and top-down algorithms are two basic aspects for determining minimal cut sets. Each gate is represented as a Boolean expression of basic events and/or other gates in this way (Ruijters and Stoelinga, 2015). Finally, using the recommended solutions for ship collision accidents, calculate and analyze the fault tree's minimal cut sets as well as the structural importance of the underlying events, to find the major causes of the accident. Figure 2 depicts the overall research structure and methodology.

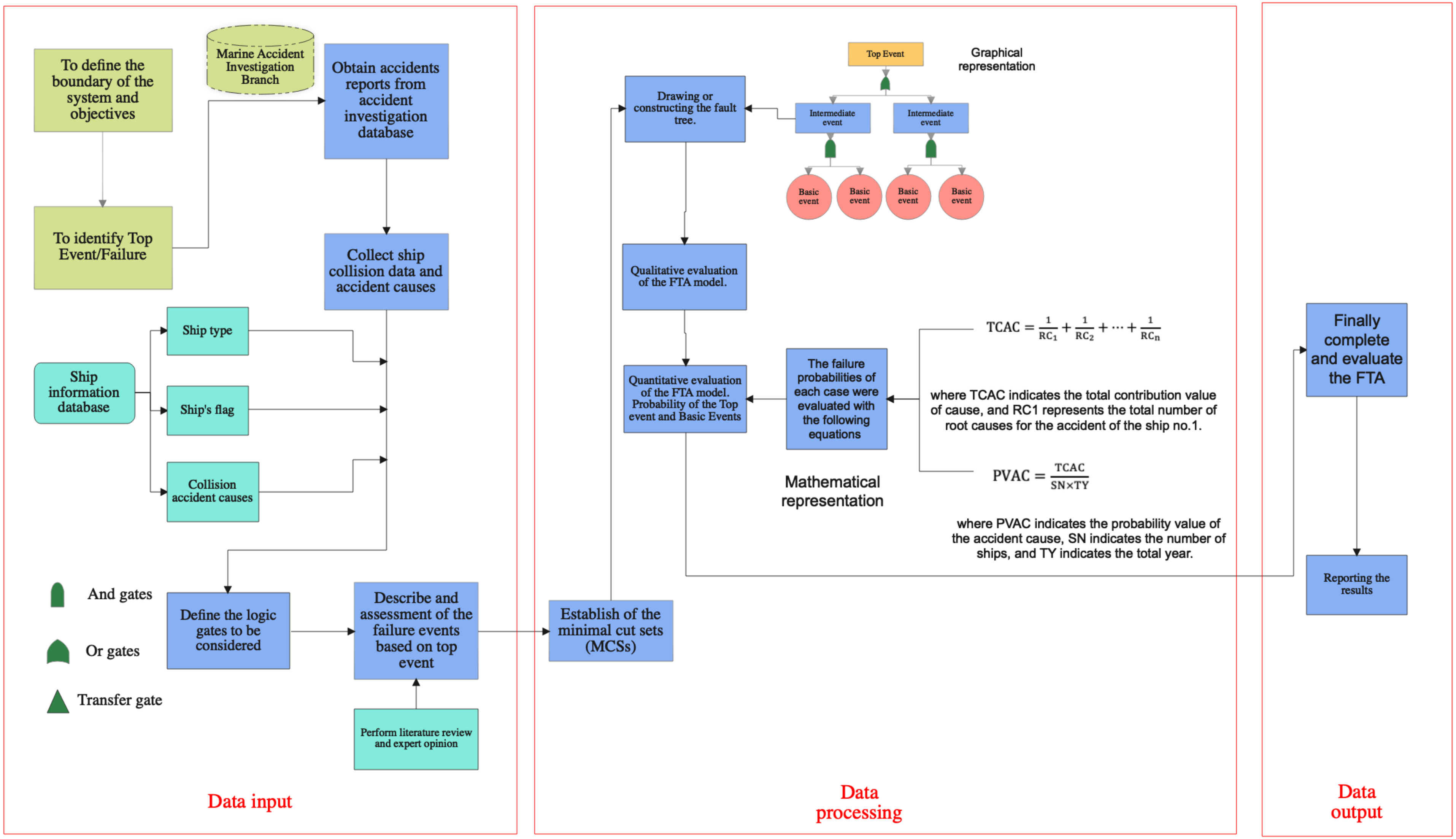

Figure 2. The flow chart of FTA

3.1. Dataset

The limitations of the study are that ships under 100 GRT (Gross tonnage) are not included in the dataset and the root causes are not clearly stated in the accident reports examined. A total of 17 ship collision accident reports are not included in the data set. A total of 62 ship accidents that resulted in collision between 2005 and 2020 were investigated.

According to the 62 accident reports examined, the distribution of ships damaged as a result of the collision by ship types is shown in figure 3. Since ship to ship risks are taken into account in the accident reports collected from MAIB, the data set in the figure was interpreted statistically on 124 data.

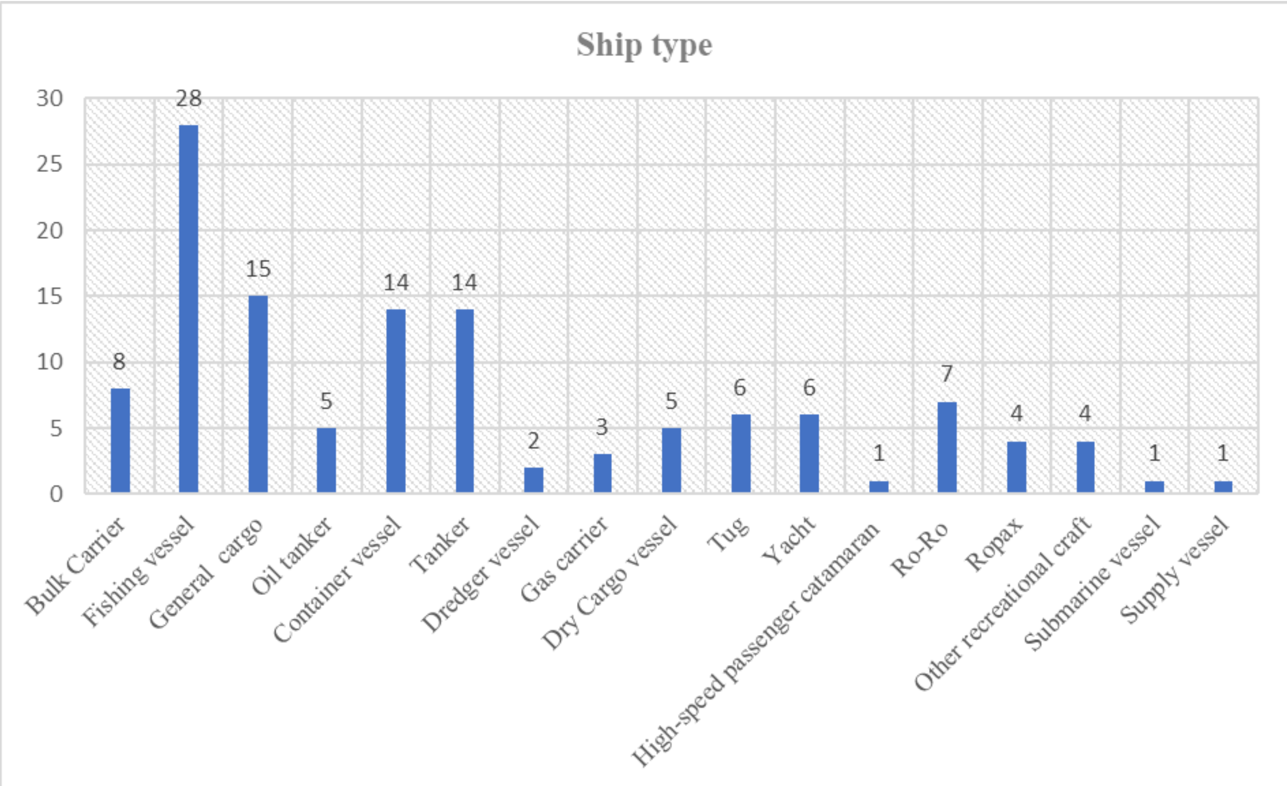

Figure 3. Distribution of collision accidents by ship type

As seen in Figure 3, fishing vessels have the highest accident rate (22.6%), followed by general cargo vessel (12.1%) and container vessels (11.3%). Distribution of collision accidents by ship flag is shown in Figure 4.

As shown in Figure 4., it is observed that the most frequent ship flag on collision accident is United Kingdom (51.6%) and Panama (6.5%). When the flags of the ships that caused the collision accidents were examined, it was determined that they had the flag convenience (FOC) status.

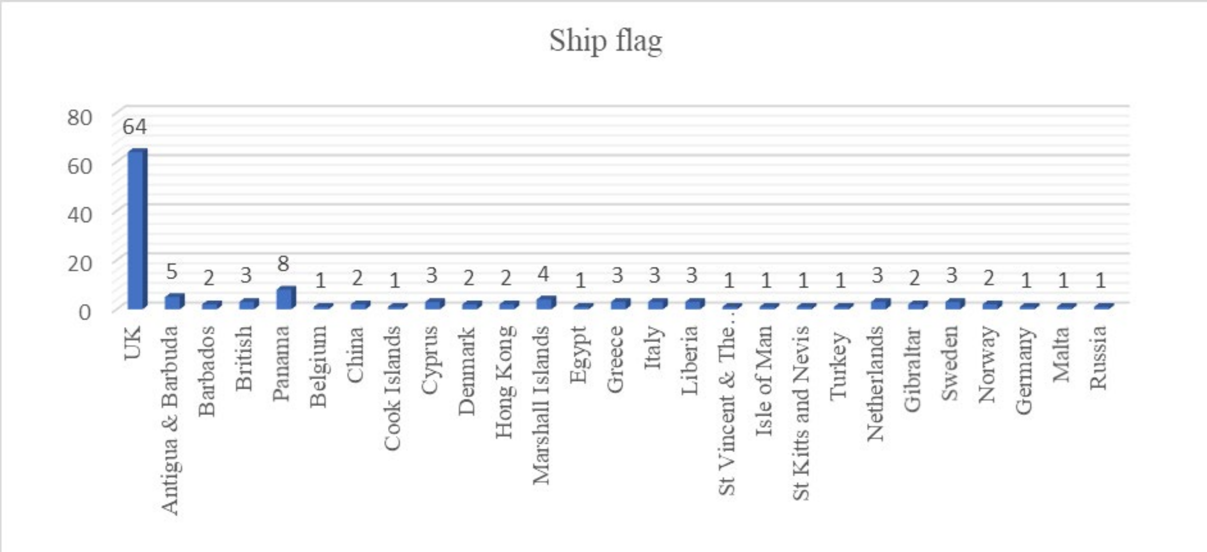

Figure 4. Distribution of collision accidents by ship flag

3.2. Findings

According to the analysis results, collision accidents (X_0-TE/ 0.00033) may occur due to either sub-standard acts or practice (X_1/0.0534) and sub-standard conditions (X_2/0.0061) as indicated in Figure 5. Sub-standard act and practices consist of intermediate causes of failure to follow the procedure (X_3/0.0283), communication failure (X_4/0.0084), and navigation failure (X_5/0.0176), while sub-standard conditions factor is affected by equipment failure (X_6/0.0027) and adverse conditions (X_7/0.0034) factors.

The Violation of COLREG (X_8/0.0158), among the other factors (SMS failure (E_2/0.0044) and misuse of navigational tools (E_1/0.0084)), is the factor that has a dominant influence on the variable of failure to follow the procedure. Also, communication failure may occur due to poor communication (E_8/0.0037), lack of bridge resource management (BRM) (E_9/0.0040) or language barrier (E_{10}/0.0007). Lack of competence is affected by the soft skills (X_{10}/0.0091), including a lack of decision making (E_{15}/0.0007) and situational awareness (X_{12}/0.0084), and hard skills (X_{11}/0.0073) influenced by a lack of knowledge (E_{12}/0.0047), lack of familiarization (E_{13}/0.0013), and lack of training (E_{14}/0.0013). Equipment failure is influenced by the operational failure of critical equipment such as main engine failure (E_{18}/0.0007), tugboat failure (E_{19}/0.0010), and navigational aids failure (E_{20}/0.0010). An adverse condition represents the severe conditions such as extreme sea conditions (E_{21}/0.0027), and heavy traffic (E_{22}/0.0007). Also, on the other hand, navigation failure consists of blind sector (E_{11}/ 0.0013) and lack of competence (X_9/0.0163).

In the view of detailed analysis, the occurrence probability risk of collision accident is found is 3.30E-04 (0.03%). The probability of the top event is computed by utilizing Boolean algebra to apply values to the probabilities of basic events until the top event is achieved. Since the minimal cut sets in the FTA is a set of basic events whose occurrence enables that the top events occur, they must be analyzed and discussed. Table 1 shows the probability distribution calculation of the events in the system. Accordingly, the top event is strongly affected by basic event-1 E1 (Misuse of navigational tools) which has the highest occurrence probability in the system. Following the accident description, FTA was built to explore the root causes of the collision accidents as shown in Figure 5.

Calculating the contribution degree of the basic events that cause accidents is another noteworthy result gained by FTA. A basic event contribution analysis was conducted for this aim performed by the Open FTA program. According to the analysis results, E1-Misuse of navigational tools (13.8%) and E16-Fatigue (12.71%) have the largest share in the occurrence of collision accidents contribution factors.

A quantitative analysis was used to identify the minimal cut sets for the collision fault tree using Boolean algebra. 85 minimal cut sets were identified as a result of the study. Table 2 represents top ten minimal cut sets combinations. According to the findings, the combinations including extreme sea conditions and misuse of navigational tools are the minimum cut sets when collision accidents are at their highest level. Furthermore, it is seen that fatigue, COLREG Rule-5 (Look out) and Lack of knowledge combinations with extreme sea conditions basic events have a great influence on the occurrence of collision accidents.

Table 1. Probabilities of the components and their contribution on the accident occurrence

EVENT NAME	EVENT NOMENCLATURE	DESCRIPTION	FAILURE PROBABILITY	TOTAL CONTRIBUTION
Top Event	T_E	COLLISION	0.00033	
Intermediate event-1	X_1	Sub-standard act and practice	0.0534	
Intermediate event-2	X_2	Sub-standard conditions	0.0061	
Intermediate event-3	X_3	Failure to follow procedure	0.0283	
Intermediate event-4	X_4	Communication failure	0.0084	
Intermediate event-5	X_5	Failure to navigation	0.0176	
Intermediate event-6	X_6	Equipment failure	0.0027	
Intermediate event-7	X_7	Adverse conditions	0.0034	
Intermediate event-8	X_8	Violation of COLREG (Collision regulation at sea)	0.0158	
Intermediate event-9	X_9	Lack of competence	0.0163	
Intermediate event-10	X_{10}	Soft skills	0.0091	
Intermediate event-11	X_{11}	Hard skills	0.0073	
Intermediate event-12	X_{12}	Situational awareness	0.0084	
Basic Event-1	E_1	Misuse of navigational tools	0.0084	0.1381
Basic Event-2	E_2	SMS failure	0.0044	0.0719
Basic Event-3	E_3	COLREG Rule-5 (Look-out)	0.0074	0.1215
Basic Event-4	E_4	COLREG Rule-6 (Safe speed)	0.0027	0.0442
Basic Event-5	E_5	COLREG Rule-8 (Action to avoid collision)	0.0044	0.0719
Basic Event-6	E_6	COLREG Rule- 22 (Visibility of lights)	0.0010	0.0166
Basic Event-7	E_7	COLREG Rule-35 (Sound signal in restricted visibility)	0.0003	0.0056
Basic Event-8	E_8	Poor communication	0.0037	0.0608
Basic Event-9	E_9	Lack of Bridge Resource Management (BRM)	0.0040	0.0663
Basic Event-10	E_{10}	Language barrier	0.0007	0.0110

Table 1. Probabilities of the components and their contribution on the accident occurrence (continued)

Basic Event-17	E_{17}	Alcohol abuse	0.0007	0.0110
Basic Event-18	E_{18}	Main engine failure	0.0007	0.0110
Basic Event-19	E_{19}	Tugboat failure	0.0010	0.0166
Basic Event-20	E_{20}	Navigational aids failure	0.0010	0.0166
Basic Event-21	E_{21}	Extreme sea conditions	0.0027	0.0442
Basic Event-22	E_{22}	Heavy traffic	0.0007	0.0110
Basic Event-11	E_{11}	Blind sector	0.0013	0.0220
Basic Event-12	E_{12}	Lack of knowledge	0.0047	0.0773
Basic Event-13	E_{13}	Lack of familiarization	0.0013	0.0220
Basic Event-14	E_{14}	Lack of training	0.0013	0.0220
Basic Event-15	E_{15}	Lack of decision making	0.0007	0.0110
Basic Event-16	E_{16}	Fatique	0.0077	0.1271

Table 2. Top ten minimal cut sets combinations

Minimal cut sets combination	Basic Events	Probability values
Minimal cut set-04	E_1*E_{21}	2.6800E-05
Minimal cut set-79	E_{16}*E_{21}	2.0790E-05
Minimal cut set-14	E_3*E_{21}	1.9980E-05
Minimal cut set-59	E_{12}*E_{21}	1.2690E-05
Minimal cut set-09	E_2* E_{21}	1.1880E-05
Minimal cut set-24	E_5* E_{21}	1.1880E-05
Minimal cut set-44	E_9* E_{21}	1.0800E-05
Minimal cut set-39	E_8* E_{21}	9.9900E-06
Minimal cut set-02	E_1*E_{19}	8.4000E-06
Minimal cut set-03	E_1*E_{20}	8.4000E-06

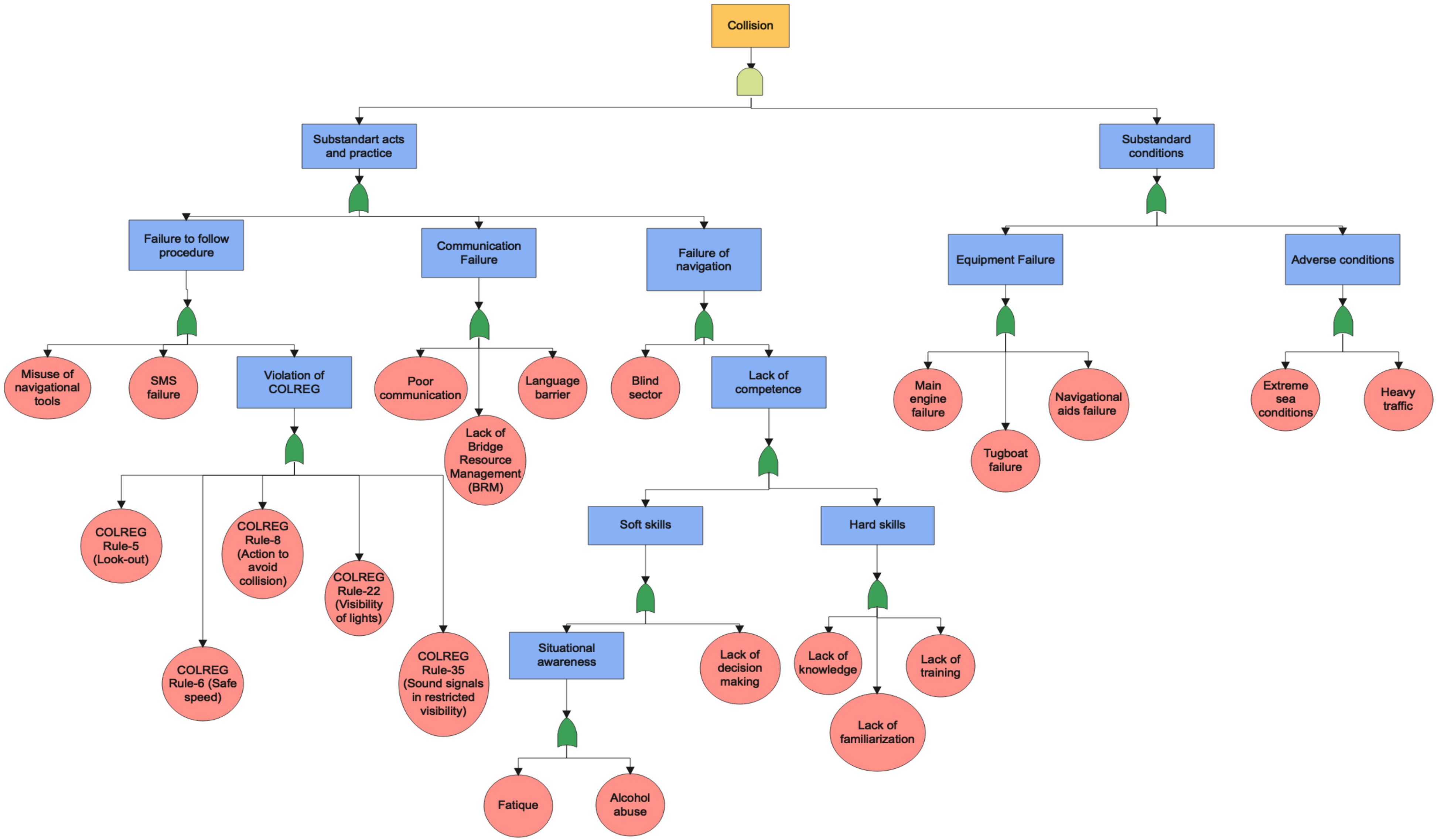

Figure 5. Fault tree of collision accidents

4. DISCUSSIONS

- Our study reveals that the factors associated to safety of navigation (misuse of navigational tools and violation of COLREG Rule-5 (Look out)), which are primarily caused by human error, have the highest impact on collision accidents.
- The findings of the study also show that sub-standard acts and practices including controllable parameters, primarily based on the knowledge, skills, and abilities of the crew, have a much greater impact on collision than sub-standard conditions. In addition, failure of equipment such as tugboat failure, navigational aids, and the main engine are secondary factors responsible for collisions.
- Along with other studies (Antao and Soares, 2006; Ugurlu *et al*., 2015; Chen *et al*., 2015; Akyuz *et al*., 2020) on collision accidents, this study makes a significant contribution to the relevant literature.
- Previous studies (Antao and Soares, 2006; Kum and Sahin, 2015; Ugurlu *et al*., 2015; Chen *et al*., 2015) found human factor to be the most important factor in collision. Parallel to these studies, our study found that navigation based factors which is caused primarily by human error played a crucial role; this result agrees with those of similar risk assessment studies.

This study used a FTA methodology to conduct a risk assessment of collision accidents. Our method is useful for estimating the probability of collision accidents but needs improvement. For example, future studies should (1) collect more data on the collision of ships of all sizes, (2) apply other risk assessment methodologies, (3) gather opinions of experts to minimize the uncertainties of the tree, and (4) consider other types of accidents in other marine regions.

5. CONCLUSIONS

Collision accidents, which account for the majority of very-serious marine accidents, have a catastrophic impact on human life and the environment. Consequently, it is essential to determine the major risks and their level of effect on the accident in order to stop future disasters. To achieve this, FTA was applied to explore the causes of collision accidents and their impact level on the incident occurrence. The findings of the research indicate that sub-standard acts and practice including drivable factors based primarily on crew operational knowledge, expertise and proficiency have a much greater impact on the collision than sub-standard conditions.

The study found that most of the factors (E1/Misuse of navigational tools, E3/COLREG Rule-5 (Look-out)) that had the greatest effect on the collision were mainly due to the inadequacy to keep a safe navigation watch. Thus, the crews' level of proficiency needs to be assessed at regular periods and, if required, the crew should participate in a refreshment course to strengthen their professional skills. In addition to COLREG in Rule 5, The lookout is an essential and vital member of the bridge crew. Many accidents could have been avoided if a well-trained lookout had been onboard. STCW 95 requires that a separate dedicated lookout be retained on the bridge in addition to the watchkeeper at all times throughout the hours of darkness and in busy marine regions when underway. Vessel owners, operators, and masters are responsible for ensuring that personnel involved in the navigation of vessels have a thorough awareness of navigational practices and the COLREGs.

It is the responsibility of policymakers to develop effective navigational safety methods with the goal of reducing human life loss and property damage costs in the event of an accident. Given the limited resources and budgets available, policymakers must prioritize safety practices. This can be accomplished with the help of a thorough grasp of the contributing elements that influence the outcome of a ship collision. Periodic BRM training and communications, the deployment of additional manpower, and regular bridge navigation exercises utilizing simulators are all possible risk reduction strategies. Internal and external information transfer, appropriate usage of marine English, and COLREG should all be part of such safety measures.

Furthermore, fatigue management, one of the other highest basic events, is a very important issue because of the devastating symptoms of

seafarers as poor judgments, slow reactions, poor memory, impaired vision are some of the signs. Fatigue risk management plans must be considered with the purpose of taking a proactive approach to prevention and management and decreasing the risk of fatigue-related accidents. A fatigue risk management plan should guarantee that fatigue information is included in a seafarer's health and safety orientation, that continuing education is incorporated into subsequent refresher training, and that crewmembers are kept informed through routine, weekly or monthly briefing of related topics.
This study makes a significant contribution to the existing literature by examining the subject from a various perspective. This research, in addition to adding to current knowledge, provides essential information to ship operators, allowing them to recognize the hazards associated with the crew's professional competency. As a result, the study's findings are critical in identifying strategies for reducing risks and preventing future accidents.

AUTHORSHIP CONTRIBUTION STATEMENT

Ali Cemal TÖZ: Conceptualization, Methodology, Validation, Formal Analysis, Writing - Original Draft, Software, Visualization, Supervision.
Müge BÜBER: Methodology, Validation, Formal Analysis, Writing - Original Draft, Writing-Review and Editing, Software, Visualization, Supervision.
Burak KÖSEOĞLU: Conceptualization, Writing - Original Draft, Resources, Visualization, Supervision.
Cenk ŞAKAR: Conceptualization, Writing - Original Draft, Resources, Visualization, Supervision.

CONFLICT OF INTERESTS

The author(s) declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

No ethics committee permissions is required for this study

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The Denotation Problematic of the Sea Area Between The Anatolian Coasts and The Balkan Peninsula

Anadolu Sahilleri ile Balkan Yarımadası Arasında Bulunan Deniz Alanının İsimlendirme Sorunsalı

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 8 Sayı: 1 (2022) 31-41

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ABSTRACT

The sea area, located between the Anatolian Coasts and the Balkan Peninsula, has been called by different names such as Aigaios Pontos, Pelagos Aigaion, Aigaion Pelagos in Greek, and Bahr-î Sefid, Cezyir-î Bahri Sefid, Inter-Islands, the Archipelago in Turkish. Societies or tribes, which trying to dominate this sea, have tried to name and interpret this sea by means of their own customs/traditions in accordance with their claims of domination. The mentioned sea is now called the "Aegean Sea" and this name is tried to be identified by the Greeks with the mythological hero Aegeus, the king of Athens, in Ancient Greece. However, it is necessary to investigate more etymological origins in naming geographical places. In this context, when the subject is examined, there are arguments the name "Aegean" has a language link with the Luwi language, which is the base culture of the Hellenic culture, and the words "Ög-Uz, Ög-İz", which means "stream, sea, water cover" in Proto-Turkic. In this study, the term Aegean; The mythological denotation of the reference in scientific studies will be discussed, evaluated within the etymological framework, and the terms the Archipelago, Inter-Islands used in the Ottoman Empire will be examined.

Keywords: The Aegean Sea, Aegeus, Proto-Turkic, The Archipelago, Inter-Islands

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ÖZET

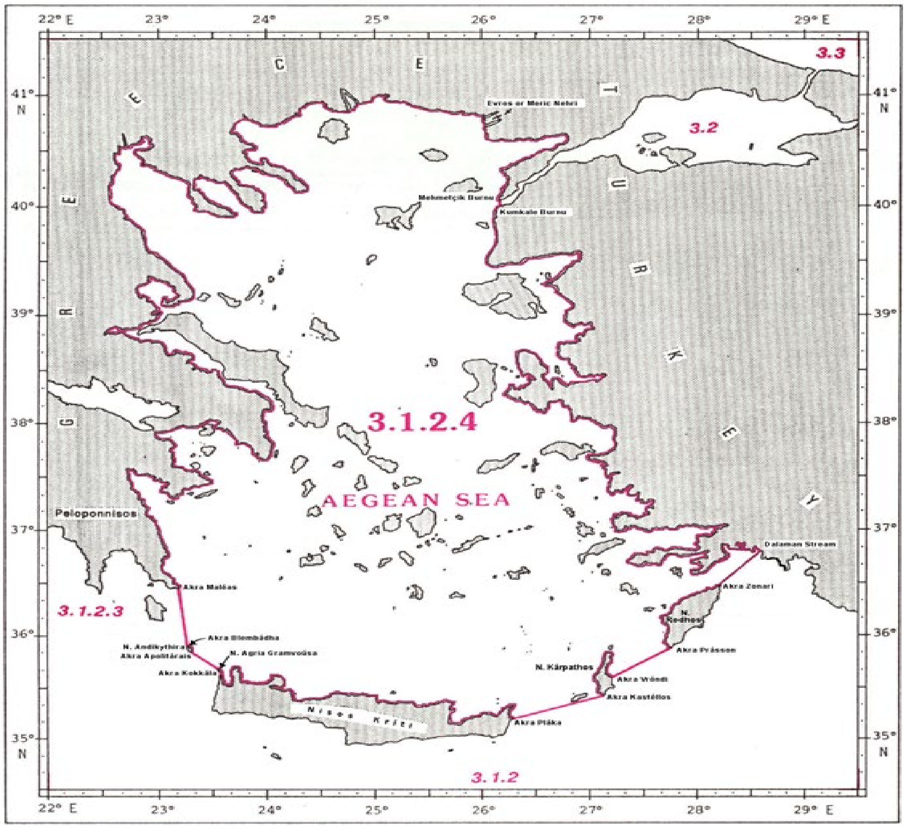
Anadolu Sahilleri ile Balkan Yarımadası arasında yer alan deniz alanı, tarihsel süreçte Yunanca; Aigaios Pontos, Pelagos Aigaion, Aigaion Pelagos, ve Türkçe; Bahr-î Sefid, Cezyir-î Bahri Sefid, Adalar arası, Adalar Denizi gibi farklı adlandırmalarla anılmıştır. Bu denizde hâkimiyet kurmaya çalışan toplumlar ya da kavimler, hâkimiyet iddiaları gereği bu denizi kendi örf/adetlerine uygun kendine özgü unsurlar vasıtasıyla adlandırmaya ve anlamlandırmaya çalışmışlardır. Bahse konu deniz, günümüzde "Ege Denizi" olarak isimlendirilmiş ve bu isim Yunanlılar tarafından, Antik Yunan'da mitolojik kahraman Atina kralı Aegeus ile özdeşleştirilmeye çalışılmaktadır. Ancak coğrafi yerlerin isimlendirilmesinde daha çok etimolojik kökenlerin araştırılması gereklidir. Bu çerçevede konu incelendiğinde "Ege" isminin Helen kültürünün dip kültürü olan Luwi diline ve bu dilin temelinde de Ön-Türkçe' de "akarsu, deniz su örtüsü" anlamına gelen "Ög-Uz, Ög-İz" kelimeleri ile bir dil bağı bulunduğuna ilişkin savlarda bulunmaktadır. Bu çalışmada Ege teriminin; bilimsel çalışmalarda atıfta bulunulan mitolojik isimlendirmeleri tartışılacak, etimolojik çerçevede değerlendirilmesi yapılacak ve Osmanlı'da kullanılan Adalar Denizi, Adalar Arası ifadeleri incelenecektir.

Anahtar Kelimeler: Ege Denizi, Aegeus, Ön-Türkçe, Adalar Denizi, Adalar Arası

1. GİRİŞ

Türkiye ile Balkan Yarımadası arasında yer alan deniz alanı, göllerle kaplı olduğu dördüncü jeolojik zamanda (kuvaterner) tektonizma sonucu çökmenin yaşanması ile oluşmuştur. İstanbul Çubuklu'da konuşlu ve Türk Deniz Kuvvetlerine bağlı, Seyir Hidrografi ve Oşinografi Başkanlığı tarafından hazırlanan deniz haritası incelendiğinde (SHODB, 2020); bu deniz alanı kabaca 35° - 41° Kuzey enlemleri ile 23° - 28° Doğu boylamları arasında bulunan, Türkiye'nin batı kıyıları ile Balkan Yarımadasındaki Yunanistan'ın doğu sahilleri arasında, Doğu Akdeniz'in kuzeye doğru uzantısı olan ve Mora Yarımadasından, güneybatıya doğru sıralanarak bir hilal biçiminde ilerleyen; Çuha (Kitara), Sıkliye (Antikitara), Girit, Çobanadası (Kasos), Kerpe (Karpatos), ve Rodos adaları ile ayrılan, irili ufaklı çoğunluğu kayalık ve yaşamsal alanı bulunmayan kayalık/adacıkların bulunduğu, kendisine has özellikleri olan yarı kapalı bir deniz olarak tanımlanabilir.

Anadolu ile Balkan Yarımadası arasında yer alan denizin sınırı ilk kez, 1928 yılında Uluslararası Hidrografi Başkanlığı'nca hazırlanan SP-23 "Limits of Ocean and Seas" dokümanında belirtilmiştir. 1937 tarihli ikinci ve 1953 tarihli üçüncü versiyonunda, söz konusu deniz sınırları aynı şekilde tanımlanmış ve 1986 yılındaki geliştirilme çalışmaları sonucunda, anılan dokümanın 2002 tarihli 4'üncü versiyonu Uluslararası Hidrografi Başkanlığı'nca yayımlanmıştır. 2002 tarihli dokümanda, önceki versiyonlara göre tek farklı olan husus Mora Yarımadası güney doğusunda yer alan Çuha (Kitara) Adasının, bu deniz kesiminden çıkartılmış olmasıdır (IHO, 2002). Bu çerçevede Şekil 1'de gösterilen bu denizin sınırları; Türkiye ana karasından Dalaman Çayı, Rodos Adası Zonari Burnu, Kerpe (Karpatos) Adası Vrondi Burnu, Kerpe (Karpatos) Adası Kastellos Burnundan Girit Adası Akra burnu, Girit Adası Kokkala Burnundan, Agria Gramvousa Kayalığı üzerinden Sıkliye (Antikitara) Adası Apolitarais Burnuna, Sıkliye (Antikitara) Adası Blembadha Burnundan, Mora Yarımadası Maleas Burnuna uzanan bir sınır ile Akdeniz'den ayrılmıştır.



Şekil 1. Anadolu ile Balkan Yarımadası Arasında Kalan Deniz'in Sınırı (IHO, 2002)

2. ANADOLU İLE BALKAN YARIMADASI ARASINDAKİ DENİZİN İSİMLENDİRİLME SORUNSALI

Anadolu ile Balkan Yarımadası arasında bulunan deniz, Akdeniz'in büyük bir körfezi konumunda yarı kapalı (Denk, 1999: 53) bir denizdir. Türkiye ve Yunanistan, aynı denize hem karşılıklı hem de bu denizin kuzey tarafında karadan yan sınır olarak komşudur. İki ülkenin hak ve menfaatlerinin bu denizde çatışması da iki ülkenin ilişkilerindeki temel sorunu teşkil etmektedir. Türkiye bu denizin yarı kapalı bir deniz olduğunu ilk defa Yunanistan'a 27 Şubat 1974 tarihinde verdiği nota ile belirtmiş ve bu konudaki tezlerini, baştan beri bu güne kadar sürdürmüştür (Başeren, 2006: 10). Yunanistan, Türkiye ile komşu olduğu bu denizin tamamında hak sahibi olmak amacındadır ve denizin kaynaklarını paylaşmak istememektedir. Bu kapsamda iki devlet arasında yaşanan sorunlar; Karasularının sınırlandırılması, Kıta Sahanlığı, Hava Sahası ve Uçuş Malumat Bölgesi (Flight Information Region (FIR)) Hattı, Gayri Askeri Statüdeki Adaların Silahlandırılması, Anlaşmalarla Yunanistan'a Devredilmemiş Coğrafi Formayonlar ile Arama/Kurtarma Sahası ile ilgili sorunlardır. Bununla birlikte bahse konu denizin adlandırılması da başka bir sorun olarak karşımıza çıkmaktadır. Yunanistan, siyasi ve politik amaçlarına ulaşmak için kendilerinin geçmişte yaşamış bir medeniyetin devamı olduğunu, coğrafyadaki yer isimlerinin kendi medeniyetinden kaldığı savını kullanarak coğrafyayı sahiplenmeye çabalamaktadır.

2.1. İsimlendirilme Sorunsalına Yunan Bakışı

Yunanlılar tarafından Thalassoloji olarak belirtilen ve Türkçe'ye denizcilik yazım geleneği olarak çevrilen terim çerçevesinde, Eskiçağ'da yaşamış şair Ibykos ve düşünür Pherekydes ve Tregedya yazarlarından Aiskhylos, Anadolu ile Balkan Yarımadası arasında yer alan deniz alanının tanımlanmasına dair ilk bilgilendirmelerde bulunanlardır (Kurul, 2021: 425). Söz konusu bilgilendirmelerde bu deniz;

Ibykos tarafından, Aigaios Pontos: Aigaios Denizi, Pherekydes ve Aiskhylos tarafından, Pelagos Aigaion: Aigaion Denizi biçiminde en erken adlandırma örnekleri olarak kullanılmıştır. Bununla birlikte Heredots (IV 85) Çanakkale Boğazı'nın Aigaios Pontos ya da Aigaion Pelagos denilen açık bir denizde son bulduğunu söylemekte, Plinius ise Naturalis Historia (N.H. IV 51) adlı eserinde bu denizin adını, Tenos ile Khios arasında, denizden birden bire fırlamış dişi keçiye benzeyen bir adadan aldığını yazmaktadır (Sevin, 2001: 4).

Bu kapsamda; Helence dil bilgisi kuralları doğrultusunda Aigaion sözcüğünün analizini gerçekleştiren dil bilimciler iki farklı etimolojik tespit ileri sürmektedirler. İlk olarak mevcut sözcük "Aikis" sözcüğüdür. Aikis: keçi, kelimesinden türetilmiş özel bir isimdir ve Pelagos: deniz, derya terimiyle tamlama oluşturmaktadır (Kurul, 2021: 426). Bu tamlama ise genel çerçevede keçi/keçi görünümlü deniz anlamına gelmektedir. İkinci anlatım ise Aigaion sözcüğüdür ve Gaia: yeryüzü, toprak kelimesinden türetilmiş bir sıfattır (Örneğin Eggaion: yeryüzünden ortaya çıkan, yerli anlamında sıfattır). Yunanlılar, anılan sıfatı, Anadolu sahilleri ile Balkan Yarımadası arasında yer alan deniz alanı ile özdeştirerek, mitografik bağlamda bu denizin yeryüzünün sürekli ve ezeli (kadim) su kütlelerinden biri olduğunu ve yeryüzü tanrıçası Gaia'nın bedeninden (soyut varlığından) ortaya çıktığını zayıf bir şekilde anlatmaktadırlar (Kurul, 2021: 426). Bir başka Yunan mitolojik anlatımında ise, söz konusu denizin ismini yeryüzü tanrıçası Gaia ile Posedion'un birlikteliğinden doğan çocuklarından birinin adı olan Aigaion'dan alındığı belirtilmektedir. Ancak yukarıda belirtilen mitolojik anlatımla açıklanmaya çalışılan etimolojik önerilerin tam anlamıyla kanıtlanabilir niteliğe sahip olmayıp, yalnızca birer filolojik yorum vasfında olduklarını belirtmek yerinde olacaktır (Sheard, 2011: 35).

Anadolu Sahilleri ile Balkan Yarımadası arasında yer alan deniz alanının isimlendirilmesi konusuna kaynaklık eden, mitolojik konuların unsurları da benzer şekilde yukarıda bahsedilen etimolojik savlar kapsamında olduğu gibi temel perspektifte iki anlatımla anılmaktadır. Bu anlatımlardan ilki ve en yaygın kabul göreni, Atina kentinin efsanevi kralı Aegeus ve Girit Kralı Minos ile ilişkilendirilir. Girit Kralı Minos'un mitolojik öykülerinde tüm Ege havzasına yayılan bir ünü ve etkisi bulunmaktadır. Minos'un efsanevi kişiliği Girit'ten başlayarak Balkan Yarımadası ile Anadolu topraklarında birçok bölgeye ulaşmakta ve farklı öykülerle anılmaktadır. Minos'un Balkan Yarımadasına uzanan öyküleri içinde, Megara Kralı Nisos'u öldürmesi kendi çağında ada dışındaki gücüne bir atıf niteliği taşımaktadır (Gür, 2018: 10). Bunlardan en önemlisi ve hepsinden ötesi Antik Çağ insanının hayal gücünde yer edinerek antik dünyada adeta evrenselleşen "labirent söylencesi"dir. Bu mitolojik anlatım, kendi öykülemesi içinde Atina ile Girit arasında yedi kız ve yedi erkek üzerinden gerçekleşen bir anlaşmayla, bir bakıma Girit'in erken dönemlerde Kıta Yunanistan'la ilişkilerine güçlü atıflar yapmaktadır. Bununla birlikte Atina Kralı Aigeus'un oğlu Thesus'u Yunanların gözünde Antik Çağ'da milli bir kahraman hâline getirmekte ve Ege Denizi'nin isimsel kökenini vurgulamaktadır. Bu çerçevede mitolojik anlatımla bezenen, Anadolu sahilleri ile Balkan Yarımadası arasında yer alan denize ismini veren öyküleme kurgusu şu şekilde cereyan etmiştir.

Kral Minos'un Girit'te hâkimiyetini sürdürdüğü sırada, Atina'da yapılan olimpiyatlara katılan Minos'un atlet olan oğlunun yarışmalar esnasında öldürülmesi, Atina ile Girit arasındaki ilişkilerin çatışmaya doğru sürüklenmesine sebep olur (Byghan, 2020: 370). Bu sorun, her yıl yedi kız ve yedi erkek Atinalının kurban edilmek üzere Girit'e gönderilmesi ile çözülür. Ancak aradan geçen yıllar içerisinde bu antlaşma oldukça ağır gelir ve Atina Kralı Aigeus her sene gönderdiği yedi kız ve yedi erkek kurbanı artık vermek istemez. Aigeus, Troizen Kralının kızı Aithara'dan olan oğlu Thesus'u, Girit Kralı Minosu öldürmesi için Girit'e gönderir. Thesus, Girit'e yelken açmadan önce babası Aigeus oğluna bir nasihatte bulunur. Buna göre Thesus görevini tamamlayıp Atina'ya sağ salim dönebilmeyi başarırsa geminin Girit'e yolculuk sırasında donattığı siyah yelkenleri (Antik Yunan'da yaşayan Simonides, yelkenlerin renginin kırmızı olduğunu belirtir.) beyaz yelkenlerle değiştirmesini ister. Böylece Aigeus, Thesus'un başarılı olduğunu ve sağ salim döndüğünü anlayabilecektir. Thesus, Girite gider, Girit Kralı Minosu yenerek öldürür ve Atina'ya dönüşe geçer. Ancak Thesus, babası Aigeus'un nasihatını unutur ve siyah yelkenleri kullanarak Atina'ya doğru yaklaşır. Kral Aigeus Atina'nın falezlerinin zirvesinden oğlunun dönüşüne şahitlik edebilmek umuduyla her gün denizi izlemektedir. Aigeus Atina açıklarında Thesus'un gemisini gördüğünde yelkenlerinin siyah renk olduğunu fark eder. Aigeus, Thesus'un savaşta yenildiğini ve hayatını kaybettiğini zanneder. Aigeus, oğlunun acısına dayanamayacağını düşünerek bulunduğu yerden denize kendisini atar[1] ve denizde kaybolur. Böylelikle bölgede yer alan deniz alanı Kral Aigeus'un ismiyle yani Aigeus/Aigeus'un Denizi olarak anılmaya başlar. Bu mitolojik kurgulu anlatım, Balkan Yarımadası ve Anadolu Sahilleri arasında yer alan deniz alanının adlandırılması hususunda yürütülen araştırmalar çerçevesinde günümüze değin aktarılmıştır.

Söz konusu deniz alanının adlandırılmasıyla ilişkili olarak aktarılan bir diğer mitolojik anlatım ise bir Amazon kraliçesinin ismine dayandırılmaktadır. Bu mitolojiye göre bir Amazon grubu Troya Savaşı esnasında liderleri Kraliçe Aige ile birlikte Troyalılara destek vermek için gemileriyle Troya'ya doğru yola çıkarlar. Bu sırada, bahse konu denizde ani bir fırtınaya yakalanırlar ve Kraliçe Aige ile beraberindeki tüm Amazonlar boğularak yaşamlarını yitirirler. Bu mitolojik anlatımda Kral Aigeus anlatısına benzer bir şekilde trajik bir ölümün yaşanması ve deniz alanına karakterin isminin verilmesi ile sonlanmaktadır (Ceccarelli, 2012: 37).

Helenistik döneme gelindiğinde, Anadolu Sahilleri ile Balkan Yarımadası arasında kalan denizin adlandırılmasına dair ilk bulguların, Sophokles'in Aias isimli trgedyası içerisinde Aigean Pelagos olarak geçtiği belirtilmektedir (Kurul, 2021: 429). Yine bu zamanın şairlerinden Euripides, bu deniz alanının adlandırmasına yönelik yazılarında ve şiirlerinde Aigean Pelagos ibaresine atıf yapmaktadır. Bununla birlikte dönemin vakanüvislerinden Heredots anılan denizin isimlendirilmesine yönelik olarak Aigaios Pontos (Aigaios Denizi) ibaresine yer verirken, Thukydides ise eserlerinde Aigeon Plagos (Aigeon Denizi) ifadesini kullanmaktadır (Kurul, 2021: 429). Milattan Önce 6'ncı yüzyılda yaşamış Karyanda'lı (Bodrum Yarımadası'nın kuzeyinde lokalizasyonu kesin olarak yapılamamış Karya kenti) Skylaks'ın Periplous (İskan edilmiş Avrupa, Asya ve Afrika Denizi'nin Çevresindeki Seyr-ü Seferi) adlı coğrafi eseresinde, söz konusu denizden Aigaion Plagos (Aigaion Denizi) olarak bahsetmektedir (Arslan, 2012: 239-246). "Helenistik Dönemle birlikte, Anadolu Yarımadası ile Balkan Yarımadası Sahilleri arasında bulunan denizin algılanması ve tanımlanmasının yazılı kayıtlarda oldukça fazla yer aldığı görülmektedir. Bu kayıtların önemli bir kısmı da, ya doğrudan denizcilik odaklı muhtelif metinler ya da dolaylı yoldan denizcilik kültürüyle ilintili kısmi paragraflar biçimindedir." (Kurul, 2021: 430).

Bahse konu deniz alanının adlandırılması çerçevesinde Helenistik Dönem'in en kapsayıcı bilgilendirmeleri, beşeri dünyanın ilk coğrafyacısı olarak bilinen Strabon tarafından sunulmaktadır. Strabon, "Coğrafi Hususlar" başlıklı eserinin neredeyse tamamında, Anadolu Sahilleri ile Balkan Yarımadası arasında yer alan deniz alanını tanımlamak ve meşruiyet kazandırmak amacıyla, Aigaion Pelagos (Αἰγαῖον πέλαγος) tamlamasını kullanmaktadır. Diğer bir ünlü coğrafya bilgini Agathemeros tarafından da, Aigaion Pelagos (Αἰγαῖον πέλαγος) tamlaması teyit edilmektedir. Öyle ki Agathemeros da tıpkı Strabon gibi coğrafi çalışmalarının neredeyse tamamında Aigaion (Αἰγαῖον) sözcüğünü kullanmış ancak bu sözcüğün belirteci olan Pelagos (πέλαγος) kelimesini ise tamlamalara dâhil etmemiştir (Kurul, 2021: 431). Bahse konu denizin isimlendirilmesi ile ilgili olarak, Helenistik Dönem içerisinde ve bu dönemin devamı niteliğinde olan Roma İmparatorluk Dönemi içerisinde kaleme alınan başka kaynaklarda da Aigaion Pelagos (Αἰγαῖον πέλαγος) ifadesine yer verilmiştir. Böylelikle söz konusu ifade, 17'nci yüzyıl kaynaklarına kadar benzer biçimde

[1] Bazı kaynaklar Atina'da ki Akropolis'in uçurumundan atladığını belirtmektedir. Böyle olması durumunda Kral Aigeus denize düşmemiştir.

kullanılmaya devam etmiş ve günümüzde kullanılan Modern Yunancada da geçerliliğini korumayı sürdürmektedir (Kurul, 2021: 434).

2.2. İsimlendirme Sorunsalına Türk Bakışı

Anadolu Yarımadası ile Balkan Yarımadası Sahilleri arasında kalan deniz alanı, günümüzde kullanılan adı ile Ege Denizi'nin isimlendirme konusu, yukarıda Antik Yunan'dan itibaren incelenmiş ve bahse konu denizin neden Ege Denizi olarak adlandırıldığına yanıt aranmıştır. Yukarıda da bahsedildiği üzere, Yunan bakış açısında söz konusu denizin isimlendirilmesi mitolojiye dayandırılmakta ve etimolojik olarak Yunan dilinden gelen bir söylemle açıklanamamaktadır. Yapılan araştırma ve incelemelerde bu kelimenin Anadolu kültürünün bir mirası ve Proto-Türkçe (Ön-Türkçe)'nin izlerini taşıdığı bazı kaynaklarda ifade edilmiştir (Akarı, 2005: 26).

Ege Denizi olarak bilinen deniz alanının isimlendirilmesi konusunun incelenmesinde, Yunan bakış açısı ile oluşturulan mitolojik savların tamamen uydurma bir hikâyeden ibaret olduğunu, Bilge Umar "Türkiye'deki Tarihsel Adlar" konulu çalışmasında; Aigeus, Aigaion Pelagos (Ege Denizi) adına bir köken ve açıklama getirmek için uydurulmuş destan kişisi olarak belirtmekte (Umar, 1993: 30) ve şöyle devam etmektedir. "Aigeon, Aegonne, Eugonia adlarının kökeni, öz biçimi, Luwi dilinden yada onun yerel ardılı Kapadokya dilinden, Aigana olmalıdır; takı olarak wana/ana ile ina, birbirinin çeşitlemesi olduğu için Aigana, Aigina adının çeşitlemesi olarak yorumlanmaktadır." (Umar, 1993: 30) Kısaca, Umar'ın (1993) çalışmasında belirtildiği gibi, Ege kelimesinin Helen diline Anadolu'da yaşamış önceki kültürden geçtiğini ve etimolojik olarak Helen kültüründe yer almadığını belirtmektedir. Umar'ın (1993) çalışması, Ege kelimesinin anlamı ve bu adlandırmanın nerelerden geldiği konusunda ve özellikle kelimenin etimolojik kökeni hakkında bilgi vermektedir. Bununla birlikte akıllara şu soru gelmektedir. Umar'ın (1993) çalışmasında belirttiği Luwiler kimdir? Anadolu'da yapılan arkeolojik kazılarda bulunan Hitit tabletleri tarih sahnesinden silinmiş birçok Anadolu halkı hakkında bilgi edinilmesini sağlamıştır. Anadolu'da yaşayan Luwi'lerin kendi adlarıyla anılan dilleri olan Luwi dilini konuşan ve Anadolu'da önemli bir uygarlığa sahip topluluk olduğu Hitit tabletlerinde yer almaktadır.

Luwi dilinde, Türkçe ya da Ön Türkçe ad ve yapılar olduğu da yapılan çalışmalar sonucu tespit edilmiştir (Akarı, 2005: 28). Coğrafya isimlerinin, kültürler arasında dillerin belli kurallarını izleyerek devir teslim edile edile günümüze kadar geldiği bilinmektedir. Bu hususta konumuza yakın bir örnek vermek gerekirse, Milattan Önce 10 bin yıllarında ılıman iklimin ve büyük göllerin olduğu Orta Asya'nın kuruması ve çölleşmesi sonucu bölgedeki Türk grupların çevre ülkelere yayılan ve kültürlere etki yapan Ön-Türkler'in Yunanistan'a ilk adını veren olduğu, Yunanistan'ın isimlendirilmesinin de köken olarak Ön-Türklerin kullandığı dile dayandığı yapılan araştırmalarda belirtilmektedir (Yazıcı, 2013: 250). Bu itibarla Ege isimlendirmesinin de Ön Türkçede yer alan; akarsu, deniz, su örtüsü anlamındaki "ÖG-ÜZ", "EG-İZ" kelimesinden geldiği savunulmaktadır (Tarcan, 1998: 27).

Ege kelimesinin kökenlerine inildiğinde, Yunan filolojisi ile açıklanamayan Ege isminin mitolojiye dayandırılmasının nedenleri anlaşılmaktadır. Coğrafyanın adlandırılmasında kullanılan isimlerin kökenlerinde yapılan etimolojik çalışmalar, günümüzde tarihsel sahiplik iddialarının vazgeçilmez bir unsuru olarak ortaya çıkmaktadır. Örneğin, Ön-Türklerin bir kolu olan Pelasglar'ın Yunanistan Yarımadasında bulunan Attika bölgesine yerleştiklerini ve Pelasg dilinde "Paelak – Su geçidi" anlamına geldiği, Helen dilinde deniz anlamına gelen kelimenin de Pelasg dilindeki "Paelak" dan geçtiği ve "Pelagos" olarak yerleştiği belirtilmektedir." (Tarcan, 1998: 27). Anadolu'daki yer isimlerinin etimolojik incelemesini yapan Bilge Umar'ın çalışmasında da, Anadolu'da kullanılan diğer birçok tarihi isim gibi Ege kelimesinin de, Anadolu'da yaşamış uygarlıkların kullandığı dilden miras kaldığı belirtilmektedir (Umar, 1993: 29). Yine yukarıda bahsedildiği üzere, Ön-Türkçe' de benzer bir ifadenin deniz, akarsu, su örtüsü anlamına gelen "Ög-Üz"ün, Ege Denizi için kullanıldığı ve bunun Antik Yunan döneminde Aegeus şekline dönüşmüş olabileceği düşünülmektedir.

Bu konuda, Çanakkale-Tübingen Troia Vakfının kurucusu ve Truva ile ilgili araştırma, değerlendirme ve yayın çalışmaları yapan, Prof. Dr. H.c. Manfred Osman Korfman tarafından ileri sürülen bulgular, Ön-Türk kültürünün Anadolu'daki yansımaları açısından oldukça önemlidir. Korfman, "Ön-Türk kültürünün karakteristiklerinden olan ateş kültürü varlığının Truva'da da görüldüğünü, Truvalıların ölülerini yaktığını, Truva Savaşı esnasında Truva Şehri içerisinde Turci'lerin varlığından bahsetmekte ve Truva'nın esas adının Wiluşa olduğunu, Wiluşa ifadesinin, Luwi diline Ön-Türkçe'den geldiğini, anlamının ise "Kutsal Halk Yönetimi" olduğunu belirtmektedir." (Akarı, 2005: 36). Anadolu Kıyıları ile Balkan Yarımadası arasında yer alan deniz alanının isimlendirilmesi konusu başta olmak üzere, Anadolu ve çevre uzantıları içerisinde yer alan coğrafi yerlere verilen isimlerin, etimolojik kökenlerini Anadolu'ya Asya'dan gelmiş olan Ön-Türkler tarafından verilmiş olabileceği değerlendirilmektedir. Bununla birlikte, yukarıda değinilen kelimelerin anlamları üzerinden yapılan incelemelerde Helen kültürünün, Anadolu coğrafyası ve yakın çevresi üzerinde mutlak bir hâkimiyeti olduğuna ilişkin bilimsel verilere ulaşılamamıştır. Sadece mitolojik efsaneler kullanılarak, Anadolu ve yakın coğrafyası üzerinde isimlendirmeler yapıldığı tespit edilmiştir.

Bu çalışma çerçevesinde, Ege Denizi'nin isimlendirilmesine yönelik olarak incelenmesi gereken diğer bir kelime de coğrafi bir tanım olan "Archipelago" dur. Ege Denizi'nde bulunan adaların mevcut varlığının fazlalığı nedeniyle Ege Denizi'nin gerçek adının bu kelimeden yani "Achipelago" kelimesinden kaynaklanan "Adalar Denizi" olduğunu savunan araştırmacı, yazar ve bilim adamları da vardır ve bu görüşlerini belgelere dayanarak savunmaktadırlar. Ege denizinde bulunan adaların çokluğu nedeniyle bu deniz alanı bazı yabancı ve Türk kaynaklarında "Adalar Denizi" olarak adlandırılmıştır. Uluslararası ölçekte takımadalar ya da adalar grubuna verilen isim olan Achipelago İngilizce' de de aynı şekilde kullanılmakta, Fransızca' da L'archipel, İtalyanca'da Arcipelago olarak yer almaktadır. Bahse konu kelime tamamen bir coğrafi ifade olan takımadaları belirtmek için kullanılmaktadır ve bir isim olarak anlamlandırılmamalıdır. "The Archipelago" olarak "Adalar Denizi" ise sadece Ege Denizi'ni belirtmek için kullanılan bir ifade değildir. Dünyanın çeşitli bölgelerinde de The Archipelago olarak adlandırılan bölgeler bulunmaktadır. Örneğin, Finlandiya kara suları içerisinde Botinya Körfezi, Finlandiya Körfezi ve Âland Denizi arasında yer alan ve Baltık Denizi'nin bir parçası/kolu olan deniz, buradaki ada grubu nedeniyle Archipelago olarak adlandırılmıştır (Rytkönen ve Kinossian, 2019: 2).[2]

Anadolu'ya gelen Türk Boyları, Anadolu'nun en batı ucuna vardıklarında karşılaştıkları büyük deniz ve denizdeki adaların çokluğunu görünce bu denize "Adalar Denizi" adını verirler. Ege Denizi'nin "Adalar Denizi" olarak adlandırılması, bölgede hüküm süren Aydınoğulları Beyliği ve Osmanlı kaynaklarında da "Adalar Denizi" veya "Adalar Arası" olarak belirtilmiştir. Bu çerçevede elde bulunan en değerli kaynaklardan biri olan, Piri Reis'in 1519 tarihli Kitab-ı Bahriye'sinde; "Bilmek gerekir ki kim ada arası demekle maruf olan ve kefere taifesi arsu paluga dimeğiyle meşhur olan Cezayir-i tertip üzerine münasip olanı beyan eyledik. Amma bu mahalde lazım olan budur kim Rumili kenarlarının ve Efrenc kenarların beyan iderüz" ifadesini kullanmıştır (Reis, (Haz. Tayyar Arı), 2008: 218). İfadeden de anlaşılacağı üzere "Adalar Arası" olarak belirtilen bölge Ege Denizi'nin olduğu alanı karşılamaktadır. Bahse konu alanın "Adalar Denizi" olarak isimlendirilmesi yabancı kaynaklarda da belirtilmiştir. Nitekim 1570 yılında Abraham Ortelius tarafından yayınlanan "Theatrum Orbis Terrarum" isimli Coğrafya Atlasındaki Anadolu ve Balkanlar kısmını gösteren bölümünde, Ege Denizi üzerinde; "Arci Pelago" yazılıdır (Manners, 2007: 37). Ayrıca, Ortelius'un oluşturduğu bu harita, Faik Sabri Duran'ın Lise Kitapları: Sınıf I, 1938 yılı baskılı "Umumi

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[2] Ayrıca, Yunanistan her ne kadar kendisini bir arşipel devlet olarak tanımlasa da bu 1982 Birleşmiş Milletler Deniz Hukuku Sözleşmesinin (BMDHS) madde 46 gereği mümkün değildir. Çünkü 1982 BMDHS 46'ncı maddenin a bendi, "Takımada Devleti" ni, bütünüyle bir veya birçok takımadadan oluşan ve başka adaları da ihtiva edebilen bir devlet olarak tanımlamaktadır.

Coğrafya Dersleri" adlı kitabının, 44'üncü sayfasında da verilmiştir (Özey, 1999: 30). Hollandalı Hendrick Doncker'in 1676 yılında bastığı atlasın İtalyanca versiyonunda da Ege Denizi "Archipelago-Adalar Denizi" olarak adlandırılmıştır (Manners, 2007: 116).

1656 tarihli "Tuhfetü'l-Kibar Fi Esfari'l-Bihar" (Deniz Savaşları Hakkında Büyüklere Armağan) adlı eserinde Kâtip Çelebi'de, "Boğaz'dan taşıra Rumeli kenarları, Eceovası, İnöz, Kavala, Avanoroz, Lonkoz, Kesendire, Selanik Körfezi, Koloz ve İzdin Körfezleri ve Eğriboz, Atina ve Mora'dan Anadolu ve Menekşe Burnu ki Anadolu'da Tekir Burnu nice ise Rumeli'nde bu dahi öyle köşeler ve güzergâhıdır. Karadan deryaya girip Girid ceziresinin şarkî ve garbî uçları bu iki burunlar önüne mümted olup sâyîr Akdeniz cezîreleri ekser bu ortada vâkî olmuştur. Olecilden bu ortalığa "Adalar Arası" derler." olarak yazmıştır (Çelebi, 2018: 79).

"Osmanlılar, Balkan Yarımadası ile Anadolu Sahilleri arasındaki deniz alanı için Ege adını hiç kullanmamışlar, önce bu denize yeni bir isim vermeden eski Türk yön isimlendirmesine göre (Özey, 1999: 213)[3] "Akdeniz" olarak daha sonra "Adalar Denizi (Bahr-i Sefid)" şeklinde adlandırmışlardır. "Adalar Denizi" sınırlarının, Çanakkale Boğazı girişinden başlayıp Girit Adası'nda son bulduğu Osmanlı coğrafya eserlerinde sıkça belirtilmektedir. Daha kesin bir ifade ile Anadolu ve Rumeli sahilleri ile Girit Adası mesafe "Adalar Denizi" dir ve Rodos'tan aşağısı Akdeniz olarak belirtilmiştir" (Bostan ve Kurumahmut, 2003b: 5). 1259 (Hicri)/1843 tarihli Mekteb-i Bahriye' de hazırlanan Ege Denizi Haritasında da Ege Denizi'nin, Bahr-i Sefid yani "Adalar Denizi" olarak adlandırıldığı görülmektedir (Bostan ve Kurumahmut, 2003b: 43-44). Mahir Mehdi tarafından yazılan 1898 (1314) tarihli Bedreka-i Zafer Yahud Teselya ve Yenişehir adlı eserde, Kiklat ada grubu tanıtılırken, Kiklad, "Adalar Denizinde" ve Mora yarımadasının doğu kıyıları karşısında bulunan birçok büyük, küçük adalardır." olarak belirtilmektedir (Kodaman, 1993: 85). Bu adlandırma, Osmanlı resmi yazışmalarında da bu şekilde geçmektedir (Bostan ve Karamahmut, 2003a). Yine aynı şekilde, Ali Tevfik tarafından 1913 tarihinde kaleme alınmış olan "Memalik-î Osmaniye'nin Coğrafyası adlı kitapta, Ege Denizi'nin adı "Adalar Denizi olarak belirtilmiştir. Ayrıca, 20'nci yüzyıl başlarında basılan Ege Denizi ve adalar trafiği için kaleme alınan rehber kitaplar arasında Bahriye Matbaasında basılan "Bahr-î Sefid Kılavuzu-Adalar Denizi'ne Âid" isimli eserle, Ahmet Râsim'in derlediği "Türkiye Adalar Denizi Kılavuzu, İmroz'dan Marmaris Burnu'na Kadar" isimli çalışmada da Ege Denizi, "Adalar Denizi" olarak isimlendirilmiştir.

Türkiye Cumhuriyetinin kurulması sonrasında; "Adalar Denizi" ifadesine, Deniz Matbaası tarafından basılan 1930 tarihli "Türk ve Yunan Deniz Harbi Hatıratı ve 1909-1913 Yunan Bahri Tarihi" adlı eserde ve 1931 tarihli "Mükemmel Umumi Atlas'ta rastlanmıştır (Akarı, 2005: 49). Deniz Müzesi Müdürlüğünce 2001 yılında hazırlanan "Türk Deniz Müzesi Harita Kataloğunda da, Ege Denizinin adlandırılmaları ile ilgili tespit edilen bulgular aşağıda olduğu gibidir (Akarı, 2005: 49).

Sayfa 40, 1854 tarihli Fransızca, yapılan adlandırma, Carte De La Meridoinale De L'archipel,

- Sayfa 54, 1860 tarihli İngilizce, yapılan adlandırma, Archipelago,
- Sayfa 70, 1954-1957 tarihli Yunan haritalarından, Yunanistan Selanik Körfezini gösteren harita, yapılan genel adlandırma, Mediterrannean,
- Sayfa 100, 1835 tarihli, İngilizce, yapılan adlandırma, Archipelago,
- Sayfa 122, 1863 tarihli, İngilizce, yapılan adlandırma, Archipelago,
- Sayfa 229, Osmanlıca, yapılan adlandırma, Adalar Denizi
- Sayfa 231, 1914-1915 tarihli, Osmanlıca, Bahri sefid (Akdeniz) Adalar Denizi
- Sayfa 245, 1923-1928 tarihli, Osmanlıca, Bahri sefid (Akdeniz) Adalar Denizi
- Sayfa 275, 1930 tarihli, Türkçe (Latin Alfabe ile basılmıştır), İzmir Körfezi ve Sakız Adasını göstermekte ve Adalar Denizi ifadesini kullanmaktadır.

[3] Türkler coğrafyayı adlandırırken yönler ve renkler arasında bir ilişki kurmuşlardır. Bu ilişki renklerin bir yönü ifade etmesine dayanır. Türklerin renkleri anlatırken kullandıkları renkler şu şekildedir; Doğu: Mavi ve yeşil, Batı: Ak, beyaz, Kuzey: Kara, siyah, Güney: Kırmızı, Kızıl.

Ayrıca bahse konu harita kataloğunda toplam sayıları üç adet olan ve üzerinde Ege ifadesi olduğu değerlendirilen haritalara ait bilgiler ise şu şekildedir. Sayfa 409, 1684 tarihli, Fransızca, Avrupa'da Türk İmparatorluğu başlıklı haritada yapılan adlandırma, Archipel, Mer Blanche, Mer Aegee, Sayfa 415, 1662 tarihli, Coğrafi ve Tarihi bilgiler içeren Asya Atlasında yapılan adlandırma, Archipelago Mare Aegeaum ve Sayfa 431'de bulunan haritada yapılan adlandırma, Aegean Sea Archipelago, şeklindedir.

Osmanlı, Ege Denizi'ni "Adalar Denizi" şeklindeki isimlendirmiş ve Cumhuriyetin ilanından sonrada hem "Adalar Denizi" hem de nadiren "Ege Denizi" isimlendirmelerinin ikisi birlikte o dönemde kullanılmıştır. Ancak, 6-21 Haziran 1941 tarihleri arasında, Ankara Dil Tarih ve Coğrafya Fakültesinde gerçekleştirilen Birinci Coğrafya Kurultayında coğrafi bölgelerin isimleri standart hale getirilmiştir. Birinci Coğrafya Kurultayı ile Türkiye coğrafyası ilk defa yedi bölgeye ayrılarak tanımlanmıştır. Birçok alanda terim birliğinin sağlanması ve karışıklığın önlenmesi için yapılan Birinci Coğrafya Kurultayı ile birlikte, Anadolu Yarımadası ile Balkan Yarımadası arasında bulunan "Adalar Denizi" olarak bilinen denizalanı, "Ege Denizi" olarak isimlendirilmiştir. Ege Denizi'nin adlandırılması ile ilgili tarihsel süreç incelendiğinde kökü 5'inci yüzyıl ve öncesine dayanan bir Helen mitolojisi ile anlatılma çabası içerisine girilmiştir. Bu tamamen elde mevcut isimlerin hikâyeler ile açıklanmasına dayandırılmaya çalışılmıştır. Bu alanda tabii olarak en çok anlatılan ve ısrarla savunulanlar sonuç bulmuş ve kabul görmüştür.

3. SONUÇLAR

Anadolu Kıyıları ile Balkan Yarımadası arasında yer alan deniz alanında yaşanan olayların, tarihsel perspektiften bağımsız ve güncel olaylardan ayrı olarak değerlendirilmesi olanaksızdır. Bu denizin adını, Yunan mitolojisinde, oğlunu öldü sanarak kendisini kayalardan atarak intihar eden Atina Kralı Aegeus'tan aldığı iddiaları (Ceccarelli, 2012: 32) da oldukça yavan, bilimsellikten uzak ve efsaneden türetilmiş bir yaklaşımdır. Bu denizin neden Ege olarak adlandırıldığı ve bu adın nereden geldiği konusu etimolojik açıdan incelendiğinde, Ege kelimesinin, Helen kültürünün dip kültürü Luwi diline ve bu dilin temelinde de Ön-Türkçe "akarsu, deniz su örtüsü" anlamına gelen "Ög-Uz, Ög-İz" kelimeleri ile bir dil bağı bulunduğunu öne süren görüşler de bulunmaktadır (Tarcan, 1998: 27).

Anadolu Kıyıları ile Balkan Yarımadası arasındaki denizin isimlendirilmesinde, Ege kelimesinin etimolojik olarak Yunanca ile bir bağı olduğu açıklanamadığından, coğrafyayı sahiplenme gayretleri içerisindeki Yunanlılar tarafından bu husus bir Yunan Kralı ile bağlantılı mitolojik bir hikâyeye dayandırılmıştır. Tarihten günümüze uzanan süreçte, daimi ve dinamik bir etkileşim merkezi kimliğine sahip olan ve çeşitli kültürel unsurları bünyesinde buluşturan Ege Denizi'nin, yukarıda belirtilen mitolojik karakterlerden yola çıkılarak isimlendirilmesi savı bilimsel bir zeminden oldukça uzaktır ve sorgulanmaya müsaittir. Öyle ki Ege Denizi'nin adlandırılmasına kaynaklık ettiği savunulan söz konusu mitolojik karakterler, zaman zaman belirli halklar veya topluluklarca benimsenmemiş olacak ki bu konuda farklı efsaneler de ileri sürülmüştür.

Coğrafya açısından bakıldığında, bu deniz alanına serpilen irili ufaklı pek çok adanın bulunması nedeniyle, Anadolu Yarımadası'na gelen ve batı kıyılarına ulaşan Türk Boyları bu deniz alanını Adalar Denizi olarak adlandırmışlardır (Özey, 2001: 31). Osmanlı Devletinin gelişip güçlenmesi ile bu bölgede hâkimiyet kurması ile Osmanlılar, İstanbul Boğazı'nın kuzeyinden başlayıp, Marmara ve Ege Denizi ile Akdeniz'i kapsayan alana "Bahr-î Sefid" adını vermişlerdir. Osmanlılar bu denizi Akdeniz'den ayrı bir parça olarak görmekten ziyade bir bütün olarak görmüşlerdir. Ancak zaman içinde Osmanlıca kitaplar ile belgelerde Ege Denizi'ni "Adalar Arası" veya "Adalar Denizi" ifadesi ile adlandırmışlardır.

Osmanlıca en eski kaynaklardan biri olan Piri Reis'in 1519 tarihli Kitab-ı Bahriyesi ile Katip Çelebi'nin 1656 tarihli, "Tuhfetü'l-Kibar Fi Esfari'l-Bihar" isimli eserinde Ege Denizi'nin adı olarak "Adalar Arası" ifadesine rastlanılmıştır (Reis, (Haz. Tayyar Arı), 2008: 218; Çelebi, 2018: 79). Bununla birlikte, 1570 yılında Abraham Ortelius tarafından yayınlanan "Theatrum Orbis Terrarum" isimli Coğrafya Atlasında ve Hollandalı Hendrick Doncker'ın 1676 yılında bastığı atlasın İtalyanca versiyonunda Ege Denizi, "Archipelago-Adalar Denizi" olarak adlandırılmıştır.

Ege ifadesi, 1941 Haziran ayında Ankara'da düzenlenen 1'inci Coğrafya Kongresinde alınan kararla resmi olarak Türkçe' ye dâhil edilmiş ve Anadolu kıyıları ile Balkan Yarımadası arasında yer alan deniz alanı için kullanılmaya başlanmıştır. Bu adlandırmaya mukabil, Osmanlılar yaklaşık olarak 400 yıl hüküm sürdükleri "Ege Denizi"ni "Adalar Denizi" olarak adlandırmış ve Osmanlı resmi belgelerinde de bu deniz alanı "Adalar Denizi" olarak yer almıştır. Bu nedenle, Ege Denizi'nin isimlendirilmesinde "Adalar Denizi" ifadesini Osmanlı'dan kalan bir miras olarak kabul ederek kullanılmasının uygun olacağı var sayılmaktadır.

ESER SAHİPLİĞİ KATKI BEYANI

Murat Kağan KOZANHAN: Kavramsallaştırma, Yöntem Bilimi, Doğrulama, Şekilsel Analiz, Kaynaklar, Yazım-Orijinal Taslak, Yazım-Gözden Geçirme ve Düzenleme.

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Accumulation of Heavy Metals (Fe, Cu, Mn, Zn, Cd, Co and Pb) in *Hemiramphus archipelagicus* Collette & Parin, 1978 and *Hemiramphus far* (Forsskål, 1775) from Ibrahim Hyderi Fish Harbor, Karachi, Pakistan

Türk Denizcilik ve Deniz Bilimleri Dergisi

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ABSTRACT

In this study, the presence of heavy metals (Fe, Cu, Mn, Zn, Cd, Co and Pb) in the muscle tissue of *Hemiramphus archipelagicus* Collette & Parin, 1978 and Hemiramphus far (Forsskål, 1775) caught in the Ibrahim Hyderi Fish Harbor, Karachi, Pakistan was investigated. The concentration ranges of trace elements in muscles tissue of *Hemiramphus archipelagicus* and *Hemiramphus far* were found as follows, respectively: Fe: 19.570 - 62.140 µg g^{-1}; Cu: 0.120 - 1.770 µg g^{-1}; Mn: 0.001 -0.080 µg g^{-1}; Zn: 7.230 - 36.450 µg g^{-1}; Cd: 0.001 - 0.008 µg g^{-1}; Co: 0.001 - 0.008 µg g^{-1}; Pb: 0.002 - 0.080 µg g^{-1}; Fe: 16.320 - 63.250 µg g^{-1}; Cu: 0.130 - 1.220 µg g^{-1}; Mn: 0.010 -0.080 µg g^{-1}; Zn: 7.260 - 20.160 µg g^{-1}; Cd: 0.000 - 0.008 µg g^{-1}; Co: 0.000 - 0.001 µg g^{-1}; Pb: 0.010 - 0.080 µg g^{-1}. Metal concentrations in muscle tissues of *Hemiramphus archipelagicus* and *Hemiramphus far* were decreased as follows, Fe>Zn>Cu>Mn>Pb>Cd>Co. All metal accumulations in muscle tissues of *Hemiramphus archipelagicus* and *Hemiramphus far* samples collected from Ibrahim Hyderi Fish Harbor were not to be exceeding the limit and all values are under the permissible range. Therefore, it is important to continue to protect the Ibrahim Hyderi Fish Harbor against possible dangers that may increase heavy metal pollution, to ensure that the measures taken are maintained in the same way and carried out regular controls.

Keywords: *Hemiramphus archipelagicus*, *Hemiramphus far*, Bioaccumulation, Ibrahim Hyderi Fish Harbor, Pakistan

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1. INTRODUCTION

Heavy metal pollution has become a serious problem worldwide due to increasing pollution levels and its effects on human health. In parallel with environmental pollution, food sources are also polluted and can create important health problems for people. The rapid development of industry and agriculture; it has caused the pollution of rivers, lakes and seas with heavy metals and this pollution has caused significant damage to the ecological environment, invertebrates, fish and people. Biologically, heavy metal accumulation in foods is an important place for human health and the continuation of the ecosystem (Djedjibegovic *et al*., 2012).

There are many toxic heavy metals in the environment that cause pollution of seas and rivers. The main sources of heavy metals that disrupt the ecological balance are; agricultural drainage, factory wastes, sewage flows, mixing of chemical flows into the waters, oil flows from sea vehicles, some organic materials, oils, agricultural fertilizers, fossil fuels, pesticides and various chemicals (Subotic *et al*., 2013; Velusamy *et al*., 2014). The creatures living in the marine ecosystem are accepted as important bioindicators in terms of heavy metals and toxic substances in the water. The reason for this is that heavy metals in water directly affect the biology and metabolism of sea creatures, and these creatures constantly store heavy metals in their digestive system, skin, shells, livers and, albeit in small amounts, in their muscles (Morgano *et al*., 2011; Subotic *et al*., 2013; Velusamy *et al*., 2014).

Heavy metals negatively affect the health of fish by creating toxic effects on the metabolism of fish as well as humans (Yousuf *et al*., 2021). Water, fat, protein and toxin/heavy metal ratio in the body of creatures living in the sea and consumed by humans are important indicators for the health and physiological status of fish (Özan and Kir, 2008). Heavy metals accumulating in rivers, seas and lakes can reach people through the food chain (Alhas *et al*., 2009). In this case, routine monitoring of heavy metal levels in both waters and sea creatures has become mandatory in order to determine whether seafood is suitable for health (Soliman *et al*., 2015).

Fish of the family Hemiramphidae are generally known as half-beaks, with the exception of a few freshwater members of the genus Hyporhamphus, mostly marine, because the lower jaw is as long as a beak (Behera *et al*., 2020). Spines are absent in fins. Represented in Indian waters by 17 species in 7 genera (Nair *et al*., 2018). Several studies on heavy metal accumulation have been carried out in other parts of the world on various fish species (Asmysari *et al*., 2013; Nursanti *et al*., 2017; Sadeghi *et al*., 2020; Shiry *et al*., 2021; Köker *et al*., 2021).

In this study, the presence of heavy metals (Fe, Cu, Mn, Zn, Cd, Co and Pb) in the muscle tissue of *H. archipelagicus* Collette & Parin, 1978 and *H. far* (Forsskal, 1775) caught in the Ibrahim Hyderi Fish Harbor, Karachi, Pakistan was investigated. It is aimed to reveal whether they are suitable for human consumption or not.

2. MATERIAL AND METHOD

Ibrahim Hyderi is a fishing village in the Korangi District of Karachi, Pakistan. The most distinctive component of the area is contiguous to Koranghi Creek. The popular Koranghi Road encompasses the industrial area; the zone has a wharf stretching out to Korangi Creek. The break wateris generally known as Ibrahim Hyderi Fish Harbor which has critical economic significance for the local fisherman of the area (Shahzad, 2020).

H. archipelagicus and *H. far* were collected during the period (Pre Monsoon (Feb-Mar), Monsoon (Aug-Sep) and Post Monsoon (Oct-Nov)) from October 2018 to September 2019 from Ibrahim Hyderi Fish Harbor, Karachi, Pakistan. Pakistan has a subtropical monsoon climate characterized by wide seasonal variations in rainfall, moderately warm temperatures, and high humidity. Generally, Pre-monsoon months are hot and humid; monsoon months are humid and rainy, post-monsoon months are quiet hot and dry but the winter months are cool and dry. These periods were chosen in order to see the effect of monsoon periods. The fish samples were collected from the Ibrahim Hyderi Fish Harbor were washed using deionized water and place in separated labeled polyethylene bags and kept in ice box. The samples were kept in freezer (-20 C°) until ready for analyses.

The concentration of the heavy metals i.e., iron (Fe), copper (Cu), manganese (Mn), zinc (Zn), cadmium (Cd), cobalt (Co), lead (Pb), and measured in mg/L of both pond water samples and fry stages of *H. archipelagicus* and *H. far* collected from the Ibrahim Hyderi Fish Harbor of district Kohat were also determined by using Atomic Absorption Spectrophotometer (AAS), model Analyat 700 USA with methods followed by Kaur *et al*. (2018) as per standards methods of American Public Health Association (APHA, 2005). The absorption wave lengths (λ) used for the determination of various metals are as follows: Fe, 248.30 nm; Cu, 324.70 nm; Mn, 279.50 nm; Zn, 213.90 nm; Cd, 228.80 nm; Co 240.73 nm and Pb 217.00 nm. Due to the lack of a reference standard material, accuracy of the analysis and the effect of the matrices in the media were controlled with the standard addition method. All studied elements were tested with standard addition method for 3 randomly selected samples. Approximately 20 ml filtered water and fish sample solution was taken for heavy metal analysis.

One-way Analysis of Variance (ANOVA) was used to determine significant differences ($p \leq 0.05$) while post hoc Tukey's (HSD) test was used to separate means where there were significant differences.

3. RESULTS

The lengths (cm) and weights (g) of *H. archipelagicus* and *H. far* 36 samples obtained for element analyses are given in Table 1. Metal concentrations in muscle tissues of *H. archipelagicus* and *H. far* are presented in Tables 2-3, respectively which include mean concentrations with associated standard deviations, minimum and maximum values, and the international limit values.

Table 1. Lenght and weight of fishes.

Season	n	*Hemiramphus archipelagicus*		*Hemiramphus far*	
		Length Min-Max (cm)	Weight Min-Max (gr)	Length Min-Max (cm)	Weight Min-Max (gr)
Pre-Monsoon	12	14.00-19.20	33-66	16.00-19.30	41-65
Monsoon	12	17.80-22.00	49-78	14.30-20.50	36-74
Post Monsoon	12	15.50-19.50	40-63	13.70-22.80	31-78
All Seasons	36	14.00-22.00	33-78	13.70-22.80	31-78

n, number of fish.

Table 2. Heavy metal concentrations in muscle of *H. archipelagicus*

Season	Mean± SD Min-Max						
	Fe	Cu	Mn	Zn	Cd	Co	Pb
PM	30.965±9.57	0.783±0.310	0.043±0.02	12.061±3.95	0.003±0.002	0.000±0.000	0.026±0.028
	19.570-46.800	0.240-1.210	0.020-0.080	7.230-19.360	0.001-0.007	0.000-0.0001	0.002-0.080
M	37.395±11.371	0.685±0.465	0.033±0.028	18.522±4.397	0.003±0.002	0.000±0.000	0.033±0.017
	21.500-56.300	0.210-1.770	0.004-0.080	12.540-26.320	0.001-0.008	0.000-0.001	0.010-0.060
PoM	43.918±13.8	0.410±0.382	0.030±0.025	22.513±7.576	0.003±0.002	0.000±0.000	0.033±0.023
	26.450-62.140	0.120-1.110	0.001-0.080	14.420-36.450	0.001-0.008	0.000-0.001	0.010-0.080
AS	37.426±12.334	0.626±0.411	0.035±0.025	17.699±6.935	0.003±0.002	0.000±0.000	0.030±0.023
	19.570-62.140	0.120-1.770	0.001-0.080	7.230-36.450	0.001-0.008	0.000-0.001	0.002-0.080

PM: Pre-Monsoon; M: Monsoon; PoM: Post Monsoon; AS: All Season

Table 3. Heavy metal concentrations in muscle of *H. far*

Season	Mean± SD Min-Max						
	Fe	Cu	Mn	Zn	Cd	Co	Pb
PM	41.303±15.014	0.795±0.330	0.045±0.021	14.152±3.454	0.001±0.001	0.000±0.000	0.021±0.024
	18.240-63.250	0.330-1.220	0.020-0.080	8.560-19.630	0.000-0.003	0.000-0.000	0.010-0.080
M	24.478±10.885	0.563±0.138	0.023±0.015	13.592±3.792	0.003±0.002	0.000±0.000	0.026±0.020
	16.360-50.740	0.360-0.780	0.010-0.060	8.210-.20.160	0.001-0.006	0.000-0.001	0.010-0.080
PoM	24.359±8.349	0.243±0.168	0.028±0.020	11.473±3.213	0.004±0.003	0.000±0.000	0.024±0.019
	16.320-44.190	0.130-0.740	0.010-0.080	7.260-17.460	0.001-0.008	0.000-0.001	0.010-0.060
AS	30.047±13.970	0.533±0.319	0.032±0.021	13.072±3.589	0.002±0.002	0.000±0.000	0.025±0.019
	16.320-63.250	0.130-1.220	0.010-0.080	7.260-20.160	0.000-0.008	0.000-0.001	0.010-0.080

PM: Pre-Monsoon; M: Monsoon; PoM: Post Monsoon; AS: All Season

4. DISCUSSIONS

Table 2 and Table 3 show that mean metal concentrations in the tissues of *H. archipelagicus* and *H. far* and international limits. Fish muscle tissue has been considered in the study of heavy metal concentration, since fish tissues are exposed to metal contamination in the aquatic system (Carla *et al*., 2004; Al-Kahtani, 2009). In this study, it was found that Fe (37.426±12.334 µg/g) for *H. archipelagicus* and Fe (30.047±13.970 µg/g) for *H. far* show higher concentration than other metals. Due to the absence of heavy metal (Fe, Cu, Mn, Zn, Cd, Co and Pb) studies in *H. archipelagicus* and *H. far*, some studies were examined for comparison.

Table 4. Comparison of concentrations in fish tissues reported in the literature

Location	Fish	Metal concentration (µg g−1 dry wt.)							Reference
		Fe	Cu	Mn	Zn	Cd	Co	Pb	
Marmara Sea (3rd station)	*T. mediterraneus*	83	1.0	-	21	0.3	-	0.8	Köker *et al*., 2021
	M. merlangus	63.1	0.6	-	19.6	0.2	-	0.9	
Gulf of Guinea	*S.aurita*	2.66	0.25	-	0.41	<0.2	-	<0.5	Botwe, 2021
	P.bellottii	1.23	0.04	-	0.17	<0.2	-	<0.5	
Liusha Bay	*S.albella*	-	1.50	-	14.2	0.03	-	0.55	Yang *et al*., 2020
Southeastern India	*H. archipelagicus*	-	-	-	-	-	-	6.34	Rajaram *et al*., 2018
	H.far	-	-	-	-	1.4	-	8.6	
Ibrahim Hyderi Fish Harbor	*H.archipelagicus*	37.426	0.626	0.035	17.699	0.03	0.000	0.030	This study
	H.far	30.047	0.533	0.032	13.072	0.02	0.000	0.025	
International limits		100	30	1.0	50	1.0	-	0.50	WHO, 1989
		-	10-100	-	40	0.5	-	0.50	FAO, 1983
		410	54	-	410	1.4	-	-	EPA, 1989

Fe concentration in *H. archipelagicus* and *H. far* had much higher values in the literature (Botwe, 2021) except for Köker (2021). Cu concentration in *H. archipelagicus* and *H. far* was lower values in the literature (Köker *et al*., 2013; Yang *et al*., 2020) and higher than Botwe (2021). Cd and Pb concentrations in *H. archipelagicus* and *H. far* were found to be lower than the studies in the literature (Köker *et al*., 2013; Rajaram *et al*., 2018; Botwe, 2021; Yang *et al*., 2020). Zn concentration in *H. archipelagicus* and *H. far* was found to be lower than Köker *et al*. (2018) and higher than Botwe (2021). No comparable study could be found in the literature, while the Mn and Co concentrations of *H. archipelagic* and *H. far* were examined (Table 4).

The variability observed in the metal levels of different species depends on feeding habits (Watanabe *et al*., 2003), ecological needs, metabolism (Canlı *et al*., 1998), age, size and length of the fish (Al-Yousuf *et al*., 2000) and their habitats (Canlı and Atli, 2003). The characteristics of the ecosystem, the quality of the water and the nutritional needs reveal this situation.

In this study, it was determined that the metal concentration for both species decreased towards November and was the highest in February. The increase in the amount of metal in the spring and the increase in agricultural activities (spraying, fertilizing and irrigation) around the lake due to evaporation after the summer months show that there is a decrease in the autumn and winter months. It has been evaluated that the reason for the decrease may be due to low evaporation and precipitation.

The ANOVA results reveal that all heavy metals vary significantly between seasons and heavy metal concentrations in fish tissues. The concentration ranges of trace elements in muscles tissue of *H. archipelagicus* and *H. far* were found as follows, respectively: Fe: 19.57-62.14 μg g^{-1}; Cu: 0.12-1.77 μg g^{-1}; Mn: 0.001-0.08 μg g^{-1}; Zn: 7.23-36.45 μg g^{-1}; Cd: 0.001-0.008 μg g^{-1}; Co: 0.001-0.008 μg g^{-1}; Pb: 0.002- 0.08 μg g^{-1}; Fe: 16.32-63.25 μg g^{-1}; Cu: 0.13- 1.22 μg g^{-1}; Mn: 0.01-0.08 μg g^{-1}; Zn: 7.26-20.16 μg g^{-1}; Cd: 0.000-0.008 μg g^{-1}; Co: 0.000-0.001 μg g^{-1}; Pb: 0.01-0.08 μg g^{-1}. Metal concentrations in muscle tissues of *H. archipelagicus* and *H. far* were decreased as follows, Fe>Zn>Cu>Mn>Pb>Cd>Co.

All metal accumulations in muscle tissues of *H. archipelagicus* and *H. far* samples collected from Ibrahim Hyderi Fish Harbor were not to be exceeding the limit and all values are under the permissible range. Therefore, it is important to continue to protect the Ibrahim Hyderi Fish Harbor against possible dangers that may increase heavy metal pollution, in order to ensure that the measures taken are maintained in the same way and to carry out regular controls.

5. CONCLUSION

As a result, it has been determined that fish *H. archipelagicus* and *H. far* from İbrahim Hyderi Fish Port are not under the threat of contamination. For this reason, it is important to continue to be protected against possible dangers that may increase heavy metal pollution in the same location, to ensure that the measures taken are maintained in the same way and to carry out regular controls.

AUTHORSHIP CONTRIBUTION STATEMENT

Farzana YOUSUF: Conceptualization, Methodology, Validation, Formal Analysis, Resources, Supervision. **Semra BENZER:** Conceptualization, Methodology, Writing - Original Draft, Writing-Review and Editing, Data Curation, Software, Visualization. **Quratulan AHMED:** Methodology, Validation, Formal Analysis, Resources, Writing-Review and Editing.

CONFLICT OF INTERESTS

The author(s) declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

No ethics committee permissions is required for this study

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Vocational Preference Tendency Analysis of Maritime Transportation Management Engineering Undergraduate Students

Deniz Ulaştırma İşletme Mühendisliği Lisans Öğrencilerinin Meslek Tercih Eğilimlerinin İncelenmesi

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 8 Sayı: 1 (2022) 49-59

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ABSTRACT

Maritime is an essential profession for both Turkey and the world. 80-90% of the world trade volume is carried out by the ships and as might be expected seafarers. The most important part of the maritime profession is undoubtedly education. It is known that education at international standards in the field of maritime is provided by the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), published by the International Maritime Organization (IMO), and the flag state carries out the inspections. In order to receive an undergraduate and an associate degree in the field of maritime in Turkey, it is necessary to take the YKS exam, choose the relevant department of the university, and get enough scores to be placed in this department. The study aims to understand better the education and career paths chosen by maritime transportation management engineering students. In the study, the preference tendencies of the students who prefer this department in the universities that provide education in the maritime transport management engineering department and the professions that the students prefer outside the department were examined. As a result of the evaluations, the most popular preferences among the students who placed maritime transportation management engineering were computer engineering, ship machinery management engineering, electrical-electronic engineering, and nursing departments. The increase in the score in the YKS exam has had a significant and negative effect on the rate of students choosing maritime transportation management engineering. The data in this study were obtained from the YÖK Atlas database.

Keywords: Maritime, seafarers, occupational preference tendency, human factor

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ÖZET

Denizcilik hem ülkemiz hem de dünyamız için önemli bir meslek grubudur. Dünya ticaret hacminin %80-90'lık kısmı denizler ve haliyle denizciler vasıtasıyla gerçekleştirilmektedir. Denizcilik mesleğinin en önemli bölümü ise kuşkusuz eğitimdir. Denizcilik alanında uluslararası standartlarda eğitimin, uluslararası denizcilik örgütü (IMO) tarafından yayınlanan, gemi adamlarının eğitim, belgelendirme ve vardiya tutma standartları sözleşmesi (STCW) ile sağlandığı, denetimlerin ise bayrak devleti tarafından yapıldığı bilinmektedir. Ülkemizde denizcilik alanında lisans ve ön lisans eğitimi alabilmek için YKS sınavına girmek, üniversitenin ilgili bölümünü tercih edip yerleşmeye hak kazanmak gerekmektedir. Çalışmanın amacı, deniz ulaştırma işletme mühendisliği öğrencilerinin seçtikleri eğitim ve kariyer yollarını daha iyi anlamaktır. Yapılan çalışmada, deniz ulaştırma işletme mühendisliği bölümünde eğitim veren üniversitelerde bu bölümü tercih eden öğrencilerin tercih eğilimlerinin belirlenmesi ve öğrencilerin bölüm dışındaki tercihte bulundukları mesleklerin incelenmesi hedeflenmiştir. Yapılan değerlendirmeler sonucunda deniz ulaştırma işletme mühendisliği kazanan öğrenciler arasında en popüler tercihler sırasıyla bilgisayar mühendisliği, gemi makineleri işletme mühendisliği, elektrik-elektronik mühendisliği ve hemşirelik bölümleri olmuştur. YKS sınavında alınan puanın artması ile öğrencelerin deniz ulaştırma işletme mühendisliğine tercihte yer verme oranını anlamlı ve olumsuz şekilde etkilemiştir. Bu çalışmadaki veriler YÖK Atlas veri tabanından elde edilmiştir.

Anahtar sözcükler: Denizcilik, gemiadamı, mesleki tercih eğilimi, insan faktörü

1. INTRODUCTION

Maritime is an indispensable profession for both our country and the world. Commercial maritime education during the Ottoman period started in 1884 with the "Leyli Tüccar Kaptan Mektebi" (Karakaya, 2011). Commercial maritime education, based in Istanbul for many years in Turkey, has spread throughout the country, especially with the start of deck education departments at Dokuz Eylül University (DEU) in 1995 and Karadeniz Technical University (KTU) in 1996. The Department of Maritime Transportation Management Engineering is a program that continues to provide education at the undergraduate level in 8 public universities and 2 foundation universities as of the 2020-2021 academic year (YÖK, 2021).

Since the 1970s, technological advancement, the growth of international trade, and developments in supply chain management have increased the need for qualified employees in the maritime industry (Park *et al*., 2019). Many developed countries face the problem of a shortage of qualified and skilled shipments for maritime enterprises (Guo *et al*., 2006). Turkey's need for a skilled workforce in line with its strategic objectives in the naval sector is constantly increasing (Öztürk *et al*., 2020). Investment in human capital is a priority for sector stakeholders because the human element has a significant impact (Altınpınar and Başar, 2021) for commercial maritime operations. Today's rapid technological change leads to the emergence of new professions while reducing the economic opportunities of some occupations. Even if the use of autonomous technologies in maritime activities increases, human participation in many of the operations in the marine field will continue, and a qualified workforce will give enterprises an advantage in competition.

Students who cannot work in the maritime profession prefer these departments, which will cause a waste of resources (Fidan and Nas, 2019). Students' motivation, academic performance, and ability to assimilate new knowledge influence their career preference tendencies (Handoyo, 2018). Physical and mental difficulties make it difficult to practice the maritime profession (Yıldız *et al*., 2016; Erginer *et al*., 2019; Uğurlu *et al*., 2022). Maritime is a socially restricted profession compared to other occupations (Demir and

Gürkan, 2020; Uğurlu *et al*., 2018). A study in Taiwan (Chen, 2001) concluded that university graduates who do not know the maritime profession during the occupational preference have lower intentions to work onboard. The younger generation, who are not motivated to participate in the labor market and do not have the appropriate qualifications to become seafarer, will adversely affect the development of the maritime sector. For the candidate students who will choose the department of transportation management engineering in Turkey, standards such as age, height, weight, and physical fitness have been set universities. Prospective students must be successful in the exam that includes physical education interviews. Additionally, they have been asked to document that they can become seafarers with a health report (YÖK, 2021).

International regulations are considered in the institutions providing maritime education, and curriculum and practices are reshaped according to the frequently changing rules. In the maritime transportation management engineering department, curriculum, instructors, infrastructure, and training equipment are regularly inspected by the Turkey Ministry of Transport and Infrastructure (UAB) according to the requirements of the seafarers' training and examination regulations (Güzel and Bolat, 2020). Moreover, internationally accepted maritime training is provided in this department. With these audits, the aim is to ensure that naval education institutions train talented personnel and well-educated young people who will provide contributions to the maritime sector. With investments in naval education, it is aimed that high value-added seafarers are exported to the world maritime fleet, and shipment contributes to the country's economy. Although there are studies in the literature examining the profession preference trends of undergraduate students with YÖK data, there is no study yet for the marine transportation management engineering department.

1.1. Department of Maritime Transportation Management Engineering

The marine transportation management engineering department focuses on maritime safety and ship safety, marine and environmental protection, navigation, shipping, stability, shipping processes, cargo handling, maritime law, import/export contracts, warehouse processes, intermodal freight transportation, and port facilities. In higher education institutions, maritime students are asked to develop their professional skills and qualifications and to obtain up-to-date professional knowledge. The curriculum of the departments of transportation management engineering authorized to train seafarers has been approved by the UAB in Turkey and complies with IMO regulations (e.g., STCW). Research in Hong Kong, China, and Greece (Lau and Ng, 2015; Lau *et al*., 2018; Pallis and Ng, 2011) students perceive the courses learned in maritime education as too theoretical. Balancing academic and pragmatic knowledge is very important in naval education. Students of the marine transportation management engineering department who graduate from a faculty authorized by UAB, who have the necessary conditions, and are successful in the exams organized by the Seafarer's Exam Center (GASM) can have the competence of an oceangoing watchkeeping officer.

Attention has been paid to the existence of ports and maritime agencies, lakes and dams in cities where higher education institutions provide maritime education at associate and undergraduate level. Maritime education institutions are geographically close to the areas where maritime activities are carried out. In this way, the students of these institutions, which can cooperate with other stakeholders, gain advantages in terms of internship, equipment, participation in panels and conferences.

Students of some universities are obliged to wear uniforms in the marine transportation management engineering department. Foreign language knowledge, physical competence, safety, and quality management are at the forefront of maritime education. While high salaries positively influence the students' desire to work onboard, personal interest, experiencing different cultures, and practicing the pieces of training they have received (Fernandez Gonzalez *et al*., 2014), living away from society and challenging work conditions negatively affect. To graduate from the marine transportation management engineering department, an offshore internship for one year must be completed. It gives an idea of whether the candidates who study offshore internships can do seafaring as a profession by putting up with the profession's challenges.

1.2. Consciousness in Choosing a Profession

The profession is a general definition that covers the activities that the individual applies for to provide for their livelihood and to survive; Turkish Language Association (TDK) states that production should be based on training and skills when defining the expression of a profession (TDK, 2021). Individuals who need to participate in business life after a certain age must choose their career; the period of profession preference usually takes shape during adolescence. In making choices, individuals need to be directed correctly, and their interests, abilities, and existing backgrounds should be evaluated. The compatibility of the occupation with physical, emotional, and personal characteristics must be taken into account. An environment, different types of anxieties, changes brought about by adolescence, and psychological pressures negatively affect students during periods of profession preference (Özdemir *et al*., 2021).

The increasing number of students enrolled in maritime transportation management engineering departments shows that interest in naval education in Turkey has increased. The appropriate choice can be ensured by directing the students correctly by considering their interests, abilities, and personality characteristics. In many studies, the preference rankings of university students in Turkey (Ada, 2014; Şimşek *et al*., 2020; Üzülmez and Arslan, 2019) are primarily shaped by the Higher Education Institutions Examination (YKS) base scores and geographical proximity. Students want to work immediately after graduation. Research (Lau *et al*., 2021) shows that participants are influential in choosing marine education because students think that they can get good grades by working less and find a job easily after graduation.

The answer to the question of whether the students who choose the maritime transportation management engineering department make a conscious choice when selecting the maritime profession or whether they prefer it by considering their YKS scores is essential not only for the students but also for the marine sector. The reason of this, the success of the person in the chosen profession contributes to the production and increases the speed of development of that profession.

2. MATERIAL AND METHOD

In this study, documentary analysis was selected as a research model. YÖK Atlas data were examined, and the vocational preference trends of the students who preferred the department of transportation management engineering were interpreted.

YÖK Atlas program prevents students from making mistakes while making their choices and provides guidance to researchers by presenting numerical data. YÖK Atlas is a valuable and reliable reference source with processed data that only YÖK can compile. The application audience will benefit from is prospective students and their families, educators, academics, researchers, and administrators during the transition to higher education (YÖK, 2020).

Higher education input indicators include the number of quotas of universities, preferred statistics, demographic data of the students who make preferences, and base scores as a result of placements. Higher education process and output indicators include the number of faculty members and title distribution, number of registered students, number of students graduating from the field.

3. RESULTS

The study with 6,290 preference data obtained through the YÖK Atlas program aimed to examine the profession preference trends of students entitled to settle in the department of transportation management engineering. Candidates for central placement in higher education programs; YKS scores are placed by the Assessment, Selection, and Placement Center (ÖSYM), considering the additional scores, if any, and the quotas and special conditions of these programs (YÖK, 2020). In the YKS exam, the weights of the tests are different in each type of score. Students are placed in the marine transportation management engineering department taking into account the kind of score and the success sequence of the dam, which is calculated numerically. In the study, 2020 YÖK Atlas preference data were used. According to the YÖK 2020 higher education institutions exam placement results report, the number of candidates who chose in 2020 is 1,113,640. Out of every 100 candidates who made the preference, 80 were entitled to universities. Students can preference up to 24 departments in the online candidate transactions system. When the preference tendencies of the students who are allowed to enter the maritime transport management engineering department are examined, 33.24% of the 6,290 choices made are the universities' maritime transport management engineering departments. The 66.76% preference segment consists of different sections. In Table 1, detailed information is given about the 15 departments preferred by the students placed in the maritime transport management engineering department.

Table 1. Preference tendencies of students placed in maritime transportation management engineering department

	Program	Number of Preferences	Preference Rate
1	Marine Transportation Management Engineering	2,091	%33.24
2	Computer Engineering	470	%7.47
3	Department of Marine Engineering	408	%6.49
4	Electrical and Electronics Engineering	327	%5.20
5	Nursing	301	%4.79
6	Mechanical Engineering	296	%4.71
7	Civil Engineering	168	%2.67
8	Department of Naval Architecture and Marine Engineering	167	%2.66
9	Industrial Engineering	150	%2.38
10	Software Engineering	141	%2.24
11	Primary Mathematics Teaching	125	%1.99
12	Veterinary	120	%1.91
13	Dentistry	80	%1.27
14	Mechatronics Engineering	74	%1.18
15	Architecture	67	%1.11
16	Other	4,985	%20.75
	Sum	6,290	%100

Quotas and preferred numbers of state and foundation universities where the maritime transportation management engineering department is located are given in table 2. These rates show the demand for departments of universities in the range of points.

Table 2. Preference statistics by universities

University	Number of Preferences	Quota	Preference Per Quota
Dokuz Eylül University (DEU)	812	72	11.3
İstanbul Technical University (ITU)	1,071	182	5.9
Karadeniz Technical University (KTU)	616	84	7.3
Ordu University (ODU)	290	41	7.1
Recep Tayyip Erdoğan University (RTEU)	217	77	2.8
Van Yüzüncü Yıl University (YYU)	25	16	1.6
İskenderun Technical University (ISTE)	265	41	6.5
İstanbul University-Cerrahpaşa (IUC)	614	72	8.5
Piri Reis University (PRU)	383	100	3.8
Girne University	25	30	0.8
Sum	4,318	715	6.0

According to Table 2 data, the three most preferred universities per quota are DEU, IUC, KTU, and ODU (Table 2). Although the maritime transport management engineering department with the highest base score is in ITU, it is seen that the university has more than one campus, and one of these campuses is in Cyprus affects the number of preferences.

Table 3 provides information about the order of succession of the students who have settled in the marine transportation management engineering department. Students who are between 23,397 (ITU) and 299,179 (YYU) dam success sequences have been eligible to settle in according to the 2020 assessment and placement results, the marine transportation management engineering department. Among the institutions that provide free and public university education, there are only three vacancies left in YYU. The 300 thousand thresholds, a prerequisite for engineering faculties, resulted in 3 quotas remaining at YYU. In foundation universities, vacant quotas are seen only where fully paid students are accepted. All quotas, including partial scholarship quotas at foundation universities, have been filled. At KKTC, Kyrenia University and ITU provide marine transportation management engineering education.

Table 3. Ranking of students placed in maritime transport management engineering department

	Min. Achievement Score	Mean Achievement Score	Max. Achievement Score
State	299,176	152,779	23,397
Foundation	295,913	181,059	52,535
KKTC	293,389	243,942	179,775

In Table 4, preference distributions of marine transportation management engineering students who settled in public universities and YKS base scores for 2020 were given. Students' profession tendencies vary according to universities. While the dentistry department is among the preferences of the students who are entitled to study at ITU, it is not among the choices of other university students in the research because of the base and top YKS scores of the departments of other universities. However, it is noteworthy that the second most popular department among students placed at IUC is ship marine engineering, which is considered a maritime profession. The second most popular department among the students who settled in KTU, ODU, and ISTE is the nursing department.

Table 4. Preference distribution of maritime transport management engineering students who are entitled to enter state universities

	ITU* (419.67)	DEU (392.33)	IUC (364.26)	KTU (341.69)	ODU (319.20)	ISTE (306.45)	RTU (288.06)	YYU (283.48)
Marine Transportation Management Engineering	%19.0	%30.82	%31.60	%36.39	%38.97	%42.82	%40.46	%31.89
Computer Engineering	%14.33	%6.10	%5.98	%7.28	%5.88	%4.34	%4.98	%7.57
Marine Engineering	%8.49	%6.9	%10.66	%6.93	%4.41	%1.90	%2.19	%1.08
Electrical and Electronics Engineering	%4.46	%6.9	%4.68	%6.57	%5.33	%5.69	%6.44	%4.32
Nursing	%0.53	%2.89	%4.29	%7.98	%7.90	%10.57	%6.56	%4.87
Mechanical Engineering	%4.24	%7.54	%2.21	%3.17	%4.04	%4.07	%7.90	%8.65
Civil Engineering	%1.48	%2.57	%3.12	%3.29	%2.39	%2.44	%4.25	****
Naval Architecture and Marine Engineering	%2.65	%2.09	%2.21	%2.58	%5.51	%1.90	%1.46	%0.54
Industrial Engineering	%3.82	%2.57	%1.69	%3.87	%1.47	%0.54	%0.85	%2.16
Software Engineering	%3.08	%1.28	%1.69	%1.53	%3.13	%1.90	%1.46	%2.16
Primary Mathematics Teaching	%4.35	%3.37	%4.68	%1.64	%2.02	%0.27	%0.12	****
Veterinary	%0.85	%4.33	%3.38	%3.52	%2.21	%0.27	%0.49	%2.70
Dentistry	%8.39	****	****	****	****	****	****	****
Mechatronics Engineering	%1.17	%0.96	%0.39	%0.24	%1.10	%0.81	%2.79	%2.70
Architecture	%0.11	%0.64	%1.04	%1.29	%1.10	%2.44	%0.49	****

*Information about the department in Istanbul and provided free education.

Based on Table 4, the chart in figure 1 is created. The decrease in the preference of the base score seen in this graph was remarkable, and the link between these two values was examined.

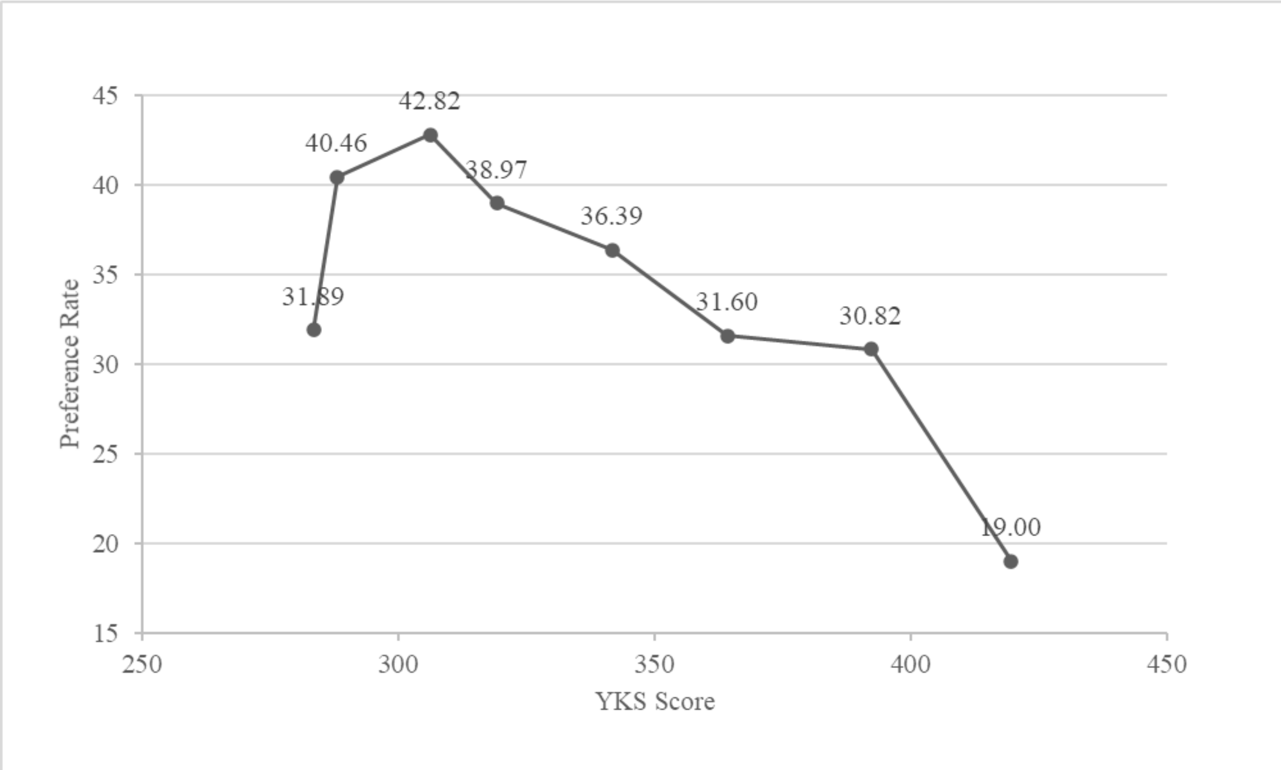

Figure 1. Impact of student scores on marine transportation management engineering in preference distribution

As a result of the analysis, the correlation between student scores and the marine transportation management engineering rate in the preference list is -0.78, i.e., high. However, the direction of the relationship was negative because the rate of preference decreased with the increase in points.

4. DISCUSSION AND CONCLUSIONS

YÖK Atlas 2020 data were used to analyze the preference trends of the students of the maritime transportation management engineering department, the choice of professions, and the variability of the scores. According to the analysis results of 6,290 preference data, YKS scores are very effective in choosing careers. The most crucial factor in the profession preference of marine transportation business engineering students is the YKS score. Choices of students placed in ITU, whose maritime transport management engineering base score is higher than other universities, include computer engineering, ship mechanical management engineering, and dentistry. There was no preference for the dentistry department among the students who settled in other universities' marine transportation business engineering department. In order to increase the quality of higher education in 2019, the YÖK decision (YÖK, 2019), which set the order of succession of dentistry department thresholds at a minimum of 80,000 affected the distribution of preferences. YÖK has set the minimum dam success order for the pharmacy department at 100,000.

For this reason, besides the students who placed ITU and DEU, the pharmacy department was not preferred. Nursing departments come to the fore instead of dentistry and pharmacy departments in students who have the right to be placed in the maritime transportation management engineering department in other universities. The fact that the most critical factors affecting the vocational choices of the students are the exam scores shows that the awareness of the intention of profession is not formed in the students (Durmuş and Tokyay, 2021). The fact that maritime transport management engineering students placed in universities with relatively high base scores prefer departments such as dentistry and pharmacy instead of maritime transport management engineering departments in other universities shows the effect of the exam score on their profession preferences.

In a study examining the factors affecting students' university and career choices (Bardakçı, 2019), it was seen that a significant part of the students had sufficient information about the department they chose before making their choice. Still, they did not have enough information about the departments' academic staff. The most critical factors in the selection of students in the university were found to be geographical proximity to the family and the adequacy of the score obtained. Students' level of knowledge about the profession and university they will choose while making the selection process significantly affects their satisfaction in the department they are placed in (Bardakçı, 2019). Geographically, being preferred in terms of proximity to the family ensures that universities in major cities of Turkey, such as Istanbul Izmir, are in high demand. According to December 2021 data, %18.71 of Turkey's population lives in Istanbul, and %5.23 lives in Izmir. In other provinces with maritime transport management engineering departments, Turkey's population is Hatay (%1.97), Van (%1.35), Trabzon (%0.96), Ordu (%0.90), Rize (%0.41) is disbanded. The high base scores of universities in cities with a high population density are related to geographical proximity. It is thought that KTU, which has a relatively higher base score compared to big cities, is among the well-established universities. The increase in the base scores reduces the density of the maritime transport management engineering department in the preferences. Similar results were observed in the study conducted by Durmuş and Tokyay (2021). The choice of the profession selected in the preference list in more than one university is accepted as an indicator of interest in that profession. It is known that making consciously department choice reduces the degree of anxiety (Aydın and Tiryaki, 2017).

Erkuş *et al*. (2020) emphasized that among the factors affecting the choice of department, finding a job and exam score were the most critical factors. A study conducted at DEU stated that employment in the maritime sector is high and knowing a foreign language provides an advantage in recruitment (Ayaz *et al*., 2018). Lusic *et al*. (2019) state a significant excess demand in the employment of watchkeeping officers in the maritime sector. While the maritime profession is expected to be preferred because it has more advantages over the occupational groups in the same YKS score range in terms of employment, the maritime profession does not receive the expected attention due to the social limitations (Uğurlu, 2016) of the job. Career development and income are crucial issues in choosing a profession (Osman, 2016). Training in maritime transport management engineering is carried out under the control of the flag state, within the scope of STCW, at international standards.

Minimum salaries for oceangoing watchkeeping officer qualifications for international seafarers are set by the International Transport Workers' Federation (2021), and as of 2021, for month cannot be less than approximately US$2,000, including overtime and leave pay. Although this fee varies from time to time with the ship type and voyage region, the minimum values and job opportunities are seen above standards Turkey. The study's influential factors in these preferences could not be detailed because data was not collected by contacting the students directly. Thanks to the data provided by YÖK, general information about the profession preference trends of the students who prefer the maritime transportation business engineering department has been obtained. In future studies, students can be contacted, detailed information about the factors affecting their profession tendencies can be collected, and comparative analysis can be made with the preference data we have. YÖK Atlas data should be examined with longitudinal study methods in the following years.

CONFLICT OF INTERESTS

The authors declare that for this article, they have no actual, potential, or perceived conflict of interests.

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Modelling The Impact of The Oil Spill Pollution in Ildır Bay, Turkey

Türkiye'nin Ildır Körfezi'nde Petrol Sızıntısının "Etkisinin" Modellenmesi

Türk Denizcilik ve Deniz Bilimleri Dergisi

Cilt: 8 Sayı: 1 (2022) 60-68

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ABSTRACT

On the 18 of December 2016 a Panama-flagged ship, M/V Lady Tuna, was grounded off the coast of Ildır Bay, Turkey. According to the authorities 75.38 m^3 (approximately 73 tons) heavy fuel-oil was released to the sea. It is the worst environmental disaster in the region mainly affecting the coastal areas of the Ildır Bay. To better understand the effects of the oil spill, a series of models were set-up in the region. The fate of the oil spill was predicted by MEDSLIK-II oil spill model forced by currents and temperature from an Aegean Sea circulation model based on NEMO (Nucleus for European Models of the Ocean) and winds from an atmospheric Re-Analysis model (ECMWF, ERA-Interim). A couple of sensitivity experiments were conducted by changing the discharge duration and amount, the sensitivity results were compared with observations. The model results are in good agreement with the available observations. The model successfully predicts the path of the oil spill in the sea surface and its final destinations along the coast. The oil makes first land contact after 36 hours of accident. Due to the dominated and consisted southward currents and weak wind speed at the time of the accident, the effects of the oil were luckily limited without any high dispersion at the coast.

Keywords: Oil spill, Hydrodynamic Modelling, Aegean Sea.

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ÖZET

18 Aralık 2016'da Panama bayraklı bir gemi olan M/V Lady Tuna, Türkiye'nin Ildır Körfezi açıklarında karaya oturdu. Yetkililere göre 75,38 m^3 (yaklaşık 73 ton) akaryakıtın denize sızmış olduğu belirlenmiş ve bu kaza Ildır Körfezi'nin kıyı bölgelerini etkileyen bölgedeki en kötü çevre felaketlerinden biri olarak kayıtlara geçmiştir. Bu sızıntının etkilerini daha iyi anlayabilmek adına bölge için bir dizi sayısal model uygulaması kurgulanmıştır. Petrol sızıntısının akıbeti, NEMO (Nucleus for European Models of the Ocean) Ege Denizi sirkülasyon modelinden elde edilen akıntı ve sıcaklık değerleri ve atmosferik yeniden-analiz modeli (ECMWF, ERA-Interim) tarafından sağlanan rüzgar verileri ile zorlanan MEDSLIK-II petrol sızıntısı modeli ile simule edilmiştir. Sızıntının deşarj süresi ve miktarı değiştirilerek hassasiyet deneyleri gerçekleştirilmiş ve bu sonuçlar gözlemlerle karşılaştırılmıştır. Model sonuçları mevcut gözlemlerle iyi bir uyum içindedir. Model, deniz yüzeyindeki petrol sızıntısının yolunu ve kıyı boyunca nihai varış noktalarını başarılı bir şekilde tahmin edebilmiştir. Kazadan 36 saat sonra sızıntının ilk kara teması gerçekleşmiş, kaza zamanındaki mevcut yüzey akıntıları ve bölgedeki zayıf rüzgar hızına bağlı olarak, petrol kıyıda büyük bir dağılım göstermemiş ve nispeten sınırlı bir alanı etkilemiştir.

Anahtar sözcükler: Petrol sızıntısı, Hidrodinamik Modelleme, Ege Denizi

1. INTRODUCTION

The Aegean Sea is an elongated large bay of the Mediterranean Sea located between Europe and the Turkish coasts. It covers an area of 215.000 km^2 and has a highly complex topography with a maximum depth of ~3.5 km. The coastline is extremely irregular with hundreds of small and large islands spread all over the Aegean Basin (Figure 1 and 2). The hydrodynamics of the Aegean Sea is mainly determined by the exchanges between the Levantine Sea at the south and the Black Sea at the North through the two-layer regime of the Turkish Straits System (Ünlüata et al. 1990) connected to the Aegean Sea by Dardanelles Strait, Poulos et al, (1997). Heavy maritime traffic load through the Turkish Straits System (Turkish Chamber of Shipping, 2021) and the positive growth trend of Turkish maritime transportation (Balık et al. 2015) suggest an increased risk of accidents in the Turkish coasts Aegean Sea. The risk of maritime accidents in Aegean Sea with potential environmental hazards is statistically shown to be contributed by the increased maritime traffic in the region, (Ventikos et al. 2017) which also states an increase in Suez–Dardanelles passages making the Turkish coasts more vulnerable.

The Ildır Bay as shown in Figure 1 are located at the western coast of Turkey. It is one of the many bays along the Turkish coast of the Aegean Sea. The bay has some of the most beautiful and untouched areas along the Aegean coast with golden beaches (over 20 beaches), It is also internationally famous with turquoise blue seas, and rich underwater fauna. Additionally, it is one of the most important windsurfing sites in Europe with favorable wind conditions with very shallow waters suitable for windsurfing. Actually, the Bay do not have any heavy ship traffics, however, there are offshore fish farms, and this specific accident has happened after the ship took her cargo from a tuna farm in the Bay. The location of the ship when the accident happened was shown in the figure (latitude: 38° 23,26' N, longitude: 26° 25,42' E) which is quite shallow with less than 5 meters of depth. She grounded at 13:40 local time on 18/12/2016 on the way to anchorage area for custom clearance formalities while the ship still under way at a speed of 11.7 knots based on accident investigation report. The pollution is due to the fuel oil leakage of the ship through the cracks on its body after the accident. A company begins the cleaning after the incident. Fortunately, most of the polluted areas were cleaned with this effort. The details of the daily recovery actions are beyond the scope of this paper.

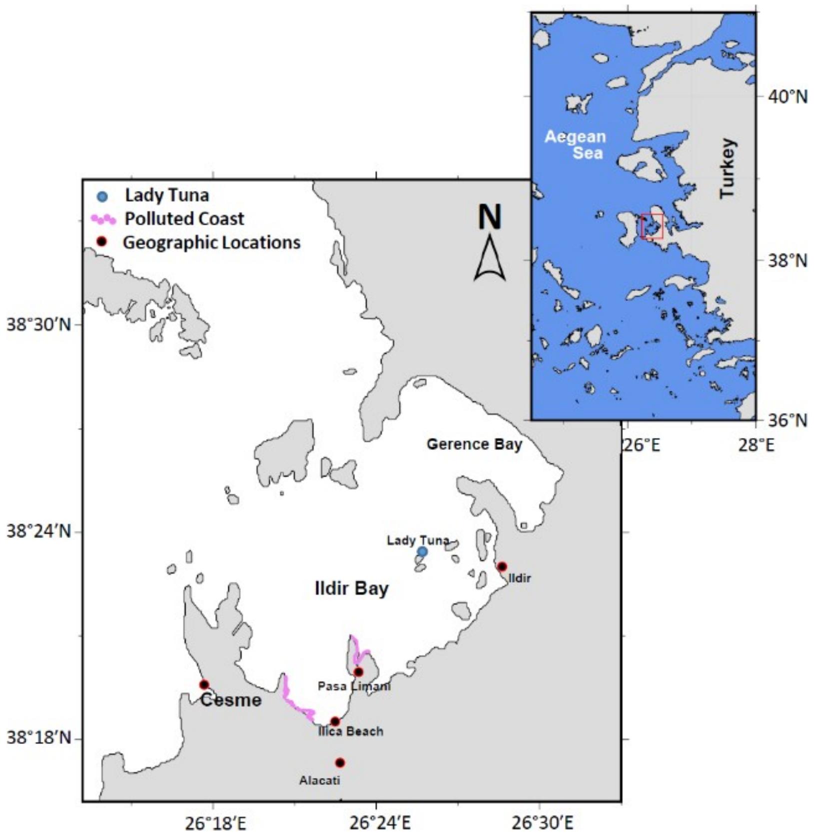

Figure 1. The study area and names of the main geographic features. The violet polygons show the polluted coastline due to oil spill. The top right figure shows the Turkish coast and the red rectangle show the boundaries of zoomed figure.

Figure 1 also show the polluted coast of the Bay. The worst pollution has happened in Paşa Limanı which is a northward directed peninsula with a small bay inside. Due to the direction and position of this bay (like an "open mouth"), most of the oil was landed in this small bay. The rest of the oil pass through this peninsula and reached the Ilıca Beach in which many touristic hotels are located.

Unfortunately, there is no clear satellite images showing the path of the oil spill. For this reason, modelling the fate of the oil spill is important for a better understanding of the consequences of this accident. There are various oil spill models used to investigate the fate of the spilled oil such as GNOME (General NOAA Operational Modeling Environment), the SPILLCALC by Tetra Tech. These models are used in regional and global studies (Beegle-Krause, 2001) and was also successfully implemented for possible oil spill scenarios at Bosphorus-Marmara Sea (Başar, 2010), in Black Sea (Başar et al. 2018) and in İstanbul Strait (Yıldız et al. 2021). MEDSLIK-II model (De Dominicis et al. 2013a, De Dominicis et al. 2013b) was used in this study due to its high flexibility. The model has been used extensively in regional oil spill mode studies (Lopez et al. 2021; Liubartseva et al. 2021; Zodiatis et al. 2021). In the MEDSLIK-II model, it is possible to provide the model spill amount, duration and the observed path of the spill from satellite derived images during the model integration.

2. MATERIAL AND METHOD

As the oil is spilled on sea, winds and currents are the main forcings controlling the spread and movement of the oil slick. In this section the setup and configuration oil spill model is described and the details of the ocean and the atmospheric models providing the ocean surface currents and the winds will be given.

2.1. NEMO Hydrodynamic Forcing

The currents and the and sea surface temperature (SST) necessary for the oil spill model are obtained from a regional ocean circulation model of the Aegean Sea. The model code is based on NEMO (Nucleus for European Models of the Ocean) at version 3.6 stable (Madec et al. 2017). The Aegean Sea is a challenging basin to set-up a numerical ocean model due to its complex coastline and islands (Mamoutos et al. 2021; Korres et al. 2010). Figure 2A shows the circulation model domain. Although the accident happened at one of the small Bay of the Turkish coasts, to better represent the circulation which is very important parameter for oil spill transport, the whole Aegean Sea was modelled. With this approach the effect of the open boundaries is minimized in the oil spill model. The model was forced by Copernicus Marine Environment Monitoring Service (CMEMS) temperature, salinity and currents at the boundaries. The model horizontal resolution is around 1.2 km, and there are 36 vertical levels. The model was forced by ECMWF (European Centre for Medium-Range Weather Forecasts) ERA-Interim atmospheric re-analysis model. The hydrodynamic model simulation ends about a week after the accident but started approximately 6 months before the oil spill with the aim of reaching an equilibrium state during the period of spill prediction.

For the same hydrodynamic model setup, the model results were actually validated with the available in-situ and satellite observations which will be covered extensively by a separate modelling study in preparation focusing on the period between August 2008 to August 2009 due to the available in-situ data for the region. The model derived currents and scalar fields for this period were found to be in good agreement with the observations as seen from the SST comparisons between the model, station based and the satellite supported CMEMS model results for the Athos (Figure 2B) and Lesvos (Figure 2C) stations shown in Figure 2A (taken from the study in preparation).

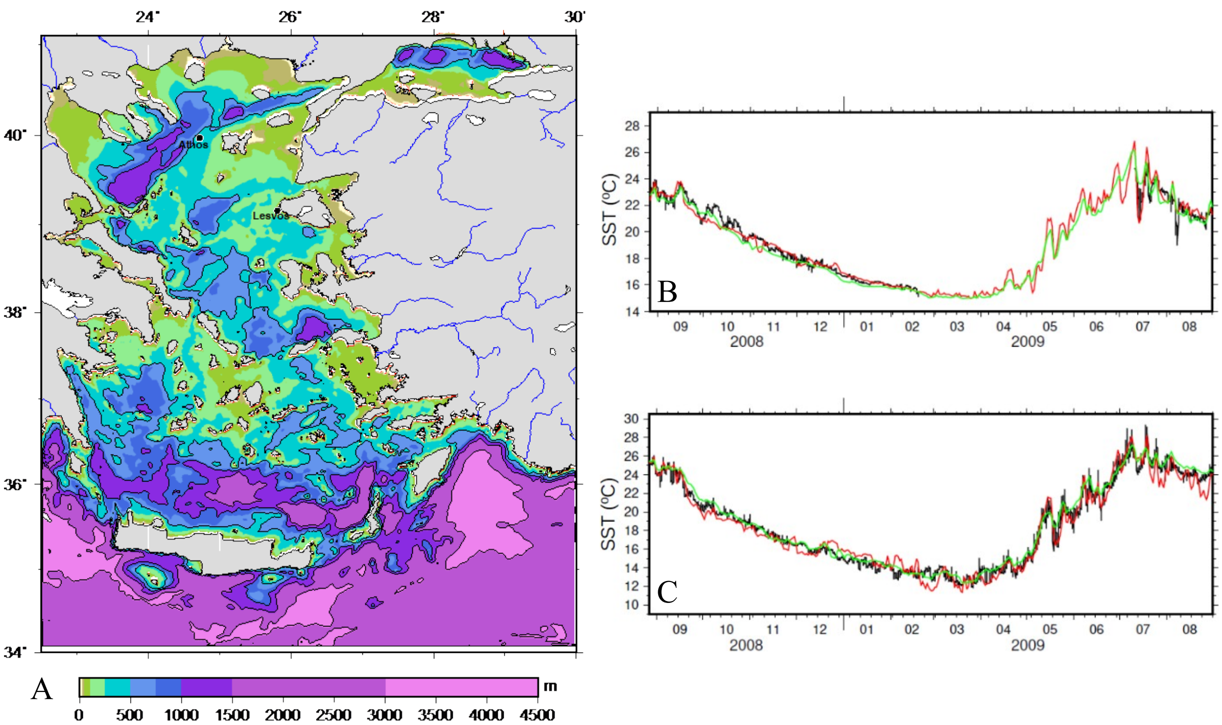

Figure 2. A) The domain and the bathymetry of the hydrodynamic model and time series comparisons of the model generated (red), station based (black), CMEMS (green) SST at B) Athos and C) Lesvos stations.

2.2. Atmospheric Model

The oil spill model input of atmospheric wind at the surface of the ocean were obtained from ECMWF. The ERA5 re-analysis product of ECMWF was chosen. ERA5 is the latest and better resolution product of the ECMWF with 4 km horizontal resolution. The atmospheric forcing was received in an hourly time interval. The wind conditions are shown in Figure 3. During the time of accident, the weather is moderate with wind speeds less than 2 m/s. The wind blows mainly from the north in the area of interest. However, a strong wind starts approximately two days after the accident and reaches up to 7 m/s on 21 December and continue several days at a similar strength. Due to the weak wind speed on following 2-3 days after the accident, it is clear that the current at the sea surface is critical parameter for the fate of the oil spill in this special case.

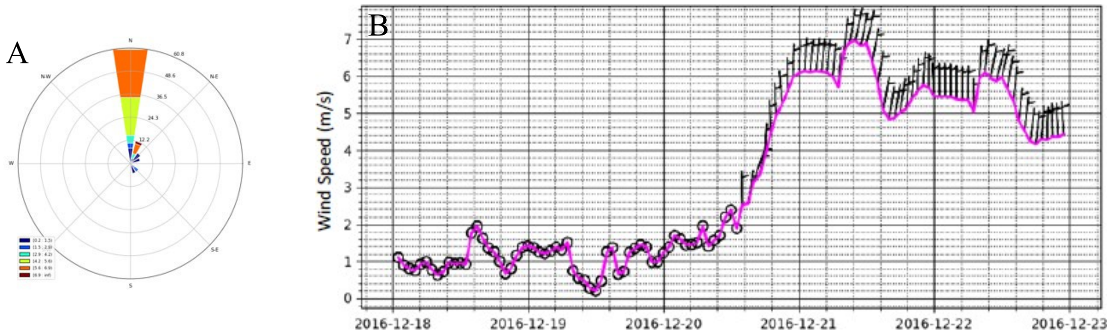

Figure 3. A) Wind rose for the period of 18.12.2016 to 23.12.2016 and B) Time series of the wind speed and wind direction from ECMWF re-analysis data set.

2.3. MEDSLIK-II oil spill model description

Oil spill model used in this study id MEDSLIK-II (De Dominicis et al. 2013a, De Dominicis et al. 2013b), based on its precursor oil spill model MEDSLIK (Lardner and Zodiatis 1998; Lardner et al. 2006; Zodiatis et al. 2008). MEDSLIK-II is a well-established 3D model used for predicting the fate of an oil spill. The details of the governing equations of the model can be found at (De Dominicis et al. 2013a). There are various regional applications of the model. The model source code is a freely available community model and can be downloaded from http://medslik-ii.org/ website. The detailed description of the model equations can be found in De Dominicis et al. 2013b.
The oil spill parameter values chosen for this specific case are given in Table 1. For the rest of the parameters the nominal values from published literature were chosen (Liubartseva et al. 2020 and Liubartseva et al. 2021). The spilled oil is assumed as heavy fuel-oil with a density 900 kg/m^3 and API gravity degree of 15.

The spill was modelled as a continuous release of oil over a period of 2h starting from 18 December 2016 at 13:30 with a total volume of 75 m^3 of oil.

Table 1. MEDSLIK-II oil spill model parameters used in this study and their nominal values from published literature.

Model parameters	Used values in this study
the tracer grid cell size, (δxT, δyT)	50 km
the thickness of the thin slick	0.0015 m
and the horizontal diffusivity coefficient, K_h	0.01 m^2/s
Amount of oil spill	70 tons
Type of oil spill	Heavy fuel oil

3. RESULTS AND DISCUSSION

The surface concertation of oil (kg/m^2) derived from the oil spill model results is shown in Figure 4. During the whole model integration, the current direction is mostly south-westward with a speed of around 0.1 m/s. This feature is persistent during the integration period with small departures.

The oil transport to that direction under the influence of current, the oil first landed on Paşa Limanı around 40 hours of accident (Figure 4c). Most of the oil was landed on this bay causing environmental disaster along the beaches. The rest of the oil travel to the south-west direction and landed on the Ilıca beach which is another important tourist place famous with its clear water. The final destination of the oil after 68 hours of integration was shown in Figure 5. The location of the polluted coast is in good agreement with the observation (as shown in Figure 1 with violet color). The surface oil concentration reaches up to 20 kg/m^2 along the coast.

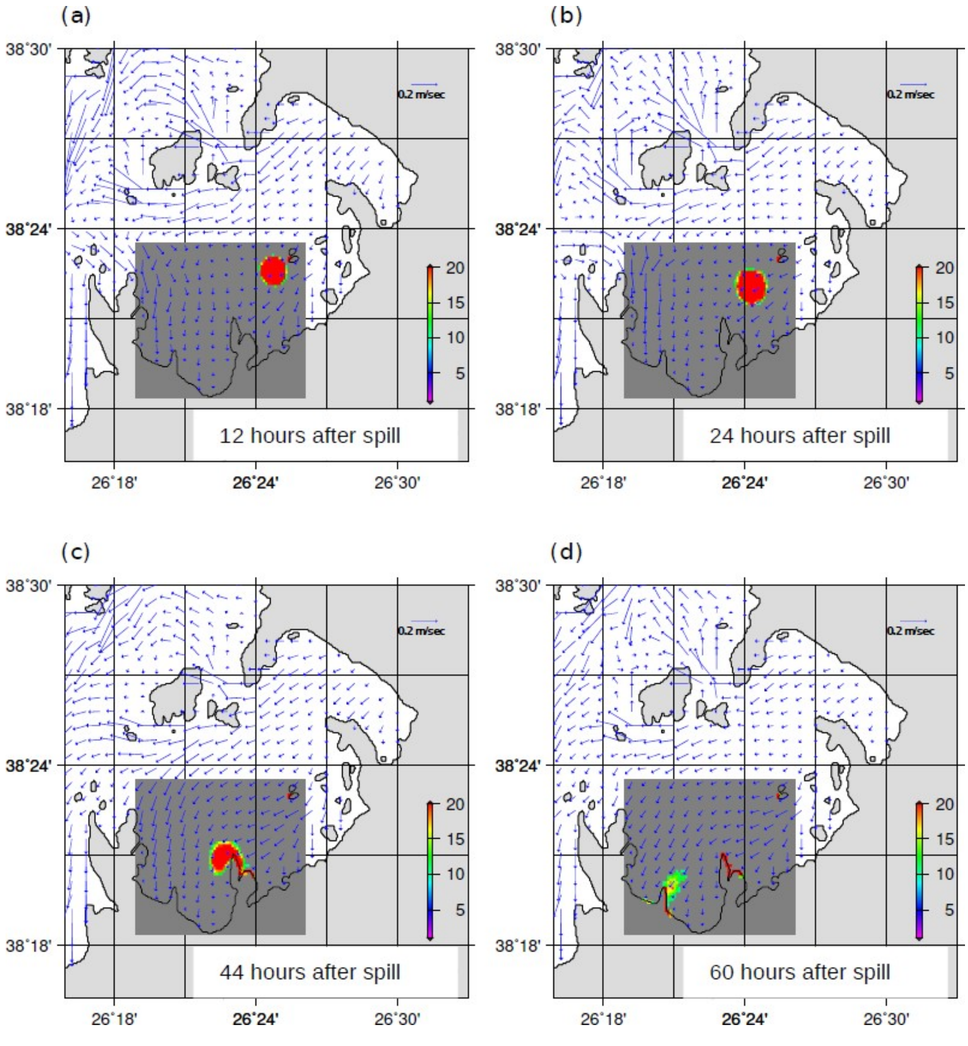

Figure 4. Oil spill model derived surface concentration of the oil overlaid on ocean current velocities. The panel shows the concentration after (a) 12, (b) 24 (c) 44 (d) 60 hours after the spill start by *18/12/2016 13:30*.

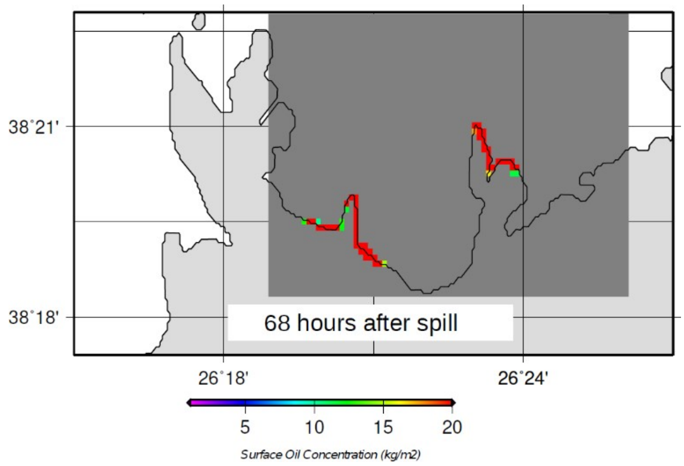

Figure 5. The surface oil concentration (kg/m^2) and the final landed position of the oil after 68 hours of integration.

Figure 6 shows the oil-fate parameters simulated by the MEDSLIK-II model. The evaporated oil (green line) is rather limited due to the cold sea water temperature at the time of incident. In average % 10 of the oil is evaporated for each model time level. The oil on the coast (blue line) is almost constant until 34 hours of integration, however after first landing of the oil on the coast there is fast flushing of the oil on the coast. At the end of the simulation there is very small amount of oil still exist at the surface of the sea (red line). Trotta et al. (2021) have shown the importance of the downscaling of the basin-wide ocean models for the early warning systems. While larger-scale operational models gives the coarse overview of the sea conditions, it is necessary to develop a regional ocean model nested in this larger-scale operational model to better forecast the oil-spill behaviour. In this study, it is shown that developed regional ocean model successfully predict the behavior of the oil spill located in a relatively small Bay.

A different oil spill dispersion model (PISCES II) was applied to model the same accident by Aydin and Solmaz (2019). The major improvement of the current study from that study is to use the real-time currents and winds generated by ocean and atmospheric model. However, Aydin and Solmaz (2019) have used the dominant wind direction and current in their studies. The winds and currents can be change with a short time frequency especially very close to the coast due to the bathymetry and coastline. The current study considers this high frequency variability which is believed quite important for oil spill dispersion.

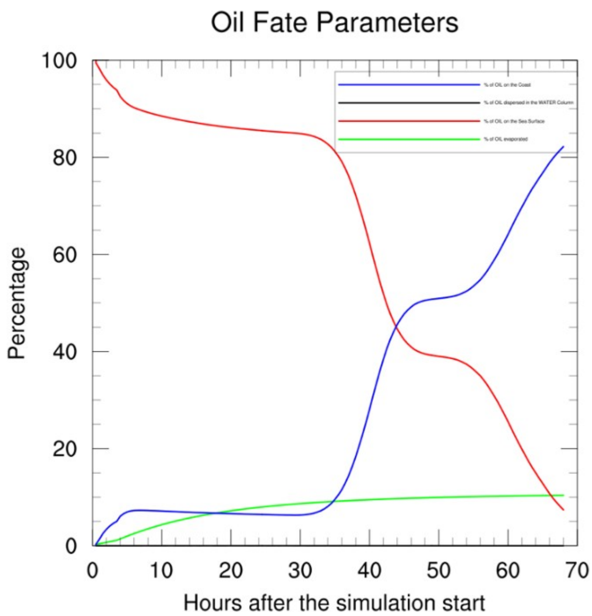

Figure 6. Oil-fate parameters simulated by MEDSLIK-II model from 18 December 2016 13:30 to 21 December 09:30. Green line is evaporated oil; blue line is the oil reaching to the coast and the red line is oil at the surface of the sea.

4. CONCLUSION

The oil spill model used in this study which is driven by the output of a regional circulation model together with the atmospheric forces was able to predict the resultant location of the oil spill quite successfully. Relatively weak wind speeds at the time of the accident and following 2-3 days emphasizes the importance of the ocean surface currents in determining the oil spill fate. Different from the atmospheric inputs used in the oil spill prediction models, ocean parameters driving the oil spill is generally not available and especially difficult to obtain in high resolution which could be very important as in the case analyzed here where the accident happened in a relatively small bay located on a very irregular shoreline.
Oil spill are one of the major threats to the marine environment and has a very short window of opportunity to fight for reducing the contamination. The biodiversity of the Mediterranean, Aegean and the Black Seas and the total fisheries production from these basins have a great importance for not only surrounding countries but also for Europe as an importer-consumer in the seafood market. Considering the adverse effects oil spills to the coastal marine environments which are vital for the marine ecosystems, the ability of prediction of the transport and behavior of the oil spills by numerical approaches is an absolute necessity and introduces a great advantage in reducing potential impacts of these hazards. However as in the case of this incident ocean surface circulation may play a significant role in determining the fate of the oil spill and the availability of high-resolution operational ocean circulation models become a crucial necessity.

AUTHORSHIP CONTRIBUTION STATEMENT

Murat GÜNDÜZ: Conceptualization, Methodology, Modelling, Analysis, Writing, Visualization.
Adil SÖZER: Conceptualization, Methodology, Analysis, Writing, Visualization, Editing.

CONFLICT OF INTERESTS

The authors declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

Authors declare that no ethics committee permissions is required for this study.

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Reproductive biology of the common carp (*Cyprinus carpio* Linnaeus, 1758) in Marmara Lake, Western Anatolia, Turkey

Marmara Gölü (Batı Anadolu/Türkiye)'nde sazanın (*Cyprinus carpio* Linnaeus, 1758) üreme biyolojisi

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 8 Sayı: 1 (2022) 69-79

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ABSTRACT

There is a knowledge gap in some lakes of Turkey regarding the reproductive biology of the common carp (*Cyprinus carpio* Linnaeus, 1758), a very important freshwater commercial species. This study aims to determine for the first time the spawning period and length at first maturity (Lm_{50}) of common carp in Marmara Lake in Western Turkey. A total of 650 individuals were sampled between December 2015 and November 2016. The overall sex ratio (♂:♀) was 0.88:1 which is no significantly different from the balanced ratio of 1:1 ($p>0.05$). The spawning period peaked in February and continued until May. Lm_{50} was estimated as 43.7 cm and 39.6 cm for females and males, respectively. This study also presented some reproductive characteristics of common carp in the lake from the westernmost point for Anatolia.

Keywords: Length at first maturity, Spawning period, Maturity stages, Gonadosomatic index, Condition factor

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ÖZET

Önemli bir tatlı su ticari türü olan sazan balığının (*Cyprinus carpio* Linnaeus, 1758) üreme biyolojisi konusunda Türkiye'nin bazı gölleri için bilgi eksikliği bulunmaktadır. Bu çalışma, Türkiye'nin batısında yer alan Marmara Gölü'ndeki sazan balıklarının yumurtlama periyodu ve ilk olgunluk boyunu (Lm_{50}) ilk kez belirlemeyi amaçlamaktadır. Aralık 2015 ile Kasım 2016 arasında toplam 650 balık örneklenmiştir. Cinsiyet oranı (♂:♀) 0,88:1'dir ve teorik 1:1 oranından önemli ölçüde farklı değildir ($p>0,05$). Yumurtlama dönemi Şubat ayında zirve yapmakta ve Mayıs ayına kadar devam etmektedir. Lm_{50}, dişiler ve erkekler için sırasıyla 43,7 cm ve 39,6 cm olarak belirlenmiştir. Bu çalışma aynı zamanda göllerdeki sazan balıklarının bazı üreme özelliklerini Anadolu'nun en batı noktasından ortaya koymuştur.

Anahtar sözcükler: İlk olgunluk boyu, Yumurtlama periyodu, Olgunluk safhaları, Gonadosomatik indeks, Kondüsyon faktörü

1. INTRODUCTION

Determining the reproductive biology of fish is of great importance in terms of fisheries management as well as filling the gap in fisheries basic sciences. Identifying reproductive characteristics of fish in each habitat is essential for successful fisheries management, since these characteristics may vary spatially (Karataş *et al.*, 2010).

Reproductive biology information, such as spawning period and length at first maturity (Lm_{50}), guides when and at what size target species should be caught for sustainable fisheries. It is a common fisheries management application that the fish are not caught during spawning periods, in other words, these periods are declared as the closed season. Technical measures such as minimum landing size and catch amount limitations are based on sexual maturity information (Avşar, 2005). Based on these data, fishing gears are arranged in such a way as to allow the juveniles to escape (Armstrong *et al.*, 1990).

Sustainable fisheries management is also required for common carp (*Cyprinus carpio* Linnaeus, 1758), a very important freshwater commercial species, whose catch has decreased by 76% from 12,058 tonnes to 2,893 tonnes in the last decade (from 2010 to 2020) in Turkey (TUIK, 2022).

The common carp is native to rivers draining to the Black, Caspian and Aral Sea in Europe and Asia but has been introduced into several freshwater ecosystems world-wide (Kottelat and Freyhof, 2007; Froese and Pauly, 2022). *C. carpio* is a benthic omnivore, both adults and juveniles feed on a variety of benthic organisms and plant material. Breeds along shores or in backwaters. Adults often undertake considerable spawning migration to suitable backwaters and flooded meadows (Kottelat and Freyhof, 2007). In temperate environments, it matures in 3-5 years (Adamek and Pistelok, 1991) and spawns in early summer and spring (Oyugi *et al.*, 2011). There is a knowledge gap in some lakes/reservoirs of Turkey regarding the reproductive biology of the *C. carpio*. Studies mostly focused on lakes and reservoirs in Central Anatolia (Düzgüneş, 1985; Çetinkaya, 1992; Bircan, 1993; Yılmaz, 1994; Bircan and Erdem, 1997; Yerli and Zengin, 1998; Karataş, 2000; Balık and Çubuk, 2001; Doğan, 2001; Özyurt and Avşar, 2001; Şen, 2001; Yılmaz and Gül, 2002; Kılıç, 2003; Karataş and Sezer, 2005; Güç, 2006; Kırankaya, 2007; Mert *et al.*, 2008). There are no studies on the lakes, except carried out in 2 reservoirs (Kemer and Bayramiç Reservoirs) in Western Anatolia (Özcan and Balık, 2007; Çolakoğlu and Akyurt, 2013).

Marmara Lake, which is an alluvial set lake with an average depth of 3-4 m, is located in Western Anatolia, Turkey (Figure 1). This lake is an important carp habitat and fishing area for which reproductive biology have not been done before. Therefore, this study aims to determine the spawning period and Lm_{50} of common carp in Marmara Lake.

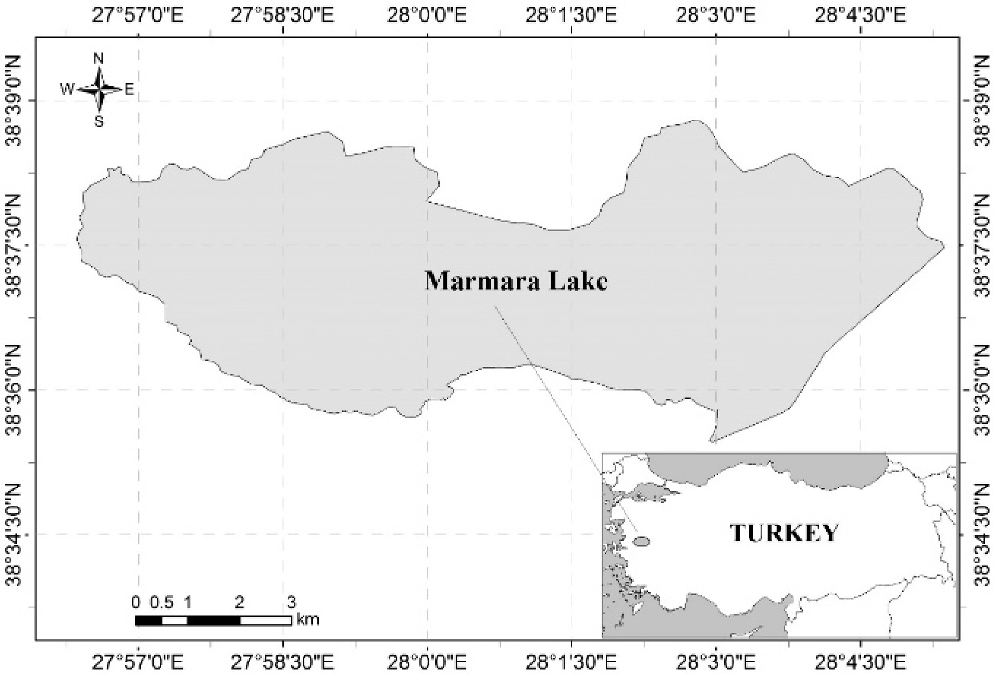

Figure 1. Study area (Marmara Lake).

2. MATERIAL AND METHOD

Monthly sampling was carried out by local commercial fishers in different areas of the Marmara Lake from December 2015 to November 2016. Ten types of multifilament gillnets (with 70, 75, 80, 90, 100 mm nominal mesh size/bar length and 210d/2 and 210d/3 twine thicknesses) and beach seine (9 mm mesh size) were used for sampling.

Fish samples were immediately transferred to laboratory in cooler boxes. The total length (*L*), body weight (*W*) and gonad weight (*Gw*) were measured to the nearest 0.1 cm, 1 g and 0.01 g, respectively. Sex was determined by macroscopic observation of gonads. Sex ratios were compared using the chi-square (χ^2) test in order to verify whether the proportion of males and females differed from the expected ratio 1:1 (Zar, 1999).

Sexual maturity stages were determined with the five-staged maturity scale (Holden and Raitt, 1974): stage I (immature) – gonads are very small and testis is whitish; stage II (maturing and recovering spent) – gonads are small, dully transparent and pinkish-whitish; stage III (ripening) – gonads are enlarged, ovary is pinkish-yellow with granular appearance and testis is whitish to creamy; no transparent ova; stage IV (ripe) – gonads are considerably enlarged, ovary is large and transparent, orange-pink with conspicuous superficial blood vessels; ripe ova are visible; testis is whitish-creamy, soft; and stage V (spent) – gonads are shortened, walls loose, flabby, empty, dark red with traces of sperm or ova.

To identify spawning period, the condition factor (*CF*) and the Gonadosomatic index (GSI) were estimated for both sexes using

$$\boldsymbol{CF} = \frac{\boldsymbol{W \times 100}}{\boldsymbol{L^3}} \qquad (1)$$

and

$$GSI = \frac{Gw}{W \times 100} \qquad (2)$$

where *Gw* and *W* are the gonad and body weights for both sexes, respectively (Ricker, 1975; Bagenal and Tesch, 1978).

Lm_{50} was examined for both sexes using samples in February and spring (March, April and May) for female, where GSI values and the proportion of mature individuals (stages III, IV and V) increased, and samples in winter (December, January, February) and spring for male. The mature (stages III, IV and V) and the immature individuals (stages I and II) were proportioned for each size group with 1 cm intervals. Lm_{50} was estimated by modeling the proportion of mature individuals to their respective length classes based on the following logistic function:

$$\boldsymbol{P = \frac{1}{1+e^{-a(L-b)}}} \tag{3}$$

where P = percentage of mature fish by length class, L = total length class, a and b are model coefficients. This analysis allows the estimation of the 95% confidence intervals for Lm_{50}. The Lm_{50} was estimated using the equation:

$$\boldsymbol{Lm_{50} = -\frac{a}{b}} \tag{4}$$

Data were analysed using “Solver” in Microsoft-Excel programme (Tokai, 1997).

3. RESULTS

A total of 650 common carp individuals were examined during the study period. Of the entire sample, 328 (50.5%) of the samples were females, 289 (44.5%) were males and 33 (5%) were of undetermined sex. Range and mean values of lengths and weights for female, male and all individuals were presented in Table 1. Length and weight values (minimum, maximum and mean) were higher in females than males. The overall sex ratio (♂:♀) was 0.88:1, which is no significantly different from the theoretical ratio of 1:1 (χ^2: 2.465, df: 1, $p > 0.05$). GSI values reached peaked for females in February (8.29) and decreased afterwards until August, and had a second smaller peak in December. Males also peaked in December (4.26), decreased afterwards until July. CF values peaked in May (♀: 1.67; ♂: 1.72) in both female and male individuals. Afterwards, the values decreased and reached their lowest value in February in both female (1.30) and male (1.27) individuals (Figure 2).
When the monthly changes of maturity stage and GSI values of females were examined, the rate of ripening (stage 3) and ripe (stage 4) individuals also increased in February, with peak GSI values. High percentages of ripe and spent (stage 5) individuals were observed from April to June when GSI was in decline (Figure 3).
In males, the rate of ripening and ripe individuals also increased since August when GSI values started to rise and reached the highest rate in March. The rate of spent male individuals from April to June increased (Figure 4).
Lm_{50} were found to be 43.7 cm and 39.6 cm for females and males, respectively (Figure 5).

Table 1. Total length and weight values of common carp (n= number of fish sampled, min= minimum, max= maximum, SE= standard error)

		Total length (cm)			Weight (kg)		
	n	min	max	mean ±SE	min	max	mean ±SE
Female	328	29.2	98.0	51.65±0.77	0.384	13.950	2.474±0.13
Male	289	24.3	82.0	45.68±0.48	0.228	8.200	1.565±0.07
All	650	24.3	98.0	48.71±0.47	0.228	13.950	2.027±0.08

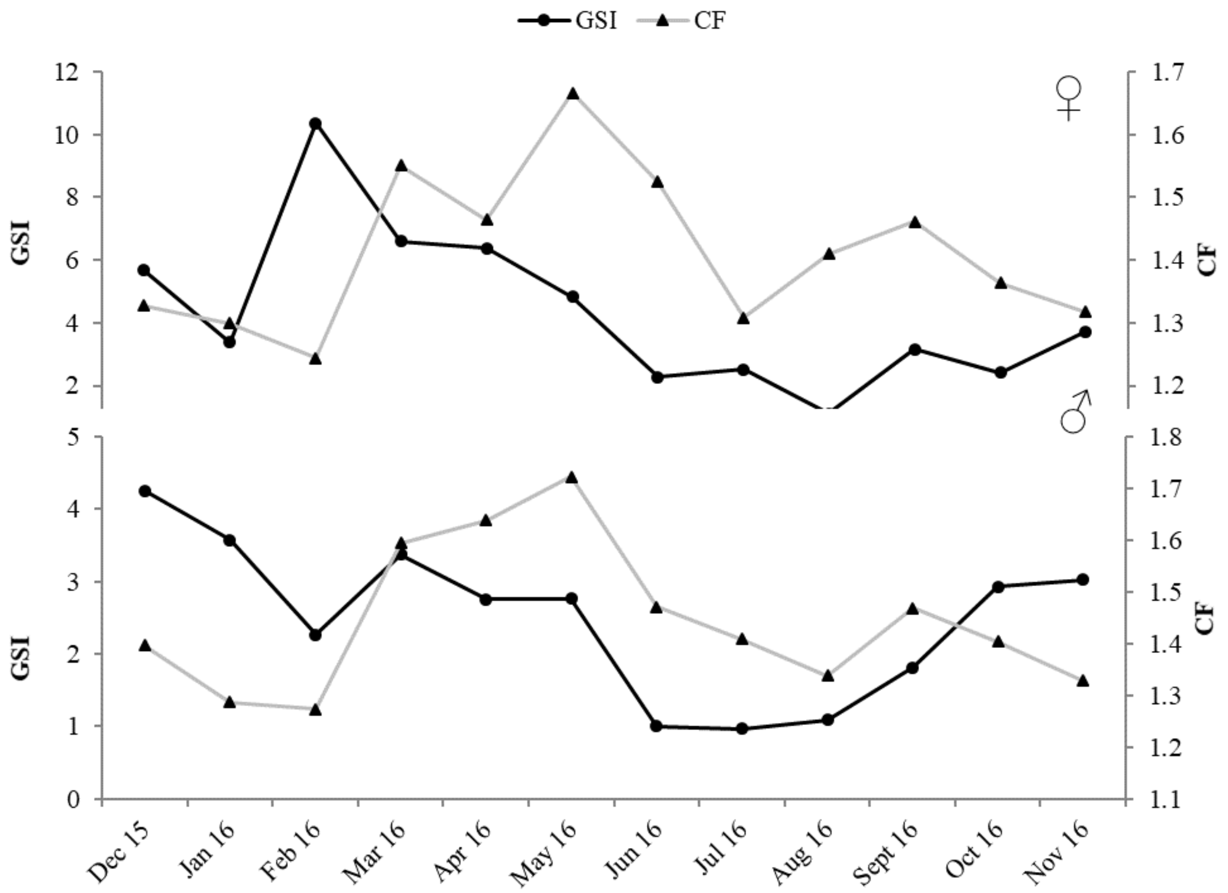

Figure 2. Gonadosomatic index (GSI) and condition factor (CF) trends for females (♀) and males (♂) over a one-year period.

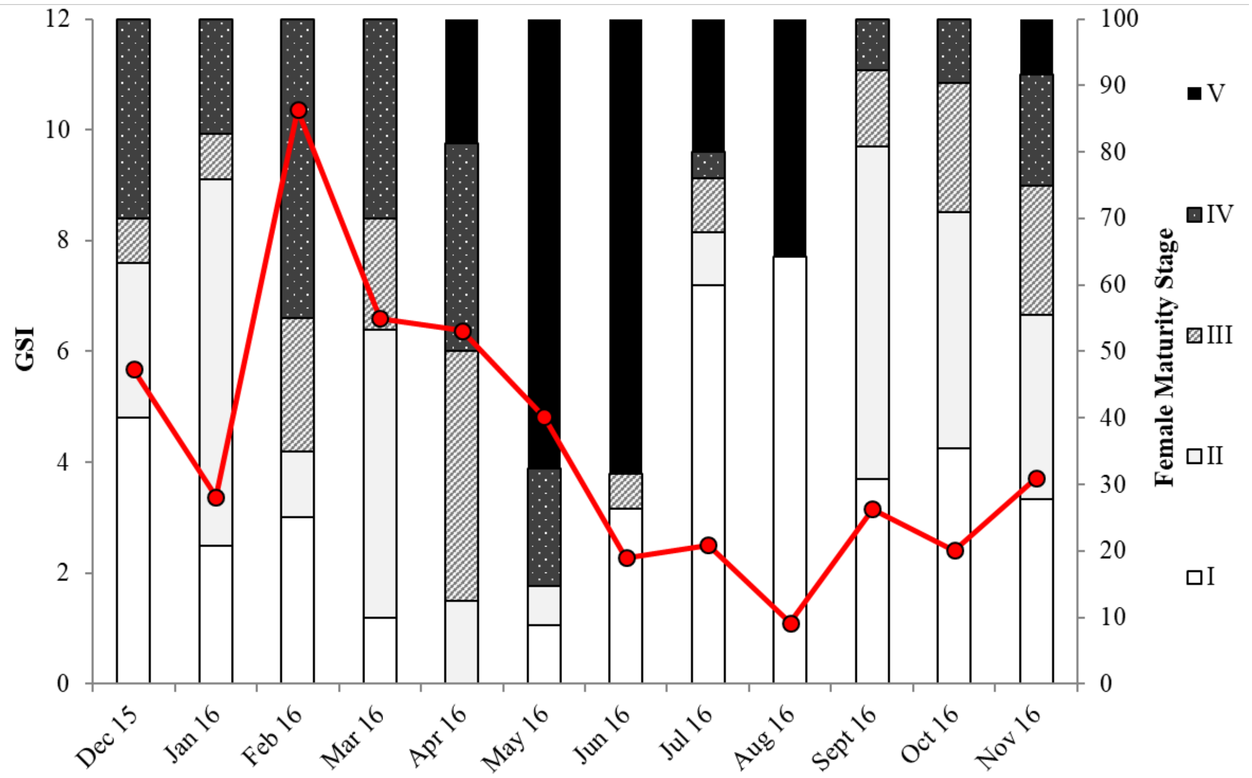

Figure 3. Monthly variations in female maturity stages (bars) and gonadosomatic index (GSI) values (red line).

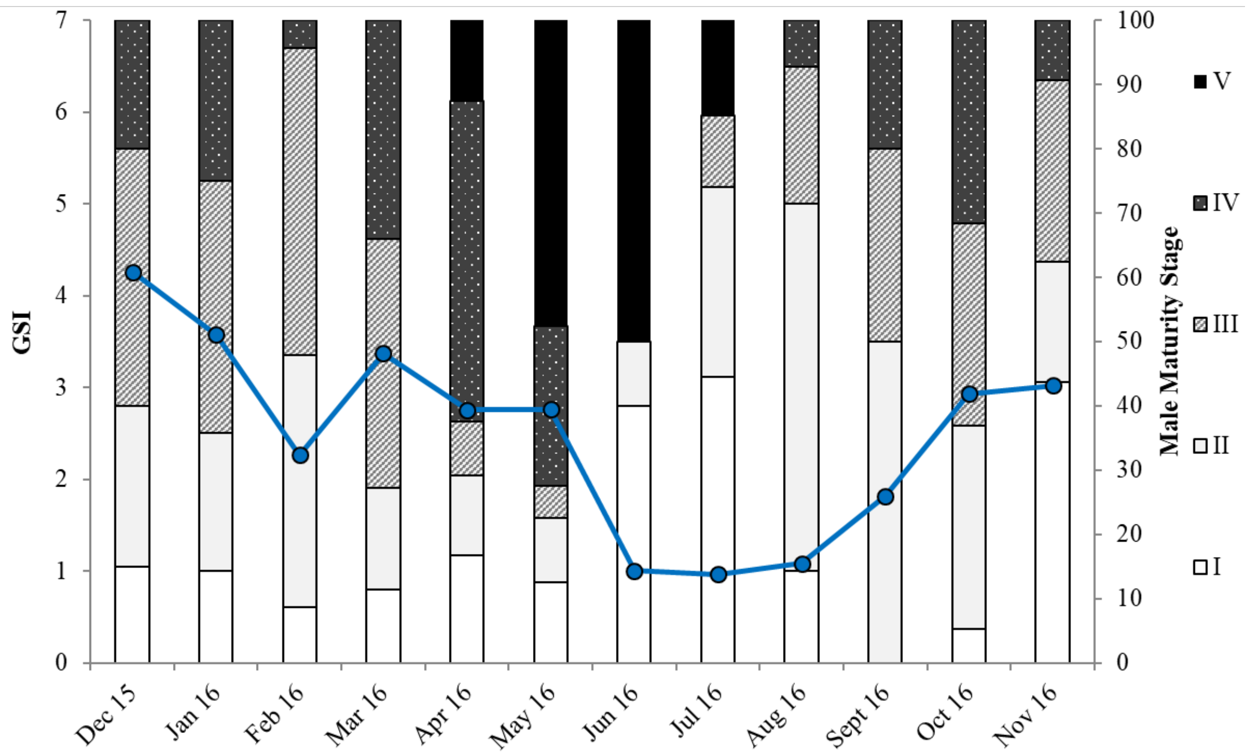

Figure 4. Monthly variations in male maturity stages (bars) and gonadosomatic index (GSI) values (blue line).

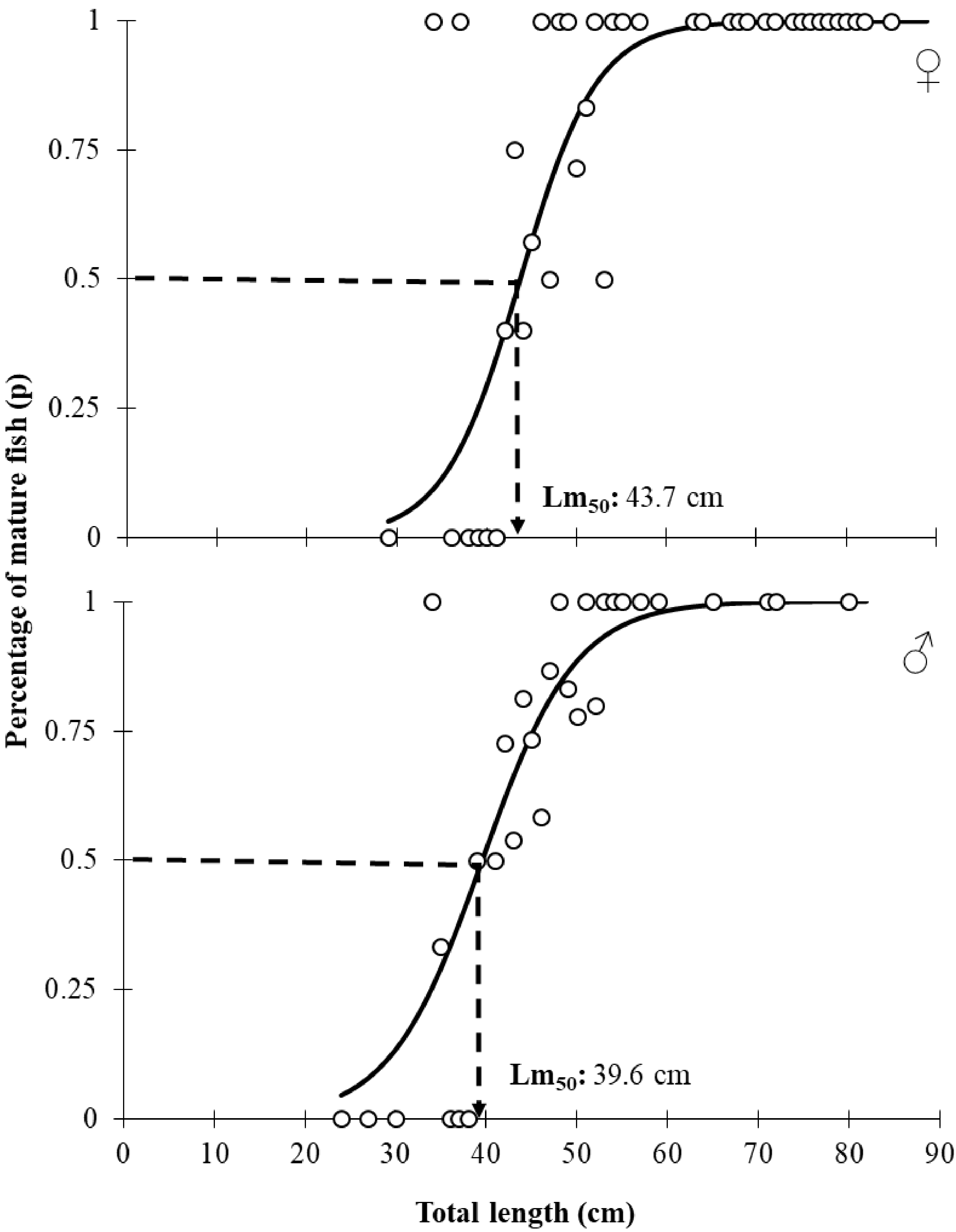

Figure 5. Length at first maturity (Lm_{50}) for females (♀) and males (♂). n= 100 females and 179 males.

4. DISCUSSIONS

The findings regarding the reproductive characteristics of common carp in this study and previous studies conducted in other localities of Turkey were presented in Table 2. In most of these studies, it was reported that females were proportionally dominant, similar to the present study. Although sex ratios are often treated as more or less fixed population characteristics, current theoretical evidence suggests that the sex ratio fluctuates under many conditions and the amplitude of these variations may be significant (Pettersson *et al.*, 2004). Although there is no statistical difference, the proportional predominance of females, which play a key role in the continuity of the population, should be seen as an advantage for the stocks in Marmara Lake. In these studies, it has been reported that the spawning period of *C. carpio* usually start in April-May. In addition, Vilizzi *et al.* (2014) examined 30 studies on the reproduction of common carp across 26 waterbodies in Anatolia (Turkey) and emphasized that the reproductive features of common carp are largely homogeneous across Anatolia, and the spawning of the species begins between March and June, and lasts for 2–7 months. In this study, according to the GSI and gonadal development results, the spawning period of the common carp is seen in February-May as annual spawning. The fish utilize a considerable part of their energy reserves on gonadal development during the spawning season, which is reflected by their inverse relationship of their GSI with their condition factor (Avşar, 2005), also confirming the spawning season. To better understand the exact duration of the spawning season, gonad samples would need to be collected at least weekly for the year and the eggs examined under histological slides to locate postovulatory follicles. The spawning periods determined in this study are not similar to other studies that mostly show the late spring-summer period. It is thought that the difference in this study may be due to the shallowness of the lake and, accordingly, the faster change in water temperature and earlier stimulation for spawning (Bondarev *et al.*, 2019). In addition to depth and temperature, biodiversity (fish species and other species), nutritional status, competition, pollution, precipitation and fisheries activities in Marmara Lake are also factors that can affect the lake's ecosystem and affect reproduction.

The seasonal ban for the province of Manisa, where Marmara Lake is located, was set for 15 March until 15 June in the previous regulation, active from 2016-2020 (Official Gazette, 2016), which was amended to 1 March-1 June in the latest regulation for 2020-2024 (Official Gazette, 2020). The current seasonal closure does protect the spring, but does not capture the February, and is hereby recommended to include February in the next updated regulations forecasted for late 2024.

Lm_{50} for males (39.6 cm) was found to be lower than females (43.7 cm) in this study. Other studies, also support that males can mature at smaller sizes than females (Avşar, 2005; Karataş *et al.,* 2010). The female Lm_{50} value being 3.7 cm above the MLS of 40 cm, shows that the MLS size is inadequate. Lm values are usually set at the minimum length of maturity for females, thus allowing the stock to at least reproduce once before catching them (Yildiz and Ulman, 2020). The Lm_{50} values in this study were higher than the values determined by Özyurt and Avşar (2001) as 28.8 cm for females and 28 cm for males in the Seyhan Dam Lake in south-eastern Turkey. It could be the fish triggered by water temperature changes. Since the Lm_{50} values were determined as fork length in the other two studies (Yerli and Zengin, 1998; Şen, 2001), they could not be compared with our values (Table 2).

Table 2. Sex ratio, spawning season and length at first maturity of *C. carpio* in different locations in Turkey (♂: male, ♀: female, *Fork length)

Author	Sex ratio (♂:♀)	Lm_{50} (cm)	Spawning period	Locality
Düzgüneş (1985)	0.95:1	-	May-Aug	Mogan Lake
Çetinkaya (1992)	0.86:1	-	May-Jul	Akşehir Lake
Bircan (1993)	0.97:1	-	Apr-Jul	Bafra Balık Lakes
Yılmaz (1994)	1.01:1	-	May-Aug	Kapulukaya Reservoir
Bircan and Erdem (1997)	0.85:1	-	Apr-Oct	Altınkaya Reservoir
Yerli and Zengin (1998)	-	♂: 26.2* ♀: 31.4*	-	Çıldır Lake
Karataş (2000)	0.84:1	-	Mar-Apr	Kazova Kaz Lake
Balık and Çubuk (2001)	0.87:1	-	Apr-May	Karacaören I Reservoir
Doğan (2001)	1.76:1	-	May-Jun	Çamlıdere Reservoir
Özyurt and Avşar (2001)	-	♂: 28.0 ♀: 28.8	May-Jul	Seyhan Dam Lake
Şen (2001)	1.68:1	♂: 29.0* ♀: 39.0*	Jun-Jul	Nazik Lake
Yılmaz and Gül (2002)	1.08:1	-	May-Jul	Hirfanlı Reservoir
Kılıç (2003)	-	-	May-Jul	Yeniçağa Lake
Karataş and Sezer (2005)	0.71:1	-	Jun-Aug	Almus Reservoir
Güç (2006)	1.14:1	-	-	Keban Reservoir
Kırankaya (2007)	0.97:1	-	Apr-Jul	Gelingüllü Reservoir
Özcan and Balık (2007)	1.14:1	-	-	Kemer Reservoir
Mert *et al*. (2008)	1.03:1	-	Jun-Jul	Apa Reservoir
Çolakoğlu and Akyurt (2013)	0.86:1	-	May-Jul	Bayramiç Reservoir
Present study	0.88:1	♂: 39.6 ♀: 43.7	Feb-May	Marmara Lake

5. CONCLUSION

In this study, the spawning period of common carp peaked in February and continued until May in Marmara Lake in Western Anatolia. It was determined that the carp began to spawn in this lake earlier than in other parts of Anatolia. Lm_{50} was 43.7 cm and 39.6 cm for females and males, respectively. With this study, findings regarding the reproductive characteristics of carp were given from a lake in the westernmost part of Anatolia.

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AUTHORSHIP CONTRIBUTION STATEMENT

Hakkı DERELİ: Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Writing-Review and Editing, Software, Visualization, Project Administration. **Turhan KEBAPÇIOĞLU:** Methodology, Formal Analysis, Writing-Review and Editing. **Yusuf ŞEN:** Methodology, Formal Analysis, Writing-Review and Editing, Visualization.

CONFLICT OF INTERESTS

The authors declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

The authors declare that this study was conducted in accordance with ethics committee procedures of human or animal experiments.

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