

Accidental Risk Analyses of the Istanbul and Canakkale Straits

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Abstract. Maritime transportation plays an important role in the world. Commercial transport and navy are international maritime activities in different countries. Thanks to the role of straits and channels, these activities can be easier and faster, Turkey has a crucial importance on it because of importance of geographical location. The Turkish Straits are a series of internationally significant waterways connecting Mediterranean Sea and Black Sea. They consist of the Canakkale Strait, the Sea of Marmara, and the Istanbul Strait, all part of the sovereign sea territory of Turkey and subject to the regime of internal waters. They are conventionally considered by the boundary between the continents of Europe and Asia. Because of this geographical importance, all kinds of huge sized vessel activities and high volume cargo transportation always keep going in this waterway. On the other hand, the more maritime activities grow the more accident risks increase. So, can be examined the accident risks on Istanbul and Canakkale Straits and can be assessed risk analysis for them. In the context of the study, one can see general information of the Turkish Straits and the regulatory regime. In addition, tables are applied for vessel movement in the Turkish Straits by years in detail in order to sense variation of the vessel. Risk analyses may also be described in sections with many variables. This paper outlines ship accidents and the risk analysis of ship accidents is applied and resulted for the Turkish Straits. The last chapter concerns the Vessel Traffic Service (VTS) System in the Turkish Straits.

1. Introduction

The Mediterranean Sea and the Black Sea region is one of the busiest waterways in the world, despite covering less than 1% of the world's oceans. This region accounts for around 16% of the global shipping activity by number of port calls, 10% by vessel deadweight tonnes and 8% of the global fleet underway at any given point. Although considered a safe and environmental form of goods transport, the impacts from maritime traffic are recognised as an anthropogenic threat to cetaceans in the Mediterranean Sea and the Black Sea [1].

The Turkish Straits are among the busiest waterways in the world. On average, there are about 43,000 vessels for non-stop passing from the Turkish Straits every year and 65% of them are less than 150 metres in length over all and these vessels generally do not require pilot assistance for strait passage. There is also a very high volume of small ferries, fishing boats and pleasure crafts crossing the Strait of Istanbul. Beside these, navy fleets which are a member of the Black Sea countries and the Turkish Navy constantly use the Turkish Straits.

1.1. Istanbul Strait

The Istanbul Strait is about 18 nautical miles in length and just 700 metres wide at the narrowest point. It contains several significant turns, which can serve to obscure oncoming traffic, and require course



alterations of up to 80 degrees. Currents in the Strait may be a strong and variable in direction. The general surface current flows from the Black Sea to the Mediterranean Sea at speeds which typically average 2 - 4 knots, but can reach 7 knots in the event of strong northerly winds. Strong southerly winds can weaken or even reverse the surface current. The reverse current is commonly known as the "Orkoz". Northbound sub-surface current, caused by the lower density of the Black Sea compared to the density of the Aegean Sea, flows between 2 and 9 metres below the surface at speeds of up to 3 knots. Significant turbulence and eddies occur where the currents mix. This can result in unpredictable navigational conditions and consequent closure of the waterway. The Strait bisects the City of Istanbul (population 15 million). Ferries and other local traffic conduct some 2,400 crossings a day. Ferries and local craft are required to give way to transiting vessels. Fishing takes place within the Straits (although not permitted in the designated traffic lanes) both by day and night [2].

1.2. Canakkale Strait

The Strait of Canakkale is about 38 nautical miles long. The passage is generally straightforward, with the exception of two significant turns, near the City of Canakkale, where the Strait reaches its narrowest width (about 1,300 metres). Navigation is consequently less hazardous than in the Strait of Istanbul, although strong currents (up to 5 knots), numerous eddies and counter currents are experienced throughout the Strait. A limited number of passenger and car ferries run daily between Canakkale on the Asian side and Eceabat and Kilitbahir on the European side. The remainder of the Strait passes through a sparsely populated region, with very little on-shore background lighting at night [2].

1.3. Regulatory Regime

Owing to their strategic importance in international commerce, politics, and warfare, the Turkish Straits have played a significant role in European and world history, and have been governed in accordance with the 1936 Montreux Convention.

The Montreux Convention (1936) established the general principle of freedom of navigation through the Turkish Straits, for all merchant vessels, by day and night. The Turkish authorities have certain powers to control transit vessels, but pilotage and towage are specifically cited as remaining optional. To be considered a "vessel in transit", the vessel must not be bound for a Turkish port, nor have a stopover of more than 48 hours, excluding involuntary waiting time. Following a number of serious incidents in the Turkish Straits, in 1994 Turkey proposed a Traffic Separation Scheme (TSS), which was adopted by International Maritime Organisation (IMO) in 1995. To improve navigational safety, Turkey also introduced, in 1994, regulations for navigation in the Straits. These were updated by a revision in 1998, and 'New Instructions' in 2002 including, among other things, the suspension of all traffic in conditions of poor visibility, the implementation of one-way traffic during the transit of certain types of vessels and the restriction of large vessels carrying hazardous cargo to daylight-only transit. At 12.00 GMT on 31 December 2003, Turkey implemented a Vessel Traffic Service within the Turkish Straits to further improve navigational safety [3].

2. Vessel Movements in the Turkish Straits

According to the data from the last 13 years, vessel movements in the Turkish Strait have to be reduced. On the other hand, total volume of vessels has been increasing year by year. While about 4500 vessels passed through the Turkish Strait in 1936, there is about huge increase of number of vessels and its volume (capacity) also increased (about 43 000 vessel) in Turkish Straits nowadays. Especially, there are about 2300 local traffic (ferry, fishing boat, supply ship, barge, tug, sailing boat, yacht) activities in a day in the İstanbul Strait. Size and volume of the vessels are increasing because of the improvement of the ship construction technology and new petrol transportation route such as the Caspian Sea and Russia. For these reasons, dangerous cargo movements in the Turkish Straits have been increasing every year. We can see vessel movements in the last 13 years in detail in table 1 and table 2 [4].

Table 1. The Statistics Summary of Vessels Passed through Istanbul Strait [4].

YILLAR / Years	Gemi Adedi / Number Of Vessels	Toplam Gros Ton / Total Gross Tonnage	Kılavuz Alan / With Pilot	Sp1 Veren / Sp1 Given	Uğraksız Gemi / Non Call In Vessels	Boyu 200 M'den Büyük / LOA Longer Than 200 M	500 GT'den Küçük / Lower Than 500 GT	Toplam Tankerler / Total Tankers			Yedekli Geçiş / Towaged
								TTA	LPG/LNG	TCH	
2006	54.880	475.796.880	26.589	53.324	31.880	3.653	2.176	7.659	814	1.680	111
2007	56.606	484.867.696	26.685	55.132	31.826	3.653	2.138	7.204	800	2.050	105
2008	54.396	515.639.614	27.001	53.232	31.762	3.911	1.800	6.564	764	1.975	119
2009	51.422	514.656.446	24.977	50.712	32.297	3.871	1.128	6.557	866	1.876	122
2010	50.871	505.615.881	26.035	50.020	28.668	3.623	1.377	6.464	1.099	1.711	115
2011	49.798	523.543.509	26.011	49.179	27.938	3.800	1.046	6.216	1.227	1.660	93
2012	48.329	550.526.579	24.812	47.638	27.345	3.866	1.064	5.913	1.336	1.779	98
2013	46.532	551.771.780	24.023	45.616	26.577	3.801	1.192	5.685	1.741	1.580	87
2014	45.529	582.468.334	24.508	44.928	26.212	4.295	928	5.587	1.540	1.618	90
2015	43.544	565.216.784	23.349	43.039	25.243	3.930	879	5.825	1.232	1.576	71
2016	42.553	565.282.287	22.356	42.132	26.050	3.873	522	6.033	989	1.681	73

Table 2. The Statistics Summary of Vessels Passed Canakkale Strait [4].

YILLAR / Years	Gemi Adedi / Number Of Vessels	Toplam Gros Ton / Total Gross Tonnage	Kılavuz Alan / With Pilot	Sp1 Veren / Sp1 Given	Uğraksız Gemi / Non Call In Vessels	Boyu 200 M'den Büyük / LOA Longer Than 200 M	500 GT'den Küçük / Lower Than 500 GT	Toplam Tankerler / Total Tankers			Yedekli Geçiş / Towaged
								TTA	LPG/LNG	TCH	
2006	48.915	595.826.240	16.871	48.264	32.061	4.845	1.404	7.204	798	1.565	131
2007	49.913	611.885.819	16.885	48.802	31.981	4.945	1.873	6.527	754	1.990	138
2008	48.978	657.396.892	18.334	48.565	31.981	5.223	844	5.990	777	1.991	162
2009	49.453	667.412.661	18.588	49.210	32.559	5.176	615	6.293	842	2.432	146
2010	46.686	672.843.533	18.678	46.469	28.768	5.098	598	6.017	902	2.333	138
2011	45.379	705.412.518	18.920	45.196	27.983	5.494	572	5.661	974	2.183	159
2012	44.613	735.728.537	18.775	44.416	27.418	5.919	519	5.656	1.038	2.304	134
2013	43.889	745.567.671	18.924	43.579	26.534	5.824	448	5.822	1.380	2.097	123
2014	43.582	761.631.756	19.107	43.238	26.257	5.902	512	5.875	1.206	2.169	116
2015	43.230	777.989.382	18.843	42.755	25.220	5.842	581	6.009	1.036	2.479	122
2016	44.035	772.922.682	19.007	43.543	26.071	5.665	661	6.041	881	2.559	139

3. Risky Zones in the Turkish Straits

A complex and versatile traffic flow is seen in the Marmara Sea. Marine traffic within the Marmara Sea is summarized as follows:

The vessels entering the Turkish Straits from the Aegean Sea or the Black Sea and passing through without interruption. These vessels proceed without stopping at the Sea of Marmara. The ships coming from Çanakkale mostly wait for drift in the anchorage or the south of the islands in the Ahırkapı port for the entrance of the Istanbul Strait.

Vessels coming from the Aegean Sea or Black Sea to the Turkish Straits and in the Ahırkapı port area in Istanbul, must provide personnel exchange, technical services stay in the port within 48 hours or less in order to not slowdown their passage.

There is a traffic in the Marmara Sea generally in the direction of the Traffic Separation Scheme. In addition to this situation, the traffic in the entrance and exit of the Istanbul Strait anchorage area is chaotic due to the heavy vessel traffic. There are also passenger ships and ferryboat lines running perpendicular to the traffic line in the Marmara Sea.

One of the most critical and intense regions of the Marmara Sea is the Ahırkapı anchorage area, the southern entrance of the Istanbul Strait. In parallel with increasing ship traffic in this area in recent years, sea hazards have also increased. Local traffic, which combines both sides of the strait, which is the scene of an average of 120 non-stop ships per day, is also increasing compared to the growing population.

There are lots of narrow zones and sharp turning points in the Turkish Straits. Beside these, pilot embarkation and disembarkation points are risky zones because of the restricted vessel maneuvers [5].

4. Vessel Accidents and Analyses

Turkish Straits are such dangerous waterways because of the tanker and dangerous cargo traffic. So, risk of accident and pollution is quite high and intolerable. When was analysed the vessel accidents that took place between January 2004 and April 2017, 70% of the accidents occurred in Ahırkapı region because of vessel dredging, bad weather, and heavy anchorage.

Statistics show that the accidents in the Turkish Straits are mainly due to the following causes [6]:

- sailing without pilot,
- heavy weather situation,
- heavy vessel traffic,
- technical deficiency, defects of vessels,
- current regime with complex and day-to-day variability,
- sharp turnaround areas,
- breach of Traffic Separation Scheme.

As the Turkish Straits, one of the world's most dangerous waterways, are exposed to intensive tanker traffic, the risk of accidents and pollution in the Straits is high. When the dangerous cargo carried by the vessels is added, the environmental dimension of the marine accidents becomes important agenda. In a large-scale, heavy accident in the marine straits can caused natural disaster and can influence millions of people for very long period, also historical and cultural heritages can be damaged [7]. Especially, if the oil pollution to be formed in Istanbul Bosphorus cannot be intervened, the possibility of intervention will be difficult because of the expansion of the area, when it is opened in the Sea of Marmara.

More than 70 people died in the Independenta and Nassia events, and the Independenta tanker accident has been passed down as one of the world's largest tanker accidents. One of the recent accidents was the Volganef 248 tanker accident. Russian flagged tanker named Volganef 248 was split into two and leaked about 1500 tons of fuel-oil because of the severe lodes in the accident [8].

There are lots of wrecks in Turkish Strait and can be seen figure 1 and list for dangerous wrecks as below.



Figure 1. Dangerous Wrecks in Istanbul Strait [9]

Dangerous Wrecks in Marmara Sea: Jack-Up Platformu (1990), Nüvo (1993), Volgodon-5064 (1996), Şirincan (1998), Ashraf-R (1998), Harem (1999), Mare (2004), PL-1 318 (1986), Volganefit-248 (1999), Nazım Bayraktar (2001), Robel (2001), Lujin (2004), Noor Alamar (2002) [9].

Accident statistics which occurred after Traffic Separation Scheme (TSS) and Vessel Traffic Service (VTS) are given in table 3 and table 4 interval from 1st January 2004 to 1st April 2017 [10].

According to these accident data, there were totally 347 ship accidents during the last 13 years. The majority of accidents happen due to navigation errors. Only 44 of these accidents occurred in the vessels with pilot. All other accidents due to navigation errors happened in vessels without pilots.

Briefly, a total of 78 people lost their lives in ship accidents because of collision, fire, grounding, engine failure, steering failure, oil leakage, drifting, manoeuvre board and navigational mistakes in the last 13 years in the Turkish Straits.

5. Turkish Straits Vessel Traffic Service (TS VTS)

The Turkish Straits VTS was established in accordance with applicable national laws and international rules and regulations in order to improve the safety of navigation, protection of life, environment, and property in the Turkish Straits by using the latest technology [11].

Marine Traffic in the VTS delineated area is monitored by using Radar, ENC, AIS, CCTV and VHF equipment such as VHF R/T, DSC and DF. VTS also receives information from various sources on anticipated vessel movements, hazards to navigation, aids to navigation and any other information of interests to VTS participants [12].

The Turkish Straits are among the busiest waterways in the world. On average 55,000 vessels transit the Straits every year and 80% of these are less than 150 metres in length. There is also a very high volume of small ferries, fishing boats and pleasure craft crossing the Strait of Istanbul.

Table 3. Accident Statistic on Istanbul Strait and Marmara Sea [10]

Place of Accident	Direction	Clush	Collision	Grounding	Fire	Sinking	TOTAL
Exit of Haydarpaşa Port	Inland Water of Strait	4	3	3	2		12
Saray Point	Inland Water of Strait	4	2		1		7
Ahırkapı Anchorage	South	130	10	9	3	1	153
Balıkçı Island	South			3			3
South Entrance of Strait	South	2	4				6
Büyük Island	South			1			1
Dilek Reef	South			6			6
Eşek Island	South			1			1
Fenerbahçe	South		1				1
Kadıköy	South		3		1		4
Kartal Anchorage	South	9	1	4		1	15
Marmara Sea	South		2				2
Zeyport	South	2	1		2		5
Zincirbozan	Inland Water of Strait			3			3
North of Istanbul Strait	North		6			1	7
Doğanarslan Anchorage	North	3		6	1		10
Marmara Island	North		2				2
Yeniköy Anchorage	North			2			2
TOTAL		154	35	38	10	3	240

Table 4. Accident Statistic on Çanakkale Strait [10]

Place of Accident	Direction	Clash	Collision	Grounding	Fire	Sinking	TOTAL
Gelibolu	Inland Water of Strait	3	9	14	3	1	30
Nara	Inland Water of Strait		4	18			22
İntepe	Inland Water of Strait			1			1
Anıtlıman	Inland Water of Strait	1					1
Poyraz Bay	Inland Water of Strait			1			1
Çardak	Inland Water of Strait			1			1
Kepez	Inland Water of Strait			3			3
Kilitbahir	Inland Water of Strait			1			1
Akbaş	Inland Water of Strait			1			1
Kumkale	South	1	3	20	6		30
Bozcaada	South		4	5			9
Gökçeada	South			1			1
Tavşan Island	South			3			3
Akçansa	South			1			1
İçdaş	North	1					1
Karabiga	North		1				1
TOTAL		6	21	70	9	1	107

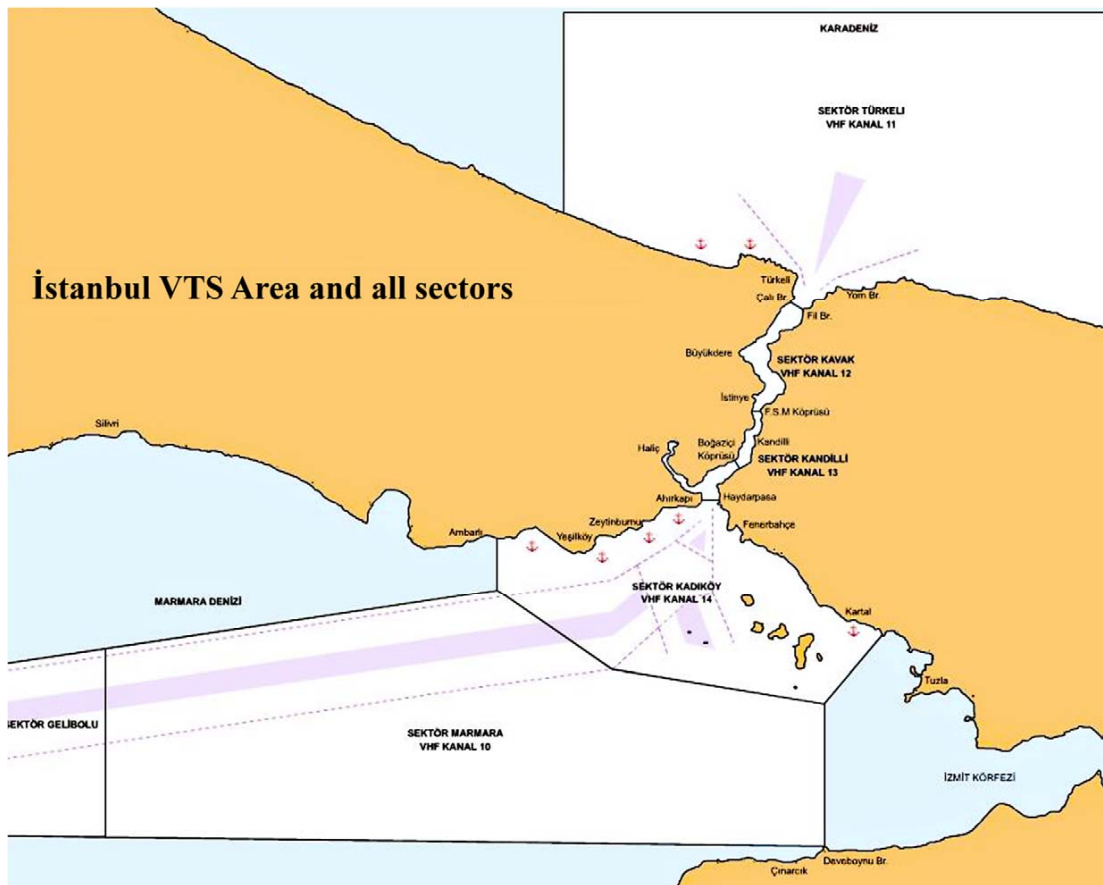


Figure 2. İstanbul VTS Area and all sectors [12].

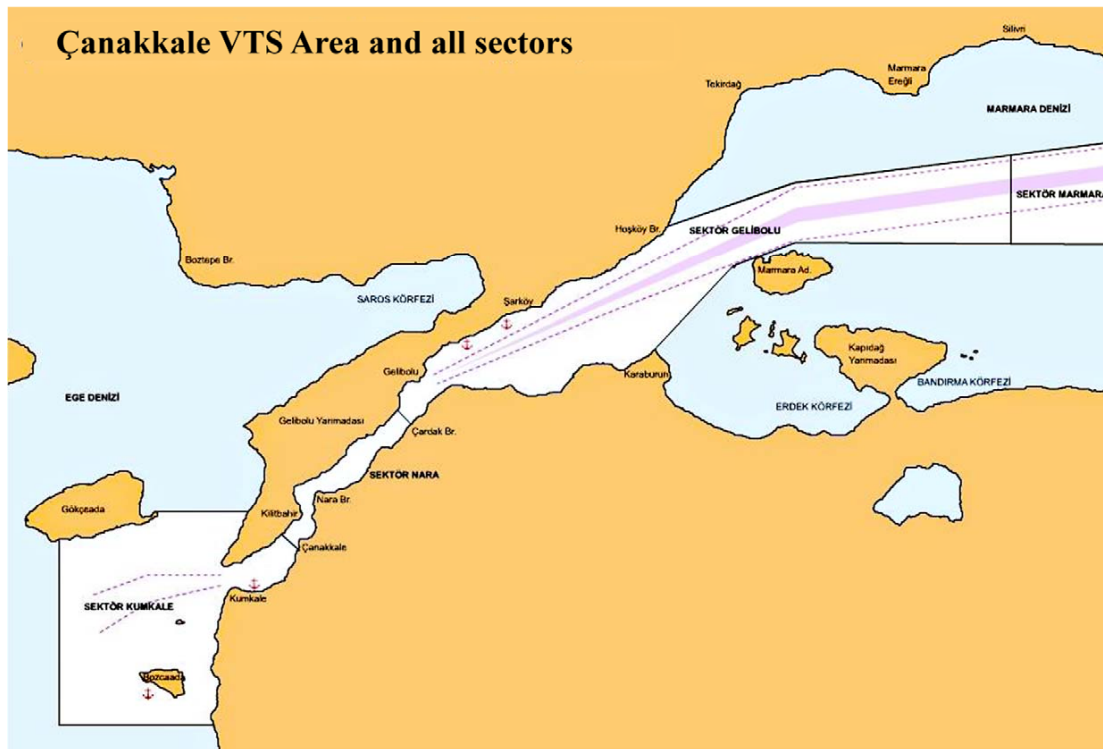


Figure 3. Çanakkale VTS Area and all sectors [12].

Turkish Straits VTS is divided into two centres: Istanbul VTS and Canakkale VTS.

Istanbul VTS area has 4 sectors: Sector Türkeli (VHF Ch 11), Sector Kandilli (VHF Ch 12), Sector Kadıköy (VHF Ch 13), Sector Marmara (VHF Ch 14).

Canakkale VTS area is divided into 3 sectors: Sector Gelibolu (VHF Ch 11), Sector Nara (VHF Ch 12), Sector Kumkale (VHF Ch 13) [13].

6. Conclusions

In this study, the definition of the Turkish Straits is done from the point of view of its legal status and international agreements. The Turkish Straits are the only waterway in the world surrounded by a state all around the world and a critical water with an intense ship movement.

As a result of this study, it can be seen that ship traffic in the Marmara Sea is mostly proceeded in traffic separation scheme. Apart from this, there are passenger ships and ferryboats, which operate vertically to the traffic separation. The riskiest area is Sector Kadıköy, which includes the Ahırkapı and Kartal anchorage areas and separation, the southern entrance of the Istanbul Strait and the Haydarpaşa Port. Safety distance and overtaking positions of vessels should be well monitored in the traffic separation scheme, short tracking distance and close overtaking positions should be avoided. It has been determined that one of the main reason of the accidents is, that the safe follow-up distance is not kept.

Especially, as the reported sea accidents in the Marmara Sea and Istanbul Strait were examined, 153 of the 240 sea accidents in the last 13 years took place in the Ahırkapı anchorage area. Of these, 139 accidents were clashes, collision and grounding. This situation showed that there is a heavy vessel traffic at the Turkish Straits with anchorage areas. Anchorage areas must be extended or new anchorage areas must be created. Besides, times of supply operations to non-stop passing vessels must be reduced. Pilotage must be compulsory for all dangerous cargo vessels and all vessels over 150m. All vessels including local traffic must stand by all the time in related sector of channel and must immediately answer sector calling.

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