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ORIGINAL PAPER

Rip current fatalities on the Black Sea beaches of Istanbul and effects of cultural aspects in shaping the incidents

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Abstract This study examined fatalities due to rip currents in the gendarmerie region of the Black Sea coasts of Istanbul during the period of 2007–2012. Effects of social and religious aspects to the nature and extend of incidents are emphasized. Analyses include the incidence rate of fatalities from rip currents, their causes, temporal and spatial distributions. Gendarmerie hazard event records show that 68 % of all drowning fatalities are associated with rip currents and that on average 33 people die from rip currents each year on the Black Sea beaches of Istanbul. Fifty-four percentage of fatalities are between 18 and 35 years of age. Difference in gender vulnerability is quite pronounced; males are nearly seven times more likely to fall victim to a deadly rip current than females. Weekends naturally have more fatalities than any other day of the week. As expected, summer season weekends are observed to have more fatalities than any other time of the year. July is the most hazardous month and is followed by August. The Muslim fasting month of Ramadan has a significant effect on reducing the fatalities with only six reported deaths during the period of 2007–2012.

Keywords Istanbul Black Sea coasts · Rip currents · Drowning deaths · Cultural aspects

1 Introduction

An overall lack of knowledge of the rip current hazards and associated fatalities in regions outside of Australia and USA has been the primary motivation and justification behind the present study. More importantly, cultural aspects that are associated with a predominantly Muslim society have never been documented before in relation to rip drowning incidents.

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The present study also endeavors to disclose some of these questions, which are normally not raised in the western societies.

The existing literature on rip currents that is basically originating from Australia and USA is rather rich in contents. From the technical point of view, considerable efforts on understanding rip currents have been attempted through field and laboratory measurements and numerical modeling as described in Dalrymple et al. (2011).

Considering the incident rates, Lushine (1991) reports on the average 150 annual deaths due to rip currents in the USA though his figures are criticized by Gensini and Ashley (2010) who give 35 annual deaths for the period of 1994–2007. On the other hand, in Australia Sherker et al. (2010) cite an average of 82 annual drownings, many of these attributable to rip currents, while Brighton et al. (2013) indicate 21 annual deaths on the average. Again for beaches in Australia, Ballantyne et al. (2005) study the behavior of international and domestic students and their knowledge of beach safety practices while drowning risk factors at surf beaches are analyzed by Morgan et al. (2009).

With respect to the dangers of and prevention methods from rip currents, Hatfield et al. (2012) report on a campaign to improve beachgoer recognition of calm-looking rip currents, known to contribute to surf drownings. Drozdzewski et al. (2012) survey people who have been caught in a rip current and survived. Williamson et al. (2012) compare attitudes and knowledge of beachgoers from rural inland residents and international tourists in Australia concerning beach safety. An important outcome of this study is that the odds of international tourists making a safe swimming choice in the vicinity of a rip current are three times lower than usual beachgoers and rural inland residents. Caldwell et al. (2013) studied the ability of beach users' knowledge of rip currents at Pensacola Beach, Florida, and found that most beach users, and particularly local participants, are overconfident in their ability to identify rip channels and currents. In the same vein, Brannstrom et al. (2014) surveyed the ability of beach users on three heavily used public beaches in Texas to identify a rip current. Only 13 % of respondents correctly selected the photograph showing the most hazardous conditions and correctly identified the precise location of the rip current. In a similar vein, Drozdzewski et al. (2015) reported the experiences of weak and non-swimmers caught in rip currents at Australian beaches.

Regarding the escape techniques from rip currents, the most commonly promoted view advices victim to swim parallel to the beach wherever the rip current weakens in strength. Likewise, Miloshis and Stephenson (2011) suggest rip current escape strategies as "do nothing" and "swim parallel to the beach." In particular, they indicate that, of the two methods, "do nothing" or "allow the rip current to take a swimmer" is the most effective strategy. However, recent studies have shown dominant rip current re-circulation within the surf zone and have endorsed "floating" as an appropriate escape strategy (McCarroll et al. 2014).

Considering the relatively few studies outside the USA and Australia, Chandramohan et al. (1997) identify rip current zones on the Goa beaches in India, while Sabet and Barani (2011) do the same for the southern coast of Caspian Sea. Arozarena et al. (2015) present an analysis of data from the Judicial Investigation Organization of Costa Rica, which indicates 1391 drownings between 2001 and 2012; approximately 590 of those drownings being due to rip currents.

While rip currents are more common for beaches facing oceans, the southern shores of the Black Sea stand as exception. Rip currents along the southern shores of the Black Sea are considerably frequent and rather dangerous owing to exceptionally high waves at times of northerly winds. Several studies on incident rates, prevention techniques, and

mechanisms of rip currents on the Black Sea beaches of Istanbul are reported by Beji and Barlas (2007, 2013), Barlas et al. (2012), and Barlas and Beji (2013).

In the present work, for 290 drowning cases on the Black Sea beaches of Istanbul between 2007 and 2012, the incidence rates, rate of fatalities from rip currents, their causes, spatial distributions, and their relation, if any, to atmospheric events are analyzed. Effects of cultural aspects in shaping the statistics are also considered and examined. In this respect, the study presents a novelty hitherto unconsidered in the literature, thus opening up a new dimension in the problem. In closing, precautions appropriate to the cultural background of the people are suggested to reduce downing incidents and related fatalities.

2 Rip currents on beaches of Black Sea

A rip current is a powerful and separate seaward current that can flow over 2 m/s running usually perpendicular to the beach, out into the sea. The rip currents may extend 50–300 m lengthwise and 6–30 m wide. The nearshore bathymetry is probably the most important factor in the formation of rip currents. A bar-trough-bar-type bottom configuration is almost a trademark of a rip current. In general, the speeds of rip currents are between 0.3 and 1.5 m/s (Dalrymple et al. 2011). Compared to 800 m freestyle world record in swimming, which is nearly 1.8 m/s, the speed of the rip currents is quite high. When a swimmer is caught in a rip, he/she is pulled offshore. If the swimmer is inexperienced, he/she attempts to swim back to shore against the rip current and consequently becomes tired of struggling, suffers exhaustion, fears, and eventually panics. In the end, as a result of wasted efforts the swimmer drowns.

Rip currents are rather common features of ocean-facing beaches but rather unusual for relatively small enclosed bodies of water. In this respect, the Black Sea is remarkably

Fig. 1 A photograph of beachside in the vicinity of Karaburun taken during a field survey

different in that rip currents are encountered frequently along the southern shores of it. Reasons for rip current occurrences are related to favorable aspects of the beaches of the Black Sea, as the existence of rip currents depends on the beach bathymetry, wind direction and speed, wave height and wave period, the form of the beach, physical structures at the beach, and the sand characteristics. Especially with cusp-like shore forms as shown in Fig. 1, many beaches on the southern coasts of the Black Sea have rather fine sand, bar-trough-bar-type underwater formations, and are open to high northerly winds with severe waves as high as 5.0 meters or even higher. Coexistence of all these factors make the beaches of the Black Sea quite predisposed to rip currents, and the overall results is that year after year lives are lost at the beaches due to rip currents.

3 Methodology

The Istanbul Gendarmerie Command's hazard event records are examined to classify rip current fatalities on the Black Sea beaches of Istanbul during the period of 2007–2012. Figure 2 shows the study location and its place within the greater Black Sea region.

The data contain the drownings recorded only in the gendarmerie region of Istanbul. The gendarmerie regions are rural areas, generally outside of towns with sparse inhabitants. Reaching these areas from the densely populated regions takes on average around 1 h. The beaches are free of charge, without parking fees; on some beaches, there are no life guards on duty. Drowning reports are made only for deaths and serious non-fatal drownings. A typical report contains the following information:

1. County, town, and beach of the drowning,
2. Date of the drowning,
3. Demographic information (e.g., age and gender),

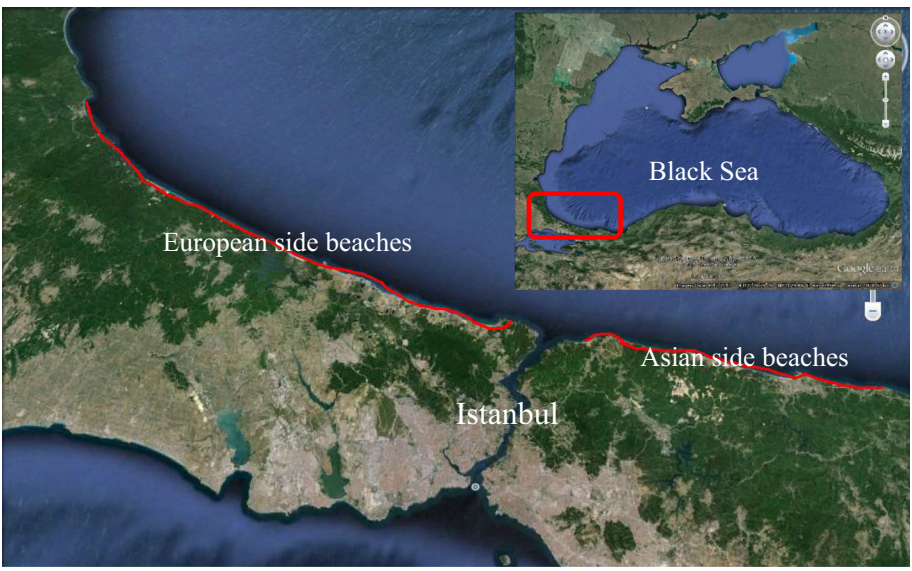

Fig. 2 Beaches considered in this study (*red lines*) and their location within the Black Sea

4. Additional details and comments (e.g., what the victim(s) was/were doing, general sea report during the day, probable cause of the incident, and hospital details if the victim(s) was/were just injured).

Another relevant set of data was obtained from Turkish State Meteorological Service. This database includes atmospheric events, such as wind directions, and magnitudes. The fatality reports and meteorological data are considered together to get an insight into fatalities by first ascertaining whether the incidents were related to the rip currents or not and then checking whether a correlation can be established between the incidents and the atmospheric events. Incident locations were mapped to depict the spatial distribution of fatal rip currents. On the day that a rip current fatality occurred, the atmospheric condition in relation to the beach was also indicated.

4 Results and discussion

Istanbul is the largest city in Turkey with a population over 15 million and has nine known beaches, four in the European and five in the Asian gendarmerie region of the Black Sea coasts as sketched in Fig. 2. The total length of the gendarmerie region beach coastline is approximately 153 km (92 km in European side and 61 km in Asian side); the coastline length of popular beaches is approximately 57 km (30 km in European side and 27 km in Asian side).

Examination of the Istanbul Gendarmerie Command's hazard event data gives a total number of 290 incidents during the period of 2007–2012; among all the reported drownings (both fatal and hospitalized non-fatal), the fatalities associated with rip currents are 195 (68 %). Based on international statistics, Brighton et al. (2013) give a range of 49–58 % for rip-related events and indicate that the traditionally cited 80–89 % is too high an estimate. On the other hand, Brewster (2010) attributes nearly 80 % of drownings in California to rip currents. While the figure of 68 % for the Black Sea beaches is above the international range, it cannot be attributed solely to uncertainty involved in the identification of the exact cause of drownings. The logs kept according to the reports of the well-trained rescuers and/or underwater search and rescue teams of the gendarmerie are quite detailed, and the examination of these records shows that every care is taken to ascertain the exact nature of the drownings. The teams usually arrive within less than an hour of drowning, question the eyewitnesses and frequently observe the rip current itself if it still exists. Therefore, considering all these points, approximately 68 % rate of rip-related

Table 1 Reported rip-related drowning fatalities during the period of 2007–2012

Year	Drowning fatalities	Rip current fatalities	Rip current fatalities (%)
2007	51	36	71
2008	34	27	79
2009	54	44	82
2010	47	30	64
2011	51	27	53
2012	53	31	59
Total	290	195	Avg. 68

events found in this study is considered an accurate enough figure. Thus, in an average year approximately 33 people drown due to rip-related drowning incidents on the Black Sea beaches of Istanbul (Table 1). Considering the range between minimum rate 53 % and maximum rate 82 %, the lowest and highest number of rip drownings would, respectively, be 27 and 44 people, depending on wind and wave conditions occurring on that particular summer.

A breakdown of fatalities, where deaths by beaches and the percentage of fatalities per kilometer, is given in Table 2. Fatality percentage per kilometer is presented as an indicator of the "danger level" of a particular beach. Since the number of swimmers would be approximately proportional to the beach length, the mere number of deaths or their percentage for a definite beach would not correctly reflect its danger level. Therefore, it is considered more meaningful to give the fatality percentage per kilometer of beach. Accordingly, Riva and Karaburun, respectively, are the most dangerous beaches in terms of rip current fatalities. These two beaches account for 6.9 and 5.1 % of total deaths per km. Figure 1 gives a snapshot of the Karaburun beach area.

Many of these fatalities occur on weekends, especially on Sundays when daily beach-going tourist population is highest (Fig. 3). Relatively large difference in fatalities between Saturday and Sunday is due to the fact that in Turkey most people in private sector work half a day on Saturdays; therefore, more people go beaches on Sundays than Saturdays. Weekends with 56 % of fatalities have more fatalities than weekdays combined.

The fatality reports also reveal a difference in gender vulnerability. Males are over seven times more likely to drown in rip currents than females (Table 3). While this trend is also reported in international statistics (Brighton et al. 2013), the difference is accentuated in Turkey due to the fact that socially men go to beaches more frequently, while women prefer to stay at home or if they go they refrain from swimming because of cultural attitudes, i.e., not wanting to show her body. In addition, many men are reported to drown while trying to save their family members or friends from the rip currents. Socially, another persistent problem is the over-confident attitude of young adults to warnings. These young people refuse to heed any safety advice and even some cases go so far as to harass lifeguards or gendarmeries who warn them on the beach.

Table 2 Total number of reported rip current fatalities by beach during the period of 2007–2012

Beach	Rip drownings	Percentage (%)	Beach length (km)	Percentage of rip drownings per km[a]
Binkilic-Cilingoz	9	4.6	2	2.3
Karaburun	30	15.4	3	5.1
Agacli	10	5.1	2.5	2.0
Kilyos	9	4.6	4.5	1.0
Riva	20	10.3	1.5	6.9
Sahilkoy	7	3.6	2.2	1.6
Alacali	8	4.1	2	2.0
Sofular	10	5.1	2	2.6
Agva	9	4.6	3	1.5
Other beaches	83	42.6		

[a] Percentage of rip drownings per km was calculated by dividing each percentage by beach length in km

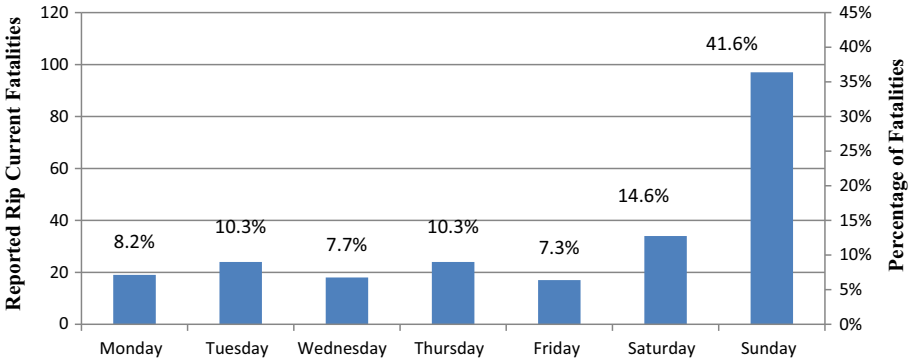

Fig. 3 Reported rip current fatalities by day of the week

Table 3 Reported rip current cases and fatalities by gender during the period of 2007–2012

Gender	Rip current fatalities	Rip current cases	Fatalities of total cases (%)	Cases (%)
Male	169	178	77.2	81.3
Female	26	41	11.9	18.7
Total	195	219	89.0	100

Children aged younger than 18 account for 22 % of all rip current fatalities. Fifty-four percentage of fatalities are between 18 and 35 years of age. This group are risk takers and overrepresented in drowning statistics (Figure 4). Lifeguards indicate that most beach-going tourists, those other than local inhabitants, lack knowledge and experience about rip currents and that most are not good swimmers.

When fatalities are considered by month, July stands out as most dangerous (Fig. 5). Half of the total fatalities occur in July, followed by 28 % in August. Normally, being a

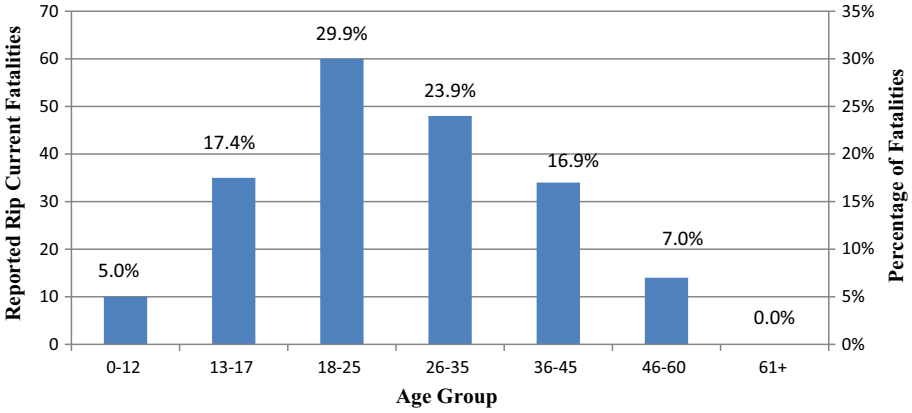

Fig. 4 Reported rip current fatalities by age

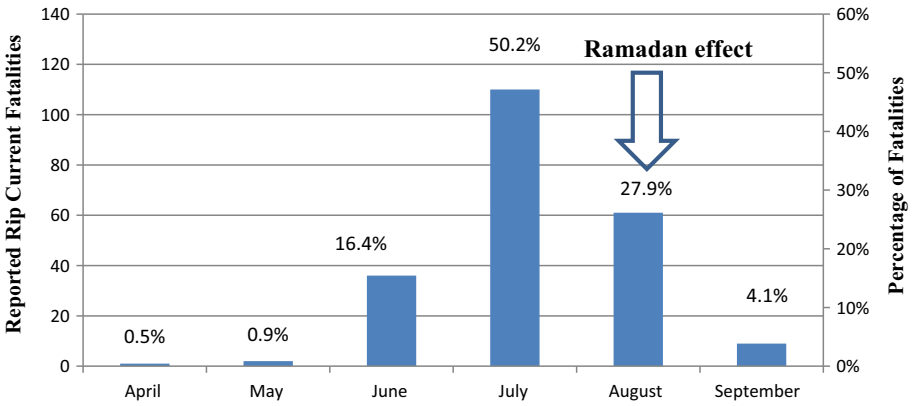

Fig. 5 Reported rip current fatalities by months

summer vacation time August would be expected to be as dangerous as July, but for the effect of Ramadan. Ramadan, the religious fasting month for Muslims, is very prominent during the period of the data set examined. The beginning and ending of Ramadan are determined by the lunar Islamic calendar. Since the lunar Islamic calendar year is 10–12 days shorter than the solar year, Ramadan migrates throughout the seasons, and each year Ramadan begins about 10–12 days earlier than the previous year. The month of Ramadan is spent by Muslims for fasting during the daylight hours from dawn to sunset. Fasting practices are primarily an act of willing abstinence from all food, drink, sexual intercourse, and some other activities. Thus, among other refrainments, people do not go to beaches, or if they go, they do not swim to avoid unintentional water intake. The month of Ramadan therefore has a very significant effect on reducing drowning fatalities. For example, fatalities during August were considerably lower than July because the month of Ramadan befalls in the month of August from 2009 to 2012.

Although the absence of lifeguards in some beaches is a problem, a more dangerous practice is that some families or groups especially prefer desolate beach parts for quite different reasons: Women in conservative families would like to avoid being observed by other men, while mostly young men or couples would prefer to consume alcohol unobserved. In such remote beach areas without lifeguards, when one is in danger, the others from the family or friends try to help him/her, resulting usually in more fatalities (Table 4). For example, on July 7, 2012, four sisters aged 10, 14, 16, and 17 drowned together. According to the drowning report, the two youngest siblings were in danger and the elder ones attempted to rescue them, but they were all caught by the rip current and all four drowned. On July 24, 2010, two friends aged 30 and 32 drowned together. According to the

Table 4 Reported rip current cases and fatalities relating to the same family or groups during the period of 2008–2012

Year	Rip current cases	Fatality
2008	2	4
2009	4	8
2010	2	4
2011	3	6
2012	7	16

drowning report, at first, one of the friends was in danger and the other one was trying to rescue him, but both were caught by the rip current, and both drowned. There were 18 families or groups involved in the rip current fatality reports, and out of these 38 people died.

The presence of rip currents along this coastline is related to the presence of onshore wind and associated wind-driven wave breaking activity. While several studies have related wind speed to the presence and hazard level of rip currents (see for instance Brewster 2010), here we simply related wind speed to the occurrence of drowning fatalities in rip currents. Wind data obtained from two different meteorological stations located in close proximity of the beaches, Kumkoy in European side and Sile in Asian side, are used here. Thus, considering the wind speeds versus rip current fatalities, about one-third of the fatalities occur when the wind speed is between 1.5 and 2.0 m/s as given in Table 5. When the wind speed is below 1 m/s, there are no rip current fatalities, simply because there are no rip currents. When the wind speed is greater than 4 m/s, the people do not go to the beaches because of very severe weather conditions. However, for the wind speeds 1.0–1.5 m/s the rip current magnitude is not too intense and that the weather and sea conditions probably look attractive for bathing. But for poor swimmers, this is the most dangerous case. Nearly 60 % of the fatalities in this wind speed interval are found to be children.

5 Concluding remarks

Rip current-related drowning deaths on the Black Sea beaches of Istanbul are examined using the data available from the logs kept by the gendarmerie who are responsible for the security of the beaches considered. The rip-related deaths are estimated to be 67.8 % of the total drownings. This percentage is higher than the international average range of 49–58 % reported by Brighton et al. (2013).

On the average, 33 people are drowned each year in rip currents on the Black Sea beaches of Istanbul. Such high drowning rate calls for a questioning of the role of educational aspects and cultural attitudes in this problem. Besides the usual precautions such as warning signs concerning the dangers of rip currents and the relevant rescue techniques of remaining afloat and avoiding to swim against the current, other educational recommendations related to social and cultural aspects are needed. Pamphlets explaining the rip currents and their dangers, one-page brochures advising on correct attitude, children educational programs, preachers in mosques addressing the problem and recommending obedience to authorities, magazine, and TV spots may be considered as educational activities.

The absence of lifeguards on some beaches contributes to fatalities. However, an equally important problem stems from the social attitudes of beachgoers. For different reasons, some young couples and families prefer isolated parts of beaches where no guards are on duty. In such circumstances, when one is in danger, in the absence of lifeguards, family or friends try to help the victim, often resulting in more fatalities.

The success of educational or informational activities in this region therefore requires much effort, especially when young adults are considered. Children are relatively easier to reach, and they are more willing to listen to the warnings and obey the instructions. Therefore, it is expected that the brochures and billboards prepared in this context as a part of a project led by Istanbul Gendarmerie Command and Istanbul Technical University will

Table 5 Reported rip current fatalities by wind speed (m/s) between 2008 and 2012

Wind speed (m/s)	Rip current fatalities	Percentage (%)
<1.0	0	0.0
1.0–1.5	22	17.2
1.5–2.0	41	32.0
2.0–2.5	21	16.4
2.5–3.0	21	16.4
3.0–3.5	20	15.6
3.5–4.0	3	2.3
4+	0	0.0

be effective over the medium term by first educating children and youngsters. Also, a Web site (www.cekenakinti.org)[1] prepared within the framework of the same project aims at providing information and warnings for all age groups. Furthermore, movie clips are made and distributed to Istanbul regional schools besides the warning brochures and signs placed at the beaches classified as dangerous.

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[1] Cekenakinti means "rip current" in Turkish.

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